Advisory Committee on
Fishery Management

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REPORT OF THE

NORTHERN PELAGIC AND BLUE WHITING FISHERIES WORKING GROUP

ICES Headquarters
27 April–5 May 1999

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

Palægade 2–4 DK–1261 Copenhagen K Denmark

Table of Contents

Table of Contents

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 27 April to 5 May 1999 to:

a) assess the status of and provide catch options for 2000 for the Norwegian spring-spawning herring stock;

b) provide any new information on the present spatial and temporal distribution of Norwegian spring-spawning herring;

c) assess the status of and provide catch options for the 1999–2000 season for the Icelandic summer-spawning herring stocks;

d) assess the status of capelin in Sub-areas V and XIV and provide catch options for the summer/autumn 1999 and winter 2000 seasons;

e) assess the status of and provide catch options for capelin in Sub-areas I and II (excluding Division IIa west of 5°W) in 2000;

f) assess the status of and provide catch options for 2000 and 2001 for the blue whiting stock;

g) update the information on the spatial and temporal distribution of the stock and fisheries on blue whiting;

h) review progress in determining precautionary reference points;

i) describe the timing of pelagic fisheries in ICES areas I; IIa,b; IVa,b; Va; Vb1,2; VIa,b; VIIa,b, the gear used in those fisheries and catch per ICES statistical rectangle per month in the relevant areas; for blue whiting the following Divisions IIIa, VIIc, VIIg-k, VIII and IX should also be considered.

j) propose, in consultation with NWWG, a Scientific Steering Group for the planned Symposium on "Capelin - What Are They Good For? Biology, Management and the Ecological Role of Capelin".

The above Terms of Reference are set up to provide ACFM with the information required to respond to requests for advice/information from NEAFC and EC DGXIV.

k) The coastal states of the Norwegian spring spawning herring (European Union, Faroes, Iceland, Norway and Russia) have requested ICES to provide catch options for the Norwegian Spring-spawning herring stock for the year 2000 based on fishing mortality in the range F=0.100, F=0.125, F=0.150 and F=0.175. Keeping these exploitation rates constant and introducing catch ceilings in the range of 1.0–1.5 m.t., ICES is requested to provide medium term consequences in terms of yield, year-to-year stability in yield and the risk that SSB should fall below a $\mathbf{B}_{pa}$ of 5.0 m.t. and $\mathbf{B}_{lim}$ of 2.5 m.t. Such consequences should be evaluated in a 5 and 10 year period.

l) NASCO has requested the Working Group to provide reviews of what is known on salmon by-catch in the fisheries dealt with.

WGNPBW will report to ACFM at its May 1999 meeting.

1.2 Participants

Jim Carscadden (Chair)	Canada
Sergei Belikov	Russia
Bjarte Bogstad	Norway
Are Dommasnes	Norway
Petter Fossum	Norway
Harald Gjøsæter	Norway

Asta Gudmundsdottir	Iceland
Kjellrun Hiis Hauge	Norway
Jan Arge Jacobsen	Faroe Islands
Per Kanneworff	Greenland
Manuel Meixide	Spain
Webjørn Melle	Norway
Terje Monstad	Norway
Ingolf Røttingen	Norway
Alexandra Silva	Portugal
Per J. Sparre	Denmark
Sigurd Tjelmeland	Norway
Hjalmar Vilhjalmsson	Iceland

2 ECOLOGICAL CONSIDERATIONS

2.1 Barents Sea

2.1.1 Climate

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°C above the long term mean, the highest temperature measured in January since 1983. During winter and spring 1999 the temperature decreased to 0.36° above the long term mean. The high temperatures during winter 1998/99 may be looked upon as a strong pulse of warm water entering the Barents sea. In the central and south-eastern parts of the Barents Sea the temperature was 0.2-0.3 °C below the long term mean in 1998. The temperature is expected to increase in 1999 due to the pulse of warm water that entered the sea last winter. The pulse will also move the front between cold Arctic water and warm Atlantic watermasses east and northward in the Barents Sea during 1999. A long term prognosis predicts a cold period in the Barents Sea 2000-2005 (Loeng *et al.* 1999).

Conclusions:

- Temperatures above the long term mean is predicted for the western part of the Barents Sea in 1999.
- Temperatures are predicted to increase above the long term mean in the central and south-eastern parts in 1999.
- A long term prognosis predict a cold period in the Barents Sea from 2000-2005.

2.1.2 Zooplankton

The standing stock of zooplankton in the Barents Sea has been monitored during the annual 0-group and capelin surveys in August-September. At this time of the year most of the production has taken place and the zooplankton abundance can be regarded as an overwintering population. The samples are taken with WP-II nets and Mocness and are divided into the following three categories: 180-1000μm (early stage copepodites), 1000-2000μm (later stages of copepodites and adult copepods) and above 2000μm (krill and amphipods). As Figures 2.1.2.1 and 2.1.2.2 show there has been a marked reduction in zooplankton biomass in the Barents Sea since the very good year 1994. This trend was reversed in 1997 and the biomass of all categories was higher than the previous year. In 1998 the biomass of zooplankton was slightly reduced again compared to the previous year. This reduction was most significant in the central and western parts of the Barents Sea. In the south-eastern parts the zooplankton biomass was constant while the zooplankton biomass in the north-eastern parts increased.

In 1999 a pulse of warm water is predicted to intrude into the eastern parts of the Barents Sea and larger areas will be opened for plankton production. In the western parts of the Barents Sea the zooplankton biomass and thus feeding conditions for pelagic fish is to a great extent dependent on the zooplankton biomass in the watermasses that enter the Barents Sea from the Norwegian Sea. The zooplankton biomass in the Norwegian Sea is predicted to go down in spring 1999 due to a reduction of the overwintering population of zooplankton (Section 2.2.5). The implication of this is that the feeding conditions for pelagic fish in the western parts of the Barents Sea are expected to deteriorate in spring and summer 1999.

Conclusions:

- Decreased abundance of zooplankton biomass in the Barents Sea in 1998 compared to 1997.
- Reduced feeding conditions for pelagic fish predicted for the western parts in 1999.
- Improved feeding condition is expected for the northern and eastern parts of the sea in 1999.

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

Bogstad *et al.* (1999) 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 1984-1998 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.* 1999) and by harp seal (Nilssen *et al.* 1999) 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). 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), 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.

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 oceanographic conditions in the Nordic Seas (Norwegian, Icelandic and Greenland Seas) have during the past 25-30 years been characterised by increasing influence of Arctic waters, mainly carried into the Norwegian Sea by the East Icelandic Current, although to some extent also via the Jan Mayen Current (Figure 2.2.1.1). This trend is driven by atmospheric forcing and as a consequence, the lateral distribution of the Norwegian Atlantic Current (NAC) is highly correlated with the wind conditions as expressed by the North Atlantic Oscillation index (NAO).

Although the NAC has shown a progressive narrowing since about 1970, its waters have during the same period been gradually warming. The trend since the 1970s has therefore been toward higher temperatures and lower salinities. These trends are demonstrated in Figures 2.2.1.2– 2.2.1.5 which show time series of temperature and salinity in the core of Atlantic Water just beyond the shelf edge where both temperature and salinity normally show the highest values. The time series are from three standard sections in the Norwegian Sea which have been observed almost regularly since 1978. These are the section Svinøy - NW, the Gimsøy, also toward NW, and a zonal section along 76.33°N near Sørkapp at Svalbard (Aure *et al.* 1999). The values which are entered in the time series are all «box means», in all sections averaged vertically between 50 and 200 m depth and horizontally over 3 stations situated in the core of the Atlantic Water. In the section Svinøy - NW this is between the positions 63.19°N, 03.40°E and 63.45°N, 02.82°E, in the section Gimsøy - NW between 68.90°N, 12.80°E and 69.13°N, 11.95°E, and in the Sørkapp section between 08.25°E and 12.15°E.

The similarities in trends during the period since the late 1970s are clear, with increasing temperatures and declining salinities since about 1980. During the late 1970s salinities were very low during the so called Great Salinity anomaly. As shown in Figure 2.2.1.4, the temperature rise has been increasing northward. Although the temperatures of the inflowing water have been rising since the mid 1970s, this shows that local effects are also important. A principal, but not the only component in this mechanism is reduced winter cooling.

Shorter term variability shows much larger deviations in both temperature and salinity than the trend which covers the whole observational period. Furthermore, this shorter term variability shows less similarity between spring and late summer. While the already mentioned Great Salinity Anomaly in the late 1970s was clearly observed throughout several years, Figure 2.2.1.2 shows that in the section Svinøy - NW there was an anomaly also in the 1990s which was mainly observed in the time series based on the sections from March/April. When this peaked in 1994, the salinities were at about the same level as in the late 1970s and the temperatures were much lower. The deviation from the trend line reached 1.2°C and 0.12 salinity units in 1994. This anomaly also occurred in the Faroe - Shetland Channel, but was not particularly large. Further it was clearly observed at Ocean Weather Station «M» at 66°N, 2°E in the Norwegian Sea, but as seen in Figure 2.2.1.3 it was weakly observed in the section Gimsøy - NW. This anomaly clearly derived from the East Icelandic Current as its effects increase toward NW in the Svinøy - NW section. This anomaly was considerably less prominent in the time series from the July/August sections.

Figure 2.2.1.3 shows a local salinity anomaly in the section Gimsøy - NW during 1997. This was possibly deriving from the Norwegian Coastal Current since salinities were particularly low near the surface and also decreased gradually toward the coast. Off Svinøy there were no indications of similar effects although the salinity in 1997 was also relatively low there. In this section there has been a decreasing tendency after very high temperature values in 1996 and the core temperature in March 1999 was lower than in March 1997 when feeding conditions for the herring stock developed to become rather meagre during the grazing season. In contrast, the section off the Lofoten Islands shows steadily increasing temperatures since 1995.

In the long term prognosis for the ocean climate in the Norwegian Sea, the increasing temperatures over the last years are now seen as an episodic event, rather than the start of a warm period. The increase is expected to culminate in 1999. This is also reflected in the temperature prognosis for the Barents Sea, where statistical models predict temperatures to be low towards 2003 and thereafter increase rapidly (Loeng et *al.* 1999).

We lack experience that may enable us to say anything about the forthcoming phytoplankton dynamics in the Norwegian Sea, based on the observations in the standard sections in March. Quite likely, the development of the mixed layer during April–May is more decisive for plankton productivity than a temperature difference of the magnitude which occurred between 1997 and 1999 in the section Svinøy - NW. Furthermore, neither 1997 nor 1999 had particularly low temperature in March compared with the whole period since 1978.

It has been observed that zooplankton biomasses were higher in 1998 than in 1997. Although the temperatures in the southern Norwegian Sea were somewhat higher in 1998 than in 1997, it seems likely that the development in the surface mixed layer was of larger importance. At least there were considerable differences between the two years with regard to this. Figure 2.2.1.6 indicates the areas where a well developed mixed layer was not observed (hatched areas) during April–May in 1997 and 1998. Obviously, there were much larger areas without a mixed layer in 1997 than in 1998, particularly in the southern Norwegian Sea. An example of the difference in the vertical profiles of temperature, salinity and density are shown in Figure 2.2.1.7. This figure shows the profiles at a station from May 1997 and a station from about the same area in April 1998. The figure shows that in 1998 there was a well developed transition layer in all three variables at about 40 m depth while there were only low gradients above 160 m depth in 1997. It may further be noted that at these stations the mixed layer temperature was higher in 1997 than in 1998, although temperatures were generally higher in 1998 than in 1997.

The reason for the difference in mixed layer development between the two years may possibly be differences in the atmospheric conditions. The most important difference is possibly that there were stronger winds over the southern Norwegian Sea during January - March in 1997 than in 1998. And furthermore, there was low mean sea level pressure over theNorthern Nordic Seas/Barents Sea both in January and April 1997, which is favourable for increased surface water transport from the Greenland and Iceland Seas into the Norwegian Sea. During April 1998 there was a weak low pressure over the British Isles and high pressure over the Greenland Sea, favouring relatively weak north easterly winds over the southern and central Norwegian Sea. Although data for cloudiness are not at hand, it is still likely that the situation in 1997 with more westerly winds was associated with a denser cloud cover over the Norwegian Sea.

Conclusions:

- The trend in temperature and salinity in the standard sections since 1970 has been towards higher temperatures and lower salinity.

- Temperatures as measured in July-August continued to increase in 1998.

- The temperature increase is expected to culminate in 1999, and the start of a colder period is expected thereafter.

- A deep mixed layer in May 1997 compared to 1998 was possibly related to atmospheric conditions favourable for increased transport of Arctic surface water into the Norwegian Sea in 1997.

2.2.2 Phytoplankton

The development of phytoplankton in the Atlantic water is closely related, first to the increase of incoming solar irradiance during March and then to the development of stratification in the upper mixed layer due to warming. Although there exist several investigations on phytoplankton in the Norwegian Sea, few of them cover the seasonal development of phytoplankton in the area and even fewer cover long-term changes. The Institute of Marine Research 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. Since 1995 a yearly coverage in May has been carried out between about 62 and 72°N where in addition to hydrography, zooplankton and herring studies, observations on nutrient and phytoplankton biomass have been obtained. Also during 1997 and 1998 extensive seasonal cover of two hydrographic sections, Svinøy-NW and Gimsøy-NW has provided the possibility of looking at interannual changes in the biology of the region.

The seasonal development of phytoplankton has been followed at OWS Mike since 1990. Figure 2.2.2.1 shows this development for 1997 and 1998, years with 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 same figure shows also 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 1991–1998. In a "normal" year the winter season extends to about March 2 and in the whole period the extension of this phase remained inside one standard deviation. The pre-bloom phase extended in average from the March 2 to April 17 and also in this period, with the exception of 1994, the year to year variations remained inside one standard deviation. The spring bloom itself starts normally on April 17 and reaches its maximum on May 22, but the year to year variations are much larger than those of the previous phases. With the exception of 1996, it seems that since 1991 the spring bloom has taken place earlier for each year. The causes for this variation are not yet clear and work is being done to clarify this especially in relation to the physical conditions prevailing in the area during the season prior to the stratification.

Probably one of the most important factor in determining the rate of growth of the phytoplankton population before the bloom is the rate at which the deep winter mixed upper layer gets shallower. Figure 2.2.2.3 shows the horizontal distribution of nitrate at 10 meter depth for the Norwegian Sea during April-May 1997 as an indicator of the development of phytoplankton. Both in a restricted area close to the western coast of Norway and in a larger area extending far out from the northwest of the Lofoten Islands, the reduction of nitrate is remarkably large, coinciding with areas with shallower mixed upper layer. Similar observations obtained during April-May 1998 (not shown) indicate that the development of the upper mixed layer has occurred earlier in relation to 1997 and hence the nitrate concentrations were lower in 1998 than in 1997. Another important factor in regulating the development of the spring bloom in the Norwegian Sea is the degree of grazing that the zooplankton population exerts on the phytoplankton. This is an aspect still under study with the data set for the years 1995-1998.

Conclusions:

- The phytoplankton bloom in 1998 peaked about one month earlier than in 1997.

- The shallow upper mixed layer observed in May 1998 may be the reason for the early bloom this year compared to 1997.

2.2.3 Zooplankton

Zooplankton biomass distributions in the Norwegian Sea presented here are mapped annually in May (since 1995) and July (since 1994) during cruises covering major parts of the Norwegian and Icelandic Seas. Zooplankton samples for biomass estimation were caught by vertical net hauls (WP2) or oblique net hauls (MOCNESS). In the present report results from the upper 200 m are presented. Total zooplankton biomasses (g m^{-2}) in May were averaged over sampling stations within three geographical regions. Zooplankton biomass distributions in May varied considerably between consecutive years within regions (Figure 2.2.3.1). Over the years 1995 to 1998 a general trend was found in the central Norwegian Sea (5°W-10°E), showing decreasing biomasses from 1995 to 1997 and an increase in 1998. In the water masses east of 10°E which includes the Norwegian continental shelf and slope waters, influenced by Norwegian coastal water, the trend was somewhat different with generally low biomasses from 1995 to 1997 and a marked mcrease in 1998. In the westernmost region, west of 5°W, biomasses decreased steadily from 1995 to 1998. This region is an Arctic region strongly influenced by the East Icelandic Current.

In July the total zooplankton biomass (g m^{-2}) in the upper 200 m was calculated as area integrated biomass within a fixed region in the central and eastern Norwegian Sea (the same for all years), standardised by surface area of the region to one squared meter surface. In May zooplankton biomass in the 0-200 m depth layer represents the whole *Calanus finmarchicus* population, and this depth layer also includes the main feeding depths of the herring at that time. In July a major part of the *C. finmarchicus* population has descended from the upper 200 m towards its wintering depths. The biomass left may still be representative for the total population, and is the best estimate available for the time being.

Zooplankton biomasses in July showed a trend different from that observed in May (Figure 2.2.3.2). Zooplankton biomass decreased from 1994 to 1996, then increased in 1997 before it decreased again in 1998. The high biomasses observed in 1997 came as a surprise as biomasses were low in May that same year. This may be related to the timing of the production cycle of the zooplankton (mainly *C. finmarchicus*) or the timing of the predator's and prey's seasonal cycles.

Conclusions:

- Average zooplankton biomass in the central Norwegian Sea in May 1998 was about the double that in 1997.
- Higher zooplankton biomass in May 1998 may in part be due to the early phytoplankton bloom this year.
- Zooplankton biomass in July 1998 was lower than in 1997, and at the level measured m 1995 and 1996.

2.2.4 Herring feeding success and zooplankton biomass

For the Norwegian spring spawning herring, the 1990s have been characterised by both high growth, during 1990 and 1991, and low growth during the 1997 feeding season. The condition factor of the herring moving into the present wintering areas in Norwegian wintering fjords in 1998 was higher than after the 1997 feeding season. However, the rise was not very large and the condition of the herring after the 1998 feeding season was below that of the 1996 feeding season (Figure 2.2.4.1). The low condition of the herring returning from the feeding migration in the Norwegian Sea in 1997, accentuated the discussion on how prey availability may vary between years within the feeding area. This was to some extent confirmed by the zooplankton biomass in the Norwegian Sea in May 1997 which was 45% lower than in 1998 (Holst *et al.* 1998).

Since 1994, when the large scale migration pattern of the herring have been mapped by at least two annual cruises (e.g. Misund *et al.* 1998, Monstad *et al.* 1998), the herring have been feeding most heavily between 10°E and 5°W. When average zooplankton biomass ofthe 5°W to 10°E longitudinal region (Figure 2.2.3.1B) is plotted against the herring condition index obtained after the feeding period in the Norwegian Sea (Figure 2.2.4.1), a close relationship is found (Figure 2.2.4.2). Although the time series is short, the existence of a strong relationship between zooplankton biomass and herring feeding success is indicated.

Such a relationship would have implications for herring management. The indicated relationship between measured zooplankton biomass in May and herring condition in the autumn will give early information on the number of individuals taken out of the population given a catch quota in tons. There are also indications that low condition leads to low fecundity due to a high percentage of atresia (ICES 1998/Assess:18). Therefore, knowledge about feeding conditions in May could indicate what the fecundity will be almost one year later.

Conclusions:

- There is a strong direct relationship between zooplankton biomass in May and herring condition in the autumn during the years 1995-1998.

2.2.5 Prediction for the 1999 feeding season

The most obvious parameter related to zooplankton biomass in one year is the spawning stock, or the size of the population starting the wintering the previous year. Zooplankton biomasses in July may represent the coming wintering population. Thus, by relating the biomass in July to the biomass in May the following year such a relationship was tested (Figure 2.2.5.1). A linear relationship explains 85% of the total variation. The time series is short, but the low biomass in July 1998 indicates a low biomass in May 1999 (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 low herring condition index can be expected for the autumn 1999.

The size of the zooplankton biomass is not just related to the overwintered population, nor is the growth of the herring related to measured zooplankton biomass alone. Based on the major trends in the long term growth data (Holst 1996), 5 to 6 years is typically needed to move from periods of low growth to periods of high growth. There is also a lag between the rise in temperature and the herring condition. From the herring condition index time series a maximal herring condition is not expected for 1999. The temperature, which influences growth of the herring directly and has implications for zooplankton growth as well, has shown a general increasing trend over the last decades at the Svinøy section during summer. Shorter cycles indicate a local minimum in temperature around 1995, and an increase thereafter. This may indicate that we are moving towards a period with generally higher growth success of the herring.

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 1998.

- If July zooplankton biomass is indicative of the size of the overwintering population, this indicates a strong relationship between spawning stock and recruitment in zooplankton.

- The relationship can be used to predict herring condition in the autumn the following year from zooplankton biomasses in July.

- From this relationship feeding conditions are predicted not to be optimal in 1999, and the herring condition in the autumn to be low.

2.3 Icelandic Waters

2.3.1 Hydrography and climate

Due to the proximity to the boundary between warm and cold currents, *i.e.* at the oceanic Polar Front in the northern North Atlantic, hydrographic conditions in the sea area north of Iceland are highly variable. Consequently, changes in intensitiy 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. Thus, time and again large displacements of the location of the Polar Front have been recorded and as a result, changes in the distribution of the various water masses. Off the south coast, however, where Atlantic water predominates, year to year fluctuations are normally much smaller.

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

Since the early 1950s annual measurements of temperature and salinity have been made along a section off the central north coast of Iceland, from the coast north to 68°N. The results of these measurements are illustrated in Figure 2.3.1a and b, which clearly shows the variability just described for the duration of the observation period (1952–1998).

Continuous time series of observations of the warm Atlantic water south of Iceland is much shorter. However, since the early 1970s periods of low salinity and temperature have alternated with periods of higher values of these parameters, but the variability has been much smaller than north and east of Iceland. With the exception of 1997, synchronous variability has been observed in the Atlantic water south of Iceland since 1971.

After the very cold spring of 1996 there was a marked increase in temperature and salinity south and west of Iceland. These conditions have prevailed since and in 1997–1998 salinity south and west of Iceland was in fact greater than recorded at any time since before the mid-1960s (>35.20).

2.3.2 Zooplankton

Zooplankton abundance in Icelandic waters has been monitored annually in May/June for more than 30 years. These investigations began as part of a programme to search for migrations of the Norwegian spring spawning herring, arriving in their feeding area north of Iceland in spring, and monitor their movements and behaviour in the following months. Synchronous unbroken time series are available from the Siglunes section off the central north coast of Iceland, beginning in 1962, and from Selvogsbanki off the western south coast since 1971.

Long term changes in 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 extremely variable north of Iceland, with the highest and lowest values differing by a factor of about 24.

Although inter-annual changes of the observed zooplankton biomass at Iceland may in part be explained by variable hydrographic conditions and timing of the phytoplankton spring bloom, comparison to other data from the northern North Atlantic shows that observed zooplankton biomass in spring is descriptive of the mean copepod biomass in that year. Recent research also shows that the variation of zooplankton biomass in the Icelandic area is in tune with long term variability of zooplankton abundance over a much larger area, i.e. in the northern North Atlantic in general (Astthorsson and Gislason 1995).

During the most recent years there has been a downward trend in zooplankton production in Icelandic waters after the high values observed in 1993 and 1994.

2.3.3 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 and Ulltang 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 and is near the pre-1965 level at present.

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 mide-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 reappeared in the waters east and northeast 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).

It seems therefore, that due to the improvement of the marine climate in the last two years, the herring have been able to migrate considerably farther west and enter the area to the northeast of Iceland. However, it is equally clear that the herring only stayed in these waters over a limited period and then resumed their migrations to the northeast again.

2.3.4 General summary

The increased intensity, heat content and salinity of the Irminger Current has, through its eastern branch, resulted in some 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 has 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 and, further, caused fluxes of cold, low salinity water into the near-surface layer north and east of Iceland. Nevertheless, in 1997 and 1998 the temperatures of the East Icelandic Current were higher, its southern and western boundary displaced farther offshore and to the north as compared to most recent years.

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 and 1998 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 1984–1998.

Year	Prey species										
	Amphipod	Krill	Shrimp	Capelin	Herring	Polarcod	Cod	Haddock	Redfish	Others	Total
1984	27	112	439	734	77	15	23	51	370	511	2359
1985	168	57	154	1618	180	3	33	47	226	1153	3637
1986	1213	106	140	827	132	140	83	109	312	658	3721
1987	1060	65	188	224	32	200	24	4	316	668	2781
1988	1232	308	128	330	8	90	9	2	220	406	2734
1989	821	238	129	578	3	32	8	10	228	725	2772
1990	136	85	191	1593	7	6	20	16	238	1555	3846
1991	70	81	191	2885	8	12	26	20	314	1109	4715
1992	105	165	389	2531	323	100	53	105	191	1065	5028
1993	269	736	332	3161	169	286	288	75	101	827	6244
1994	621	781	571	1180	162	664	234	53	83	735	5084
1995	1065	569	397	689	127	277	429	127	212	930	4821
1996	690	1247	368	610	55	119	608	78	111	735	4621
1997	434	584	344	1041	7	147	435	49	50	590	3681
1998	679	745	456	987	75	50	208	28	15	650	3892

Table 2.1.3.2 Annual consumption 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 fro.. 1990–1996. 1000 tonnes (wet weight). For harp seals, the most conservative estimates in Nilssen *et al.* (1999) 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 Parathemisto.

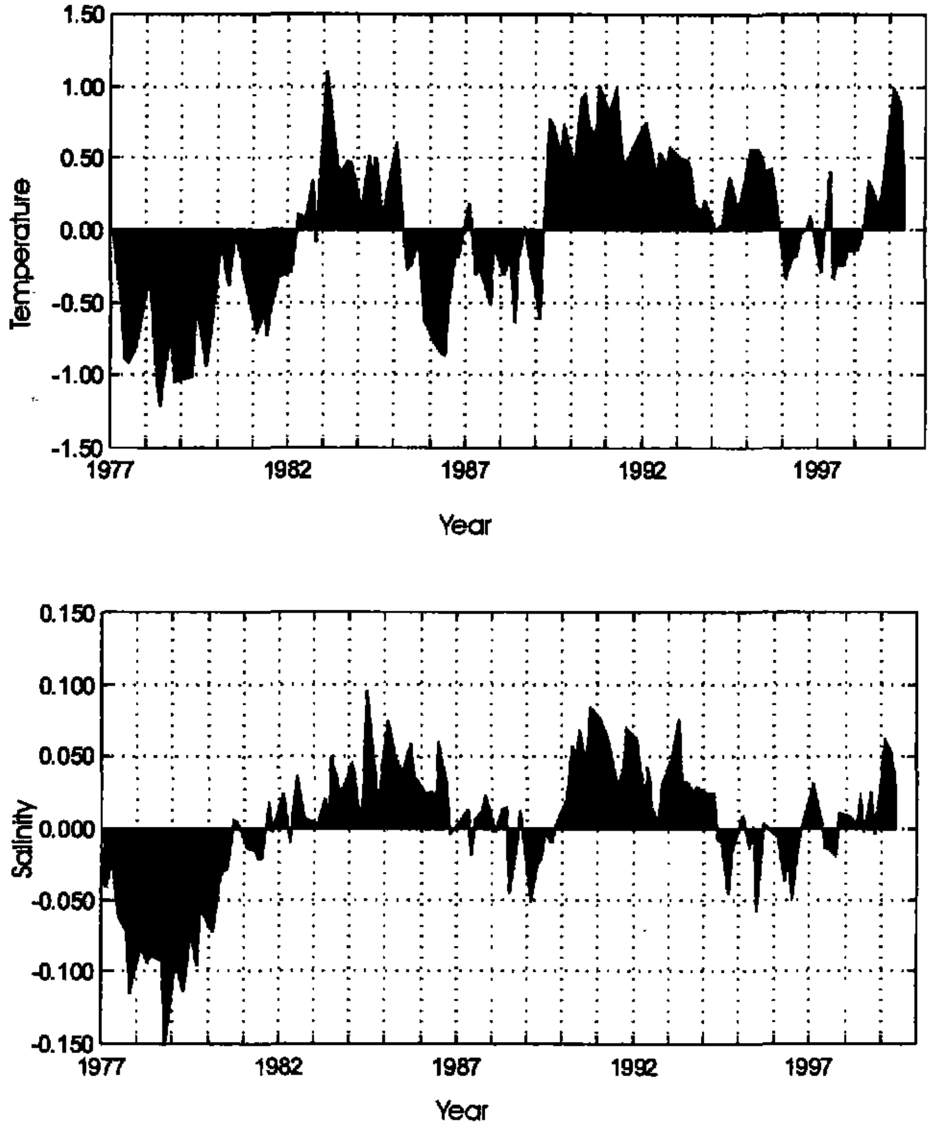


Figure 2.1.1.1. Temperature and salinity anomalies in the Norway-Bear Island section during the period 1977-1999.

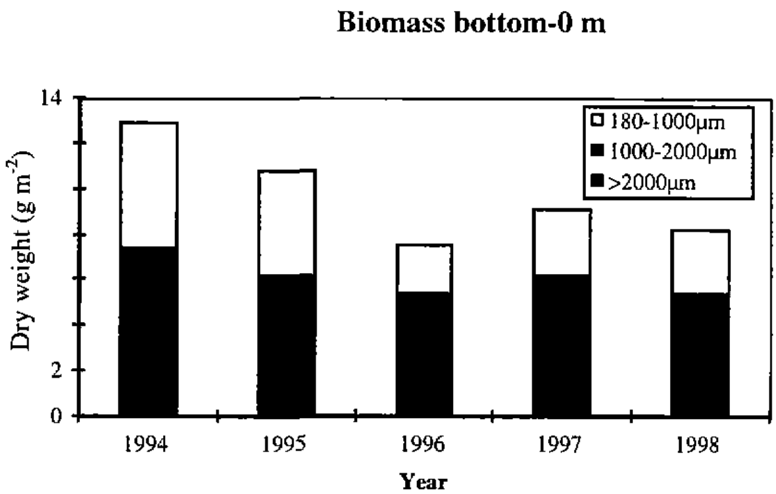


Figure 2.1.2.1. Zooplankton biomass, mean values for the whole Barents Sea, from 1994-98.

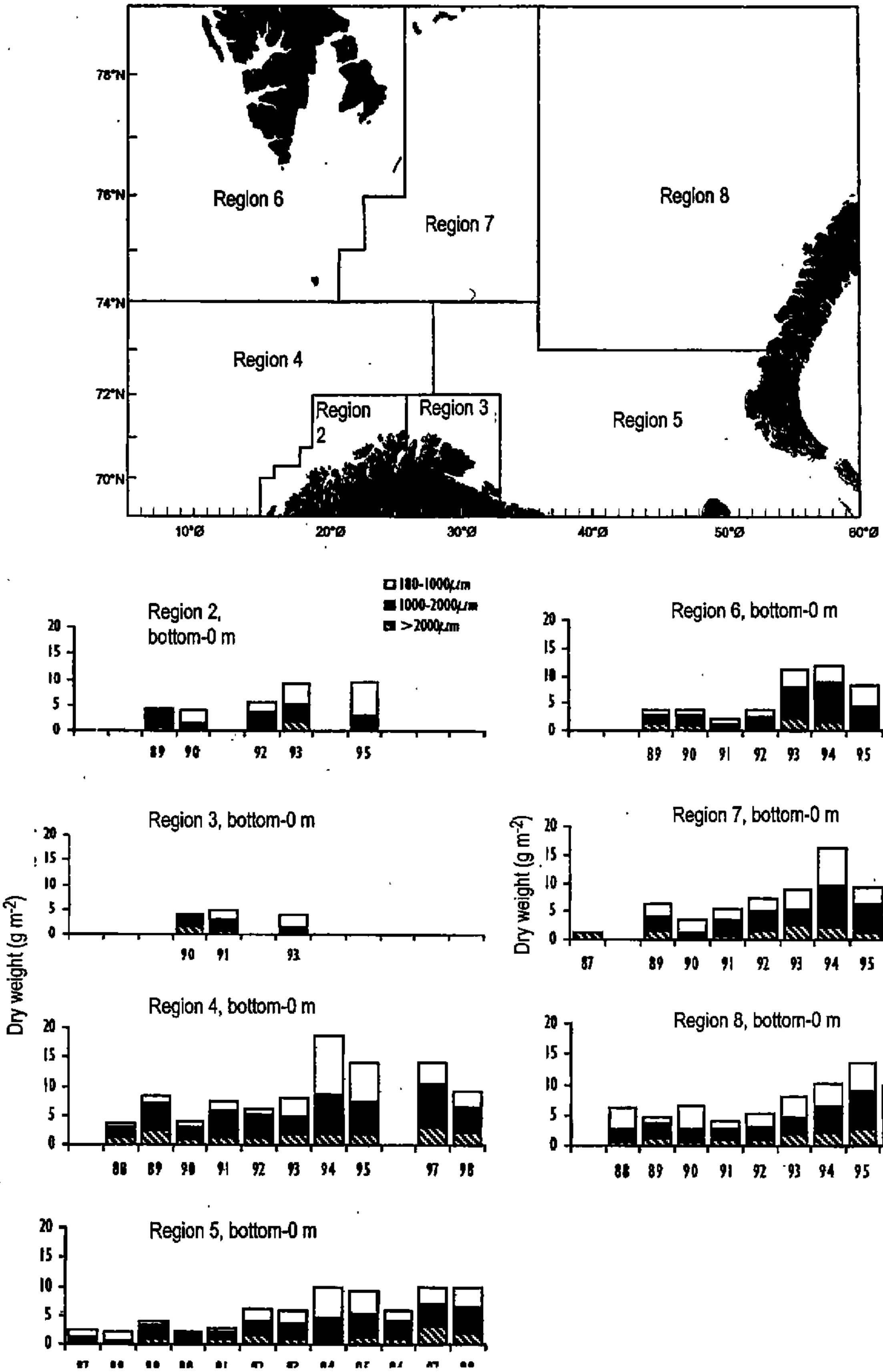


Figure 2.1.2.2. Mean values of size separated zooplankton biomass, gm-2, from bottom-0 m in the regions 2-8.

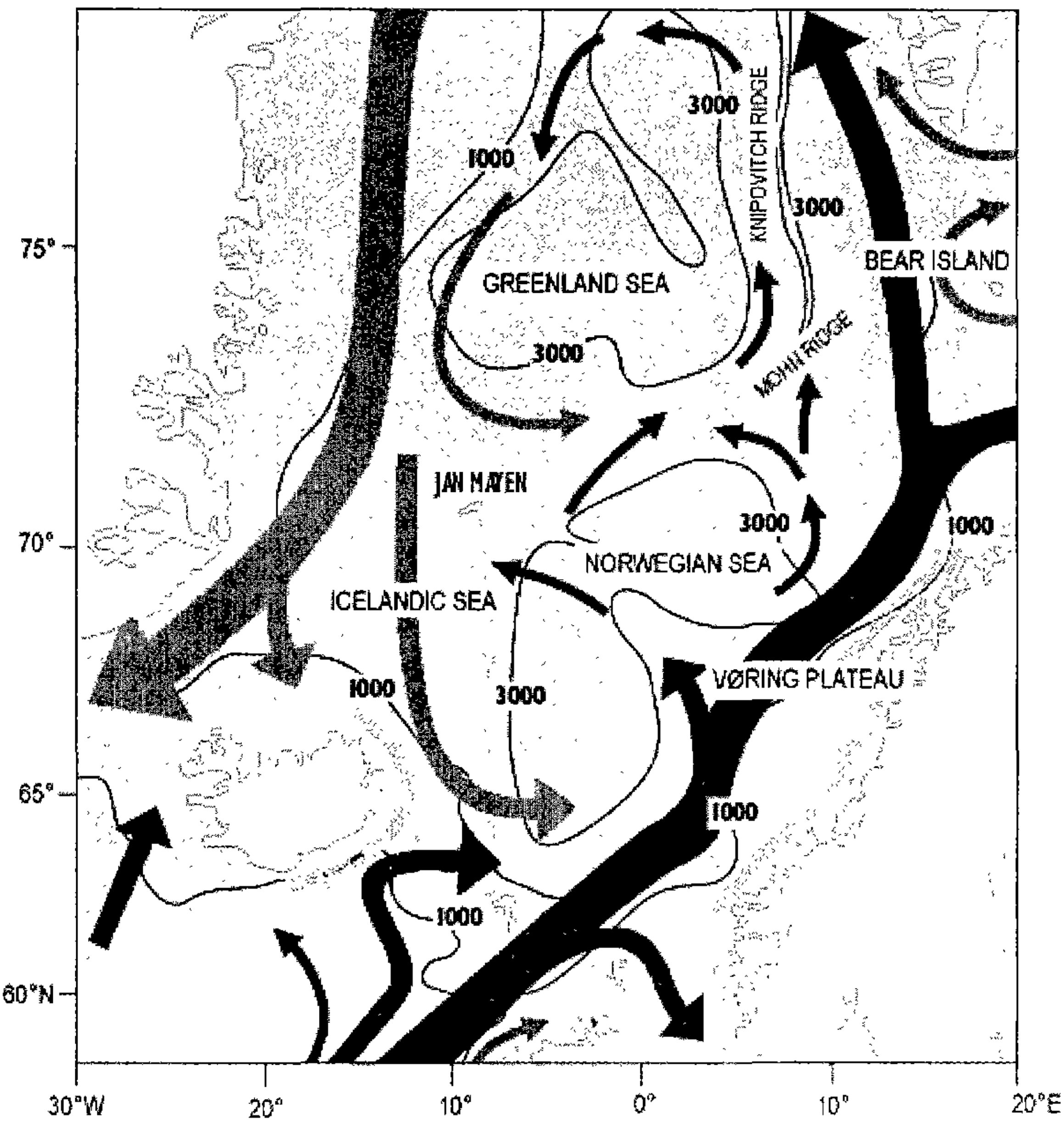


Figure 2.2.1.1. Main surface current system in the Nordic Seas. Dark arrows: warm Atlantic water. Light arrows: cold Arctic water. Light arrows along the coasts: coastal currents.

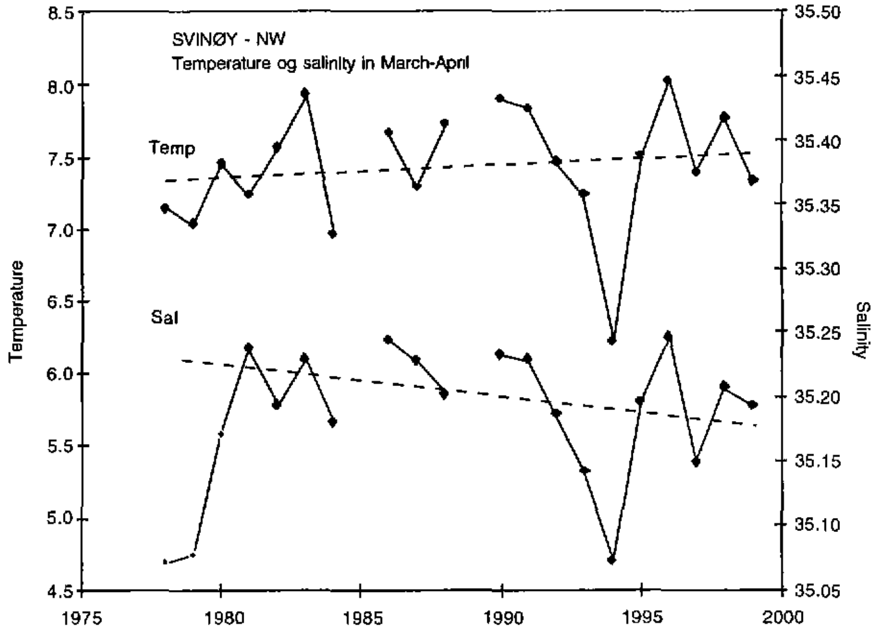


Figure 2.2.1.2. Temperature and salinity in the section Svinøy - NW, observed during March/April, in the core of Atlantic Water near the shelf edge, averaged between 50 and 200 m depth and horizontally over three stations across the core.

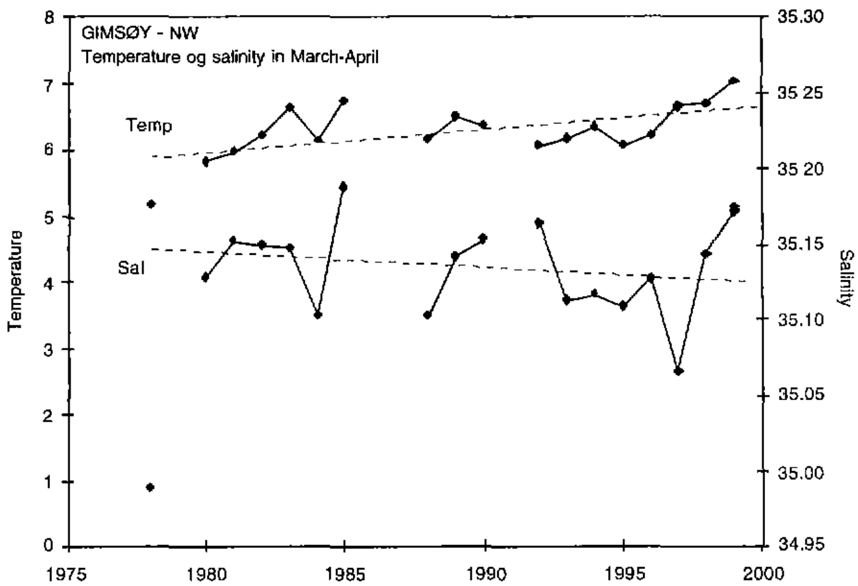


Figure 2.2.1.3. Temperature and salinity in the section Gimsøy - NW, observed during March/April, in the core of Atlantic Water near the shelf edge, averaged between 50 and 200 m depth and horizontally over three stations across the core.

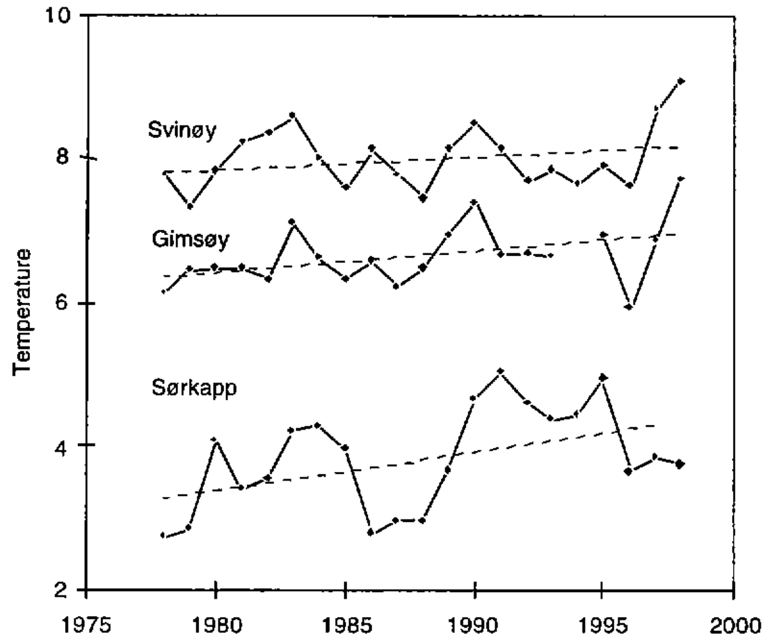


Figure 2.2.1.4. Temperature, observed during July/August, in the core of Atlantic Water beyond the shelf edge in the sections Svinøy - NW, Gimsøy - NW and Sørkapp - W, averaged between 50 and 200 m depth and horizontally over three stations across the core.

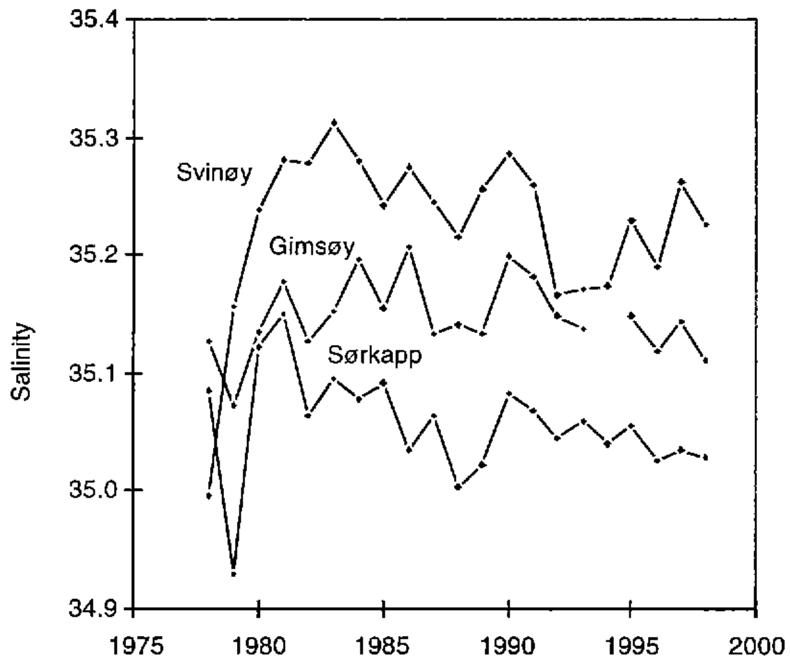


Figure 2.2.1.5. Salinity, observed during July/August, in the core of Atlantic Water beyond the shelf edge in the sections Svinøy - NW, Gimsøy - NW and Sørkapp - W, averaged between 50 and 200 m depth and horizontally over three stations across the core.

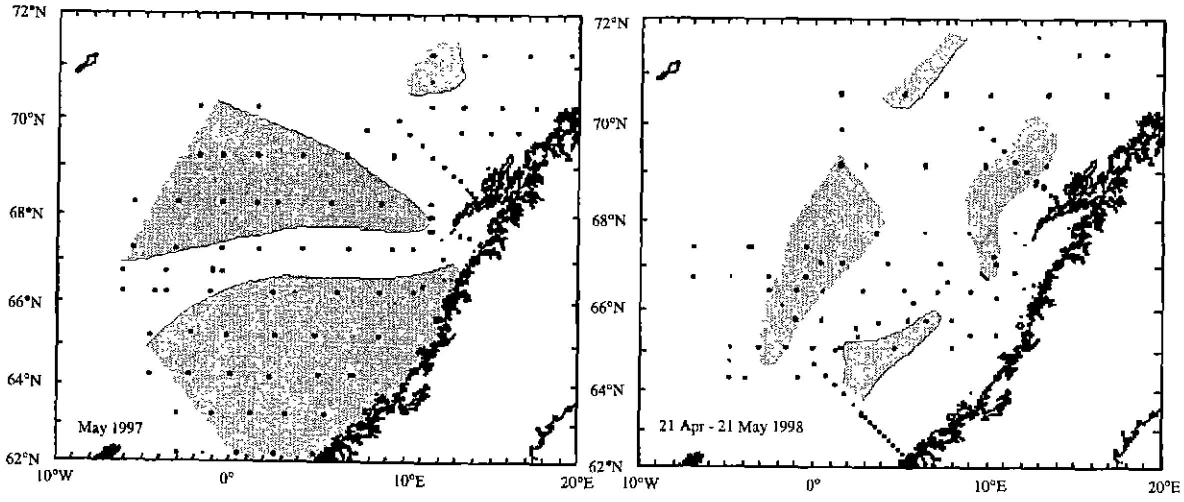


Figure 2.2.1.6. Areas (hatched) without a well developed mixed layer During April /May 1997 and 1998.

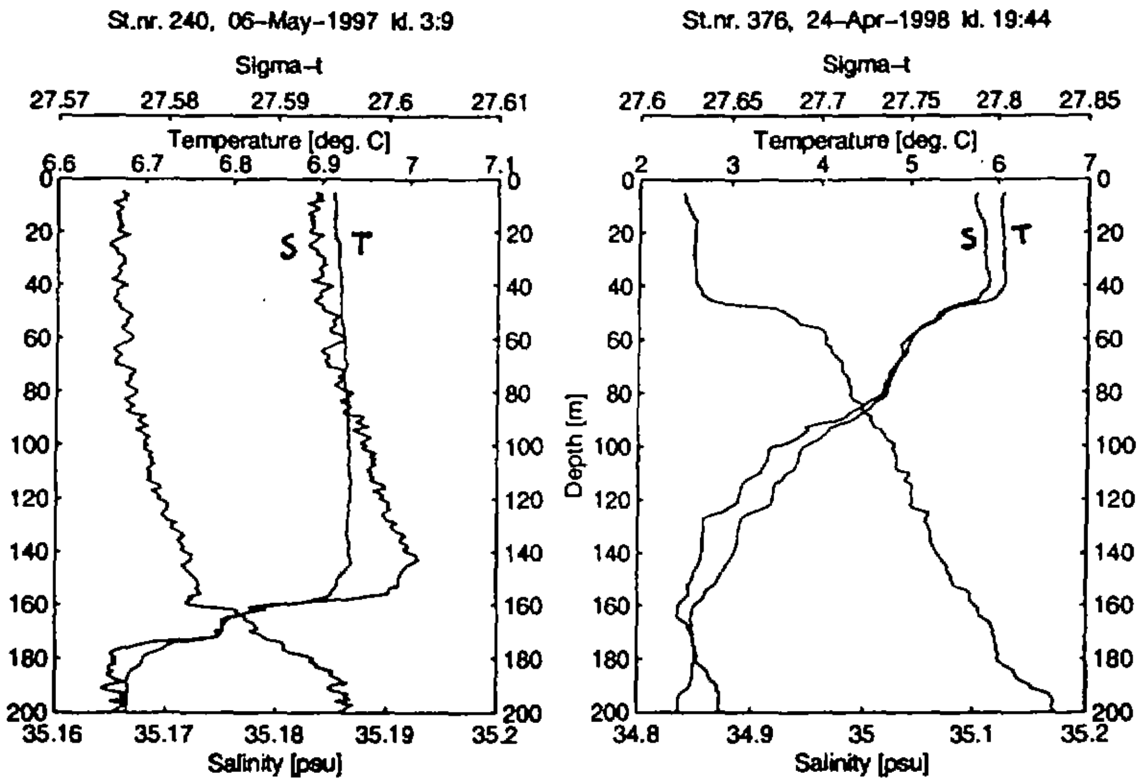


Figure 2.2.1.7. Temperature, salinity and density profiles at a station from May 1997 and from a station in the same area in April 1998.

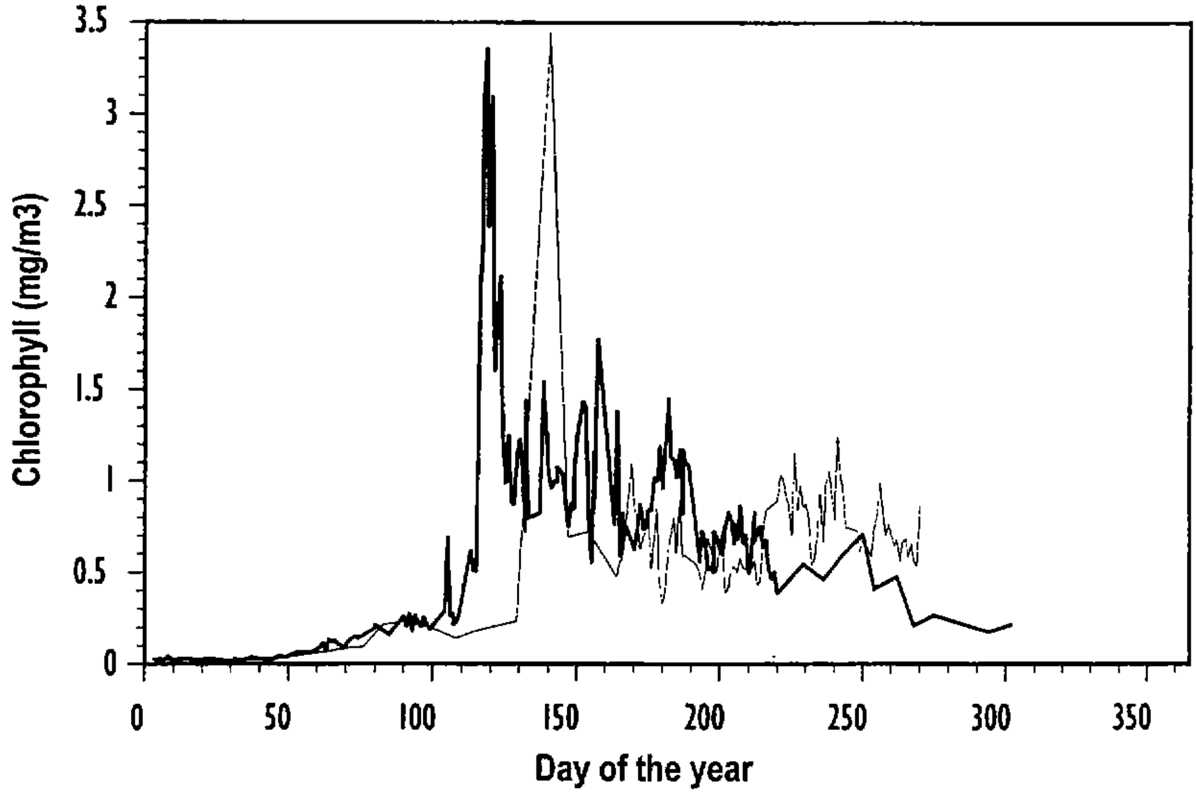


Figure 2.2.2.1. Distribution of chlorophyll *a* at 10 m depth during the year at Weather Station Mike. Thin line: 1997, thick line: 1998.

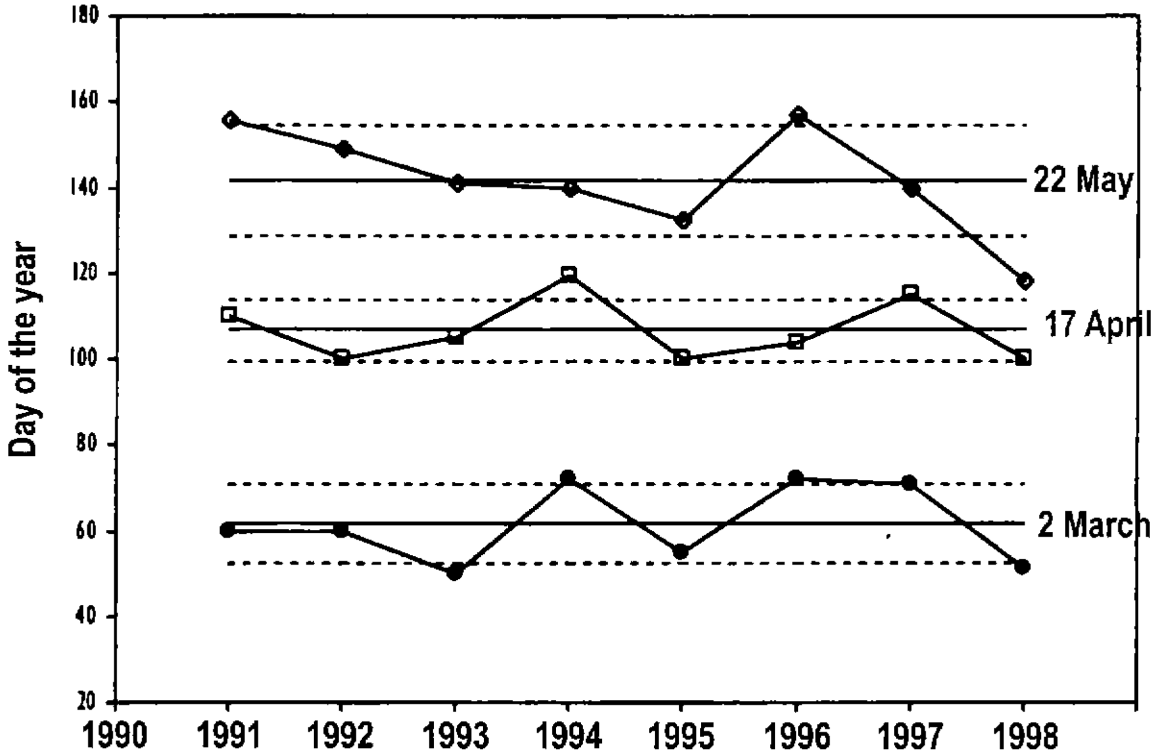


Figure 2.2.2.2. Year to year variation in the different phases of the development of phytoplankton at Weather Station Mike in the period 1991 to 1998. Circles: winter phase; squares: pre-bloom phase; diamonds: spring bloom. Continuous lines represent the average for each period. Broken lines represent one standard deviation for each period.

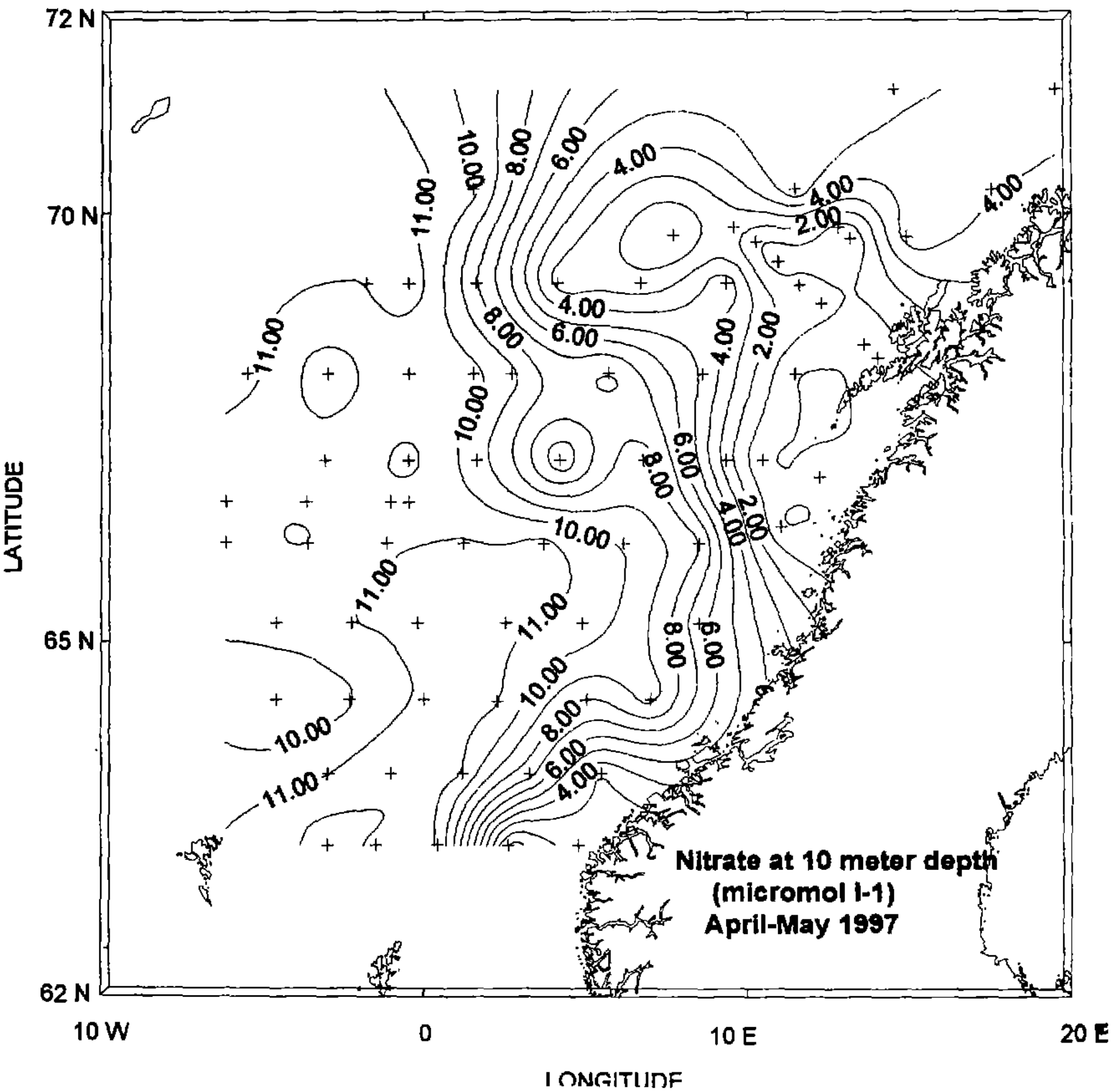


Figure 2.2.2.3. Nitrate (μ mol l^{-1}) distribution in May 1997 at 10 m depth.

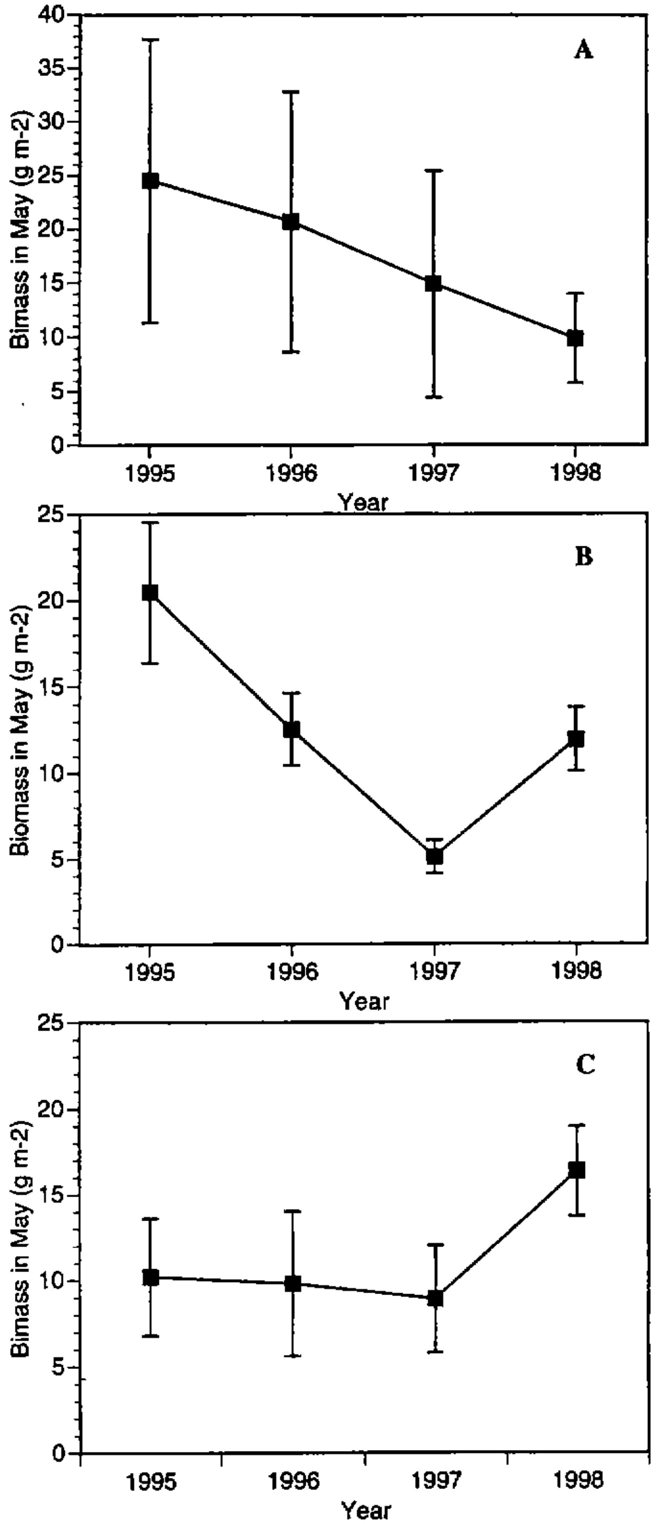


Figure 2.2.3.1. Zooplankton biomass (dry weight) in the upper 200 m. A: Arctic influenced water west of 5°W. B: Atlantic dominated water from 5°W to 10°E. B: Norwegian continental shelf region east of 10°E. Error bars: 95% confidence limits.

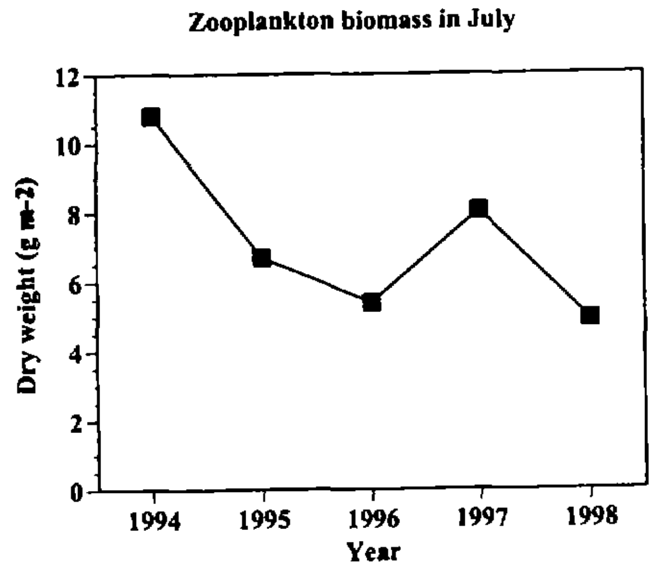


Figure 2.2.3.2. Zooplankton biomass from the upper 200 m in July-August.

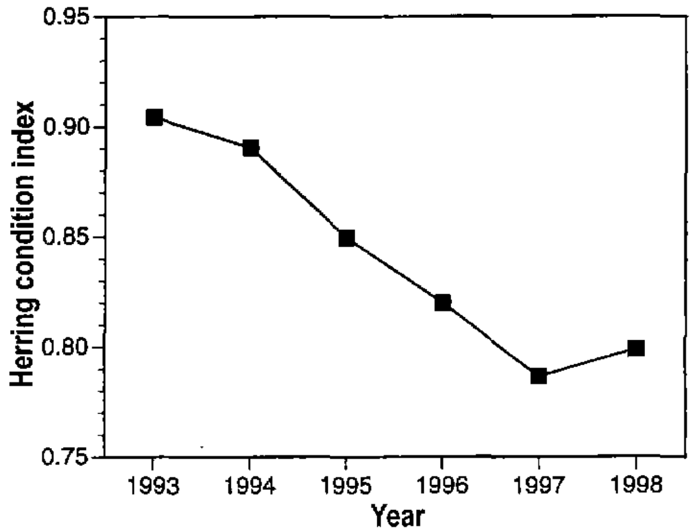


Figure 2.2.4.1. Individual weight to length ratio (herring condition index) for Norwegian spring spawning herring. Data from September, October, and November, for herring 30-35 cm body length.

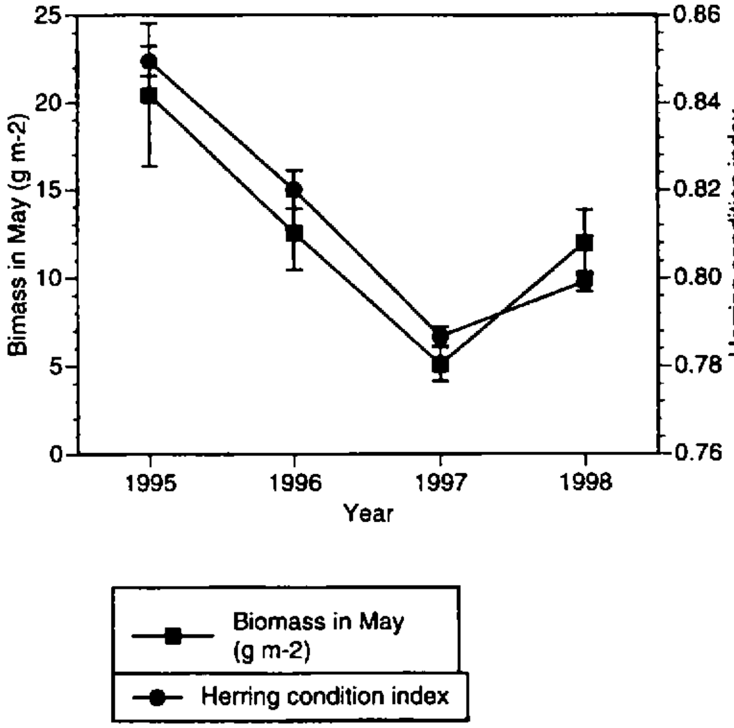


Figure 2.2.4.2. Zooplankton biomass (dry weight) in the Norwegian Sea in May (0-200 m, between 5°W and 10°E) vs. herring condition index (individual weight and length ratio, September-November, 30-35 cm).

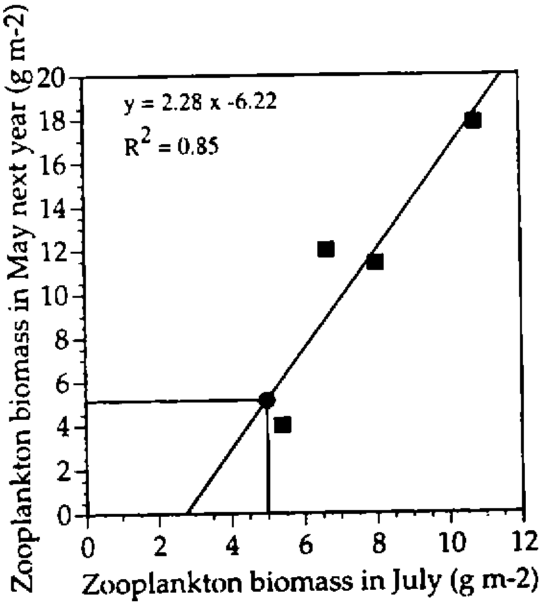
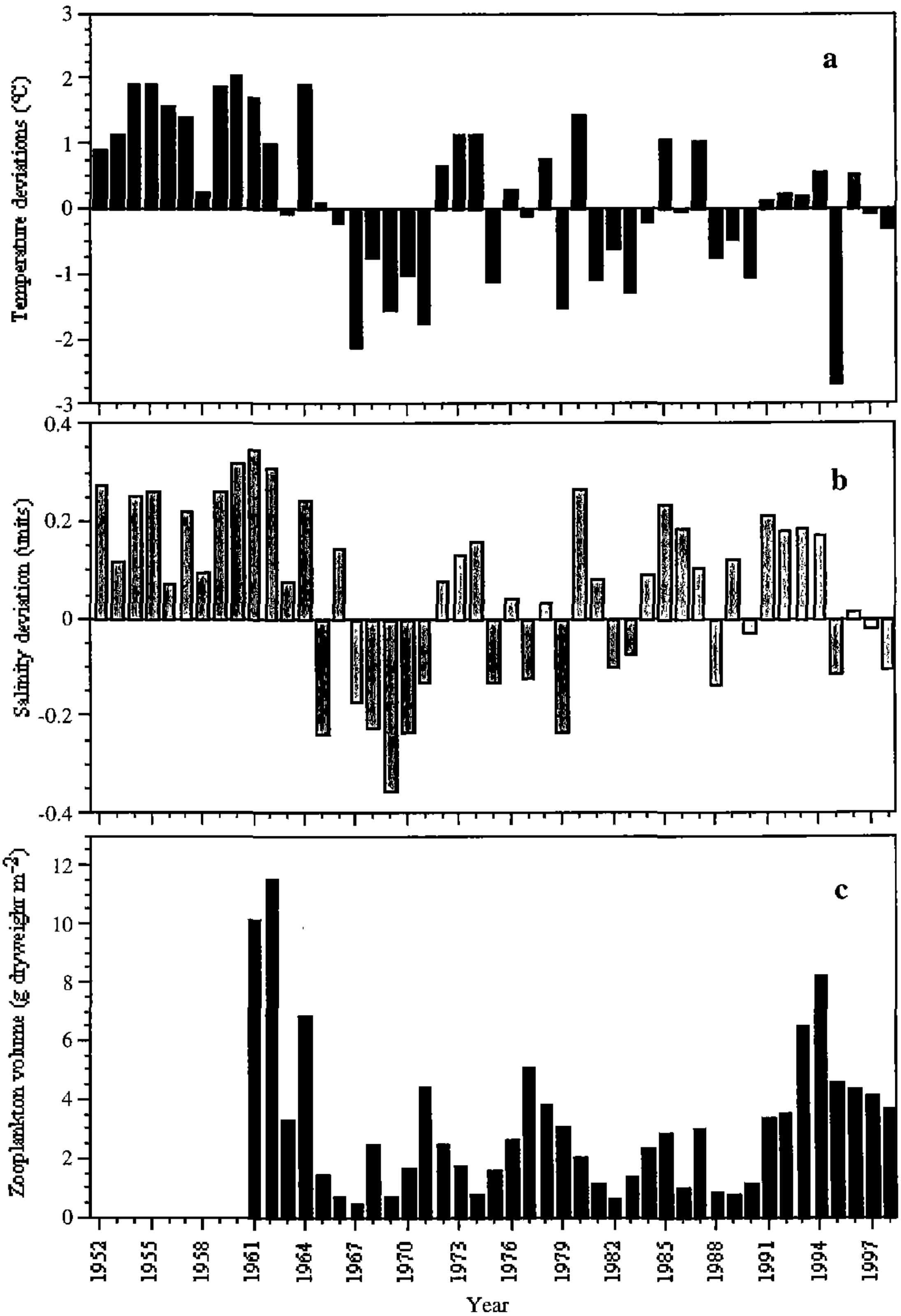


Figure 2.2.5.1. Zooplankton biomass in July vs. zooplankton biomass in May the following year (squares). Prediction of biomass May 1999 from biomass in July 1998 (circle) using estimated linear relationship.

Figure 2.3.1. Variations of temperature (a), salinity (b) and zooplankton biomass (c) north of Iceland in May/June 1952-1998



3 NORWEGIAN SPRING-SPAWNING HERRING

3.1 The Fisheries

3.1.1 Management agreements for 1998

At a meeting in Oslo in October 1997 the coastal states of the Norwegian Spring-Spawning herring reached an agreement to limit their total catch to 1.3 million tonnes in 1998, and on the allocation of this TAC. The agreement included allowances for the parties to take part of their quotas in the Exclusive Economic Zones (EEZs) of other parties that have joined the agreement. An agreement, similar to that for 1997, was made through the North East Atlantic Fisheries Commission (NEAFC) on a TAC for 1998, and on an allocation, for the fishing areas outside national jurisdiction in the Norwegian Sea.

3.1.2 The fisheries

3.1.2.1 Description of the fisheries in 1998

Denmark: The Danish fishery was carried out in spring (30,000 t), summer (10,000 t), and autumn (3,500 t), mainly in the international areas in the Norwegian Sea.

The Faroes: The Faroese fishery started in the Faroese EEZ in April. In May the fishery also took place in international waters and in the Jan Mayen EEZ. The summer fishery terminated in late June. The autumn fishery took place in the Norwegian EEZ, west of Lofoten, during September.

France: No information was received on the French fishery.

Germany: No information was received on the German fishery.

Iceland: The fishery started in late April and followed the part of the stock that migrated south-west and west into the Faroese EEZ. By mid-May no more catches could be made in that area du to the scattered condition of the herring. The Icelandic vessels then shifted the fishing area to a more northerly part of the stock, which was then migrating in a north-westerly direction towards the Jan Mayen area. By the end of May approximately 75,000 tonnes had been fished. From the later part of May to the later part of June the fishery took place in the border areas between the international, Jan Mayen and Icelandic waters. The catches taken within the Icelandic EEZ, to the east and north-east of Langanes, during the latter half of June, most likely derive from herring migrations northward from Faroese waters. In autumn, approximately 7,000 t was caught in Norwegian EEZ on herring returning to the wintering areas.

Ireland: The Irish fishery decreased in 1998 compared to earlier years, and only a few vessels participated in this fishery. A catch of 2,313 t was taken in February. Only 124 t were taken in the Norwegian Sea in spring, bringing the total to 2,437 t.

Netherlands: The Dutch fishery took part 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 occurs in easily available concentrations in the period September until March. The fishery is carried out by many size categories of vessels. In 1998 approximately 169,000 t were caught in the wintering area in Northern Norway, and 126,000 t in the spawning season. Less than 10,000 t were caught in the spring/summer fishery in the Norwegian Sea, approximately 441,000 t in autumn on the herring migrating to, and wintering in, the wintering areas in Northern Norway.

Russia: In 1998 the Russian fishery in spring started in the beginning of February within the shelf area of the Norwegian EEZ, in the area near Sklinna and Langrunnen Bank (approximately 65°N-62°N), and terminated on the Tren Bank (approximately 64°N) in late March. In February-March the catch was 82,497 t. In May-June a fishery was carried out in the Faroese EEZ where 5,000 t were caught. In the international area in the Norwegian Sea the Russian catches in July-September were 4,500t. At the beginning of September the fishery started within the Norwegian EEZ, in the area near Andøy and Malangen Banks (approximately 69°N-71°N). In September the catch was 31,552 t. All of the Russian catch was used for human consumption.

Sweden: No information was received on the Swedish fishery.

UK (Scotland): The decreasing trend in the UK fishery continued in 1998, the catch totalled 15,978 t.

3.1.2.2 Timing of the fisheries in ICES areas in 1998

Table 3.1.2.2.1 gives an general overview of the timing of the fisheries in the ICES areas, and Figure 3.1.2.2.1 shows the main migration routes in 1998, together with dates (months) which are placed in the general area where the fisheries took place at that time.

3.1.2.3 Gear used in the fisheries

Table 3.1.2.3.1 gives an overview of the gear used in the national fisheries for Norwegian spring spawning herring.

3.1.2.4 Catch per ICES statistical rectangle in 1998

The catch per ICES statistical rectangle per quarter and for the whole year is shown in Figures 8.1.1.1 - 8.1.1.5. Data from France, Ireland and Netherlands were not available on statistical rectangles.

3.1.3 Management agreements for 1999

At a meeting in Reykjavik in October 1998 the coastal states of the Norwegian Spring-Spawning herring agreed to limit their catches to 1.302 million tonnes in 1999, and on the allocation of this TAC. Further, NEAFC decided for 1999 to prolong the agreement regarding fishing on Norwegian spring-spawning herring outside the waters of national jurisdiction in the Norwegian Sea.

3.2 Catch Statistics

The total annual catches of Norwegian spring-spawning herring for the period 1972–1998 (1998 preliminary) are presented in Tables 3.2.1 (by fishery) and 3.2.2 (by country).

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 1998 to obtain the total international catch-at-age and weight-at-age was done using the computer programme described by Patterson (WD, 1999). 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 little information on the non-sampled fisheries was available). The Working Group noted, with frustration, that almost half of the nations participating in the fishery for Norwegian spring-spawning herring in 1998, did not sample their catch (Table 3.2.3).

Some countries provided age distributions with a younger plus-group than used by the Working Group (Faroes 11+, Denmark: 12+). These catches were distributed on older age groups according to the age distribution found from the international acoustic survey in the Norwegian Sea in 1998 (Table 3.3.3.1). Totally, the 1992 year class dominates in the catches. It was noted that the 1991 year class appeared as the most numerous in the Icelandic catches. However, the Icelandic age distributions were included as reported.

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 (3,228 samples representing 407,752 t or 55% of the total Norwegian catch in 1998) 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 on the spawning area in the time period 15.02-21.03 1999 (Working Document by A. Slotte and A. Dommasnes). The abundance estimate is given in Table 3.3.1.1. The spawning area in 1999 stretched along the Norwegian coast from 58°N to approximately 69°30N.

3.3.2 Wintering areas

The wintering area was surveyed acoustically in December 1998 and in January 1999 (Working Document by K. Foote and I. Røttingen). The abundance estimates obtained during these surveys are given in Tables 3.3.2.1 and 3.3.2.2.

3.3.3 Feeding areas

The feeding area in the Norwegian Sea was surveyed acoustically during the ICES co-ordinated multinational survey in April - May 1998 (Holst *et al.* 1998). 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 the southern part of 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 1998 (Holst *et al.* 1998) are given in Table 3.3.4.1.

Table 3.3.4.1 includes information on juvenile herring back to 1990, but such estimates exist back to 1984. There is reason to believe that estimates of juvenile herring obtained with the old analogue equipment is not comparable with the estimates obtained with the digital equipment. The change to digital equipment was completed by 1991. The working group in 1998 therefore decided to use only the estimates obtained by the present digital equipment (ICES 1998).

The results from the 0-group herring survey in Norwegian Fjord 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

The larval survey 1999 started off Northern Norway at April 11. The sampling equipment was Gulf-III during daytime (0600-2200 hours) and dipnets during nighttime (2200-0600 hours). At every third station nutrient composition, chlorophyll content and zooplankton biomass were measured. Herring larvae were found from the start of the survey. Between 10 and 100 larvae/m^2 were found on the banks at approximately 68° -69°N (Fig. 3.3.5.1). These larvae were in the later yolksac stage (1d), and in the first post yolksac stage (2a). Farther south there was an area with somewhat fewer larvae (66°-68°N), but between 62°-66°N high concentrations of large larvae were found. More than 100 larvae/m^2 were found all along the coast, and more than 1000 larvae/m^2 were found at the Haltenbank (65°N). Most of these larvae were in stage 2a, when the yolksac is resorbed and the dorsal fin start to develop. At this stage they have started to grow and are beyond the most critical stage for starvation. The composition of the zooplankton community and the high sea temperature indicates early spring bloom in 1999 with high zooplankton growth rates. In such situations only larvae hatching early in the season will find suitable food (copepod eggs and early naupliar stages) for first feeding.

Very few larvae were found south of 62°N, however, more than 100 larvae/m^2 were found in an area south of Karmøy. These larvae were newly hatched and in the earlier yolksac stages. The larval index estimated for 1999 in the area 60°-68°N was found to be 19.9*10^{12}, a significant reduction compared to the previous years (Table 3.3.5.1.).

3.4 Tagging Experiments

The Norwegian tagging experiments on herring have continued. No herring will be tagged in 1999, but recovery of tags from supervised detector plants has continued, as well as from the standard magnets in the production line of fish processing plants and from individuals (Working Document by A. Dommasnes).

Efforts to find and correct errors in the Norwegian tagging data from previous years have continued. All records of recovered tags have been checked, and two types of error have occurred:

1) It has been found that a few records of recovered tags have been mislaid or placed in the wrong category (age group, year of release, year of recovery). This has resulted in a few small changes in the number of tags recovered.

2) There are a number of changes in the number of fish of each year class that have been screened at the processing factories. This is due to two causes:

   (a) The size of the catch that has gone through the tag detectors has been checked against existing records, and in many cases the recorded catch has been found to be incorrect. In some cases this is because only part of the catch has passed through the detector, and the rest has been put on a different conveyor belt or been delivered at another factory.

   (b) The catch in tonnes has been converted to number of fish screened using a length sample from the catch. In addition, age samples from this catch or from another catch in the same area and time period have been used to distribute the number of fish screened on age groups. The distribution of number of fish on age groups has been done in a spreadsheet, and a number of errors have been found and corrected in the spreadsheets. As a by-product, there also now exist good records of which samples have been used.

During the tagging process, the total length of the herring is measured. For each 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.

For stock assessment purposes, tags are used only from tag detectors with known efficiency, which are supervised in order to recover the tagged herring for biological analyses. In 1998, 36 tagged herring of the year classes 1983+, 1986-89, 1990, 1991 and 1992 were recovered from such detectors in two Norwegian factories. Magnet efficiency for the detectors was tested to be 100%, and a total of 50 million herring (13,420 t) were screened. All the tagged and recovered herring were measured, weighed, and aged.

A preliminary analysis (WD, A. Dommasnes) indicates that herring of the year classes 1983+ are well mixed with the population being fished 2 years after tagging, while herring of the year classes 1986 and younger need 3 years to mix well with the population that is being fished and delivered to the factories with supervised tag recovery plants. This may be due to structural changes in the Norwegian herring fishery. Traditionally most of the fishery for Norwegian spring spawning herring, as well as the recovery of tags, was in the spawning areas. In recent years the dominating fishery has taken place in the wintering area. In addition, the fishery now targets larger size groups for human consumption, which give a higher price.

For the year classes 1984 - 1987 both the number of fish tagged and the number of tags recovered are low. In order to use some of the recovered tags from these year classes, data from the year classes 1986-89 have been pooled, thus creating an aggregated group of year classes. The corrected table of tagging data for year class 1983+, for the year classes 1986 - 89 aggregated, and for the year classes 1990, 1991 and 1992 is given in Table 3.4.1.

3.5 Stock assessment

3.5.1 Models for stock assessment

Because of the inherent instability of the stock assessments made the previous two years, where different plausible assumptions yielded very different results, the WG at its 1998 meeting allocated to two of its members the task of investigating by correspondence topics related to the error structure.

Norwegian spring spawning herring is a case study at the ICES Comprehensive Fishery Evaluation WG (Comfie). At its January 1999 meeting the error structure of the tuning was investigated in more detail, were it was found that by changing the probability distribution of the surveys from gamma with constant variance to gamma with constant CV the perceived stock was halved (ICES CM 1999/D:1). With respect to the latter estimate using a log-normal distribution the perceived stock was again almost halved (WD by S. Tjelmeland).

Further work (WD by S. Tjelmeland) has shown that the cause of the problem may be the rigid model for the F at age in the last year of catch data. Due to over-simplification or random errors in the catch at age in the last year this model may generate bias in the back-calculated cohorts. Different probability distributions will weight small and large numbers differently which in turn will cause differences in the perceived stock. Since the relative error in the catch at age the last year may be large for small year-classes, including small year-classes in the tuning without including a separate F in the last year may generate large errors in the assessment.

The WG concluded that the F in the last year should be a parameter to be estimated for all the year-classes that constitute the bulk of the stock and that only terms from these year-classes should be used in the likelihood function. Using the log-normal distribution the survey measurements are shown not to be log-normally distributed (WD by S. Tjelmeland). Since it is unreasonable to assume that measurements of age groups that are small originate from probability distributions that have the same variance as measurements from age groups that are large, the WG chose the gamma distribution with constant CV as the most appropriate model among the models considered.

The tuning software was changed this year, from a Fortran-based package to Mathematica notebooks. The latter can be viewed by the program MathReader, as can the Mathematica notebooks that document the actual runs in more details than given in this report.[1]

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. For VPA calculations the fishing mortality at the last true age is calculated as the population-weighted mean fishing mortality from ages 8 to 13. 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 catch and in the stock and maturity ogive for the period 1950-1998 are given in Table 3.5.2.1.

A VPA run for the period 1907-1997 was presented (WD by Østvedt and Toresen). In the working document there also is an analysis on recruitment success correlated with climatic variations (North Atlantic Oscillation). The VPA applied in the WD differs in some respects from the formal ICES VPA run:

- The weight at age in the catch is revised by incorporating catch weights from the Icelandic summer/autumn fishery.
- The VPA in the WD is calculated by applying Pope's approximation. However, the results differ little from the formal VPA which runs back to 1950.

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[1] The software documentation and run documentation is found in the directory acfm\wgnpbw\1999\Report\TuningDocumentation in the ICES computer system.

The Working Group regards this WD as an important step in the process of extending the time-series on the biological data for the Norwegian spring spawning herring stock. However, due to time constraints, the working group could not in full evaluate the new weight data, or discuss what relevance the climatic variations or changes of spawning area has on the stock recruitment relation. The working group therefore decided for the time being not to change the weights at age in the catch or to increase the stock/recruitment relation with pre-1950 data as a basis for the medium-term projections.

3.5.2.1 Survey data

The same surveys as used at previous WG meetings were also used 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 in the December survey and age 5 in the other surveys. At last year's meeting some points were considered outliers and are as a rule excluded also in the tuning runs made this year. Table 3.5.2.1.1 shows the input file to the tuning procedure, where also the data points that are considered as outliers are given.

With the exception of the international survey in the Norwegian Sea there was a considerable increase in numbers for all year-classes in all surveys as compared to the survey estimates in the preceding year. The increase occurs for all age groups and thus the assumption of identical independent distributions fails to some extent.

The surveys were compared to the VPA at the time of the survey, i.e. the appropriate fraction of the total mortality was applied to the VPA before the contribution to the likelihood function was calculated. For the surveys in 1999, the same mortality as in 1998 was applied, a simplification that is justified when the change in catch from one year to the next is not large.

3.5.2.2 Tagging data

In addition to the tagging data for the 1983 year-class that were used at previous WG meetings, data for the 1986-1989 (as one group), 1990 and 1991 year-classes were also included into the likelihood function (data in Table 3.4.1). The first recoveries used for the 1983 year-class are those two years after the release and the first recoveries used for younger herring are those three years after the release (WD by A. Dommasnes).

3.5.2.3 Larvae index

This year also a larvae index series (WD by P. Fossum) was included as a possible tuning series, where the larvae index is predicted from the spawning stock biomass using the same distribution form as used for the surveys, although always with a separate variance parameter. (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 the assessment made in 1998. However, in this meeting the variance was supposed proportional to the expectation value. i.e. a constant CV was assumed.

Instead of using a selection pattern in the last year of data determined with two parameters, F-values the last year of data for selected year-classes that constitute the bulk of the spawning stock were used as tuning parameters. Only the selected year-classes were entered into the likelihood function. For other year-classes the F-value in the last year of data were interpolated between the estimated F-values.

The WG considers it a weakness of the assessment procedure that correlation of errors between age groups in the surveys are not accounted for. For instance, some points were by previous WG meetings excluded as outliers, and this assumption has also been used this year. However, for instance, if some points are high-end outliers and the reason lies with imperfect biological sampling, other points will be measured too low. Investigations into the statistical properties of the surveys with the aim of providing an age-specific probability distribution should be encouraged.

3.5.3.2 Probability of tag recovery

The assumption on probability distribution of tag returns is unchanged from last year, i.e. a Poisson distribution was assumed.

3.5.4 Stock assessment

The equations for fitting the VPA to the survey data were described in the report from the 1998 meeting of this WG. The difference from the tuning made at that meeting is that now a constant CV rather than a constant variance is used in the gamma distribution, and that the probability density values are not explicitly calculated, rather a built-in procedure in the Mathematica software is used.

The parameters estimated were:

1 Catchability (Cat1) of the survey on the spawning grounds.

2 Catchability (Cat2) of the December survey in Ofoten.

3 Catchability (Cat3) of the January survey in Ofoten.

4 Catchability (Cat4) of the international survey on the spawning grounds.

5 CV of the survey probability distributions.

6 F in the last year of catch data for the 1983 year-class.

7 F in the last year of catch data for the 1990 year-class.

8 F in the last year of catch data for the 1991 year-class.

9 F in the last year of catch data for the 1992 year-class.

10 Survival of tagged fish in the tagging year.

The following exploratory runs, summarised in Table 3.5.4.1 were made:

Run 1. All surveys with a common CV and the tagging series for the 1983 year-class were used. The year-classes in the tuning and in the likelihood were 1983, 1990, 1991 and 1992.

Run 2. With respect to Run 1 all tagging series were included.

Run 3. With respect to Run 1 the larvae index series predicted by the spawning stock was included.

Run 4. With respect to Run 3 all the tagging series were included.

Run 5. With respect to Run 4, the points that by the WG meeting 1998 were perceived as outliers were retained.

Run 6. With respect to run 1, only the age structure is used, i.e. the relative number by age for each year are used For both the VPA and the surveys in the likelihood terms. The reason for performing this run is the large increase for all year-classes in the last year of data in all cruises except the international cruise in the Norwegian Sea. Using only the age structure each year in effect removes all year effects.

Run 7. With respect to Run 2, the last year of acoustic data is excluded, except for the international survey in the Norwegian Sea.

Run 8. With respect to Run 5, the 1993 year-class was included.

Figure 3.5.4.1 shows the histogram from Run 2 of cumulative density function values in bins of 0.1 from 0.0 to 1.0 for the survey measurements with expectation values taken from the VPA. Each bar is divided in two: The upper part shows the number of points in each bin originating from the 50% smallest survey values and the lower part shows the number of points in each bin originating from the 50% largest survey values. If the assumption of a gamma distribution with constant CV that is used in the tuning were met by the data, the histograms should tend to be flat. Some clustering is observed, so the chosen probability function is not fully appropriate. Viewed as a group, the histogram seems reasonably flat. However, the larger points tend to cluster in the middle and the smaller points to the ends. The assumption on the probability distribution of the surveys may not be correct, or there could be problems elsewhere in the tuning procedure. Problems connected to the choice of distributional assumptions should be studied further for this stock.

Figure 3.5.4.2 shows the value of the log-likelihood function when each parameter is varied 50% to each side from the maximum likelihood estimate. The curves are fairly flat around the maximum, so the parameters, especially the F-values in the latest year of catch data, are not very well estimated. Perhaps more importantly, the curves are skewed, with the likelihood falling off faster towards smaller than towards larger parameter values than the maximum likelihood estimate. Even if the estimated values of the parameters correspond to the maximum probability of observing what has been actually observed, the expected values of the parameters will be larger than the maximum likelihood estimate. Therefore, the expected value of the stock size the latest year will be smaller than the value corresponding to the maximum likelihood estimate of the parameters. This is consistent with the Bayesian estimate of the spawning stock made at this WG in 1998 (ICES CM 1998/ACFM:18), where the maximum likelihood estimate of the spawning stock in 1997 was 10 million tonnes and the expectation value of the Bayesian posterior distribution was 6 million tonnes.

This observation suggests that making the probabilistic medium-term forecasts using symmetric stock distributions in the starting year may give an overly optimistic picture. A more correct approach would be to make the medium-term forecast based on a Bayesian posterior distribution. In view of the importance of the possibility of using the medium-term spreadsheet also outside of this WG, it would be useful to convey the asymmetry and correlations in the Bayesian posterior to the spreadsheet.

In all runs except for Run 6 the spawning stock biomass in 1997 is about 2.5 million tonnes larger than was estimated this meeting in 1988. Run 6 which uses the same trend in the acoustic data as was used at that meeting shows an increase of less than 10%. The larger value of the spawning stock in 1997 perceived this year is therefore largely due to the inclusion of the anomalous survey data for the Norwegian coast surveys.

The difference between runs is smaller than previously, which indicates that the new tuning assumptions give more robustness to the tuning.

Figure 3.5.4.3 shows the herring larvae index together with the corresponding catchability times the spawning stock from Run4. There is a very large reduction during the two last years that is not compatible with the development of the spawning stock for any realistic parameter combination and which therefore largely must be considered due to random fluctuations in the data. The uncertainty in this series is thus large during the latest years even if the series as a whole seems to follow the general trend of the spawning stock. The WG feels that more years should be added to this series before it is used for assessment purposes, but will also underline the importance of bringing more sources of information into the assessment process.

The WG recommends that Run 2 be adopted. However, caution should be observed since the large increase of all year-classes observed for the cruises along the Norwegian coast might be spurious, which could be caused by as yet unknown environmental conditions leading to changed behavior of the herring that in turn affects the target strength. In that case these data points should be considered outliers and run 7 is the more appropriate. If the increase in these surveys is a result of normal variations, combined with the survey estimates from previous years being on the average too small due to a combination of chance fluctuations, the resulting increase of the estimated spawning stock is part of an inevitable variance in the assessment methodology. The change in the assessment induced by the latest data falls within the error range of the assessment previously adopted by this WG (CV on log-scale of 0.4), so the WG feels that the increases observed are not large enough for the data to be excluded as outliers. The result of the international survey in the Norwegian Sea in May 1999 may shed more light on this issue.

Investigations into possible causes of the recent increases in the acoustic estimates should be encouraged.

3.5.5 Assessment of the 1994 and younger year classes

The RCT3 program was used for predicting the abundance of the 1994–1998 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 1994–1998 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	1999 WG	1998 WG
1994	2.905	2.481
1995	1.561	0.396
1996	5.144	3.724
1997	3.655	2.771
1998	5.908	-

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 1998 from the Working Group's best estimate (Run 2) described in Section 3.5.4 for the 1992 and older year classes. The fishing mortalities for the 1994–1996 year classes in 1998 were adjusted so that the abundance at age 3 of those year classes are the same as those predicted by RCT3. The fishing mortality of the 1993 year-class was set to the average of the fishing mortality of the 1992 and 1994 year-classes. 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_{3-14} weighted by the population number (hereafter denoted as $F_{5-14,w}$) as the reference F for this stock. The $F_{5-14,w}$ 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 1999 (Table 3.6.1.1) gave an estimate of $F_{0.1}$=0.20 (based on ages 3-16+), while F_{max} was not defined. Yield per recruit vs. F is plotted in Figure 3.5.7.1.

3.6 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, 1999, was taken from the final VPA for the year classes 1996 and older. For the 1997 and 1998 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 1999 was set equal to the weight at age obtained from biological samples taken during the December 1998 survey. The maturity at age in 1999 and 2000 was set equal to that observed for 1998 during the December 1997 survey. The weight at age in the stock in 2000 was set equal to the average of the 1998 and 1999 value, while the weight at age in the catch in 1999 was set equal to the average of the 1997 and 1998 values, except for ages 15 and 16+, where the 1998 value was used. 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 1999 and later years was set equal to 1998 exploitation pattern.

3.6.2 Results of the short-term prediction

Assuming that the internationally agreed TAC of 1,302,000 t in 1999 is taken, this will cause the fishing mortality ($F_{5-14,u}$) to increase from 0.11 in 1998 to 0.12 in 1999. The effects of different levels of $F_{5-14,u}$ on the catch in 2000 and on the stock and SSB in 2001 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 12.0 million tonnes in 1997 to 10.7 million tonnes in 1999, and will decrease further to 9.0 million tonnes in 2000. From 2000 to 2001, the spawning stock biomass will decrease for all values of F. With a *status quo* TAC in 2000, the $F_{5-14,u}$ will increase from 0.12 in 1999 to 0.13 in 2000. The fishing mortality in 1999 of 0.12 is somewhat lower than the value of 0.17 obtained in last year's assessment.

The differences between the spawning stock biomass given here and those given for run 2 in Table 3.5.4.1, is due to the use of Pope's approximation in the assessment model and due to differences in the size of the 1993 and younger year classes.

3.7 Bayesian Stock Assessment and Estimation of Uncertainty

No Bayesian analysis was carried out this year due to time constraints.

3.8 Progress in determining precautionary reference points

The progress in this area is described in a review by I. Røttingen (WD, 1999) which gives a chronological list of relevant statements and actions:

<u>ACFM, May 1996</u>

> ***Special comments:*** *There is considerable uncertainty regarding the actual level of the stock and especially regarding the possible future development of the stock under management strategies. Preliminary medium-term analysis indicates that there is a high probability of SSB falling below MBAL within 10 years with management regimes implementing fishing mortalities above 0.15 or catch levels above 1,500,000 t. This is the result of the low probability of several years of strong recruitment within a 10-year period for this stock. There are no accumulated long-term gains from increasing the fishing mortality above the level of 1995. The utilisation of the strong year classes, which are currently present in the population, can be extended over a considerable time period without overall losses in which case they would also contribute to the spawning stock over a longer period.*

<u>The Coastal States of the Norwegian spring spawning herring, December 1996 (The coastal states are EU, Faroes, Iceland, Norway and Russia)</u>

> At a meeting in Oslo in December 1996 the coastal states agreed on a TAC for 1997 of 1.5 million t. The basis for this decision was the catch control rule outlined in the ACFM May 1996 report, i.e. a fishing mortality of 0.15 and a catch ceiling of 1.5 million t.

<u>ACFM, May 1997</u>

> The headings "Management objectives" and "Advice on management" were introduced in 1997 as part of the new format for the ACFM report, and for Norwegian spring spawning herring the following statements were given:
>
> ***Management objectives:*** *Management agencies have adopted a strategy for 1997 based on F=0.15, with a catch ceiling of 1.5 million tonnes and a minimum SSB of 2.5 million tonnes. The same strategy in 1998 gives a catch of 1.2 million tonnes. If the same strategy is continued after 1998, the catches will decrease further due to poor recruiting year classes.*
>
> ***Advice on management:*** *ICES advises that the present harvest control rule should not be exceeded. It is important that the management agencies consider possible modifications of the catch control rule, as soon as possible, to incorporate a reduction in F towards very low levels in the event of the stock biomass declining towards MBAL.*

The Coastal States of the Norwegian spring spawning herring, October 1997

Although the agreed TAC was set to 1.3 million t for 1998, the discussions on TAC for 1998 were based on the catch control rule given above.

ICES Study Group on the Precautionary Approach to Fisheries Management, February 1998

In the chapter on Reference points in the report from the February 1998 meeting the following is stated:

The SG suggests B_{lim}=MBAL=2,500,000 t, F_{pa}=0.15, indicated by medium-term simulations and adopted by the Working Group, together with a catch constraint of 1.5 mill. tonnes. No B_{pa} or F_{lim} are suggested. Since this is a stock which is dominated by a few outstanding year classes, management discussions have concentrated on how fast it is advisable to deplete the present year classes, rather than on harvest control rules that require a certain B_{pa} as trigger for special actions.

WGNPBW, April-May 1998

Spawning stock biomass values calculated in assessments made since 1990 in the Assessment Quality Control Diagram indicated that a CV of 0.4 would be appropriate for this stock. Applying the relation $B_{pa} = B_{lim} * exp(sigma*1.645)$ (ICES 1998) gives a B_{pa} of approximately 5 million t.

The Working Group did not find F_{lim} to be a relevant reference point for this stock.

ACFM, May 1998

In the section on "Management objectives" ACFM repeated that the management agencies have since 1997 adopted a strategy based on F=0.15, with a catch ceiling of 1.5 million t and a minimum SSB of 2.5 million t. In addition the following statements were given:

Advice on management: *ICES advises that the harvest control rule above should not be exceeded, and this corresponds to 1 263 thousand t in 1999. In order to comply with the precautionary approach it is important that the management agencies consider possible modifications to the catch control rule as soon as possible to incorporate a reduction in F towards very low levels when SSB is below 5 million t, to show the reduction in SSB towards B_{lim}.*

Proposed reference points: *Examination of the stock recruitment data suggests that the probability of poor recruitment increase at SSBs below 2.5 million t, which defines B_{lim}. In order to take into account uncertainty in estimating biomass, a B_{pa} =5.0 million t is proposed. Simulations indicate that F_{pa}=0.15 is adequate when used in conjunction with a catch ceiling.*

Medium-term simulations indicate that the probability of SSB falling below B_{lim} can be almost halved when a reduction in F at SSB levels below B_{pa} = 5.0 million t is applied. An example of such a reduction would be to reduce the F linearly to 0.05 as the SSB falls from 5.0 million t to 2.5 million t.

The Coastal States of the Norwegian spring spawning herring, October 1998

It was agreed to set the TAC for 1999 to 1.3 million t. The basis for this TAC was the catch control rule described in the ACFM May 1998 report. (i.e. F=0.15 and catch ceiling of 1.5 million t). The coastal states did not discuss in detail, or did not decide, on any pre-agreed measures on reduction in F below the SSB level of B_{pa}= 5.0 million t proposed by ACFM.

The present status regarding precautionary reference points for the Norwegian spring spawning herring can be summed up as follows:

F_{pa}: A value of 0.15 had been suggested by ACFM and seems to be adopted by the management agency.

B_{lim}: A value of 2.5 million t has been suggested by ACFM. This value seems also to be adopted by the management agency.

B_{pa}: A value of 5.0 million t has been proposed by ACFM. The adoption of this value into a practical international fishery agreement has so far not been discussed by the management agency.

F_{lim}: WGNPBW did not find this to be a relevant precautionary reference point for this stock.

The Working Group is of the opinion that the following precautionary reference points are relevant for the management advice on Norwegian spring spawning herring, and should therefore be maintained in the advice from ACFM:

$F_{pa} = 0.15$

$B_{lim} = 2.5$ million t

$B_{pa} = 5.0$ million t

Further, the Working Group is of the opinion that ACFM should reiterate its advice from May 1998 which stated that in order to comply with the precautionary approach it is important that the management agencies consider possible modifications to the catch control rule as soon as possible to incorporate a reduction in F towards very low levels when SSB is below 5 million t, in order to slow the reduction in SSB towards B_{lim}. An example of such a reduction would be to reduce F linearly to 0.05 as the SSB falls from 5.0 million t to 2.5 million t.

3.9 Harvest Control Rule

At present, despite the uncertainty in the stock estimate, the spawning stock seems to be at a high level. However, due to reduced recruitment, the spawning stock is now declining (Table 3.6.2.1). Many countries participate in the fishery for Norwegian spring-spawning herring (Section 3.1.2), and the stock is exploited by highly efficient purse seine and pelagic trawler fleets. This stock has a known vulnerability to collapse at high levels of exploitation. In the mid 1960s the condition of this stock changed very rapidly, from record catches in 1966–67 to a depleted stock in 1969. If, in the future, the spawning stock decreases toward the precautionary reference point, rapid relevant management action will be required to prevent a further decline. The best condition for doing so is through pre-agreed management measures to reduce in F at low spawning stock levels.

In the UN agreement on "Straddling fish stocks and highly migratory fish stocks", it is stated that the Management Strategies for this kind of stocks should include measures which can be implemented when the precautionary reference points are approached. In the ACFM reports from both May 1997 and May 1998 the importance of pre-agreed measures to act appropriately if the stock reaches low levels is stressed. In the section on "Advice on management" ACFM stated in May 1998: "In order to comply with the precautionary approach it is important that the management agencies consider possible modifications to the catch control rule as soon as possible to incorporate a reduction in F towards very low levels when SSB is below 5 million t, to slow the reduction in SSB towards B_{lim}". Further, in the section "Proposed reference points" ACFM in May 1998 suggested how such a reduction could be implemented in the management of the stock: "An example of such a reduction would be to reduce F linearly to 0.05 as the SSB falls from 5.0 to 2.5 million t."

The F-reduction suggested by ACFM is augmented by incorporating F=0.05 at SSB levels lower than 2.5 million t (ICES 1998) to the harvest control rule which is illustrated in Figure 3.9.1, and used as a basis in responding to the request on medium-term simulations from the Coastal States for Norwegian spring spawning herring. The request does not point to any preferred way of reducing the F at low SSB values. However, in order to clarify the effect of reducing F at SSBs lower than 5.0 mill. t. runs are also made with the following F's below B_{pa}:

- F= 0.15, *i.e.* no reduction in F
- F is decreased linearly from F=0.15 at SSB=5.0 million t to F=0.0 at SSB at 3.75 million t.

The results are given in Section 3.10.

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 (item k in 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	Performance values
Fishing mortality	0.100, 0.125, 0.150, 0.175	As requested
Catch ceiling	In the range 1.0 - 1.5 million t.	1.0, 1.25, 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
Management action if F reaches low levels	Not indicated in request	Linear decrease in F from 0.15 at B_{pa} to 0.05 at B_{lim} (ACFM 1998) (similar decreases were also made with other requested F's (0.100, 0.125, 0.175)). Alternatives using F=0.15: a) No decrease in F at B_{pa}. b) Linear decrease from B_{pa} to F=0.0 at SSB at 3.75 m.t.
Measure of stability of catches	"year-to-year stability in yield"	Average difference of highest and lowest yield in each simulation run
Yield	"in terms of yield"	Average annual yield (tonnes) of the time range for the simulation run (5 or 10 years).
Risk	Probability to fall below B_{pa} and B_{lim}	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 2. (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) was introduced this year to avoid the occurrence of year classes outside the range observed.

Uncertainty in current stock size was assumed to be adequately reflected by a standard error of 0.4 on a log scale for ages 4 and older in 1999, taken from the quality control sheets. 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 0.4 at age 4.

The projections started at January 1 1999 and the allocated catch for 1999 was implemented using an F of 0.12. 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.

1000 simulations were performed for each harvest control rule. For various harvest control rule parameters, the average yields for the 5- year period 2000-2004 and 10-year period 2000-2009 as a function of harvest control rule parameters is given in Table 3.10.1 and 3.10.2. The average difference between maximum and minimum yield in each run for the various harvest control rule parameters for these two periods is given in Tables 3.10.3-3.10.4. The probabilities of SSB falling below B_{pa}=5.0 million tonnes and below B_{lim}=2.5 million tonnes in these two periods (here also the SSB in the year after the end of the simulation period (2005/2010) is considered when the probability is calculated) given in Tables 3.10.5-3.10.8.

In order to investigate the effect of various strategies for reducing F when the SSB falls below B_{pa}, it was attempted to keep the fishing mortality constant for all SSB values, or to reduce F linearly towards zero at 3.75 million tonnes, in addition to the strategy for reducing F mentioned above. This was only done for F=0.15 and a catch ceiling of 1.5 million tonnes. The results of this analysis are given in Table 3.10.9.

From these tables, the following conclusions can be drawn:

1. Continued fishing using the present harvest control rule illustrated in Fig. 3.9.1, 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. 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.

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

4. Lowering the catch ceiling will increase the year to year stability of the catches.

Figure 3.10.1 and 3.10.2 show the development of SSB and yield for F=0.15 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. 5, 25, 50, 75 and 95 percentiles are given to illustrate the uncertainty in the prognosis.

3.11 Management Considerations

The tuning model applied in the assessment, compared with last year, seems to be more stable by the incorporation of new probability distributions of the surveys (Section 3.5.5). The input data have been expanded including series of tagged herring younger that the 1983 year class (section 3.4). There has further been added one year more of data to the acoustic survey series.

If the post-summer 1998 acoustic estimates are included in the tuning process, the spawning stock in 1999 is estimated to 11.67 million t, if they are excluded the spawning stock estimate is 9.70 million t. Given the uncertainties expressed in Section 3.5.4, the Working Group stresses the uncertainty of the level of stock size.

A lowering of the catch ceiling could decrease the potential year-to-year variability for catch-levels set on the basis of a fixed F and a perceived stock estimate with a considerable error-range believed to be the case for this stock (Section 3.10).

The management agency should take into account that the assessment of the stock is not considered to be precise, and that the medium term projections indicate a considerable stock decline (Section 3.10). Further, it is considered highly important that the harvest control rule used in the exploitation of this stock should be robust to assessment uncertainty. At present, an implicit harvest control rule is applied whereby the catch is restricted to the lower of the catch for F=0.15 and the maximum catch of 1.5 million tonnes. However, the Working Group notes that in the period from 1950 to 1963, when the spawning stock was depleted from 14 million tonnes to 2.6 million tonnes, catches only exceeded 1.5 million tonnes in one year, and fishing mortality only exceeded 0.15 in one year. Although recent selection patterns show a lower fishing mortality on juvenile fish than in that period, it is not demonstrably the case that the harvest control rule presently applied is sufficiently cautious to ensure a low probability of stock depletion. Pre-agreed management plans for remedial action if the spawning stock approaches a precautionary level should be incorporated into the adopted harvest control rule, as discussed in Section 3.8.

The immatures and adults of this stock form a central part of the ecosystem in the Barents and Norwegian Seas, respectively (Section 2). The herring has an important role as a transformer of the production of zooplankton biomass and energy to a form which is available to organisms at a higher level of the food chain. A large stock of herring will utilise larger quantities of plankton (and over larger areas) than a small stock will do.

The current stock assessment indicates a large spawning stock in 1999, but the level is considered imprecise. However, the medium term development of this stock is clear. The spawning stock is supported by two strong year classes (1991 and 1992) and reached a maximum in 1997. The projections indicate that the spawning stock will continue declining due to the recruitment of weak year classes (Fig. 3.10.1).

3.12 New Information on the Present Spatial and Temporal Distribution of Norwegian Spring-Spawning Herring

Information on the migration pattern up to autumn 1998, mainly based on the ICES PGSPEN international surveys in spring/summer of 1998 (Holst et al. 1998) was provided to the ACFM November 1998 meeting, and formed the basis for the answer to the request from NEAFC.

3.12.1 Wintering areas 1998/1999

The spawning stock this year wintered in the Vestfjorden area as it has done since 1987/1988. However, this year it seems to have been a two step immigration into Vestfjorden. The herring stopped up in the outer part of the fjord, and did not start migrating into the inner part of Vestfjorden and to Ofotfjorden before 1. November, almost one month later that usual. However, by the end of November large amounts of herring were located in the traditional wintering areas. (WD by Foote and Røttingen). In January the herring emigrated from the Vestfjorden area.

3.12.2 Spawning season 1999

The spawning in 1999 occurred over a wide area along the Norwegian coast, from Lindesnes in the south (approx. 58°N) to north of Vesterålen (approx. 70°N). The distribution of herring larvae (Figure 3.3.5.1) indicates the distribution of the spawning areas.

No major changes have been observed in the spatial and temporal distribution of Norwegian spring-spawning herring in the wintering season 1998/1999 and in the spawning season 1999 compared to the situation in the previous year.

3.12.3 Feeding areas in 1999

Information on the emigration from the spawning areas and the distribution in the feeding areas in the Norwegian Sea in spring/summer 1999 will be mapped on an ICES co-ordinated survey in May 1999. The results will be made available in a report to the ICES Annual Science Conference. The autumn ACFM meeting will receive this report together with information on immigration to the 1999/2000 wintering areas.

Table 3.1.2.2.1 Timing of fisheries in ICES areas.

ICES Area	Timing of fisheries for Norwegian spring spawning herring
I	No fishery
IIa	January: Large fishery in fjord areas in Northern Norway. February-March: Fishery on spawning areas on the coastal banks off Western Norway. April: Minor international fishery in the Norwegian Sea. May : Large International fishery in the Norwegian Sea. June: International fishery in the Norwegian Sea. July: Minor international fishery in the Norwegian Sea. August -September: International fishery off Northern Norway. September-December: Large fishery in fjord areas in Northern Norway.
IVa	February-March: Fishery on the spawning areas in coastal waters off Western Norway. Some catches may be taken in northern areas in spring.
IVb	No fishery.
Va	June: Fishery mainly by Icelandic and Faroese vessels.
Vb1	May: International fishery.
Vb2	No fishery.
VIa-b	No fishery.
VIIa-b	No fishery.
IIIa	No fishery.
VIIc	No fishery.
VIIg-k	No fishery.
VIII	No fishery.
IX	No fishery.
XIVa	June: One catch by an Icelandic vessel .

Table 3.1.2.3.1 Gear used in the fisheries for Norwegian spring spawning herring.

Nation	Gear used
Denmark	Mainly purse seine
Faroes	Purse seine
France	No information
Germany	Pelagic trawl
Iceland	Purse seine
Ireland	Pelagic trawl
Netherlands	Pelagic trawl
Norway	Mainly purse seine
Russia	Pelagic trawl
Sweden	Pelagic trawl and purse seine
UK (Scotland)	Pelagic trawl and purse seine

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

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 catches by fishery and ICES area given in ICES 1998
[6] Details of distribution of 1998 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[1]	743,925	124,049	35,519	68,136	197,789	2,437	12,827	-	15,978	7,003	605	14,863	1,223,131

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

Table 3.2.3																										
Record No	Country	Quarter	Area	Sampled	Official	WG	No. of	No. fish	No. fish	CN	CN	CN	CN	CN	CN	CN	CN	CN	CN	CN	CN	CN	CN	CN	CN	CN
				Catch	Catch	Catch	samples	aged	measured	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Norwegian	0	16	1998																							
1	Norway	1	IIa	294719	268802	268802	90	8207	8566	0	0	685	3260	54042	113120	572828	332035	86212	36545	3358	1488	393	17305	439	36699	0
2	Norway	2	IIa	7816	7407	7407	21	939	1149	0	0	501	468	1087	1163	12774	8248	2262	1328	376	0	36	1842	0	2933	0
3	Norway	3	IIa	115517	115264	115264	31	806	1523	0	0	7039	5566	46573	26183	130714	99660	32769	13038	3190	0	0	1559	0	13963	0
4	Norway	4	IIa	325873	325934	325873	72	3800	6687	0	0	10313	8092	66794	150025	468345	320278	84869	31688	4276	352	0	14625	0	16815	0
5	Norway	1	IVa	0	25917	25917	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	409	409	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	253	253	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	Russia	1	IIa	82497	85113	82497	21	2180	25497	0	0	8332	0	5404	21845	166235	118394	25192	6843	1101	719	2891	4338	5039	1420	0
9	Russia	2	IIa	3405	3405	3405	17	1117	15610	0	0	2051	592	991	1835	6206	2226	365	49	54	29	98	93	96	0	0
10	Russia	3	IIa	0	36052	36052	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	Russia	2	IVa	452	452	452	1	99	99	0	0	272	79	132	244	824	295	48	6	7	4	13	12	13	0	0
12	Russia	2	Vb	1643	1643	1643	3	248	4241	0	0	990	285	478	886	2995	1074	176	24	26	14	47	45	46	0	0
13	Denmark	1	IIa	8910	8910	8910	21	1014	2053	0	0	0	0	553	2802	26051	8131	987	158	197	316	0	59	0	218	0
14	Denmark	2	IIa	22449	22420	22449	4	238	492	0	0	0	0	2095	3465	35219	21679	7495	1773	1451	2579	0	1011	0	3744	0
15	Denmark	3	IIa	3426	3426	3426	1	99	99	0	0	6521	6521	4923	2578	362	0	0	0	362	0	0	0	0	0	0
16	Denmark	4	IIa	705	705	705	1	99	99	0	0	1342	1342	1013	531	75	0	0	0	75	0	0	0	0	0	0
17	Iceland	2	IIa	183992	184058	183992	6	341	341	0	0	0	0	0	2341	153311	210327	90442	25780	4683	15817	0	64837	0	12504	0
18	Iceland	3	IIa	0	3131	3131	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	Iceland	4	IIa	0	4131	4131	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	Iceland	2	XIVa	0	746	746	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	Iceland	2	Va	1775	1775	1775	2	132	132	0	0	0	0	0	0	1427	1834	1019	245	0	122	0	571	0	163	0
22	Iceland	2	Vb1	4014	4014	4014	4	209	209	0	0	0	0	0	128	3523	5253	1473	576	256	448	0	1601	0	128	0
23	France	1	IIa	0	605	605	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	Sweden	1	IIa	0	520	520	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	Sweden	2	IIa	0	9778	9778	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	Sweden	3	IIa	0	4475	4475	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	Sweden	4	IIa	0	90	90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	Germany	2	IIa	0	303	303	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	Germany	3	IIa	0	6699	6700	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	Netherlan(	2	IIa	0	14018	559	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	Netherlan(	3	IIa	0	100	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	Netherlan(	2	IVa	0	0	12168	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	UK(Scot)	2	IIa	0	5609	5609	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	UK(Scot)	3	IIa	0	5514	5614	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	UK(Scot)	4	IIa	0	4755	4755	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	Ireland	1	IIa	0	2313	2313	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	Ireland	2	IIa	124	124	124	2	94	289	0	0	0	2	67	203	134	46	30	9	0	0	0	0	0	0	0
38	Faroes	2	IIa	52418	48858	48858	11	300	1207	0	0	0	0	1136	4779	53650	51385	21247	2900	17279	0	0	2213	0	8200	0
39	Faroes	2	Vb	0	3560	3560	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	Faroes	3	IIa	0	15717	15717	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41	Denmark	2	Vb	0	30	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-1																										

Table 3.2.4

Record No	Country	Quarter	Area	Sampled	Official	WG	No. of	No. fish	No. fish	CW	CW	CW	CW	CW	CW	CW	CW	CW	CW	CW	CW	CW	CW	CW	CW	CW
				Catch	Catch	Catch	samples	aged	measured	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Norwegian	0	16	1998																							
1	Norway	1	IIa	294719	268802	268802	90	8207	8566	0.000	0.000	0.061	0.095	0.172	0.181	0.219	0.245	0.284	0.311	0.322	0.393	0.344	0.352	0.387	0.374	0.000
2	Norway	2	IIa	7816	7407	7407	21	939	1149	0.000	0.000	0.059	0.095	0.203	0.196	0.210	0.229	0.256	0.291	0.320	0.320	0.320	0.336	0.396	0.343	0.000
3	Norway	3	IIa	115517	115264	115264	31	806	1523	0.000	0.000	0.086	0.127	0.269	0.264	0.292	0.320	0.357	0.372	0.404	0.398	0.397	0.379	0.396	0.451	0.000
4	Norway	4	IIa	325873	325934	325873	72	3800	6687	0.000	0.000	0.097	0.155	0.225	0.245	0.269	0.290	0.323	0.350	0.379	0.296	0.376	0.396	0.396	0.414	0.000
5	Norway	1	IVa	0	25917	25917	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	409	409	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	253	253	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	Russia	1	IIa	82497	85113	82497	21	2180	25497	0.000	0.000	0.069	0.000	0.168	0.174	0.209	0.233	0.269	0.313	0.375	0.344	0.371	0.380	0.377	0.407	0.000
9	Russia	2	IIa	3405	3405	3405	17	1117	15610	0.000	0.000	0.075	0.132	0.199	0.225	0.266	0.292	0.327	0.348	0.316	0.351	0.348	0.366	0.356	0.000	0.000
10	Russia	3	IIa	0	36052	36052	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	2	IVa	452	452	452	1	99	99	0.000	0.000	0.075	0.132	0.199	0.225	0.266	0.292	0.327	0.348	0.316	0.351	0.348	0.366	0.356	0.000	0.000
12	Russia	2	Vb	1643	1643	1643	3	248	4241	0.000	0.000	0.075	0.132	0.199	0.225	0.266	0.292	0.327	0.348	0.316	0.351	0.348	0.366	0.356	0.000	0.000
13	Denmark	1	IIa	8910	8910	8910	21	1014	2053	0.000	0.000	0.000	0.000	0.205	0.201	0.216	0.242	0.298	0.317	0.339	0.370	0.000	0.386	0.000	0.386	0.000
14	Denmark	2	IIa	22449	22420	22449	4	238	492	0.000	0.000	0.000	0.000	0.233	0.256	0.255	0.277	0.305	0.333	0.365	0.362	0.000	0.367	0.000	0.367	0.000
15	Denmark	3	IIa	3426	3426	3426	1	99	99	0.000	0.000	0.130	0.158	0.173	0.208	0.191	0.000	0.000	0.000	0.228	0.000	0.000	0.000	0.000	0.000	0.000
16	Denmark	4	IIa	705	705	705	1	99	99	0.000	0.000	0.130	0.158	0.173	0.208	0.191	0.000	0.000	0.000	0.228	0.000	0.000	0.000	0.000	0.000	0.000
17	Iceland	2	IIa	183992	184058	183992	6	341	341	0.000	0.000	0.000	0.000	0.000	0.253	0.277	0.297	0.331	0.346	0.331	0.378	0.000	0.411	0.000	0.438	0.000
18	Iceland	3	IIa	0	3131	3131	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	Iceland	4	IIa	0	4131	4131	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	Iceland	2	XIVa	0	746	746	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	Iceland	2	Va	1775	1775	1775	2	132	132	0.000	0.000	0.000	0.000	0.000	0.000	0.283	0.305	0.343	0.371	0.000	0.446	0.000	0.427	0.000	0.443	0.000
22	Iceland	2	Vb1	4014	4014	4014	4	209	209	0.000	0.000	0.000	0.000	0.000	0.253	0.269	0.286	0.303	0.310	0.331	0.315	0.000	0.392	0.000	0.417	0.000
23	France	1	IIa	0	605	605	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	Sweden	1	IIa	0	520	520	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	Sweden	2	IIa	0	9778	9778	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	Sweden	3	IIa	0	4475	4475	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	Sweden	4	IIa	0	90	90	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	Germany	2	IIa	0	303	303	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	Germany	3	IIa	0	6699	6700	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	Netherlanc	2	IIa	0	14018	559	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	Netherlanc	3	IIa	0	100	100	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	Netherlanc	2	IVa	0	0	12168	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	UK(Scot)	2	IIa	0	5609	5609	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	UK(Scot)	3	IIa	0	5514	5614	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	UK(Scot)	4	IIa	0	4755	4755	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
36	Ireland	1	IIa	0	2313	2313	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
37	Ireland	2	IIa	124	124	124	2	94	289	0.000	0.000	0.000	0.197	0.231	0.239	0.249	0.277	0.335	0.360	0.000	0.000	0.000	0.000	0.000	0.000	0.000
38	Faroes	2	IIa	52418	48858	48858	11	300	1207	0.000	0.000	0.000	0.000	0.266	0.271	0.285	0.306	0.336	0.350	0.413	0.000	0.000	0.426	0.000	0.426	0.000
39	Faroes	2	Vb	0	3560	3560	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
40	Faroes	3	IIa	0	15717	15717	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
41	Denmark	2	Vb	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
-1																										

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	35490.00	35461.00	27	2743	1450	99.95
Faroes	52418.00	64575.00	11	1207	300	99.85
France	0.00	605.00	0	0	0	0.00
Germany	0.00	7002.00	0	0	0	0.00
Iceland	183992.00	191320.00	6	341	341	100.02
Ireland	124.00	2437.00	2	289	94	99.83
Netherlands	0.00	14118.00	0	0	0	0.00
Norway	743925.00	717407.00	214	17925	13752	99.98
Russia	85902.00	124570.00	38	41107	3297	99.88
Sweden	0.00	14863.00	0	0	0	0.00
UK(Scot)	0.00	15878.00	0	0	0	0.00
Total IIa	1101851.00	1188236.00	298	63612	19234	99.97

Sum of Offical Catches : 1188236.00
Unallocated Catch : -16072.00
Working Group Catch : 1172164.00

AREA : IVa

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Norway	0.00	26579.00	0	0	0	0.00
Russia	452.00	452.00	1	99	99	100.06
Total IVa	452.00	27031.00	1	99	99	100.06

Sum of Offical Catches : 27031.00
Unallocated Catch : 12168.00
Working Group Catch : 39199.00

AREA : Va

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Iceland	1775.00	1775.00	2	132	132	99.95
Total Va	1775.00	1775.00	2	132	132	99.95

Sum of Offical Catches · 1775.00
Unallocated Catcn : 0.00
Working Group Catch · 1775.00

AREA : Vb

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Denmark	0.00	30.00	0	0	0	0.00
Faroes	0.00	3560.00	0	0	0	0.00
Russia	1643.00	1643.00	3	4241	248	100.11
Total Vb	1643.00	5233.00	3	4241	248	100.11

Sum of Offical Catches : 5233.00
Unallocated Catch : 0.00
Working Group Catch : 5233.00

AREA : Vb1

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Iceland	4014.00	4014.00	4	209	209	100.00
Total Vb1	4014.00	4014.00	4	209	209	100.00

Sum of Offical Catches : 4014.00
Unallocated Catch : 0.00
Working Group Catch : 4014.00

AREA : XIVa

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Iceland	0.00	746.00	0	0	0	0.00
Total XIVa	0.00	746.00	0	0	0	0.00

Sum of Offical Catches : 746.00
Unallocated Catch : 0.00
Working Group Catch : 746.00

PERIOD : 1

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Denmark	8910.00	8910.00	21	2053	1014	99.96
France	0.00	605.00	0	0	0	0.00
Ireland	0.00	2313.00	0	0	0	0.00
Norway	294719.00	294719.00	90	8566	8207	99.95
Russia	82497.00	85113.00	21	25497	2180	99.87
Sweden	0.00	520.00	0	0	0	0.00
Period Total	386126.00	392180.00	132	36116	11401	99.93

Sum of Offical Catches : 392180.00
Unallocated Catch : -2616.00
Working Group Catch : 389564.00

PERIOD : 2

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Denmark	22449.00	22450.00	4	492	238	99.99
Faroes	52418.00	52418.00	11	1207	300	99.85
Germany	0.00	303.00	0	0	0	0.00
Iceland	189781.00	190593.00	12	682	682	100.02
Ireland	124.00	124.00	2	289	94	99.83
Netherlands	0.00	14018.00	0	0	0	0.00
Norway	7816.00	7816.00	21	1149	939	100.00
Russia	5500.00	5500.00	21	19950	1464	100.11
Sweden	0.00	9778.00	0	0	0	0.00
UK(Scot)	0.00	5609.00	0	0	0	0.00
Period Total	278088.00	308609.00	71	23769	3717	99.99

Sum of Offical Catches : 308609.00
Unallocated Catch : -1328.00
Working Group Catch : 307281.00

PERIOD : 3

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Denmark	3426.00	3426.00	1	99	99	99.76
Faroes	0.00	15717.00	0	0	0	0.00
Germany	0.00	6699.00	0	0	0	0.00
Iceland	0.00	3131.00	0	0	0	0.00
Netherlands	0.00	100.00	0	0	0	0.00
Norway	115517.00	115517.00	31	1523	806	100.02
Russia	0.00	36052.00	0	0	0	0.00
Sweden	0.00	4475.00	0	0	0	0.00
UK(Scot)	0.00	5514.00	0	0	0	0.00
Period Total	118943.00	190631.00	32	1622	905	100.01

Sum of Offical Catches :	190631.00
Unallocated Catch :	101.00
Working Group Catch :	190732.00

PERIOD : 4

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Denmark	705.00	705.00	1	99	99	99.80
Iceland	0.00	4131.00	0	0	0	0.00
Norway	325873.00	325934.00	72	6687	3800	100.00
Sweden	0.00	90.00	0	0	0	0.00
UK(Scot)	0.00	4755.00	0	0	0	0.00
Period Total	326578.00	335615.00	73	6786	3899	100.00

Sum of Offical Catches :	335615.00
Unallocated Catch :	-61.00
Working Group Catch :	335554.00

Total over all Areas and Periods

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Denmark	35490.00	35491.00	27	2743	1450	99.95
Faroes	52418.00	68135.00	11	1207	300	99.85
France	0.00	605.00	0	0	0	0.00
Germany	0.00	7002.00	0	0	0	0.00
Iceland	189781.00	197855.00	12	682	682	100.02
Ireland	124.00	2437.00	2	289	94	99.83
Netherlands	0.00	14118.00	0	0	0	0.00
Norway	743925.00	743986.00	214	17925	13752	99.98
Russia	87997.00	126665.00	42	45447	3644	99.89
Sweden	0.00	14863.00	0	0	0	0.00
UK(Scot)	0.00	15878.00	0	0	0	0.00
Total for Stock	1109735.00	1227035.00	308	68293	19922	99.97

Sum of Offical Catches :	1227035.00
Unallocated Catch :	-3904.00
Working Group Catch :	1223131.00

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 : (10) Russia 3 IIa
Using Only
>> (3) Norway 3 IIa

Filling-in for record : (18) Iceland 3 IIa
Using Only
>> (3) Norway 3 IIa

Filling-in for record : (19) Iceland 4 IIa
Using Only
>> (4) Norway 4 IIa

Filling-in for record : (20) Iceland 2 XIVa
Using Only
>> (17) Iceland 2 IIa

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  Filling-in for record : ( 23)   France                 1 IIa
Using Only
  >>  ( 13)  Denmark               1 IIa

  Filling-in for record : ( 24)   Sweden                 1 IIa
Using Only
  >>  ( 13)  Denmark               1 IIa

  Filling-in for record : ( 25)   Sweden                 2 IIa
Using Only
  >>  ( 14)  Denmark               2 IIa

  Filling-in for record : ( 26)   Sweden                 3 IIa
Using Only
  >>  ( 15)  Denmark               3 IIa

  Filling-in for record : ( 27)   Sweden                 4 IIa
Using Only
  >>  ( 16)  Denmark               4 IIa

  Filling-in for record : ( 28)   Germany                2 IIa
Using Only
  >>  ( 14)  Denmark               2 IIa

  Filling-in for record : ( 29)   Germany                3 IIa
Using Only
  >>  ( 15)  Denmark               3 IIa

  Filling-in for record : ( 30)   Netherlands            2 IIa
Using Only
  >>  ( 14)  Denmark               2 IIa

  Filling-in for record : ( 31)   Netherlands            3 IIa
Using Only
  >>  ( 15)  Denmark               3 IIa

  Filling-in for record : ( 32)   Netherlands            2 IVa
Using Only
  >>  ( 14)  Denmark               2 IIa

  Filling-in for record : ( 33)   UK(Scot)               2 IIa
Using Only
  >>  ( 14)  Denmark               2 IIa

  Filling-in for record : ( 34)   UK(Scot)               3 IIa
Using Only
  >>  ( 15)  Denmark               3 IIa

  Filling-in for record : ( 35)   UK(Scot)               4 IIa
Using Only
  >>  ( 16)  Denmark               4 IIa

  Filling-in for record : ( 36)   Ireland                1 IIa
Using Only
  >>  ( 13)  Denmark               1 IIa

  Filling-in for record : ( 39)   Faroes                 2 Vb
Using Only
  >>  ( 38)  Faroes                2 IIa

  Filling-in for record : ( 40)   Faroes                 3 IIa
Using Only
  >>  (  3)  Norway                3 IIa

  Filling-in for record : ( 41)   Denmark                2 Vb
Using Only
  >>  ( 38)  Faroes                2 IIa
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Catch Numbers at Age by Area

Ages	IIa	IVa	Va	Vb	Vb1	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	81527.15	373.87	0.00	990.00	0.00	0.00	82891.02
3	69636.45	402.36	0.00	285.00	0.00	0.00	70323.81
4	235630.53	6178.78	0.00	555.80	0.00	0.00	242365.11
5	354772.19	12187.88	0.00	1213.30	128.00	9.49	368310.88
6	1676836.13	71241.78	1427.00	6669.38	3523.00	621.60	1760319.00
7	1209323.75	41894.01	1834.00	4593.25	5253.00	852.78	1263750.75
8	365110.91	11881.95	1019.00	1631.16	1473.00	366.70	381482.72
9	124544.67	4278.76	245.00	222.61	576.00	104.53	129971.56
10	39903.04	1115.44	0.00	1209.40	256.00	18.99	42502.87
11	23162.27	1532.74	122.00	14.00	448.00	64.13	25343.14
12	3381.56	49.44	0.00	47.00	0.00	0.00	3478.00
13	107791.00	2181.56	571.00	196.56	1601.00	262.88	112604.01
14	5535.40	51.60	0.00	46.00	0.00	0.00	5633.00
15	102171.02	5440.65	163.00	561.60	128.00	50.70	108514.96
16	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Mean Weight at Age by Area (Kg)

Ages	IIa	IVa	Va	Vb	Vb1	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	0.1116	0.0721	0.0000	0.0750	0.0000	0.0000	0.1110
3	0.1507	0.1032	0.0000	0.1320	0.0000	0.0000	0.1503
4	0.2173	0.1857	0.0000	0.2084	0.0000	0.0000	0.2164
5	0.2219	0.1939	0.0000	0.2374	0.2530	0.2530	0.2210
6	0.2491	0.2294	0.2830	0.2765	0.2690	0.2770	0.2485
7	0.2774	0.2545	0.3050	0.3027	0.2860	0.2970	0.2768
8	0.3169	0.2915	0.3430	0.3350	0.3030	0.3310	0.3163
9	0.3390	0.3161	0.3710	0.3498	0.3100	0.3460	0.3382
10	0.3734	0.3528	0.0000	0.4109	0.3310	0.3310	0.3737
11	0.3733	0.3646	0.4460	0.3510	0.3150	0.3780	0.3721
12	0.3670	0.3441	0.0000	0.3480	0.0000	0.0000	0.3664
13	0.3967	0.3552	0.4270	0.4123	0.3920	0.4110	0.3960
14	0.3774	0.3792	0.0000	0.3560	0.0000	0.0000	0.3772
15	0.4071	0.3709	0.4430	0.4260	0.4170	0.4380	0.4055
16	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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
2		101	183	44			16		407			106
3	255	5	187	59			128	1792	231			1366
4	146	373	0	54			676	7621	7638		381	337
5	6805	103	345	12			1375	3807	11243		1905	1286
6	202	5402	112	354			476	2151	2586		10640	2979
7		182	4489	122			63	322	957		6708	11791
8			146	4148			13	20	471		1280	7534
9				102			140	1	0		434	1912
10							35	124	0		130	568
11							1820	63	165		39	132
12								2573	0		0	0
13									2024		175	0
14											0	392
15+											804	437
Total	7408	6166	5462	4895	-	-	4742	18474	25756	-	22496	28840

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

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
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.

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
3	4114	1169	367
4	22461	3599	1099
5	13244	18867	4410
6	4916	13546	16378
7	2045	2473	10160
8	424	1771	2059
9	14	178	804
10	7	77	183
11	155	288	0
12	0	415	0
13	3134	60	112
14		2472	0
15+			415
Total	50504	44915	35987

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	1990	1991	1992	1993	1994	1995	1996[1]	1997[2]	1998[3]
Age									
1	4.4	24.3	32.6	102.7	6.6	0.5	0.1	2.6	9.5
2		5.2	14.0	25.8	59.2	7.7	0.25	0.04	4.7
3			5.7	1.5	18.0	8.0	1.8	0.4	0.01
4					1.7	1.1	0.6	0.35	0.01
5							0.03	0.05	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 1975–1998 (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	465	273	341	11,640	12,719

Table 3.3.4.3 Norwegian spring-spawning herring. Abundance indices for 0-group herring in the Barents Sea, 1973–1998.

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

Table 3.3.5.1 The indices for herring larvae for the period 1981–1999 ($N*10^{-12}$).

Year	Index	Year	Index
1981	0.3	1991	8.6
1982	0.7	1992	4.6
1983	2.5	1993	24.7
1984	1.4	1994	19.5
1985	1.1	1995	18.2
1986	0.7	1996	27.7
1987	1.3	1997	66.6
1988	9.2	1998	42.4
1989	13.4	1999	19.9
1990	18.3		

Table 3.4.1. Tagging data for the year classes 1983+, 1986-89 aggregated, and for the year classes 1990, 1991 and 1992. For the year classes 1986-89, 1990, 1991 and 1992 the numbers of tags that were recovered only 2 years after release have been printed on grey background, and should not be used for stock assessment.

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
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		0	3	2	3	2	3	0	0	0	
1998	0.000509		1	3	1	1	2	2	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
1993		14472				
1994		38152				
1995	0.011554	20620	5			
1996	0.004038	24585	5	7		
1997	0.003867		2	7	0	
1998	0.000509		0	1	0	1

Tagging data for the 1990 year class

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

Tagging data for the 1991 year class

Year	Screened billion	Number tagged	Recaptured	
			95 release	96 release
1995		33995		
1996		25683		
1997	0.030952		21	
1998	0.012459		8	6

Tagging data for the 1992 year class

Year	Screened billion	Number tagged	Recapt.
			96 release
1996		8417	
1997			
1998	0.020695		7

Table 3.5.2.1

Run title : Herring Spring-spawn (run: SEPBJA02/S02)

At 4-May-99 14:50:40

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

YEAR,	1950,	1951,	1952,	1953,	1954,	1955,	1956,	1957,	1958,
AGE									
0,	511260,	163550,	1372160,	569720,	1067599,	517560,	536390,	500190,	966699,
1,	200000,	760769,	914970,	505500,	707109,	287110,	202370,	329080,	279810,
2,	60000,	40000,	123290,	58130,	85540,	51010,	62710,	21950,	66640,
3,	27620,	660,	3930,	74010,	26630,	9300,	11650,	2330,	1750,
4,	18480,	38380,	6050,	4660,	143550,	27640,	25160,	37330,	1790,
5,	18550,	17240,	60230,	10090,	14290,	204510,	31420,	15380,	11090,
6,	54700,	16440,	13630,	35560,	23600,	11430,	255510,	22850,	8930,
7,	62860,	51560,	20450,	8190,	49030,	18960,	11000,	198530,	19440,
8,	7950,	60200,	38020,	11090,	12810,	27470,	20390,	7200,	97350,
9,	8860,	7710,	37790,	31410,	19980,	8530,	26420,	12730,	7070,
10,	10950,	8270,	7920,	39490,	44040,	19340,	13070,	18250,	12300,
11,	8690,	10310,	8570,	6170,	46070,	29560,	19830,	8840,	20090,
12,	19450,	10760,	10770,	9120,	8840,	20320,	27280,	12120,	9870,
13,	36830,	25350,	10680,	9410,	10060,	5870,	16330,	14930,	7740,
14,	6640,	34800,	18650,	9880,	13300,	8460,	6300,	13160,	7090,
15,	10700,	4740,	25630,	21550,	12680,	10360,	8890,	3370,	6940,
+gp,	23730,	30510,	30810,	51490,	67640,	47700,	47620,	24770,	18620,
0 TOTALNUM,	1087269,	1281250,	2703549,	1455471,	2352767,	1305128,	1322340,	1243010,	1543221,
TONSLAND,	933000,	1278400,	1254800,	1090600,	1644500,	1359800,	1659400,	1319500,	986600,
SOPCOF %,	100,	100,	100,	100,	100,	100,	100,	100,	100,

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

YEAR,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,	1968,
AGE										
0,	1789628,	1288431,	620750,	369320,	480700,	361300,	230300,	392650,	42680,	178360,
1,	198530,	1358079,	1607560,	408110,	211920,	272830,	378090,	66280,	987710,	43700,
2,	32550,	39250,	288480,	104130,	204530,	22030,	285360,	167800,	7040,	38830,
3,	1510,	12170,	3120,	184380,	76040,	11460,	8990,	204870,	139230,	9910,
4,	2680,	1820,	810,	800,	83580,	39900,	25620,	2690,	325400,	188050,
5,	2590,	2810,	410,	310,	530,	204580,	57110,	46660,	2660,	138740,
6,	14660,	2440,	1500,	720,	180,	1370,	219970,	130600,	42130,	1420,
7,	11480,	9620,	1940,	2020,	360,	150,	1950,	288450,	113200,	9400,
8,	24070,	7330,	6160,	1190,	1830,	300,	1490,	3790,	172080,	13410,
9,	110380,	20390,	4920,	5910,	930,	2490,	740,	1430,	890,	34510,
10,	8860,	116300,	13610,	5260,	10770,	2930,	1910,	1740,	570,	200,
11,	12430,	8520,	72810,	11700,	9250,	9560,	4000,	2620,	350,	110,
12,	19800,	12970,	4970,	81350,	17410,	8240,	10050,	1100,	850,	80,
13,	8850,	15350,	4500,	4420,	92370,	15300,	10780,	6910,	890,	250,
14,	7740,	5670,	6300,	5470,	7960,	77280,	13870,	7210,	1750,	260,
15,	8520,	4720,	2170,	6560,	6040,	4580,	70400,	9670,	1430,	180,
+gp,	15070,	12170,	3840,	8670,	12490,	29100,	17910,	46000,	9010,	1520,
0 TOTALNUM,	2269350,	2918041,	2643849,	1200320,	1216889,	1063400,	1338540,	1380469,	1847871,	658930,
TONSLAND,	1111100,	1101800,	830100,	848600,	984500,	1281800,	1547700,	1955000,	1677200,	712200,
SOPCOF %,	100,	100,	100,	100,	100,	100,	100,	100,	100,	100,

1

Run title : Herring Spring-spawn (run: SEPBJA02/S02)

At 4-May-99 14:50·40

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

YEAR,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,
AGE										
0,	56120,	11930,	3050,	34710,	2930,	6590,	3060,	2010,	4300,	2010,
1,	50710,	52940,	4290,	4100,	350,	780,	360,	240,	620,	240,
2,	14190,	3320,	8510,	2040,	170,	390,	180,	120,	310,	120,
3,	18820,	630,	182,	3538,	239,	10,	327,	2325,	2210,	302,
4,	80,	1860,	102,	348,	2520,	24,	13,	544,	2360,	1216,
5,	880,	60,	124,	358,	65,	2450,	91,	0,	34,	2032,
6,	470,	330,	36,	248,	151,	26,	3067,	0,	0,	87,
7,	70,	330,	111,	69,	28,	20,	1,	1309,	42,	0,
8,	1170,	100,	113,	149,	18,	0,	0,	0,	1077,	62,
9,	3360,	1340,	36,	20,	0,	0,	0,	0,	0,	503,
10,	3600,	2620,	441,	0,	0,	0,	0,	0,	0,	0,
11,	30,	2810,	691,	49,	0,	0,	0,	0,	0,	0,
12,	20,	30,	545,	59,	0,	0,	0,	0,	0,	0,
13,	20,	10,	0,	59,	0,	0,	0,	0,	0,	0,
14,	20,	20,	2,	0,	18,	0,	0,	0,	0,	0,
15,	40,	10,	12,	0,	0,	0,	0,	0,	0,	0,
+gp,	200,	190,	0,	0,	0,	0,	0,	0,	0,	0,
0 TOTALNUM,	149800,	78530,	18245,	45748,	6489,	10291,	7099,	6548,	10953,	6572,
TONSLAND,	67800,	62300,	21100,	13161,	7017,	7619,	13713,	10436,	22706,	19824,
SOPCOF %,	100,	100,	100,	99,	100,	101,	100,	100,	100,	100,

Table 3.5.2.1 continued

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

YEAR,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,
AGE										
0,	3260,	690,	830,	2260,	12700,	3386,	2857,	1381,	1385,	1549,
1,	380,	80,	110,	110,	468,	170,	1315,	138,	633,	279,
2,	190,	40,	1190,	20,	167,	249,	20722,	309,	3577,	911,
3,	635,	641,	417,	1382,	318,	448,	2150,	53979,	1978,	6292,
4,	187,	581,	459,	789,	2119,	539,	1550,	1759,	50139,	2506,
5,	687,	228,	860,	451,	952,	6154,	1650,	1450,	1867,	55037,
6,	1122,	817,	220,	626,	618,	1820,	13000,	1550,	350,	945,
7,	33,	1584,	451,	196,	682,	1264,	5900,	10500,	706,	368,
8,	0,	44,	828,	507,	129,	1561,	5500,	7500,	2800,	596,
9,	0,	1,	35,	605,	460,	722,	6300,	4200,	1200,	1458,
10,	253,	0,	10,	12,	733,	1634,	1000,	7700,	950,	887,
11,	0,	269,	11,	4,	14,	648,	3100,	1947,	450,	282,
12,	0,	0,	96,	4,	4,	0,	5000,	6600,	783,	336,
13,	0,	0,	0,	12,	14,	0,	0,	8000,	650,	268,
14,	0,	0,	0,	0,	86,	0,	0,	0,	700,	156,
15,	0,	0,	0,	0,	0,	165,	0,	0,	45,	54,
+gp,	0,	0,	0,	0,	0,	0,	264,	247,	0,	0,
0 TOTALNUM,	6747,	4974,	5518,	6978,	19466,	18759,	70309,	107260,	68213,	71925,
TONSLAND,	12864,	18577,	13736,	16655,	23054,	53532,	169872,	225256,	127306,	135301,
SOPCOF %,	100,	100,	100,	100,	100,	100,	100,	100,	100,	100,

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

YEAR,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,
AGE										
0,	712,	102,	10,	163,	657,	43,	0,	0,	0,	0,
1,	193,	40,	337,	15,	13,	2,	0,	0,	0,	0,
2,	2520,	1554,	333,	134,	724,	810,	113,	3014,	2182,	8289,
3,	289,	1863,	844,	1259,	2841,	3250,	5759,	3436,	13045,	7032,
4,	362,	266,	278,	3310,	10687,	11009,	34646,	71362,	27095,	24237,
5,	565,	1188,	141,	498,	8727,	36392,	62281,	157100,	179578,	36831,
6,	32429,	1085,	1470,	119,	862,	16480,	63784,	94058,	199362,	176032,
7,	347,	22628,	887,	1198,	365,	1558,	23109,	40628,	76121,	126375,
8,	80,	129,	21885,	575,	2960,	814,	1551,	10341,	32649,	38148,
9,	68,	152,	250,	22568,	1863,	3733,	1585,	568,	6087,	12997,
10,	330,	204,	46,	248,	41011,	3566,	6975,	737,	2002,	4250,
11,	138,	241,	9,	64,	0,	64541,	8374,	6609,	3240,	2534,
12,	68,	65,	69,	25,	0,	283,	91188,	1757,	9052,	348,
13,	32,	18,	10,	124,	0,	46,	407,	83655,	1912,	11260,
14,	26,	59,	26,	0,	0,	10,	25,	0,	37033,	563,
15,	0,	17,	53,	0,	0,	207,	0,	0,	30,	10852,
+gp,	0,	31,	1,	0,	0,	0,	45,	0,	0,	0,
0 TOTALNUM,	38158,	29641,	26648,	30300,	70711,	142742,	299842,	473266,	589388,	459749,
TONSLAND,	103830,	86411,	84683,	104448,	232457,	479228,	905501,	1220283,	1426507,	1223131,
SOPCOF %,	100,	100,	100,	100,	100,	102,	100,	101,	100,	100,

1

Run title . Herring Spring-spawn (run: SEPBJA02/S02)

At 4-May-99 14·50:40

Table 2 Catch weights at age (kg)

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

Table 3.5.2.1 continued

Table 2 Catch weights at age (kg)

YEAR,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,	1968,
AGE										
0,	.0090,	.0060,	.0060,	.0090,	.0080,	.0090,	.0090,	.0080,	.0090,	.0100,
1,	.0300,	.0110,	.0100,	.0230,	.0260,	.0240,	.0160,	.0170,	.0150,	.0270,
2,	.0710,	.0740,	.0450,	.0550,	.0470,	.0590,	.0480,	.0400,	.0360,	.0490,
3,	.1350,	.1190,	.0870,	.0850,	.0980,	.1390,	.0890,	.0630,	.0660,	.0750,
4,	.2310,	.1880,	.1590,	.1480,	.1710,	.2190,	.2170,	.2460,	.0930,	.1080,
5,	.2590,	.2770,	.2760,	.2880,	.2750,	.2390,	.2340,	.2600,	.3050,	.1580,
6,	.2870,	.3370,	.3220,	.3330,	.2680,	.2980,	.2620,	.2650,	.3050,	.3750,
7,	.3100,	.3180,	.3720,	.3600,	.3230,	.2950,	.3310,	.3010,	.3100,	.3830,
8,	.3270,	.3630,	.3630,	.3520,	.3290,	.3390,	.3600,	.4100,	.3330,	.3640,
9,	3440,	.3790,	.3930,	.3500,	.3360,	.3500,	.3670,	.4250,	.3590,	.3820,
10,	.3600,	.3600,	.4070,	.3740,	.3410,	.3580,	.3860,	.4560,	.4130,	.4410,
11,	.3720,	.4200,	3970,	.3840,	.3580,	.3510,	.3950,	.4600,	.4460,	.4100,
12,	.3830,	.4110,	4220,	.3740,	.3850,	.3670,	.3930,	.4670,	.4010,	.4420,
13,	.3920,	.4390,	.4470,	.3940,	.3530,	.3750,	.4040,	.4460,	.4080,	.5170,
14,	.3970,	.4500,	.4650,	.3990,	.3810,	.3720,	.4010,	.4590,	.4390,	.4910,
15,	.4060,	.4440,	.4520,	.4110,	.3860,	.4270,	.4290,	.4650,	.4270,	.4640,
+gp,	.4110,	.4480,	.4520,	.4160,	.3860,	.4340,	.4370,	.4740,	.4310,	.4870,
0 SOPCOFAC,	1.0004,	1.0014,	1.0017,	.9997,	1 0003,	.9995,	.9995,	1.0001,	1.0005,	.9991,

1

Run title : Herring Spring-spawn (run: SEPBJA02/S02)

At 4-May-99 14:50:40

Table 2 Catch weights at age (kg)

YEAR,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,
AGE										
0,	0090,	.0080,	.0110,	.0110,	.0060,	.0060,	.0090,	.0070,	.0110,	.0120,
1,	0210,	.0580,	.0530,	.0290,	.0530,	.0550,	.0790,	.0620,	.0910,	.1000,
2,	.0470,	.0850,	.1210,	.0620,	.1060,	.1170,	.1690,	.1320,	.1930,	.2100,
3,	.0720,	.1050,	.1770,	.1030,	.1610,	.1680,	.2410,	.1890,	.3160,	.2740,
4,	.1050,	.1710,	.2160,	.1540,	.2130,	.2220,	.3180,	.2500,	.3500,	.4240,
5,	.1520,	.2560,	2500,	.2150,	2390,	.2490,	.3580,	.2800,	.3980,	.4540,
6,	2960,	.2160,	.2770,	.2580,	.2550,	.2650,	.3810,	.2980,	.4390,	.4950,
7,	.3760,	.2770,	.3050,	.2950,	.2770,	.2880,	.4130,	.3230,	.4950,	.5240,
8,	.3290,	.2980,	.3330,	.3220,	.2870,	.2990,	.4290,	.3360,	.5110,	.5960,
9,	.3290,	.3040,	.3530,	.3410,	.3240,	.3370,	.4840,	.3790,	.5580,	.6130,
10,	.3410,	.3050,	3660,	.3540,	.3380,	.3520,	.5060,	.3960,	.5830,	.6500,
11,	.3630,	.3090,	.3770,	.3650,	.2570,	.2670,	.3840,	.3000,	.5370,	.5900,
12,	.3850,	.3570,	.3880,	.3760,	.2570,	.3240,	4660,	.3640,	.5370,	.5900,
13,	.3770,	3480,	.3990,	.3870,	.2570,	.3240,	.4660,	.3640,	.5370,	5900,
14,	.4510,	.3570,	.4190,	.4060,	.2570,	3240,	4660,	.3640,	.5370,	5900,
15,	.4230,	.3670,	.4440,	.4300,	.2570,	.3240,	.4660,	.3640,	.5370,	.5900,
+gp,	.4290,	.3760,	.4440,	.4300,	.2570,	.3240,	.4660,	.3640,	5370,	.5900,
0 SOPCOFAC,	1.0036,	1.0030,	1.0001,	.9935,	1.0011,	1.0051,	1.0002,	1.0004,	.9991,	.9998,

Table 2 Catch weights at age (kg)

YEAR,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,
AGE										
0,	.0100,	.0120,	.0100,	0100,	0110,	0090,	.0090,	.0070,	.0100,	.0080,
1,	.0880,	1010,	.0820,	0870,	0900,	.0470,	.0220,	.0770,	.0750,	0620,
2,	.1810,	.2020,	.1630,	.1590,	.1650,	.1450,	.0220,	0970,	.0910,	0750,
3,	.2930,	.2660,	.1960,	2560,	.2170,	.2180,	.2140,	0550,	.1240,	.1240,
4,	.3590,	.3990,	.2910,	3120,	2650,	2620,	.2770,	2490,	.1730,	.1540,
5,	.4160,	4490,	.3410,	3780,	3370,	3250,	.2950,	.2940,	.2530,	.1940,
6,	.4360,	.4600,	.3680,	4150,	.3780,	.3460,	.3380,	.3120,	.2320,	.2410,
7,	.4820,	4850,	.3800,	.4350,	.4100,	.3810,	.3600,	.3520,	.3120,	.2650,
8,	.4820,	.4720,	.3970,	.4490,	.4260,	.4000,	.3810,	.3740,	.3280,	3040,
9,	.5390,	.6180,	.4360,	.4480,	.4350,	.4130,	.3970,	3980,	.3490,	.3050,
10,	.5530,	.6450,	.4500,	5060,	.4440,	4050,	.4090,	4020,	.3530,	.3170,
11,	.5180,	.6080,	.4920,	4930,	.4680,	4260,	.4170,	.4010,	.3700,	.3080,
12,	.5180,	.5940,	.4810,	.4990,	.4610,	.4150,	.4350,	4100,	.3850,	.3340,
13,	.5180,	.5940,	.4810,	4990,	.4610,	4150,	.4350,	4100,	.3850,	.3340,
14,	.5180,	.5940,	.4810,	.4990,	.4610,	.4150,	.4350,	.4100,	.3850,	.3340,
15,	.5180,	.5940,	.4810,	.4990,	.4610,	4150,	.4350,	4100,	.3850,	.3340,
+gp,	.5180,	.5940,	.4810,	.4990,	.4610,	.4150,	.4350,	.4100,	.3850,	.3340,
0 SOPCOFAC,	1.0016,	.9999,	1.0007,	1.0001,	.9981,	.9999,	.9997,	1.0010,	.9979,	.9998,

Table 3.5.2.1 continued

Table 2 Catch weights at age (kg)

YEAR,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,
AGE										
0,	.0100,	.0070,	.0070,	.0070,	.0070,	.0070,	.0070,	.0070,	.0070,	.0070,
1,	.0600,	.0780,	.0150,	.0750,	.0300,	.0630,	.0630,	.0630,	.0630,	.0630,
2,	.2040,	.1020,	.1040,	.1030,	.1060,	.1020,	.1020,	.1360,	.0890,	.1110,
3,	.1880,	.2300,	.2080,	.1910,	.1530,	.1940,	.1530,	.1360,	.1670,	.1500,
4,	.2640,	.2390,	.2500,	.2330,	.2430,	.2390,	.1920,	.1680,	.1840,	.2160,
5,	.2600,	.2660,	.2880,	.3040,	.2820,	.2800,	.2340,	.2060,	.2070,	.2210,
6,	.2820,	.3050,	.3120,	.3370,	.3200,	.3170,	.2830,	.2620,	.2320,	.2490,
7,	.3060,	.3080,	.3160,	3650,	.3300,	.3280,	.3280,	.3090,	.2770,	.2770,
8,	.3090,	.3760,	.3300,	.3610,	.3650,	.3560,	.3490,	.3370,	.3050,	.3160,
9,	.3910,	.4070,	.3440,	.3710,	.3730,	.3720,	.3560,	.3660,	.3310,	.3380,
10,	.4220,	.4120,	.3720,	.4030,	.3790,	.3900,	.3740,	.3600,	.3280,	.3740,
11,	.3640,	.4240,	.3540,	.3650,	.3800,	.3790,	.3660,	.3610,	.3440,	.3720,
12,	.4290,	.4280,	.3980,	.3940,	.3850,	.3990,	.3930,	.3670,	.3430,	.3660,
13,	.4290,	.4280,	.3980,	.4040,	.3900,	.4030,	.3870,	.3790,	.3970,	.3960,
14,	.4290,	.4280,	.3980,	.4060,	.3950,	.4050,	.4000,	.3790,	.3570,	.3770,
15,	.4290,	.4280,	.3980,	.4080,	.4000,	.4070,	.4000,	.3790,	.5100,	.4060,
+gp,	.4290,	.4280,	.3980,	.4100,	.4050,	.4050,	.4000,	.3790,	.5100,	.4060,
0 SOPCOFAC,	1.0007,	.9992,	1.0015,	1.0024,	.9981,	1.0192,	1.0000,	1.0075,	9996,	.9995,

1

Run title : Herring Spring-spawn (run: SEPBJA02/S02)

At 4-May-99 14:50·40

Table 3 Stock weights at age (kg)

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

Table 3 Stock weights at age (kg)

YEAR,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,	1968,
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,	.2320,	.2190,	.1850,	1940,	.1860,	.1850,	.1800,	.1150,
5,	.2520,	.2700,	.2500,	.2910,	.2530,	2130,	.1990,	.2190,	.2280,	.2060,
6,	.2600,	.2910,	.2920,	.3000,	.2940,	.2640,	.2360,	2220,	.2690,	.2660,
7,	.2900,	.2930,	.3020,	.3160,	.3120,	.3170,	2600,	.2490,	.2700,	.2750,
8,	.3000,	.3210,	.3040,	.3240,	.3290,	.3630,	3630,	.3060,	2940,	.2740,
9,	.3050,	.3180,	.3230,	.3260,	.3270,	.3530,	.3500,	.3540,	.3240,	.2850,
10,	.3150,	.3200,	.3220,	.3350,	.3340,	.3490,	.3700,	.3770,	.4200,	3500,
11,	.3250,	.3440,	.3210,	.3380,	.3410,	.3540,	.3600,	.3910,	.4300,	.3250,
12,	.3300,	.3490,	.3440,	.3340,	.3490,	.3570,	3780,	.3790,	.3660,	.3630,
13,	.3400,	.3700,	.3570,	.3470,	.3410,	.3590,	.3870,	.3780,	3680,	.4080,
14,	.3450,	.3790,	.3630,	.3540,	.3580,	.3650,	.3900,	.3610,	.4330,	.3880,
15,	.3550,	.3750,	.3650,	.3580,	.3750,	.4020,	.3940,	.3830,	.4140,	.3780,
+gp,	.3600,	.3800,	.3700,	.3580,	.3750,	.4020,	.3940,	.3830,	.4140,	.3780,

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Table 3.5.2.1 continued

Run title : Herring Spring-spawn (run: SEPBJA02/S02)
At 4-May-99 14:50:40

Table 3 Stock weights at age (kg)

YEAR,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,
AGE										
0,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,
1,	.0080,	.0080,	.0150,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,
2,	.0470,	.0470,	.0800,	.0700,	.0850,	.0850,	.0850,	.0850,	.0850,	.0850,
3,	.1000,	.1000,	.1000,	.1500,	.1700,	.1700,	.1810,	.1810,	.1810,	.1800,
4,	.1150,	.2090,	.1900,	.1500,	.2590,	.2590,	2590,	2590,	.2590,	.2940,
5,	.1450,	.2720,	.2250,	.1400,	.3420,	.3420,	.3420,	.3420,	.3430,	.3260,
6,	.2700,	.2300,	.2500,	.2100,	.3840,	.3840,	.3840,	.3840,	.3840,	.3710,
7,	.3000,	.2950,	.2750,	.2400,	.4090,	.4090,	.4090,	4090,	.4090,	.4090,
8,	.3060,	.3170,	.2900,	.2700,	.4040,	.4440,	.4440,	4440,	.4440,	.4610,
9,	.3080,	.3230,	.3100,	.3000,	.4610,	.4610,	.4610,	.4610,	.4610,	.4760,
10,	.3180,	.3250,	.3250,	.3250,	.5200,	.5200,	.5200,	.5200,	.5200,	.5200,
11,	.3400,	.3290,	.3350,	.3350,	.5340,	.5430,	.5430,	.5430,	.5430,	.5430,
12,	.3680,	.3800,	.3450,	.3450,	.5000,	.4820,	.4820,	.4820,	.4820,	.5000,
13,	.3600,	.3700,	.3550,	.3550,	.5000,	.4820,	.4820,	4820,	.4820,	.5000,
14,	.3930,	.3800,	.3650,	.3650,	.5000,	.4820,	.4820,	.4820,	.4820,	.5000,
15,	.3970,	.3910,	.3900,	.3900,	.5000,	.4820,	4820,	.4820,	.4820,	.5000,
+gp,	.3970,	.3910,	.3900,	.3900,	.5000,	.4820,	4820,	.4820,	.4820,	.5000,

Table 3 Stock weights at age (kg)

YEAR,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,
AGE										
0,	.0010,	0010,	.0010,	0010,	.0010,	.0010,	0010,	.0010,	.0010,	.0010,
1,	.0100,	.0100,	.0100,	0100,	.0100,	.0100,	0100,	.0100,	.0100,	.0150,
2,	.0850,	.0850,	.0850,	.0850,	.0850,	.0850,	.0230,	.0850,	.0550,	.0500,
3,	.1780,	.1750,	.1700,	.1700,	.1550,	.1400,	.1480,	.0540,	.0900,	.0980,
4,	.2320,	.2830,	.2240,	.2040,	.2490,	.2040,	.2340,	.2060,	.1430,	.1350,
5,	.3590,	.3470,	.3360,	.3030,	.3040,	.2950,	.2650,	.2650,	.2410,	.1970,
6,	.3850,	.4020,	.3780,	.3550,	.3680,	.3380,	.3120,	.2890,	.2790,	2770,
7,	.4200,	.4210,	.3870,	.3830,	.4040,	.3760,	3460,	.3390,	.2990,	.3150,
8,	.4440,	.4650,	.4080,	.3950,	.4240,	.3950,	.3700,	.3680,	.3160,	.3390,
9,	.5050,	.4650,	.3970,	.4130,	.4370,	.4070,	.3950,	.3910,	3420,	.3430,
10,	.5200,	.5200,	.5200,	.4530,	.4360,	.4130,	.3970,	.3820,	.3430,	.3590,
11,	.5510,	5340,	.5430,	.4680,	.4930,	.4220,	.4280,	.3880,	.3620,	.3650,
12,	.5000,	5000,	.5120,	5060,	.4950,	.4370,	4280,	.3950,	.3760,	.3760,
13,	.5000,	5000,	.5120,	5060,	.4950,	.4370,	4280,	.3950,	.3760,	.3760,
14,	.5000,	5000,	.5120,	5060,	.4950,	4370,	.4280,	.3950,	.3760,	.3760,
15,	.5000,	.5000,	.5120,	.5060,	.4950,	.4370,	.4280,	.3950,	.3760,	.3760,
+gp,	.5000,	.5000,	.5120,	.5060,	.4950,	.4370,	.4280,	.3950,	3760,	.3760,

Table 3 Stock weights at age (kg)

YEAR,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,
AGE										
0,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,
1,	.0150,	.0080,	.0110,	.0070,	.0080,	.0100,	.0180,	.0180,	.0180,	.0180,
2,	.1000,	.0480,	.0370,	0300,	.0250,	0250,	.0250,	.0250,	.0250,	.0250,
3,	.1540,	.2190,	.1470,	.1280,	.0810,	.0750,	.0660,	.0760,	.0960,	.0740,
4,	.1750,	.1980,	.2100,	.2240,	.2010,	.1510,	.1380,	.1180,	1180,	.1470,
5,	.2090,	.2580,	.2440,	.2960,	.2650,	.2540,	.2300,	.1880,	1740,	.1740,
6,	.2520,	2880,	.3000,	.3270,	.3230,	.3180,	.2960,	.2610,	.2290,	.2170,
7,	.3050,	.3090,	.3240,	.3550,	.3540,	.3710,	.3460,	.3160,	.2860,	.2420,
8,	.3670,	.4280,	.3360,	3450,	.3580,	.3470,	.3880,	.3460,	3230,	.2780,
9,	.3770,	.3700,	.3430,	.3670,	.3810,	.4120,	.3630,	.3740,	.3700,	.3040,
10,	.3590,	.4030,	.3820,	3410,	.3690,	.3820,	.4090,	.3900,	.3780,	.3100,
11,	.3950,	.3870,	.3660,	.3610,	.3960,	.4070,	.4140,	.3900,	.3860,	.3590,
12,	.3960,	.4400,	.4250,	.4300,	.3930,	.4100,	.4220,	.3840,	.3600,	.3400,
13,	.3960,	4400,	.4250,	.4700,	.3740,	.4100,	.4100,	.3980,	.3930,	.3440,
14,	.3960,	.4400,	.4250,	.4700,	.4030,	.4100,	.4100,	.3980,	.3910,	.3850,
15,	.3960,	.4400,	.4250,	.4700,	.4000,	.4100,	.4050,	.3980,	.3910,	.3630,
+gp,	.3960,	.4400,	.4250,	.4500,	.4000,	.4100,	.4470,	.3980,	.3910,	.3750,

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Table 3.5.2.1 continued

Run title : Herring Spring-spawn (run: SEPBJA02/S02)

At 4-May-99 14:50:40

Table 5 Proportion mature at age

YEAR,	1950,	1951,	1952,	1953,	1954,	1955,	1956,	1957,	1958,
AGE									
0,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
3,	.0000,	.0000,	.0000,	.0000,	.0000,	.0800,	.0800,	.0000,	.0800,
4,	.1000,	.1000,	.1000,	.1000,	.1000,	.2200,	.2200,	.0000,	.2200,
5,	.3000,	.3000,	.3000,	.3000,	.3000,	.3700,	.3700,	.5000,	.3700,
6,	.6000,	.6000,	.6000,	.6000,	.6000,	.8500,	.8500,	.6000,	.8500,
7,	.9000,	.9000,	.9000,	.9000,	.9000,	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,
11,	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,
13,	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,
15,	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,

Table 5 Proportion mature at age

YEAR,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,	1968,
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,	.0800,	.0400,	.0000,	.0400,	.0200,	.0000,	.0100,	0000,	.0000,
4,	.2200,	.2200,	.3500,	.1100,	0300,	.0600,	.3400,	.1500,	.0100,	.0000,
5,	.3700,	.3700,	.6800,	.6700,	3200,	2800,	.3500,	1.0000,	.2300,	.0100,
6,	.8500,	.8500,	.9400,	1.0000,	.9000,	.3200,	.7600,	.9600,	1.0000,	7600,
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,

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Run title : Herring Spring-spawn (run: SEPBJA02/S02)

At 4-May-99 14:50.40

Table 5 Proportion mature at age

YEAR,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,
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,	.1000,	.1000,	.1000,	.1000,	.0000,	.0000,
3,	.6200,	.0600,	.1000,	.0000,	.5000,	.5000,	.5000,	.5000,	.7300,	.1300,
4,	.8900,	.1300,	.2500,	.1000,	.9000,	.9000,	1.0000,	.9000,	.8900,	9000,
5,	.9500,	.3100,	.6000,	.2500,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
6,	1.0000,	.1700,	.9000,	.6000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,	.9000,	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 3.5.2.1 continued

Table 5 Proportion mature at age

YEAR,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,
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,	.1000,	.2500,	.3000,	.1000,	.1000,	.1000,	.1000,	.1000,	.1000,	.1000,
4,	.6200,	.5000,	.5000,	.4800,	.5000,	.5000,	.5000,	.2000,	.3000,	.3000,
5,	.9500,	.9700,	.9000,	.7000,	.6900,	.9000,	.9000,	.9000,	.9000,	.9000,
6,	1.0000,	1.0000,	1.0000,	1.0000,	.7100,	.9500,	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,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,
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,	.1000,	.4000,	.1000,	.1000,	.0100,	.0100,	0000,	.0000,	.0000,	.0000,
4,	.3000,	.8000,	.7000,	2000,	.3000,	.3000,	.0100,	.0100,	.3000,	.3000,
5,	.9000,	.9000,	1.0000,	.8000,	.8000,	.8000,	.8000,	.4500,	.9000,	.9000,
6,	1.0000,	.9000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	.9000,	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,

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Table 3.5.2.1.1 Survey data used in the tuning procedure, input file. For each cruise in the tuning there is a mask of 0/1 values applied to the survey data when outliers are removed.

```
(* The year for December refers to the year after (attributed to Jan 1) *)

(*
 The system is changed to surveys not named by yearclass at the
 WG meeting 1997. Keeps old stuff commented for a while.
*)

(* Numbers in milions, time of year in months          *)
(* Youngest age is 1 year, oldest age is plusgroup      *)
(* If fewer age groups than oldest, the rest is measured to 0 *)

acousticSpawn   = {
            "Spawning grounds",
            {
             {1000000,"Unit"},
             {2,    "First age in data"},
             {5,    "First age to include in tuning"},
             {2.0,  "Time of year in months"}
            },
            {
             {1988, {   0, 255,  146, 6805,  202 }},
             {1989, {  101,   5,  373,  103, 5402,  182 }},
             {1990, {  183, 187,    0,  345,  112, 4489,  146 }},
             {1991, {   44,  59,   54,   12,  354,  122, 4148,  102 }},
             {1994, {   16, 128,  676, 1375,  476,   63,   13,  140,   35, 1820 }},
             {1995, {    0, 1792, 7621, 3807, 2151,  322,   20,    1,  124,   63, 2573 }},
             {1996, {  407, 231, 7638, 11243, 2586,  957,  471,    0,    0,  165,    0, 2024 }},
             {1998, {    0,   0,  381, 1905, 10640, 6708, 1280,  434,  130,   39,    0,  175,    0, 804}},
             {1999, {  106, 1366,  337, 1286, 2979, 11791, 7534, 1912,  568,  132,    0,    0, 392,    0, 437}}
            },
            { (* Mask *)
             {1988, {  0,  0,  0,  0,  0 }},
             {1989, {  0,  0,  0,  0,  0,  0 }},
             {1990, {  0,  0,  0,  0,  0,  0,  0 }},
             {1991, {  0,  0,  0,  0,  0,  0,  1,  0 }},
             {1994, {  0,  0,  0,  1,  1,  0,  0,  0,  0,  1 }},
             {1995, {  0,  0,  0,  1,  1,  1,  0,  0,  0,  0,  1 }},
             {1996, {  0,  0,  0,  0,  1,  1,  1,  0,  0,  0,  0,  1 }},
             {1998, {  0,  0,  0,  0,  1,  1,  1,  1,  0,  0,  0,  0,  0,  1}},
             {1999, {  0,  0,  0,  0,  1,  1,  1,  1,  1,  0,  0,  0,  0,  0,  1}}
            }
           };
acousticDecember = {
           "December in Ofoten",
           {
            {1000000,"Unit"},
            {1,    "First age in data"},
            {4,    "First age to include in tuning"},
            {11 0,  "Time of year in months"}
           },
           {
            {1992, {   0,  36, 1247, 1317,  173,   16,  208,  139, 3742,   69 }},
            {1993, {  72, 1518, 2389, 3287, 1267,   13,   13,  158,   26, 4435 }},
            {1994, {   0,  16, 3708, 4124. 2593, 1096,   34,   25,  196,   29, 3239 }},
            {1995, { 380, 183, 5133, 5274, 1839, 1040,  308.   19,   13,  111,   39,  907 }},
            {1996, {   0, 1465, 3008, 13180, 5637,  994,  552,   92,    0,    7,   41,   15,  393 }},
            {1997, {   9,  73,  661, 1480. 6110, 4458, 1843,  743,   66,    0,    0,  126,    0, 842 }},
            {1998, {  65, 1207,  441, 1832, 3862, 12051, 8242, 2068,  629,  111,   14,    0,  392,    0, 220}}
           },
           { (* Mask *)
            {1992, {  0,  0,  0,  1,  0,  0,  0,  0,  1,  0 }},
            {1993, {  0,  0,  0,  1,  1,  0,  0,  0,  0,  1 }},
            {1994, {  0,  0,  0,  1,  1,  1,  0,  0,  0,  0,  1 }},
            {1995, {  0,  0,  0,  1,  1,  1,  1,  0,  0,  0,  0,  1 }},
            {1996, {  0,  0,  0,  0,  1,  1,  1,  1,  0,  0,  0,  0,  1 }},
            {1997, {  0,  0.  0,  0,  1,  1,  1,  1,  0,  0,  0,  0,  0,  1 }},
            {1998, {  0,  0,  0,  0,  1,  1,  1,  1,  1,  0,  0,  0,  0,  0,  1 }}
           }
          };
```

```
acousticJanuary = {
        "January in Ofoten",
        {
         {1000000,"Unit"},
         {2,    "First age in data"},
         {5,    "First age to include in tuning"},
         {0.012,   "Time of year in months"}
        },
        {
         {1991, {  90, 220,  70,  20, 180,  150, 5500, 440 }},
         {1992, {  0, 410,  820,  260,  60,  510, 120, 4690,  30 }},
         {1993, {  0,  61, 1905, 2048, 256,  27, 269, 182, 5691, 128 }},
         {1994, { 73, 642, 3431, 4847, 1503,  102,  29, 161, 131, 3679 }},
         {1995, {  0,  47, 3781, 4013, 2445, 1215,  42,  24, 267,  29, 4326 }},
         {1996, {  0, 315, 10442, 13557, 4312, 1271, 290,  22,  25, 200,  58, 1146 }},
         {1998, { 214, 267, 1938, 4162, 9647, 6974, 1518, 743,  16,  4,  0, 181,  7, 314 }},
         {1999, {  0, 1357,  198, 1455, 4452, 12971, 7226, 1875, 498,  15  15,  0, 156,  0, 220}}
        },
        { (* Mask *)
         {1991, {  0,  0,  0,  0,  0,  0,  1,  0 }},
         {1992, {  0,  0,  0,  0,  0,  0,  0,  1,  0 }},
         {1993, {  0,  0,  0,  1,  0,  0,  0,  0,  1,  0 }},
         {1994, {  0,  0,  0,  1,  1,  0,  0,  0,  0,  1 }},
         {1995, {  0,  0,  0,  1,  1,  1,  0,  0,  0,  0,  1 }},
         {1996, {  0,  0,  0,  0,  1,  1,  1,  0,  0,  0,  0,  1 }},
         {1998, {  0,  0,  0,  0,  1,  1,  1,  1,  0,  0,  0,  0,  0,  1 }},
         {1999, {  0,  0,  0,  0,  1,  1,  1,  1,  1,  0,  0,  0,  0,  0,  1 }}
        }
       };

acousticYoung =  {
        "Young herring in the Barents Sea",
        {
         {1000000,"Unit"},
         {1,    "First age in data"},
         {1,    "First age to include in tuning"},
         {5.5,   "Time of year in months"}
        },
        {
         {1984, { 21400 }},
         {1985, {   0, 19900 }},
         {1986, {   0,   0, 3000}},
         {1990, { 4400 }},
         {1991, { 24300, 5200 }},
         {1992, { 32600, 14000,  5700 }},
         {1993, {102700, 25800,  1500 }},
         {1994, {  6600, 59200, 18000, 1700 }},
         {1995, {  500,  7700, 8000, 1100 }},
         {1996, {   0,  210,  910,  280 }},
         {1997, {  600,   10,  400,  400,  50 }}
        }
       };
acousticNorwegian = {
        "Herring in the Norwegian Sea",
        {
         {1000000,"Unit"},
         {1,    "First age in data"},
         {3,    "First age to include in tuning"},
         {4.5,   "Time of year in months"}
        },
        {
         {1996,{ 0,  0, 4114, 22461, 13244, 4916, 2045, 424,  14,  7, 155,  0, 3134 }},
         {1997,{ 0,  0, 1169, 3599, 18867, 13546, 2473, 1771, 178,  77, 288, 415,  60, 2472 }},
         {1998,{24, 1404, 367, 1099, 4410, 16378, 10160, 2059, 804, 183, 112,  0,  0,  0, 415 }}
        },
        { (* Mask *)
         {1996,{ 0,  0,  0,  1,  1,  1,  1,  1,  0,  0,  0,  0,  1 }},
         {1997,{ 0,  0,  0,  1,  1,  1,  1,  1,  1,  0,  0,  0,  0,  1 }},
         {1998,{ 0,  0,  0,  1,  1,  1,  1,  1,  1,  1,  0,  0,  0,  0,  1 }}
        }
       };
acousticSurveys = {acousticSpawn,acousticDecember,acousticJanuary,acousticYoung,acousticNorwegian};
```

Table 3.5.4.1 Summary of tuning runs. Cat1-C4 are estimated multiplicative constants to the VPA that ensures a best possible fit to the surveys, where survey 1 is on the spawning grounds, survey 2 the December Ofoten survey, survey 3 the January Ofoten survey and survey 4 the international survey in the Norwegian Sea. F83 and F90-F92 are the estimated F-values in the last year of data for the 1983 and 1990-1992 year classes.

Run no	1	2	3	4	5	6	7	8 **
SSB 1999	11.75	11.67	13.15	12.89	12.95	11.59	9.70	13.04
SSB 1998	11.81	11.74	13.10	12.87	12.91	11.65	9.95	12.84
SSB 1997	12.47	12.40	13.69	13.46	13.48	12.27	10.75	13.24
SSB 1996	6.89	6.86	7.50	7.39	7.35	6.73	6.18	7.21
Total log likelihood	-220	-235	-268	-283	-245	-1053*	-253	-256
Log likelihood surveys	-97	-97	-97	-97	-107	-914*	-85	-118
Log likelihood tags	-124	-139	-124	-138	-138	-139	-139	-139
Survey variance	2.90	2.88	2.78	2.78	2.64	----------	2.49	2.51
Cat1	0.54	0.55	0.49	0.50	0.48		0.55	0.48
Cat2	0.45	0.49	0.41	0.41	0.42		0.51	0.43
Cat3	0.58	0.58	0.53	0.54	0.54		0.59	0.56
Cat4	0.83	0.83	0.75	0.76	0.77		0.95	0.78
F83	0.10	0.10	0.08	0.08	0.09	0.10	0.11	0.09
F90	0.13	0.13	0.11	0.12	0.12	0.13	0.15	0.12
F91	0.10	0.10	0.09	0.09	0.10	0.11	0.12	0.10
F92	0.09	0.09	0.08	0.08	0.08	0.09	0.10	0.08
CV surveys	0.38	0.38	0.37	0.37	0.36	0.38	0.37	0.36
Tagging survival	0.44	0.44	0.46	0.46	0.46	0.43	0.42	0.45

*) Likelihood based on different data
**) F93 estimated at 0.06

Table 3.5.5.1

NORWEGIAN SPRING-SPAWNING HERRING recruits as 3-year-olds
6,26,2

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	25242	177	-11	-11	-11	-11	-11
1984	1059	34	-11	-11	-11	-11	-11
1985	6576	23	-11	-11	-11	-11	-11
1986	354	0.25	-11	-11	-11	-11	-11
1987	1021	0.25	-11	-11	54	-11	70
1988	2467	3	-11	-11	-11	-11	820
1989	6235	58	-11	5200	-11	1247	1905
1990	11375	31	24300	14000	676	2389	3431
1991	30957	119	32600	25800	7621	3708	3781
1992	39204	105	102700	59200	7638	5133	10442
1993	-11	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	-11	-11	-11
1997	-11	39	9500	-11	-11	-11	-11
1998	-11	59	-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.

Yearclass = 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

Yearclass = 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

Yearclass = 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

Yearclass = 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

Yearclass = 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

Yearclass = 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: SEPBJA02/S02)

At 4-May-99 14:50:40

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

Table 8 Fishing mortality (F) at age

YEAR,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,	1968,
AGE										
0,	.0689,	.1068,	.1360,	.3679,	.0451,	.0621,	.5500,	.1392,	.1961,	.7997,
1,	.7079,	1421,	.4130,	.2658,	.9250,	.0665,	.1786,	.7192,	1.7622,	.7439,
2,	.5811,	.6955,	.0835,	.0871,	.4621,	.5117,	.1927,	.2389,	.3323,	6937,
3,	.1058,	.7587,	.1583,	.1028,	.1240,	.0612,	.6737,	.3137,	.5034,	3.2066,
4,	.0781,	.1698,	.0927,	.0525,	.0588,	.0840,	.1789	.4085,	1.1192,	4.5599,
5,	.0769,	.1041,	.0497,	.0442,	0424,	.1886,	.1573,	.5321,	.8593,	4.7169,
6,	.1160,	.0916,	.0705,	.1097,	.0310,	.1391,	2997,	.5982,	1.3102,	1.8048,
7,	.0990,	0985,	.0928,	.1213,	0698,	.0309,	.2829,	7536,	1 6834,	1.2122,
8,	.1150,	.0804,	.0802,	.0718,	.1458,	.0725,	.4469,	1.3073,	1.4826,	9377,
9,	.0987,	.1278,	.0675,	.0976,	.0700,	.2847,	.2423,	.9790,	1.3296,	1.5726,
10,	.1140,	.1357,	.1117,	.0907,	.2443,	.3074,	3472,	1.3436,	1.4501,	1.2945,
11,	1475,	.1449,	.1118,	.1256,	2153,	.3356,	.8375,	1.0666,	1 0905,	1.3198,
12,	1777,	.2138,	.1117,	.1666,	2626,	.2856,	.6639,	.5451,	1.2609,	.7483,
13,	.2207,	.1925,	.1012,	.1302,	.2729,	.3657,	.6932,	1.3723,	1.1286,	1.9490,
14,	.1678,	.2032,	.1069,	.1628,	.3429,	.3634,	.6227,	1.4701,	1.9718,	1.2342,
15,	.1127,	.1387,	.1057,	.1466,	.2569,	3195,	.6204,	1.1880,	1.4777,	1 3620,
+gp,	1127,	.1387,	.1057,	.1466,	2569,	.3195,	.6204,	1.1880,	1.4777,	1.3620,
0 FBAR 5-14,	.1333,	.1393,	.0904,	.1121,	.1697,	2374,	.4594,	.9968,	1 3567,	1 6790,

1

Run title : Herring Spring-spawn (run: SEPBJA02/S02)

At 4-May-99 14:50.40

Traditional vpa using screen input for terminal F

Table 8 Fishing mortality (F) at age

YEAR,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,
AGE										
0,	.0921,	.3347,	.2441,	.7939,	.0035,	.0118,	.0159,	.0030,	.0130,	.0050,
1,	1.6597,	.2501,	.4295,	1.7489,	.0323,	.0023,	.0016,	.0031,	.0023,	.0018,
2,	1.7485,	1.2205,	.1204,	.9309,	.7288,	.0937,	.0013,	.0013,	.0099,	.0011,
3,	2.0406,	.5307,	.2855,	.0983,	.4069,	.1233,	.1561,	.0300,	.0432,	.0171,
4,	.2604,	1.4843,	.1419,	1.2887,	.0893,	.0609,	.2243,	.3938,	.0365,	.0286,
5,	.7590,	.2998,	.3119,	.9578,	.8552,	.1115,	.3212,	.0022,	.0354,	.0379,
6,	.6023,	.6842,	.2794,	1.8090,	1.5110,	.9654,	.1880,	.0005,	.0026,	.1147,
7,	.3507,	1.1086,	.4857,	1.2502,	1.1078,	.7734,	.0379,	.1083,	.2687,	.0030,
8,	.4226,	1.1726,	1.6241,	2.9486,	1.3527,	.0086,	.0141,	.0090,	.1158,	.7485,
9,	.6056,	1.1825,	2.5238,	1.7610,	.0147,	.0192,	.0101,	.0083,	.0106,	.0690,
10,	.6310,	1.3751,	1.9510,	.0388,	0293,	.0174,	.0228,	.0119,	.0097,	.0124,
11,	.6261,	1 5563,	2.2737,	1.5553,	.0471,	.0351,	.0206,	.0271,	.0140,	.0114,
12,	.8732,	3.9033,	1.8357,	2.0473,	.0090,	.0576,	.0424,	.0244,	.0325,	.0165,
13,	.3927,	1.6255,	.2170,	1.1132,	.0136,	.0105,	.0714,	.0517,	.0291,	.0391,
14,	.8364,	.8120,	2.7742,	.3301,	1.2442,	.0161,	.0124,	.0899,	.0636,	.0350,
15,	.5776,	1.4061,	2.0280,	2.1062,	.6032,	.0165,	.0190,	.0146,	.1157,	.0793,
+gp,	.5776,	1.4061,	2.0280,	2.1062,	.6032,	.0165,	.0190,	.0146,	.1157,	.0793,
0 FBAR 5-14,	.6100,	1.3720,	1.4276,	1.3812,	.6185,	.2015,	.0741,	.0333,	.0582,	.1088,

Table 3.5.6.1 continued

Table 8 Fishing mortality (F) at age

YEAR,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,
AGE										
0,	.0041,	.0068,	.0116,	.0148,	.0005,	.0032,	.0004,	.0039,	.0014,	.0006,
1,	.0023,	.0002,	.0027,	.0038,	.0076,	.0000,	.0031,	.0001,	.0044,	.0007,
2,	.0035,	.0006,	.0090,	.0012,	.0144,	.0101,	.0050,	.0018,	.0033,	.0157,
3,	.0103,	.0210,	.0110,	.0186,	.0340,	.0701,	.1654,	.0233,	.0203,	.0104,
4,	.0124,	.0110,	.0178,	.0247,	.0340,	.0705,	.3436,	.1875,	.0258,	.0307,
5,	.0192,	.0179,	.0193,	.0207,	.0357,	.1241,	.3000,	.5875,	.2929,	.0338,
6,	.0251,	.0272,	.0205,	.0166,	.0339,	.0841,	.3902,	.4797,	.2553,	.2236,
7,	.0544,	.0426,	.0179,	.0216,	.0214,	.0853,	.3991,	.5920,	.3946,	.4372,
8,	.0035,	.0920,	.0268,	.0238,	.0169,	.0592,	.5933,	1.2624,	.2892,	.6414,
9,	.0021,	.0333,	.0916,	.0233,	.0257,	.1171,	.3356,	1.2486,	.6434,	.2270,
10,	.0427,	.0025,	.6964,	.0399,	.0338,	.1136,	.2228,	.8276,	1.0630,	1.4616,
11,	.0146,	.0553,	.3917,	.5462,	.0575,	.0359,	.3073,	.8219,	.0924,	1.0588,
12,	.0134,	.0173,	.0240,	.1999,	2.2586,	.0005,	.3953,	2.0562,	.9048,	.0876,
13,	.0195,	.0158,	.0205,	.0035,	3.2773,	.2937,	.0006,	2.1502,	1.5336,	.8806,
14,	.0474,	.0232,	.0186,	.0243,	.0298,	.2407,	.5035,	.0007,	1.4985,	4.7159,
15,	.0422,	.0581,	.0276,	.0221,	.0290,	.0698,	.3792,	1.3962,	.4168,	.3809,
+gp,	.0422,	.0581,	.0276,	.0221,	.0290,	.0698,	.3792,	1.3962,	.4168,	.3809,
0 FBAR 5-14,	.0242,	.0327,	.1327,	.0920,	.5791,	.1154,	.3448,	1.0027,	.6968,	.9768,

Table 8 Fishing mortality (F) at age

YEAR,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	FBAR 96-98
AGE											
0,	.0001,	.0000,	.0000,	.0000,	.0001,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0002,	.0000,	.0001,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0151,	.0039,	.0003,	.0001,	.0001,	.0001,	.0001,	.0064,	.0086,	.0099,	.0083,
3,	.0088,	.0198,	.0037,	.0022,	.0027,	.0011,	.0016,	.0063,	.0495,	.0497,	.0352,
4,	.0007,	.0095,	.0035,	.0170,	.0217,	.0122,	.0141,	.0231,	.0593,	.1160,	.0661,
5,	.0082,	.0027,	.0059,	.0073,	.0539,	.0908,	.0841,	.0778,	.0706,	.1015,	.0833,
6,	.0238,	.0185,	.0038,	.0058,	.0148,	.1293,	.2147,	.1671,	.1269,	.0870,	.1270,
7,	.1131,	.0198,	.0179,	.0036,	.0210,	.0318,	.2544,	.1952,	.1875,	.1050,	.1626,
8,	.1497,	.0531,	.0227,	.0137,	.0105,	.0567,	.0381,	.1634,	.2246,	.1280,	.1720,
9,	.1275,	.4384,	.1310,	.0279,	.0533,	.0156,	.1413,	.0167,	.1295,	.1240,	.0901,
10,	.0694,	.6363,	.2163,	.1762,	.0615,	.1297,	.0348,	.0856,	.0713,	.1190,	.0920,
11,	.9170,	.0632,	.0455,	.4904,	.0001,	.1231,	.4722,	.0398,	.6045,	.1150,	.2531,
12,	.7529,	1.6749,	.0219,	.1664,	.0012,	.3500,	.2418,	.1598,	.0667,	.1100,	.1122,
13,	.0102,	.4237,	1.6296,	.0471,	.0009,	.9446,	1.1850,	.3442,	.2470,	.1050,	.2321,
14,	.1734,	.0220,	1.9531,	.0483,	.0000,	.1000,	4.0282,	.0007,	.2378,	.1010,	.1131,
15,	.0897,	.1527,	.0238,	.0286,	.0592,	.1152,	.0000,	.3033,	.2616,	.0960,	.2203,
+gp,	.0897,	.1527,	.0238,	.0286,	.0592,	.1152,	.0000,	.3033,	.2616,	.0960,	
0 FBAR 5-14,	.2345,	.3353,	.4048,	.0987,	.0217,	.1972,	.6695,	.1250,	.1966,	.1096,	

1

Table 3.5.6.2

Run title : Herring Spring-spawn (run: SEPBJA02/S02)

At 4-May-99 14:50:40

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,
AGE									
0,	7473748,	1439078,	938987,	835771,	397029,	237538,	274748,	236506,	278105,
1,	262358,	3007097,	575014,	298670,	304949,	97946,	65556,	79447,	66148,
2,	142205,	94445,	1175816,	178474,	90917,	81693,	22821,	14702,	13263,
3,	108558,	54134,	35944,	470458,	68991,	31748,	30092,	5554,	4649,
4,	40165,	90878,	46533,	30573,	398069,	56914,	26464,	24821,	4564,
5,	49706,	32858,	74664,	39490,	25883,	329323,	46426,	20449,	17911,
6,	85994,	41064,	26685,	58688,	33055,	20954,	264511,	37050,	16177,
7,	79923,	68950,	33821,	21705,	47220,	26265,	16977,	204017,	29773,
8,	19630,	62971,	54572,	27216,	17923,	36105,	20851,	13593,	157223,
9,	28024,	16159,	48627,	43450,	22398,	14241,	28532,	16060,	11033,
10,	32020,	23300,	13194,	38355,	34489,	17428,	11467,	22112,	12644,
11,	25817,	26545,	19288,	10623,	29357,	25611,	13211,	8660,	17343,
12,	56309,	21416,	21893,	15808,	8572,	21008,	19308,	9537,	6636,
13,	61467,	46664,	17436,	17846,	12761,	6559,	16201,	14095,	7087,
14,	9515,	49494,	37816,	14018,	14488,	10052,	5102,	12433,	10750,
15,	25669,	7575,	39378,	30821,	11151,	11239,	7869,	3809,	9483,
+gp,	56929,	48758,	47336,	73642,	59483,	51748,	42150,	27995,	25443,
TOTAL,	8558030,	5131388,	3207003,	2205606,	1576736,	1076371,	912285,	750839,	688233,

0

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

YEAR,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,	1968,
AGE										
0,	4053428,	1913386,	732827,	177125,	1646403,	905561,	79326,	453493,	35822,	46386,
1,	56387,	1538203,	699104,	260052,	49847,	639834,	345996,	18608,	160413,	11970,
2,	10738,	11294,	542520,	188063,	81052,	8036,	243395,	117663,	3686,	11196,
3,	1618,	2442,	2291,	202892,	70081,	20760,	1959,	81610,	37672,	1075,
4,	3839,	1253,	984,	1683,	157563,	53282,	16807,	859,	51327,	19600,
5,	3763,	3056,	910,	772,	1374,	127875,	42166,	12097,	492,	14426,
6,	14389,	2999,	2370,	745,	636,	1134,	91146,	31010,	6115,	179,
7,	13096,	11028,	2355,	1901,	575,	531,	849,	58137,	14675,	1420,
8,	23826,	10209,	8601,	1847,	1450,	461,	443,	551,	23551,	2346,
9,	126308,	18279,	8109,	6833,	1480,	1078,	369,	244,	128,	4602,
10,	8841,	98496,	13846,	6524,	5334,	1188,	698,	249,	79,	29,
11,	9744,	6790,	74015,	10658,	5128,	3596,	752,	425,	56,	16,
12,	13068,	7237,	5056,	56966,	8091,	3559,	2213,	280,	126,	16,
13,	4799,	9417,	5030,	3892,	41507,	5355,	2302,	980,	140,	31,
14,	5384,	3312,	6686,	3913,	2940,	27193,	3198,	991,	214,	39,
15,	8596,	3918,	2327,	5171,	2862,	1796,	16274,	1476,	196,	26,
+gp,	15205,	10102,	4117,	6834,	5918,	11413,	4140,	7024,	1235,	216,
TOTAL,	4373023,	3651422,	2111146,	935870,	2082240,	1812650,	852032,	785697,	335927,	113573,

0
1

Run title : Herring Spring-spawn (run: SEPBJA02/S02)

At 4-May-99 14 50.40

Traditional vpa using screen input for terminal F

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

YEAR,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,
AGE										
0,	96074,	6207,	2098,	9074,	127017,	85007,	29426,	100187,	50393,	61332,
1,	8476,	35624,	1806,	668,	1668,	51461,	34155,	11775,	40609,	20224,
2,	2313,	655,	11279,	478,	47,	657,	20874,	13864,	4773,	16472,
3,	2275,	164,	79,	4065,	77,	9,	243,	8476,	5629,	1921,
4,	37,	254,	83,	51,	3172,	44,	7,	179,	7080,	4641,
5,	177,	25,	50,	62,	12,	2497,	36,	5,	104,	5875,
6,	111,	71,	16,	31,	20,	4,	1922,	22,	4,	86,
7,	25,	52,	31,	10,	4,	4,	1,	1371,	19,	4,
8,	364,	15,	15,	16,	3,	1,	2,	1,	1059,	13,
9,	791,	205,	4,	3,	1,	1,	1,	1,	1,	812,
10,	822,	371,	54,	0,	0,	1,	0,	1,	1,	1,
11,	7,	376,	81,	7,	0,	0,	1,	0,	1,	1,
12,	4,	3,	68,	7,	1,	0,	0,	0,	0,	1,
13,	7,	1,	0,	9,	1,	1,	0,	0,	0,	0,
14,	4,	4,	0,	0,	3,	1,	1,	0,	0,	0,
15,	10,	1,	1,	0,	0,	1,	1,	1,	0,	0,
+gp,	49,	27,	0,	0,	0,	1,	1,	1,	0,	0,
TOTAL,	111544,	44057,	15664,	14482,	132026,	139688,	86671,	135885,	109674,	111382,

0

Table 3.5.6.2 continued

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

YEAR,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,
AGE										
0,	121686,	15393,	10919,	23297,	3776878,	158922,	982208,	53994,	154504,	368879,
1,	24812,	49273,	6216,	4388,	9333,	1534783,	64404,	399160,	21867,	62731,
2,	8207,	10064,	20028,	2520,	1777,	3766,	623986,	26104,	162278,	8852,
3,	6690,	3325,	4089,	8069,	1024,	712,	1516,	252416,	10594,	65757,
4,	1626,	5699,	2803,	3481,	6817,	851,	572,	1106,	212255,	8935,
5,	3881,	1382,	4851,	2370,	2923,	5671,	683,	349,	789,	178044,
6,	4868,	3277,	1168,	4096,	1998,	2428,	4312,	435,	167,	507,
7,	66,	4086,	2745,	985,	3467,	1662,	1921,	2512,	232,	111,
8,	3,	54,	3370,	2321,	830,	2921,	1314,	1109,	1196,	135,
9,	5,	3,	42,	2824,	1951,	702,	2370,	625,	270,	771,
10,	652,	4,	2,	33,	2375,	1636,	538,	1458,	154,	122,
11,	1,	538,	4,	1,	28,	1976,	1257,	370,	549,	46,
12,	1,	1,	438,	2,	0,	22,	1641,	796,	140,	431,
13,	1,	1,	1,	368,	2,	0,	19,	951,	88,	49,
14,	0,	0,	1,	0,	316,	0,	0,	17,	95,	16,
15,	0,	0,	0,	0,	0,	264,	0,	0,	14,	18,
+gp,	0,	0,	0,	0,	0,	0,	90,	35,	0,	0,
0 TOTAL,	172500,	93101,	56678,	54758,	3809718,	1716317,	1686829,	741438,	565193,	695403,

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

YEAR,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	1999,	GMST 50-96	AMST 50-96
AGE													
0,	928154,	1692833,	4606964,	5834210,	880443,	435030,	234266,	771446,	0,	0,	0,	236400,	931321,
1,	149879,	377315,	688248,	1873052,	2372005,	357921,	176867,	95246,	313646,	0,	0,	83000,	361948,
2,	25487,	60925,	153403,	279800,	761525,	964384,	145520,	71909,	38724,	127519,	0,	25658,	136892,
3,	3543,	10207,	24674,	62348,	113750,	309568,	392039,	59157,	29050,	15610,	51335,	8446,	54999,
4,	56014,	3022,	8613,	21159,	53547,	97642,	266147,	336898,	50598,	23795,	12784,	5794,	45296,
5,	7458,	48179,	2577,	7387,	17905,	45098,	83021,	225864,	283358,	41041,	18238,	3705,	31722,
6,	148145,	6367,	41358,	2205,	6312,	14603,	35447,	65691,	179856,	227258,	31915,	2390,	22991,
7,	349,	124504,	5380,	35461,	1887,	5353,	11044,	24613,	47841,	136354,	179305,	1561,	18322,
8,	62,	268,	105065,	4548,	30410,	1590,	4463,	7370,	17428,	34138,	105663,	1013,	13870,
9,	61,	46,	219,	88403,	3861,	25900,	1293,	3698,	5387,	11983,	25852,	624,	11294,
10,	529,	46,	25,	165,	73998,	3151,	21946,	966,	3130,	4074,	9111,	406,	9561,
11,	24,	425,	21,	18,	119,	59892,	2382,	18243,	764,	2509,	3113,	266,	7957,
12,	14,	8,	343,	17,	9,	103,	45577,	1279,	15090,	359,	1925,	161,	6979,
13,	339,	6,	1,	289,	13,	8,	62,	30802,	938,	12150,	277,	92,	6523,
14,	17,	289,	3,	0,	237,	11,	3,	16,	18791,	631,	9415,	47,	4651,
15,	0,	13,	244,	0,	0,	204,	8,	0,	14,	12751,	491,	27,	4051,
+gp,	0,	24,	5,	0,	0,	0,	0,	0,	0,	0,	9970,		
0 TOTAL,	1320078,	2324476,	5637146,	8209058,	4316021,	2320458,	1420086,	1713196,	1004615,	650170,	459393,		

1

Table 3.5.6.3

Run title : Herring Spring-spawn (run: SEPBJA02/S02)

At 4-May-99 14:50:40

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,
AGE									
0,	74737,	14391,	9390,	8358,	3970,	2375,	2747,	2365,	2781,
1,	20989,	240568,	46001,	23894,	24396,	7836,	5244,	6356,	5292,
2,	66836,	44389,	552635,	83883,	42731,	38396,	10726,	6910,	6234,
3,	108558,	54134,	35944,	470458,	68991,	31748,	30092,	5554,	4649,
4,	81936,	185391,	94927,	62369,	812061,	110983,	54252,	33756,	9311,
5,	114323,	75574,	171727,	90828,	59530,	701457,	106781,	46624,	43345,
6,	219285,	104712,	68046,	149653,	84290,	54480,	658632,	94478,	47236,
7,	219789,	189613,	93008,	59690,	129854,	72230,	46685,	534523,	87831,
8,	56926,	182615,	158259,	78926,	51977,	104703,	60469,	39420,	460663,
9,	85474,	49285,	148313,	132523,	68313,	43434,	87023,	48982,	33650,
10,	100863,	73395,	41561,	120818,	108642,	54899,	36121,	69654,	39829,
11,	83905,	86272,	62687,	34524,	95412,	83235,	42936,	28146,	57231,
12,	185821,	70672,	72246,	52166,	28286,	69326,	63717,	31472,	22562,
13,	208988,	158658,	59283,	60675,	43388,	22302,	55083,	47924,	24451,
14,	32827,	170756,	130466,	48363,	49985,	34680,	17603,	42893,	37841,
15,	92923,	27421,	142548,	111573,	40366,	40685,	28485,	13788,	34139,
+gp,	207790,	177966,	172778,	268794,	217113,	188878,	153848,	102182,	92867,
0 TOTALBIO,	1961971,	1905812,	2059817,	1857493,	1929304,	1661648,	1460445,	1155025,	1009911,

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

YEAR,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,	1968,
AGE										
0,	40534,	19134,	7328,	1771,	16464,	9056,	793,	4535,	358,	464,
1,	4511,	123056,	55928,	20804,	3988,	51187,	27680,	1489,	12833,	958,
2,	5047,	5308,	254985,	88390,	38094,	3777,	114396,	55302,	1732,	5262,
3,	1618,	2442,	2291,	202893,	70081,	20760,	1959,	81610,	37672,	1075,
4,	7832,	2555,	2283,	3685,	291492,	103368,	31261,	1590,	92389,	22540,
5,	9482,	8252,	2275,	2247,	3477,	272374,	83911,	26492,	1121,	29718,
6,	37412,	8726,	6922,	2235,	1869,	2993,	215104,	68842,	16450,	477,
7,	37980,	32312,	7112,	6008,	1793,	1682,	2208,	144762,	39622,	3905,
8,	71477,	32772,	26148,	5986,	4769,	1675,	1607,	1685,	69240,	6428,
9,	385239,	58128,	26191,	22275,	4839,	3807,	1292,	863,	416,	13116,
10,	27850,	315187,	44585,	21854,	17816,	4145,	2583,	940,	331,	102,
11,	31669,	23357,	237588,	36023,	17486,	12729,	2706,	1660,	241,	52,
12,	43124,	25257,	17392,	190267,	28236,	12704,	8363,	1061,	460,	59,
13,	16315,	34841,	17957,	13504,	141538,	19225,	8908,	3706,	514,	125,
14,	18574,	12553,	24268,	13851,	10527,	99253,	12471,	3576,	926,	151,
15,	30517,	14692,	8492,	18513,	10732,	7221,	64121,	5655,	811,	97,
+gp,	54738,	38387,	15234,	24467,	22192,	45879,	16313,	26900,	5113,	818,
0 TOTALBIO,	823918,	756960,	756979,	674772,	685393,	671834,	595675,	430667,	280231,	85347,

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Run title : Herring Spring-spawn (run: SEPBJA02/S02)

At 4-May-99 14:50:40

Traditional vpa using screen input for terminal F

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

YEAR,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,
AGE										
0,	961,	62,	21,	91,	1270,	850,	294,	1002,	504,	613,
1,	678,	2850,	271,	67,	167,	5146,	3416,	1178,	4061,	2022,
2,	1087,	308,	9023,	334,	40,	558,	17743,	11785,	4057,	14002,
3,	2275,	164,	79,	6098,	130,	16,	440,	15341,	10189,	3458,
4,	43,	532,	157,	76,	8215,	114,	18,	463,	18337,	13643,
5,	256,	68,	112,	87,	41,	8538,	122,	17,	356,	19153,
6,	300,	164,	40,	66,	78,	17,	7381,	85,	16,	320,
7,	76,	154,	85,	25,	18,	16,	6,	5606,	78,	15,
8,	1113,	49,	43,	44,	10,	6,	7,	5,	4700,	58,
9,	2435,	662,	13,	8,	3,	3,	5,	6,	5,	3863,
10,	2614,	1207,	176,	1,	2,	3,	2,	5,	6,	5,
11,	23,	1238,	271,	22,	1,	2,	3,	2,	4,	5,
12,	13,	12,	236,	25,	6,	1,	1,	2,	2,	3,
13,	24,	5,	0,	33,	4,	5,	1,	1,	2,	1,
14,	15,	15,	1,	0,	13,	3,	4,	1,	1,	2,
15,	39,	5,	6,	0,	0,	3,	3,	4,	0,	1,
+gp,	193,	104,	0,	0,	0,	3,	3,	4,	0,	1,
0 TOTALBIO,	12145,	7599,	10532,	6977,	10000,	15283,	29448,	35506,	42318,	57164,

Table 3.5.6.3 continued

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

	YEAR,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,
	AGE										
	0,	1217,	154,	109,	233,	37769,	1589,	9822,	540,	1545,	3689,
	1,	2481,	4927,	622,	439,	933,	153478,	6440,	39916,	2187,	9410,
	2,	6976,	8555,	17024,	2142,	1511,	3201,	143517,	22188,	89253,	4426,
	3,	11908,	5819,	6952,	13718,	1586,	997,	2243,	136305,	9535,	64442,
	4,	3772,	16128,	6278,	7102,	16975,	1737,	1337,	2278,	303525,	12062,
	5,	13934,	4795,	16301,	7180,	8886,	16731,	1810,	925,	1901,	350746,
	6,	18744,	13174,	4416,	14541,	7352,	8206,	13453,	1258,	466,	1403,
	7,	278,	17204,	10623,	3773,	14008,	6250,	6647,	8516,	694,	350,
	8,	14,	251,	13752,	9167,	3519,	11539,	4861,	4082,	3780,	456,
	9,	26,	12,	168,	11664,	8524,	2858,	9361,	2443,	924,	2644,
	10,	3390,	23,	11,	151,	10354,	6758,	2135,	5570,	529,	439,
	11,	4,	2871,	20,	4,	136,	8339,	5380,	1437,	1986,	167,
	12,	4,	3,	2242,	11,	2,	98,	7023,	3143,	527,	1619,
	13,	3,	3,	3,	1862,	8,	0,	82,	3757,	329,	183,
	14,	1,	2,	3,	2,	1562,	0,	0,	65,	359,	61,
	15,	1,	1,	2,	2,	2,	1152,	0,	0,	54,	69,
	+gp,	1,	1,	2,	2,	2,	1,	383,	137,	0,	0,
0	TOTALBIO,	62754,	73925,	78528,	71995,	113130,	222934,	214495,	232562,	417592,	452169,

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

	YEAR,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,
	AGE										
	0,	9282,	16928,	46070,	58342,	8804,	4350,	2343,	7714,	0,	0,
	1,	22482,	30185,	75707,	131114,	189760,	35792,	31836,	17144,	56456,	0,
	2,	25487,	29244,	56759,	83940,	190381,	241096,	36380,	17977,	9681,	31880,
	3,	5456,	22354,	36271,	79806,	92138,	232177,	258746,	44959,	27888,	11551,
	4,	98025,	5984,	18087,	47397,	107630,	147440,	367283,	397539,	59706,	34979,
	5,	15588,	124301,	6287,	21866,	47449,	114549,	190949,	424624,	493043,	71411,
	6,	373325,	18337,	124073,	7210,	20388,	46437,	104923,	171452,	411870,	493151,
	7,	1064,	384719,	17430,	125885,	6679,	19860,	38211,	77778,	136824,	329977,
	8,	227,	1147,	353019,	15691,	108868,	5517,	17317,	25501,	56294,	94903,
	9,	230,	170,	750,	324437,	14712,	106708,	4694,	13829,	19933,	36429,
	10,	1898,	186,	97,	563,	273052,	12036,	89761,	3769,	11831,	12628,
	11,	96,	1643,	77,	64,	472,	243761,	9862,	71148,	2947,	9006,
	12,	54,	37,	1458,	74,	37,	421,	192334,	4910,	54323,	1221,
	13,	1344,	24,	6,	1358,	47,	33,	255,	122591,	3686,	41795,
	14,	69,	1273,	13,	1,	956,	44,	11,	65,	73472,	2428,
	15,	0,	55,	1035,	2,	1,	837,	34,	0,	55,	46286,
	+gp,	0,	105,	19,	2,	1,	0,	0,	0,	0,	0,
0	TOTALBIO,	554628,	636693,	737159,	897752,	1061374,	1211059,	1344938,	1401002,	1418009,	1217644,

1

Table 3.5.6.4

Run title : Herring Spring-spawn (run: SEPBJA02/S02)

At 4-May-99 14:50:40

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,
AGE									
0,	0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	0,	0,	0,	0,	0,	0,	0,	0,	0,
2,	0,	0,	0,	0,	0,	0,	0,	0,	0,
3,	0,	0,	0,	0,	0,	2494,	2361,	0,	365,
4,	8031,	18178,	9338,	6134,	79681,	23924,	11632,	0,	2009,
5,	33648,	22205,	50292,	26768,	17486,	253913,	38628,	22772,	15690,
6,	128696,	61620,	39993,	87861,	49424,	45343,	545487,	55460,	39312,
7,	193150,	166707,	81908,	52702,	113774,	70582,	45659,	520778,	85895,
8,	55829,	177955,	154693,	77404,	50796,	102267,	58910,	38606,	450687,
9,	83911,	48296,	144835,	129497,	66621,	42503,	84833,	47824,	32913,
10,	98989,	72021,	40670,	117631,	105456,	53399,	35121,	67982,	38804,
11,	82352,	84626,	61452,	33791,	92272,	80917,	41559,	27406,	55634,
12,	182363,	69234,	70784,	51061,	27539,	67548,	61743,	30551,	21842,
13,	204510,	155357,	58003,	59424,	42365,	21749,	53644,	46643,	23788,
14,	32087,	166896,	127825,	47269,	48731,	33841,	17096,	41747,	37004,
15,	91121,	26825,	139410,	109056,	39250,	39663,	27700,	13447,	33356,
+gp,	203759,	174099,	168974,	262730,	211109,	184134,	149608,	99659,	90738,
0 TOTSPBIO,	1398442,	1244018,	1148177,	1061325,	944504,	1022277,	1173980,	1012876,	928038,

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

YEAR,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,	1968,
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,	126,	178,	89,	0,	2727,	407,	0,	779,	0,	0,
4,	1684,	544,	780,	397,	8564,	6059,	10285,	226,	814,	0,
5,	3429,	2977,	1516,	1476,	1091,	73726,	28480,	24745,	233,	183,
6,	30965,	7240,	6364,	2178,	1652,	931,	156291,	61324,	14215,	298,
7,	37046,	31519,	6942,	5847,	1754,	1652,	2114,	132254,	32985,	3408,
8,	69608,	32026,	25553,	5854,	4630,	1638,	1514,	1457,	58810,	5766,
9,	375776,	56536,	25627,	21730,	4734,	3645,	1243,	771,	358,	11041,
10,	27125,	306308,	43433,	21334,	17127,	3959,	2458,	810,	282,	88,
11,	30741,	22678,	231448,	35044,	16859,	12126,	2452,	1470,	213,	45,
12,	41734,	24355,	16943,	184337,	27095,	12162,	7710,	990,	400,	54,
13,	15722,	33668,	17512,	13130,	135677,	18259,	8188,	3183,	453,	101,
14,	17993,	12118,	23653,	13425,	10021,	94287,	11543,	3041,	749,	131,
15,	29726,	14274,	8278,	17972,	10304,	6890,	59367,	4947,	690,	83,
+gp,	53319,	37294,	14849,	23752,	21307,	43775,	15103,	23531,	4345,	703,
0 TOTSPBIO,	734991,	581715,	422987,	346478,	263541,	279513,	306746,	259527,	114547,	21901,

1

Run title · Herring Spring-spawn (run. SEPBJA02/S02)

At 4-May-99 14.50.40

Traditional vpa using screen input for terminal F

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

YEAR,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,	1978,
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,	3,	51,	1621,	1077,	0,	0,
3,	1133,	9,	8,	0,	62,	8,	213,	7534,	7296,	442,
4,	37,	59,	38,	7,	7218,	100,	18,	395,	16018,	12061,
5,	222,	20,	64,	19,	37,	8318,	116,	16,	350,	18796,
6,	278,	26,	34,	32,	66,	15,	7135,	84,	16,	312,
7,	72,	136,	80,	19,	16,	14,	6,	5463,	75,	14,
8,	1051,	43,	36,	32,	9,	5,	7,	5,	4577,	53,
9,	2258,	580,	10,	6,	3,	3,	5,	6,	5,	3779,
10,	2418,	1036,	143,	1,	2,	3,	2,	5,	6,	4,
11,	22,	1044,	212,	19,	1,	2,	3,	2,	4,	5,
12,	12,	8,	193,	20,	6,	1,	1,	2,	2,	3,
13,	23,	4,	0,	29,	4,	5,	1,	1,	2,	1,
14,	13,	13,	1,	0,	12,	3,	4,	1,	1,	2,
15,	36,	5,	5,	0,	0,	3,	3,	4,	0,	1,
+gp,	180,	89,	0,	0,	0,	3,	3,	4,	0,	1,
0 TOTSPBIO,	7754,	3072,	823,	185,	7440,	8534,	9138,	14598,	28351,	35475,

Table 3.5.6.4 continued

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

YEAR,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,
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,	1172,	1430,	2052,	1349,	156,	98,	217,	13396,	937,	6342,
4,	2301,	7935,	3087,	3350,	8333,	850,	637,	440,	89471,	3554,
5,	13015,	4574,	14424,	4941,	6019,	14651,	1557,	773,	1637,	309921,
6,	18418,	12943,	4342,	14300,	5125,	7615,	12746,	1182,	447,	1352,
7,	273,	16876,	10446,	3709,	13770,	6105,	6292,	7907,	657,	331,
8,	13,	245,	13511,	9009,	3460,	11300,	4513,	3545,	3618,	422,
9,	25,	12,	164,	11464,	8375,	2783,	8917,	2124,	854,	2547,
10,	3325,	22,	10,	148,	10166,	6582,	2056,	5051,	469,	373,
11,	4,	2813,	19,	4,	133,	8186,	5140,	1304,	1938,	148,
12,	4,	3,	2203,	11,	2,	96,	6650,	2521,	474,	1581,
13,	3,	3,	3,	1834,	5,	0,	81,	2985,	278,	166,
14,	1,	2,	3,	2,	1534,	0,	0,	64,	304,	38,
15,	1,	1,	2,	2,	2,	1127,	0,	0,	51,	65,
+gp,	1,	1,	2,	2,	2,	1,	364,	118,	0,	0,
0 TOTSPBIO,	38558,	46861,	50269,	50126,	57082,	59393,	49170,	41411,	101135,	326839,

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

YEAR,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,
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,	537,	8791,	3572,	7860,	907,	2287,	0,	0,	0,	0,
4,	28968,	4712,	12468,	9322,	31739,	43520,	3613,	3907,	17541,	10218,
5,	13809,	110176,	6190,	17220,	37193,	89459,	149224,	186778,	434056,	62674,
6,	366890,	16228,	122179,	7098,	20055,	45158,	101165,	166101,	400622,	481601,
7,	1036,	340419,	17140,	123966,	6565,	19502,	36697,	75139,	132284,	321670,
8,	220,	1124,	346976,	15436,	107135,	5405,	16994,	24714,	54224,	92301,
9,	224,	160,	729,	318718,	14416,	104955,	4559,	13601,	19383,	35444,
10,	1857,	172,	94,	545,	267338,	11704,	88117,	3681,	11572,	12293,
11,	87,	1609,	76,	60,	465,	237193,	9267,	69811,	2733,	8770,
12,	50,	31,	1433,	72,	36,	400,	184944,	4760,	53158,	1189,
13,	1323,	23,	5,	1331,	46,	29,	223,	116680,	3543,	40742,
14,	67,	1251,	11,	1,	942,	43,	7,	64,	70677,	2368,
15,	0,	54,	1017,	2,	1,	815,	34,	0,	53,	45161,
+gp,	0,	102,	19,	2,	1,	0,	0,	0,	0,	0,
0 TOTSPBIO,	415068,	484850,	511907,	501634,	486839,	560471,	594843,	665237,	1199846,	1114431,

1

Table 3.5.6.5

Run title : Herring Spring-spawn (run: SEPBJA02/S02)

At 4-May-99 14:50:41

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,	747374528,	19619720,	13984440,	933000,	.0667,	.0536,
1951,	143907872,	19058122,	12440190,	1278400,	.1028,	.0623,
1952,	93898736,	20598168,	11481774,	1254800,	.1093,	.0673,
1953,	83577048,	18574948,	10613264,	1090600,	.1028,	.0646,
1954,	39702940,	19293044,	9445042,	1644500,	.1741,	.1083,
1955,	23753766,	16616486,	10222784,	1359800,	.1330,	.0928,
1956,	27474766,	14604454,	11739810,	1659400,	.1413,	.1202,
1957,	23650592,	11550270,	10128766,	1319500,	.1303,	.1009,
1958,	27810500,	10099110,	9280376,	986600,	.1063,	.0960,
1959,	405342656,	8239181,	7349921,	1111100,	.1512,	.1333,
1960,	191338576,	7569599,	5817150,	1101800,	.1894,	.1393,
1961,	73282688,	7569781,	4229869,	830100,	.1962,	.0904,
1962,	17712450,	6747726,	3464779,	848600,	.2449,	.1121,
1963,	164640160,	6853931,	2635414,	984500,	.3736,	.1697,
1964,	90556040,	6718337,	2795131,	1281800,	.4586,	.2374,
1965,	7932618,	5956751,	3067464,	1547700,	.5046,	.4594,
1966,	45349292,	4306677,	2595275,	1955000,	.7533,	.9968,
1967,	3582244,	2802310,	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,	8500676,	152834,	85341,	7619,	.0893,	.2015,
1975,	2942588,	294481,	91377,	13713,	.1501,	.0741,
1976,	10018746,	355060,	145980,	10436,	.0715,	.0333,
1977,	5039342,	423184,	283511,	22706,	.0801,	.0582,
1978,	6133164,	571644,	354752,	19824,	.0559,	.1088,
1979,	12168616,	627544,	385577,	12864,	.0334,	.0242,
1980,	1539331,	739250,	468611,	18577,	.0396,	.0327,
1981,	1091881,	785283,	502691,	13736,	.0273,	.1327,
1982,	2329739,	719953,	501261,	16655,	.0332,	.0920,
1983,	377687968,	1131299,	570824,	23054,	.0404,	.5791,
1984,	15892212,	2229345,	593929,	53532,	.0901,	.1154,
1985,	98220904,	2144953,	491698,	169872,	.3455,	.3448,
1986,	5399436,	2325615,	414106,	225256,	.5440,	1.0027,
1987,	15450380,	4175923,	1011349,	127306,	.1259,	.6968,
1988,	36887848,	4521683,	3268388,	135301,	.0414,	.9768,
1989,	92815440,	5546285,	4150682,	103830,	.0250,	.2345,
1990,	169283312,	6366928,	4848499,	86411,	.0178,	.3353,
1991,	460696704,	7371595,	5119077,	84683,	.0165,	.4048,
1992,	583420992,	8977518,	5016334,	104448,	.0208,	.0987,
1993,	88044336,	10613738,	4868385,	232457,	.0477,	.0217,
1994,	43503000,	12110586,	5604710,	479228,	.0855,	.1972,
1995,	23426612,	13449378,	5948435,	905501,	.1522,	.6695,
1996,	77144512,	14010032,	6652366,	1220283,	.1834,	.1250,
1997,	0,	14180096,	11998462,	1426507,	.1189,	.1966,
1998,	0,	12176444,	11144312,	1223131,	.1098,	.1096,
Arith. Mean ,	89330848,	6818475,	4232028,	622141,	.4869,	.3758,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		

1

Table 3.5.6.6 Summary

	RECRUITS Age 3	TOT BIO	SP BIO	LANDINGS	Y/SSB	FBAR 5-14	FW 5-14
1950	10855816	17994092	13984440	933000	0.0667	0.0536	0.0584
1951	5413445	16064644	12440190	1278400	0.1028	0.0623	0.0696
1952	3594390	14517918	11481774	1254800	0.1093	0.0673	0.0728
1953	47045816	17413606	10613264	1090600	0.1028	0.0646	0.0663
1954	6899104	18582072	9445042	1644500	0.1741	0.1083	0.1124
1955	3174835	16130418	10222784	1359800	0.1330	0.0928	0.0783
1956	3009160	14417276	11739810	1659400	0.1413	0.1202	0.1099
1957	555352	11393960	10128766	1319500	0.1303	0.1009	0.1026
1958	464887	9956042	9280376	986600	0.1063	0.0960	0.0787
1959	161775	7738261	7349921	1111100	0.1512	0.1333	0.1129
1960	244166	6094614	5817150	1101800	0.1894	0.1393	0.1359
1961	229051	4387368	4229869	830100	0.1962	0.0904	0.1046
1962	20289262	5638076	3464779	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	3693425	2595275	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	1.6790	3.4499
1969	227478	94191	77541	67800	0.8744	0.6100	0.5949
1970	16366	43788	30718	62300	2.0281	1.3720	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	806947	691812	501261	16655	0.0332	0.0920	0.0202
1983	102350	729171	570824	23054	0.0404	0.5791	0.0294
1984	71228	646663	593929	53532	0.0901	0.1154	0.0918
1985	151564	547160	491698	169872	0.3455	0.3448	0.3831
1986	25241628	1699171	414106	225256	0.5440	1.0027	1.0756
1987	1059403	3246076	1011349	127306	0.1259	0.6968	0.4086
1988	6575709	4346440	3268388	135301	0.0414	0.9768	0.0379
1989	354271	4973776	4150682	103830	0.0250	0.2345	0.0237
1990	1020720	5603354	4848499	86411	0.0178	0.3353	0.0157
1991	2467439	5586236	5119077	84683	0.0165	0.4048	0.0174
1992	6234831	6243559	5016334	104448	0.0208	0.0987	0.0201
1993	11375000	6724278	4868385	232457	0.0477	0.0217	0.0458
1994	30956850	9298202	5604710	479228	0.0855	0.1972	0.0930
1995	39203920	12743790	5948435	905501	0.1522	0.6695	0.1498
1996	5915695	13581674	6652366	1220283	0.1834	0.1250	0.1221
1997	2905020	13518722	11998462	1426507	0.1189	0.1966	0.1097
1998	1560954	11857646	11144312	1223131	0.1098	0.1096	0.0983
Mean	5206728	5526017	3890761	609620	0.4987	0.3855	
0 Units	(Thousands)	(Tonnes	(Tonnes	(Tonnes)			

Table 3.6.1.1

The SAS System

21:17 Wednesday, May 5, 1999

Herring Norwegian Spring-spawners

Prediction with management option table: Input data

Year: 1999								
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	5133500.0	0.1500	0.0000	0.1000	0.1000	0.102	0.0497	159.000
4	1278400.0	0.1500	0.3000	0.1000	0.1000	0.150	0.1160	200.000
5	1823800.0	0.1500	0.9000	0.1000	0.1000	0.223	0.1015	214.000
6	3191500.0	0.1500	1.0000	0.1000	0.1000	0.240	0.0870	241.000
7	17930500	0.1500	1.0000	0.1000	0.1000	0.264	0.1050	277.000
8	10566300	0.1500	1.0000	0.1000	0.1000	0.283	0.1280	311.000
9	2585200.0	0.1500	1.0000	0.1000	0.1000	0.315	0.1240	335.000
10	911100.00	0.1500	1.0000	0.1000	0.1000	0.345	0.1190	351.000
11	311300.00	0.1500	1.0000	0.1000	0.1000	0.386	0.1150	358.000
12	192500.00	0.1500	1.0000	0.1000	0.1000	0.386	0.1100	355.000
13	27700.000	0.1500	1.0000	0.1000	0.1000	0.386	0.1050	397.000
14	941500.00	0.1500	1.0000	0.1000	0.1000	0.382	0.1010	367.000
15	49100.000	0.1500	1.0000	0.1000	0.1000	0.382	0.0960	406.000
16+	997000.00	0.1500	1.0000	0.1000	0.1000	0.407	0.0960	406.000
Unit	Thousands	-	-	-	-	Kilograms	-	Grams

Year: 2000								
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	3655000.0	0.1500	0.0000	0.1000	0.1000	0.088	0.0497	159.000
4	.	0.1500	0.3000	0.1000	0.1000	0.149	0.1160	200.000
5	.	0.1500	0.9000	0.1000	0.1000	0.199	0.1015	214.000
6	.	0.1500	1.0000	0.1000	0.1000	0.229	0.0870	241.000
7	.	0.1500	1.0000	0.1000	0.1000	0.253	0.1050	277.000
8	.	0.1500	1.0000	0.1000	0.1000	0.281	0.1280	311.000
9	.	0.1500	1.0000	0.1000	0.1000	0.310	0.1240	335.000
10	.	0.1500	1.0000	0.1000	0.1000	0.328	0.1190	351.000
11	.	0.1500	1.0000	0.1000	0.1000	0.373	0.1150	358.000
12	.	0.1500	1.0000	0.1000	0.1000	0.363	0.1100	355.000
13	.	0.1500	1.0000	0.1000	0.1000	0.365	0.1050	397.000
14	.	0.1500	1.0000	0.1000	0.1000	0.384	0.1010	367.000
15	.	0.1500	1.0000	0.1000	0.1000	0.373	0.0960	406.000
16+	.	0.1500	1.0000	0.1000	0.1000	0.391	0.0960	406.000
Unit	Thousands	-	-	-	-	Kilograms	-	Grams

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	5908000.0	0.1500	0.0000	0.1000	0.1000	0.088	0.0497	159.000
4	.	0.1500	0.3000	0.1000	0.1000	0.149	0.1160	200.000
5	.	0.1500	0.9000	0.1000	0.1000	0.199	0.1015	214.000
6	.	0.1500	1.0000	0.1000	0.1000	0.229	0.0870	241.000
7	.	0.1500	1.0000	0.1000	0.1000	0.253	0.1050	277.000
8	.	0.1500	1.0000	0.1000	0.1000	0.281	0.1280	311.000
9	.	0.1500	1.0000	0.1000	0.1000	0.310	0.1240	335.000
10	.	0.1500	1.0000	0.1000	0.1000	0.328	0.1190	351.000
11	.	0.1500	1.0000	0.1000	0.1000	0.373	0.1150	358.000
12	.	0.1500	1.0000	0.1000	0.1000	0.363	0.1100	355.000
13	.	0.1500	1.0000	0.1000	0.1000	0.365	0.1050	397.000
14	.	0.1500	1.0000	0.1000	0.1000	0.384	0.1010	367.000
15	.	0.1500	1.0000	0.1000	0.1000	0.373	0.0960	406.000
16+	.	0.1500	1.0000	0.1000	0.1000	0.391	0.0960	406.000
Unit	Thousands	-	-	-	-	Kilograms	-	Grams

Notes: Run name : MANBJA04
Date and time: 05MAY99:21:18

Table 3.6.2.1 The SAS System Herring Norwegian Spring-spawners Prediction with management option table 21:17 Wednesday, May 5, 1999

Year: 1999					Year: 2000					Year: 2001	
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
1.0920	0.1196	11729974	10735840	1301999	0.0000	0.0000	10039836	9124506	0	10196729	9138910
.	.	.	.	.	0.0500	0.0055	.	9119039	60694	10140632	9079537
.	.	.	.	.	0.1000	0.0110	.	9113575	121037	10084867	9020553
.	.	.	.	.	0.1500	0.0164	.	9108114	181030	10029435	8961958
.	.	.	.	.	0.2000	0.0219	.	9102656	240675	9974331	8903748
.	.	.	.	.	0.2500	0.0274	.	9097202	299976	9919556	8845921
.	.	.	.	.	0.3000	0.0329	.	9091752	358932	9865105	8788474
.	.	.	.	.	0.3500	0.0383	.	9086304	417548	9810978	8731405
.	.	.	.	.	0.4000	0.0438	.	9080860	475824	9757173	8674712
.	.	.	.	.	0.4500	0.0493	.	9075419	533763	9703687	8618390
.	.	.	.	.	0.5000	0.0548	.	9069981	591367	9650519	8562440
.	.	.	.	.	0.5500	0.0603	.	9064547	648637	9597667	8506857
.	.	.	.	.	0.6000	0.0657	.	9059116	705576	9545129	8451639
.	.	.	.	.	0.6500	0.0712	.	9053688	762186	9492903	8396784
.	.	.	.	.	0.7000	0.0767	.	9048263	818469	9440986	8342290
.	.	.	.	.	0.7500	0.0822	.	9042842	874426	9389378	8288154
.	.	.	.	.	0.8000	0.0876	.	9037424	930059	9338077	8234374
.	.	.	.	.	0.8500	0.0931	.	9032010	985372	9287079	8180947
.	.	.	.	.	0.9000	0.0986	.	9026598	1040364	9236385	8127872
.	.	.	.	.	0.9500	0.1041	.	9021190	1095039	9185992	8075145
.	.	.	.	.	1.0000	0.1096	.	9015785	1149398	9135897	8022764
.	.	.	.	.	1.0500	0.1150	.	9010384	1203443	9086100	7970728
.	.	.	.	.	1.1000	0.1205	.	9004985	1257176	9036598	7919033
.	.	.	.	.	1.1500	0.1260	.	8999590	1310598	8987390	7867678
.	.	.	.	.	1.2000	0.1315	.	8994198	1363712	8938474	7816661
.	.	.	.	.	1.2500	0.1369	.	8988810	1416520	8889848	7765978
.	.	.	.	.	1.3000	0.1424	.	8983425	1469023	8841510	7715629
.	.	.	.	.	1.3500	0.1479	.	8978043	1521223	8793459	7665610
.	.	.	.	.	1.4000	0.1534	.	8972664	1573122	8745693	7615919
.	.	.	.	.	1.4500	0.1588	.	8967288	1624721	8698211	7566555
.	.	.	.	.	1.5000	0.1643	.	8961916	1676023	8651009	7517515
.	.	.	.	.	1.5500	0.1698	.	8956547	1727030	8604088	7468797
.	.	.	.	.	1.6000	0.1753	.	8951181	1777742	8557445	7420399
.	.	.	.	.	1.6500	0.1808	.	8945819	1828162	8511078	7372318
.	.	.	.	.	1.7000	0.1862	.	8940459	1878291	8464986	7324554
.	.	.	.	.	1.7500	0.1917	.	8935103	1928131	8419167	7277102
.	.	.	.	.	1.8000	0.1972	.	8929750	1977685	8373620	7229963
.	.	.	.	.	1.8500	0.2027	.	8924401	2026953	8328343	7183132
.	.	.	.	.	1.9000	0.2081	.	8919054	2075937	8283334	7136609
.	.	.	.	.	1.9500	0.2136	.	8913711	2124639	8238591	7090392
.	.	.	.	.	2.0000	0.2191	.	8908371	2173061	8194114	7044477
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANBJA04 Date and time : 05MAY99:21:18 Computation of ref. F: Simple mean, age 5 - 14 Basis for 1999 : TAC constraints

Table 3.10.1 Medium-term simulation output. Average catch in the period 2000-2004, for different parameters in harvest control rule.

Ybar(00-04)		F level 0.100	0.125	0.150	0.175
	1	0.75	0.82	0.87	0.90
Maximum catch	1.25	0.80	0.90	0.97	1.03
	1.5	0.82	0.94	1.03	1.11

Table 3.10.2 Medium-term simulation output. Average catch in the period 2000-2009, for different parameters in harvest control rule.

Ybar(00-09)		F level 0.100	0.125	0.150	0.175
	1	0.66	0.71	0.75	0.77
Maximum catch	1.25	0.69	0.76	0.81	0.85
	1.5	0.71	0.79	0.84	0.90

Table 3.10.3 Medium-term simulation output. Average difference between maximum and minimum yield for each run in the period 2000-2004, for different parameters in harvest control rule.

Ybar(00-04)		F level 0.100	0.125	0.150	0.175
	1	0.48	0.42	0.35	0.30
Maximum catch	1.25	0.64	0.64	0.60	0.55
	1.5	0.75	0.82	0.82	0.81

Table 3.10.4 Medium-term simulation output. Average difference between maximum and minimum yield for each run in the period 2000-2009, for different parameters in harvest control rule.

Ybar(00-09)		F level 0.100	0.125	0.150	0.175
	1	0.66	0.64	0.62	0.60
Maximum catch	1.25	0.85	0.88	0.89	0.89
	1.5	0.99	1.08	1.12	1.14

Table 3.10.5 Medium-term simulation output. Probability of SSB falling below B_{pa}=5.0 million tonnes in the period 2000-2004.

P(00-04)		F level 0.100	0.125	0.150	0.175
	1	0.37	0.45	0.48	0.55
Maximum catch	1.25	0.40	0.51	0.58	0.63
	1.5	0.42	0.53	0.65	0.69

Table 3.10.6 Medium-term simulation output. Probability of SSB falling below B_{pa}=5.0 million tonnes during the period 2000-2009.

P(00-09)		F level 0.100	0.125	0.150	0.175
	1	0.72	0.77	0 79	0.82
Maximum catch	1.25	0.74	0.82	0.85	0.87
	1.5	0.75	0.83	0.89	0.91

Table 3.10.7 Medium-term simulation output. Probability of SSB falling below B_{lim}=2.5 million tonnes in the period 2000-2004.

P(00-04)		F level 0.100	0.125	0.150	0.175
	1	0.00	0.00	0.00	0.00
Maximum catch	1.25	0.00	0.00	0.00	0.01
	1.5	0.00	0.00	0.00	0.01

Table 3.10.8 Medium-term simulation output. Probability of SSB falling below Blim=2.5 million tonnes in the period 2000-2009.

P(00-09)		F level 0.100	0.125	0.150	0.175
Maximum catch	1	0.06	0.13	0.16	0.20
	1.25	0.08	0.15	0.19	0.23
	1.5	0.09	0.14	0.19	0.25

Table 3.10.9 Medium-term simulation output. For the periods 2000-2004 and 2000-2009: Average catch, difference between maximum and minimum catch and risk of SSB falling below B_{pa}=5 million tonnes and B_{lim}=2.5 million tonnes for various strategies of reducing F at SSB levels below B_{pa}=5 million tonnes, with F=0.15 and a catch ceiling of 1.5 million tonnes.

	Ybar (00-04)	Ybar(00-09)	P(04)B_{lim}	P(09)B_{lim}	P(04)B_{pa}	P(09)B_{pa}	Diff (04)	Diff (09)
No change below B_{pa}	1.05	0.91	0.03	0.38	0.64	0.88	0.79	1.05
Linearly to 0.05 at 2.5 and 0.05 below	1.03	0.84	0.00	0.19	0.65	0.89	0.82	1.12
Linearly to zero at 3.75	1.01	0.78	0.00	0.03	0.64	0.89	0.88	1.24

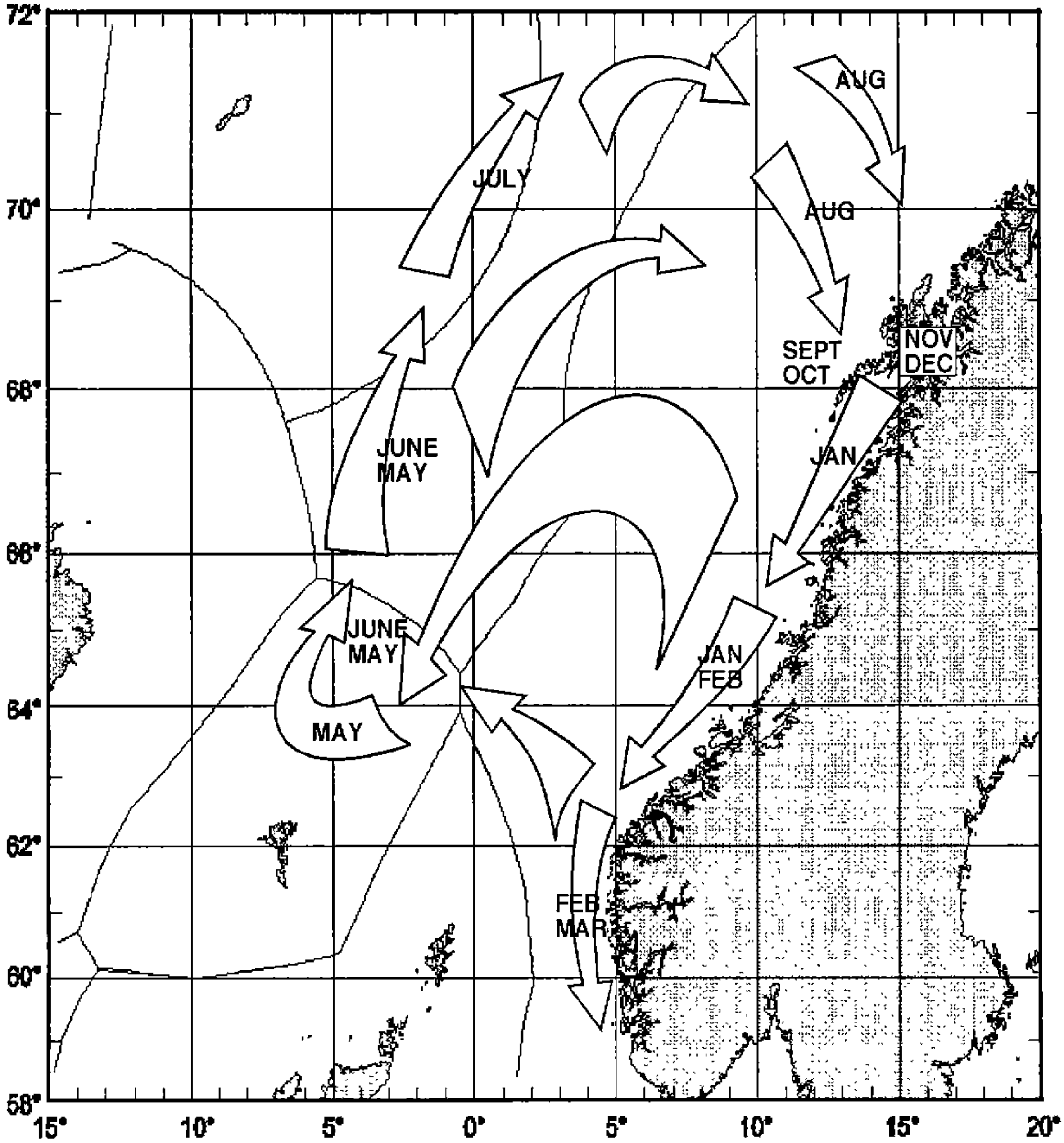


Figure 3.1.2.2.1 The migration pattern of Norwegian spring spawning herring (arrows) during 1998. Dates indicate the time of year and the general area in which the fishery took place at the time (See also figures 8.1.1.1 - 8.1.1.5).

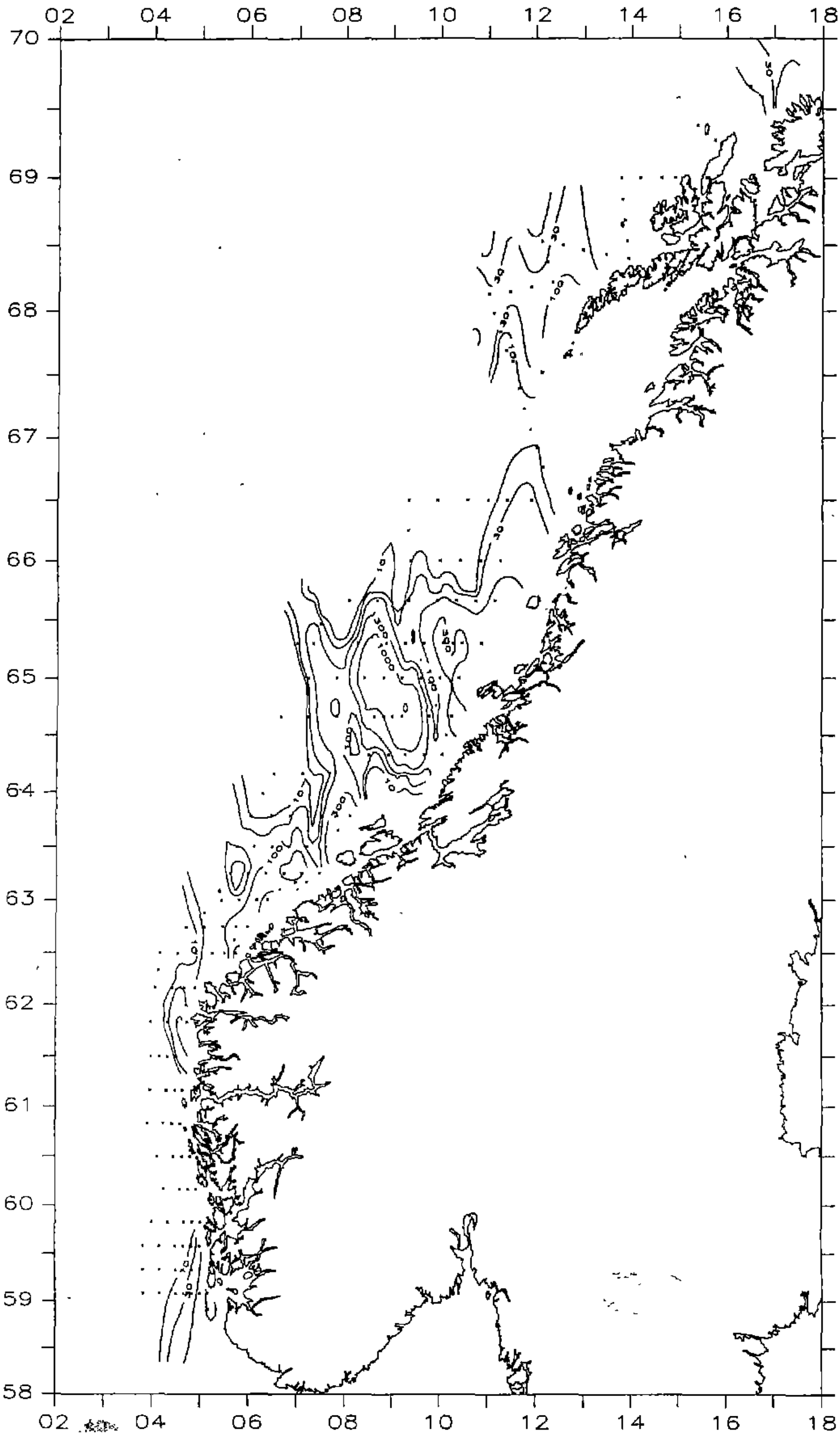


Figure 3.3.5.1 Norwegian spring spawning herring. Distribution of herring larvae in April 1999.

Figure 3.5.4.1 Histogram from Run 2 of cumulative density function values for the survey terms in the likelihood function in 0.1 width bins from 0.0 to 1.0, bin number is stated on the x-axis. The upper part of each bar originates from the 50% lowest points, lower part from the 50% highest points.

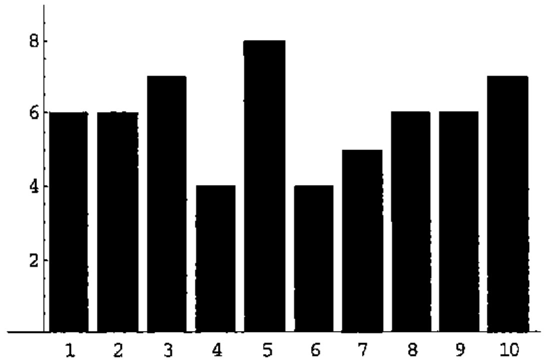


Figure 3.5.4.2 Variation of the log-likelihood function when each parameter is varied 50% to each side of the maximum likelihood estimate. Parameter numbering as in the beginning of section 3.5.4.

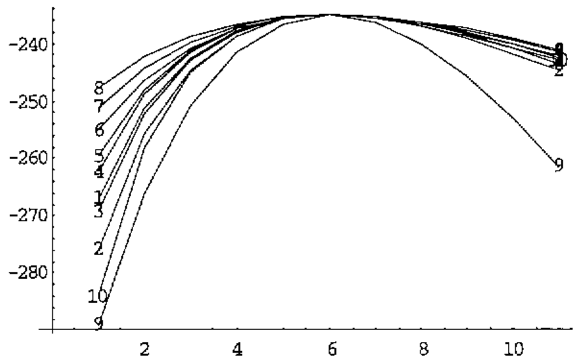
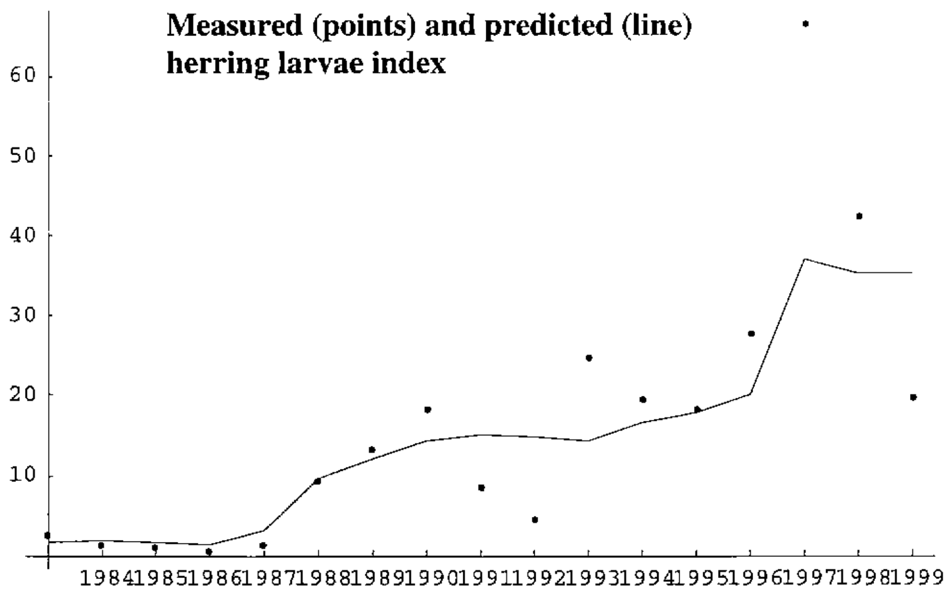


Figure 3.5.4.3 The herring larvae index as used in some exploratory tuning runs and the prediction of the index from the spawning stock resulting from Run 4.



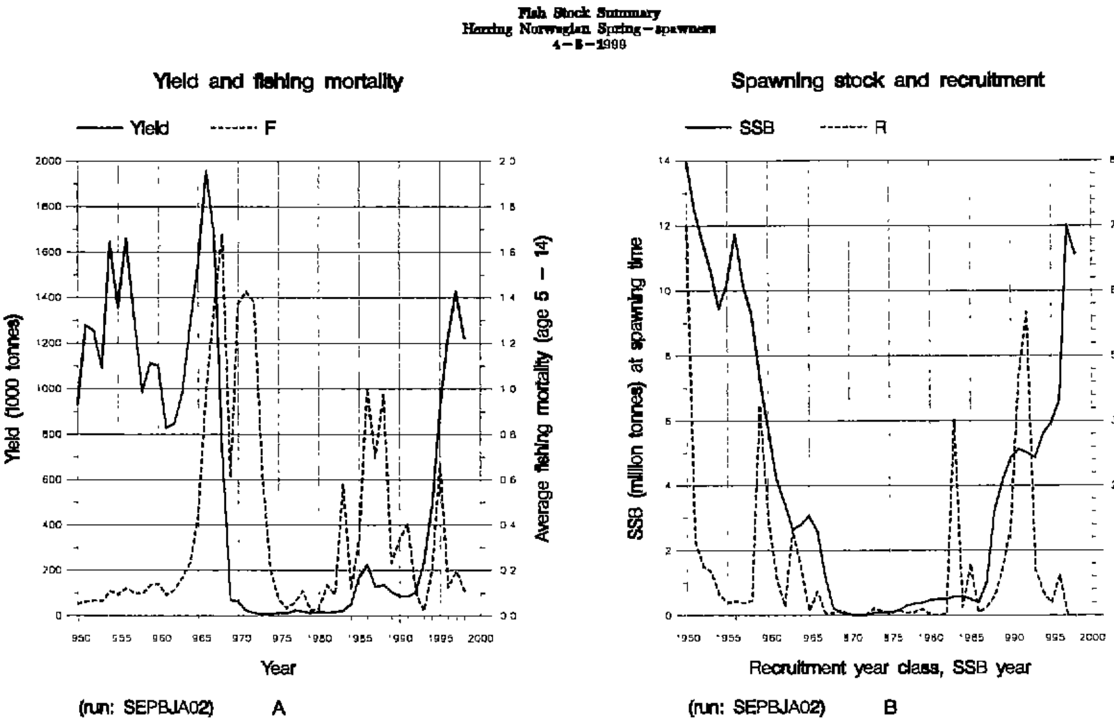


Figure 3.5.6.1

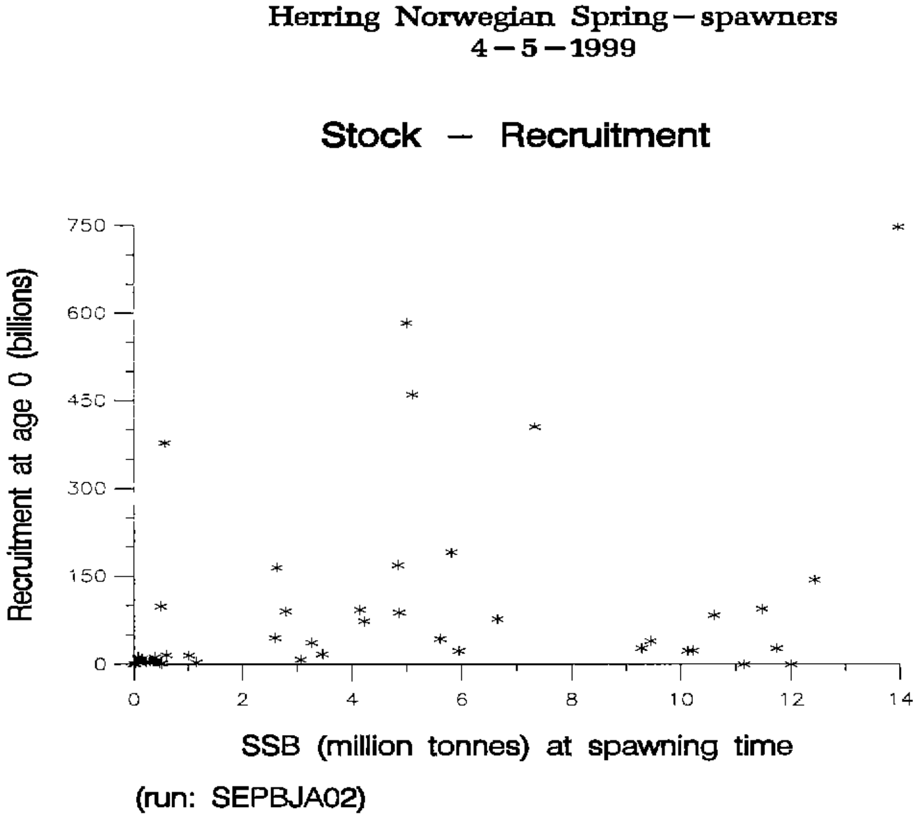


Figure 3.5.6.2

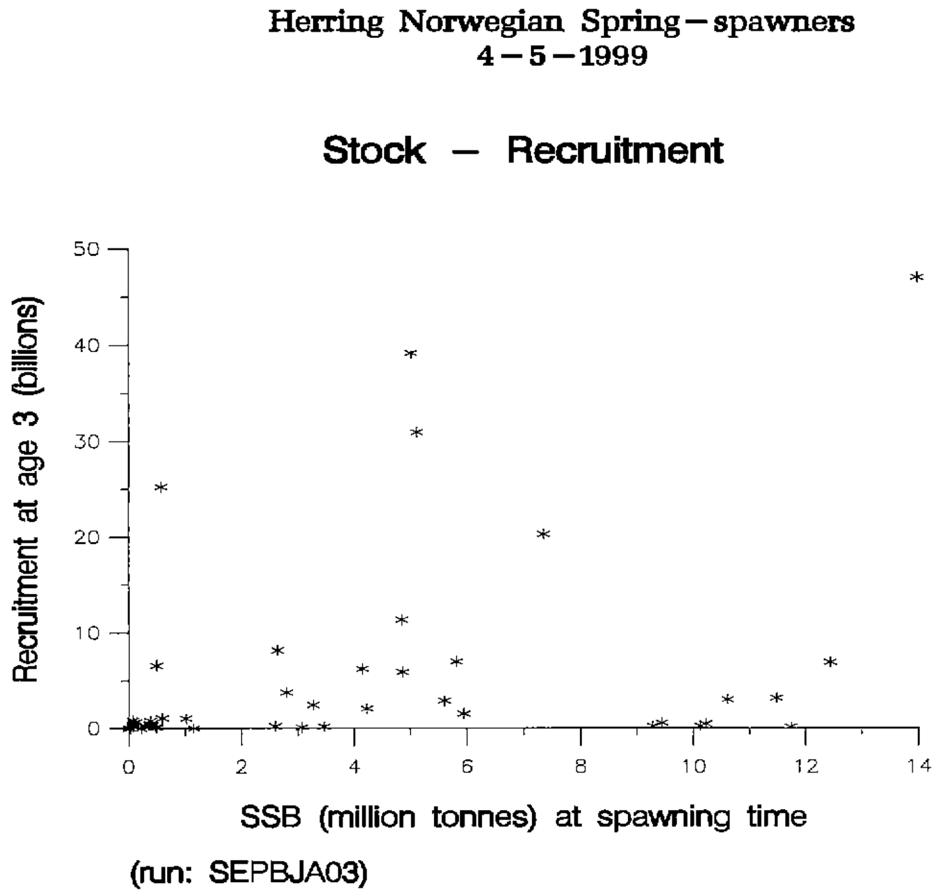


Figure 3.5.6.3

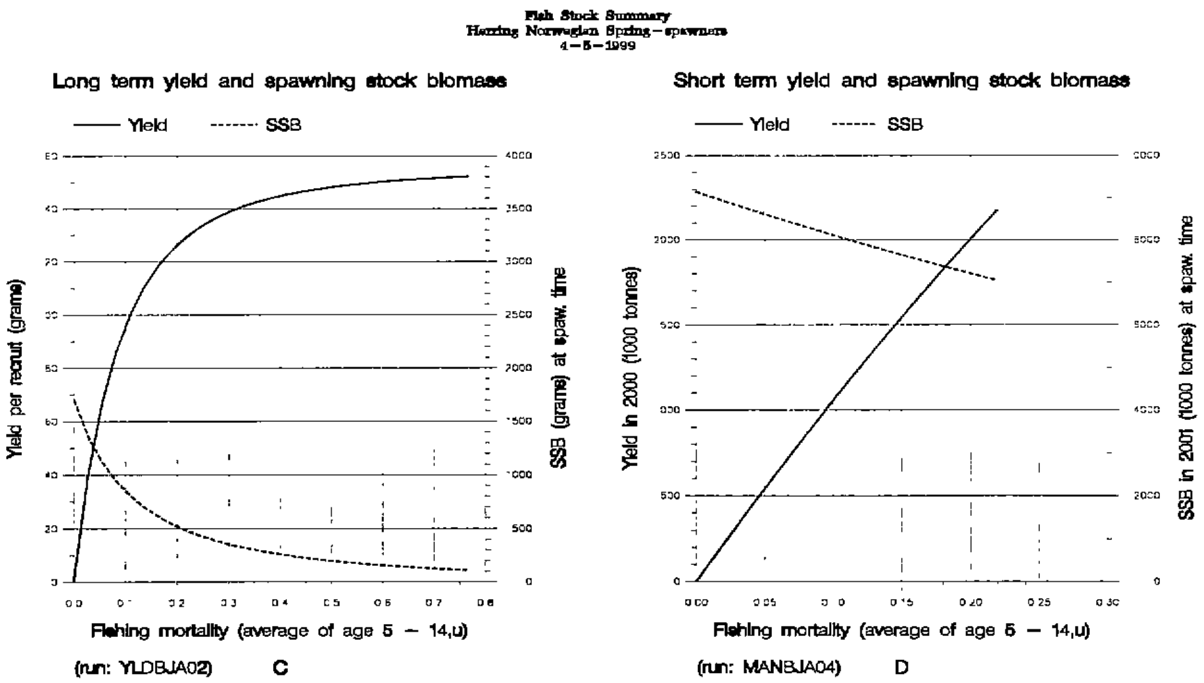


Figure 3.5.7.1

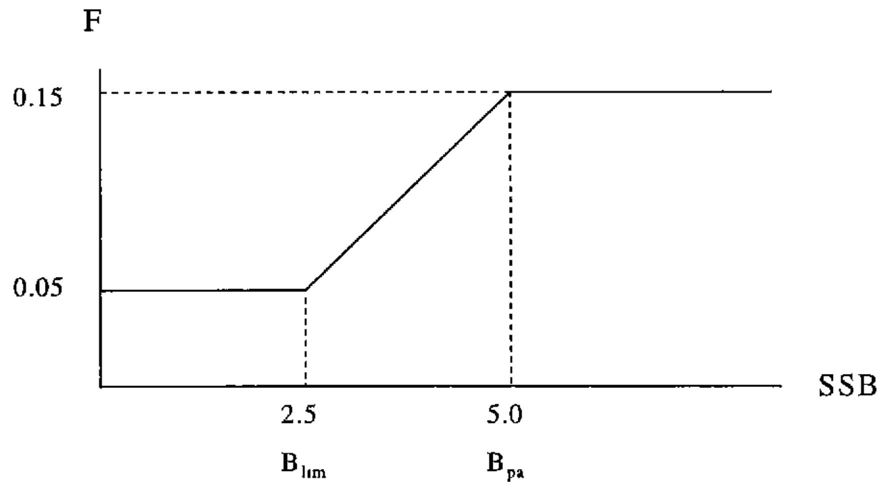


Figure 3.9.1 Illustration of the harvest control rule used in the medium-term simulations.

Fig 3.10.1 SSB percentiles - Norwegian spring-spawning herring

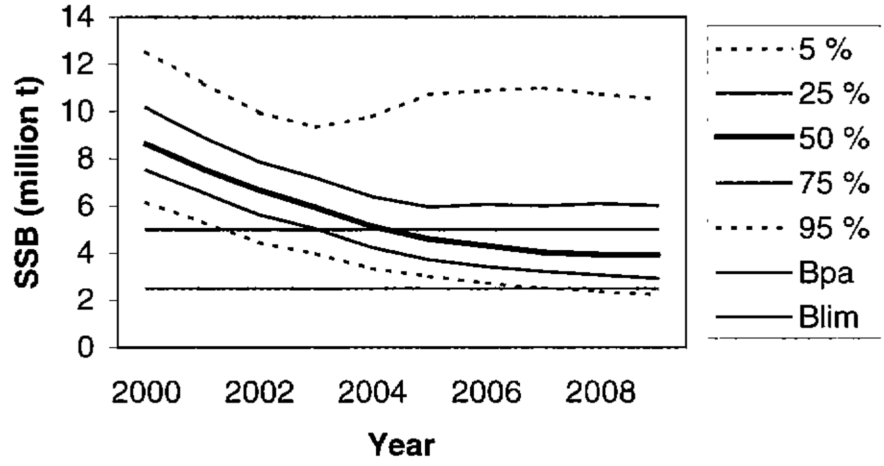
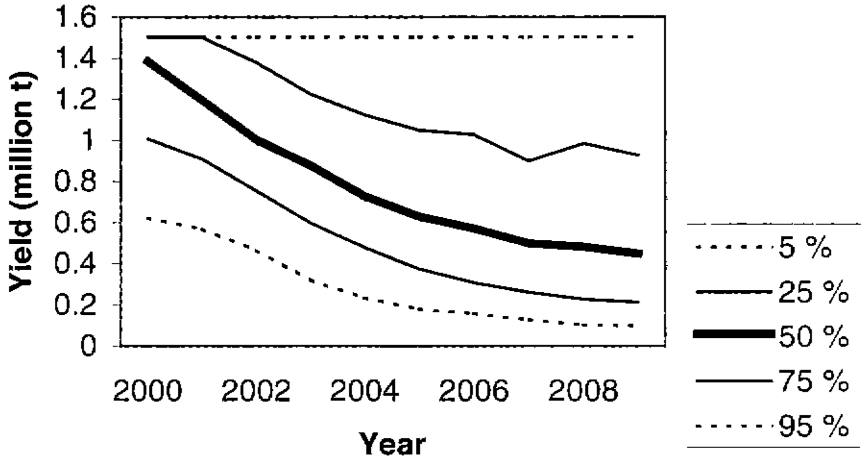


Fig 3.10.2 Yield percentiles Norwegian spring spawning herring



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.

4.2 Catch Statistics

The international catch by country and season in the years 1965-1999 is given in Table 4.2.1. Following the recommendation from ACFM, there was no fishing for Barents Sea capelin during 1998. In its autumn meeting in 1998 ACFM stated that according to the harvest control rule given in Section 4.5 the catch in 1999 would be 79,000 t. ACFM considered this to be consistent with the precautionary approach and recommended that the harvest control rule be applied in 1999. ACFM further recommended that if there is a fishery, it should be directed on the spawning stock in the first quarter of the year. During its autumn 1998 meeting the Mixed Russian Norwegian Fishery Commission decided to set a quota of 80,000 t on Barents Sea capelin for the winter season 1999, divided by 60% (48,000 t.) to Norway and 40% (32,000 t) to Russia.

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 $14.1 \cdot 10^{12}$ larvae in the Norwegian EEZ in 1998 is the highest estimate obtained during the period 1981-1998. 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 is 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 1998 of 428 would correspond to a year class strength of 219 billion one-year-olds in autumn 1999.

4.3.2 Acoustic stock size estimates in 1998

The 1998 acoustic survey was carried out jointly by two Russian and two Norwegian vessels in the period 10 September to 6 October (WD by Anon.). Also this year the Norwegian vessels had restricted access to the Russian EEZ but since four vessels were available to the survey of which two could work in the Russian EEZ, the total coverage of the stock was considered satisfactory. 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 2.1 mill. tonnes, and was dominated by the 1997 year class (one-year-olds) which constituted about 70% by numbers and 40% by weight. About 45% (932,000 t) of the stock biomass consisted of maturing fish (> 14 cm).

4.3.3 Other surveys

During the Norwegian demersal fish survey in February 1999 observations of capelin by acoustics and by pelagic and demersal trawls were made. No stock size estimate was attempted but the observations confirmed the composition of the stock as observed during the autumn 1998 capelin survey. Samples of cod stomachs during this period give valuable information for the modelling of maturing capelin as prey item for cod (WD by Bogstad and Gjøsæter). Russian observations of the capelin were made during demersal fish surveys and during the fishery for capelin 1999 (WD by

Ushakov and Prozorkevitch). Due to lack of complete biological material and shortage of time the biomass of capelin was not assessed during those investigations.

4.4 Historical stock development

An overview of the development of the Barents Sea capelin stock in the period 1989-1998 is given in Tables 4.4.1-4.4.10. The methods and assumptions used for constructing the tables were explained in Appendix A to ICES 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 Tables 4.4.9 and 4.4.10. However, for giving a crude overview of the development of the Barents Sea capelin stock the tables may be adequate. It should be noted that this year, the historic stock size estimates of capelin have been adjusted following the revisions proposed by Gjøsæter *et al.* (1998a and 1998b). The adjustments are minor but will influence most of the estimated quantities in these tables.

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. Fishing mortality coefficients by age group for the autumn season and natural mortality coefficients by age group for immature and mature capelin are shown in Tables 4.4.4 and 4.4.5. Stock size at 1 January in numbers by age group and total biomass and the mean weight by age group at 1 January are shown in Tables 4.4.6 and 4.4.7. Proportion of mature stock by age group at 1 January and spawning stock biomass at 1 April are shown in Tables 4.4.8 and 4.4.9. Table 4.4.10 gives an aggregated summary for the entire period 1973-1998.

4.5 Stock assessment autumn 1998

As decided by the Northern Pelagic and Blue Whiting Fisheries Working Group at its 1998 meeting (ICES 1998/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 1998 meeting (Gjøsæter *et al.*, WD).

A probabilistic forecast of the spawning stock to the time of spawning at 1 April 1999 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), data on size and composition of the cod stock (from the Arctic Fisheries Working Group, ICES 1999/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).

Because of inconsistencies in the data or in the model assumptions, in some years (1974 and 1975, which is 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. Consequently, a fitted Beverton-Holt model gave a value of the spawning stock at which the recruitment was half the maximum of nearly zero. This implies that there is no positive lower limit to the spawning stock using a yield-maximisation approach. Therefore, a target spawning stock size (SSB_{target}) could not be estimated and 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 expectation value of about 120,000 t.

Probabilistic prognoses for the maturing stock from October 1, 1998 until April 1, 1999 were made, with a CV on the abundance estimate in the range 0.15-0.30. The probability for the spawning stock to fall below B_{lim} was zero for catches lower than about 100,000 t. The meeting also concluded that capelin recruitment in 1999 would probably not be influenced to any noticeable degree by young herring.

ACFM at its autumn 1998 meeting (ICES 1999/CRR:229) 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 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. (slightly above the expectation value of the modelled SSB in 1989) to be valid in years with low abundance of herring in the Barents Sea. A B_{pa} was defined at 500,000 t. It was stressed that the value of B_{pa} should not be fixed, but should vary with the uncertainty of the estimated stock size. In absolute terms this uncertainty increases with stock size. In mathematical terms: $B_{pa} = B_{lim}$ + (median – 5^{th} percentile of predicted SSB). 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_{pa} with maximum 50% probability and below B_{lim} with maximum 5% probability, ACFM advised that a TAC should not exceed 79,000 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 History of reference points and harvest control rules

In the late 1970s, based on the available knowledge about the spawning stock/recruitment relationship, a target spawning stock biomass of 500,000 t was accepted as a harvest control rule by the Mixed Norwegian-Soviet Fisheries Commission. This harvest control rule remained in effect after Hamre and Tjelmeland (1982) had calculated the optimal yield of the capelin stock and found that it occurred at a spawning stock level of between 400,000 and 500,000 t. A key assumption in their analysis was that the mortality of mature capelin in the period September-March is the same as the mortality of immature capelin from September one year to September the next year. The study by Hamre and Tjelmeland was carried out on data from a period when the mortality of capelin was relatively stable, and when capelin recruitment was not influenced by herring as the amount of herring in the Barents Sea was negligible.

In the 1980s, the mortality of capelin increased and became more variable. This can probably be connected to the development of the Northeast Arctic cod stock (Tjelmeland and Bogstad, 1993). Also, predation by the strong 1983 year class of Norwegian Spring-Spawning herring during its presence in the Barents Sea in 1984-1985 had a large negative influence on capelin recruitment in those years (Hamre, 1991). The capelin stock collapsed in 1984-1986 and did not recover to a level where fishing could be recommended until 1991. Although the existing harvest control rule proved to be an effective rebuilding tool in the late 1980s, it was realised that the biological basis for the harvest control rule was no longer valid. Consequently, new harvest control rules for capelin would have to take into account both the predation by cod on mature capelin and the effect of young herring on capelin recruitment. To address this, Tjelmeland and Bogstad (1993) and Tjelmeland (1997) have attempted to find new harvest control rules for capelin taking these two factors into account, and including uncertainty in data and models in the analysis. This was done using the multispecies models Multspec, Capsex and CapTool. The recent development of the harvest control rules was outlined in Section 4.5.

The concept of harvest control rules has evolved very much in the 20 years since the target spawning stock biomass of 500,000 t was introduced, and so has our knowledge about the capelin stock and its interactions with the cod and herring stocks. The harvest control rule of leaving a spawning stock biomass of 500,000 t has been applied by the Mixed Norwegian-Russian Fisheries Commission for more than 20 years. In the future it should, however, be modified to take into account new biological knowledge and to fit into the recently introduced precautionary framework.

4.7 Future reference points and principles of stock assessment

There is no need to define a B_{pa} in order to ensure that the realised SSB is larger than B_{lim} with a given probability. In CapTool the probability distribution of the spawning stock is calculated for various levels of catch, which in turn gives the catch that realises the management goal of a certain probability for the realised spawning stock to be larger than B_{lim}. This is in contrast to F-based assessment where the catch is given as a function of F and the need for a F_{pa} arises because the realised F may be different from the F that corresponds to the given catch quota.

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 safeguarding against recruitment failure. However, it is possible that even at higher values of the spawning stock the 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 yet precluded a simulation analysis to find SSB_{target}.

The Capsex model presented to the WG last year that is used to parameterise the maturation function used in CapTool and which also will be used to evaluate SSB_{target} is based on input data that are stochastic in nature. Stochastic prognostic runs should be based on stochastic historic runs during which parameters to be used in the prognostic part are estimated. Input data that could be integrated with Capsex and that could be part of a stochastic analysis include the cod stock assessment, the stomach content data, the evacuation rate model and the trawl-acoustic measurement of the capelin stock.

In connection with developing SSB_{target} there seems to be a need for a refined stock-recruitment function, since exceptionally good recruitment years may give outstanding recruitment from very low spawning stocks. The usual assumption that all stock-recruitment points belong to the same probability distribution may therefore not be valid. Treating very good and very poor recruitment conditions separately should thus be considered.

One of the central assumptions made in the models used to calculate the spawning stock biomass of capelin is that in January-April, all predation by cod on capelin is predation by immature cod on mature capelin. Bogstad and Gjøsæter (Working Document) discussed this assumption. They found that in the period 1993-1998, between 17 and 35 % of the content of capelin in cod stomachs (averaged over all cod > 25 cm) in January-April consisted of capelin < 13 cm (when capelin with undetermined length is excluded). Most of this capelin will be considered immature in autumn when using a maturation function that is not cut-off, as mentioned in Section 4.5. Predation on capelin by cod < 25 cm is infrequent and can be ignored for management purposes. In some years, mature cod is found in significant amounts in the Barents Sea. These results should be taken into account in calculations of historical spawning stock biomass.

The WG wants to point out that the perception of the spawning stock in 1989 (and other years) may change as more information becomes available, for example about the predation pressure on capelin in the Barents Sea as mentioned above. Therefore, if B_{lim} is to be based on a rule (e.g. the spawning stock that produced the 1989 year class) this rule and not the realisation of the rule for one particular parameter combination should be implemented in the assessment. The information presented to the managers would then be the rule that B_{lim} is the spawning stock that produced the 1989 year class and the probability for the spawning stock to fall below B_{lim} as function of catch. That B_{lim} is stochastic, because it is a function of stochastic quantities should not complicate the communication with the managers.

In a recent analysis of the stock-recruitment relationship (Gjøsæter and Bogstad, 1998) for capelin it was shown that a Beverton-Holt function

$$R = \frac{789SSB}{SSB + 113}$$

(SSB in thousand tonnes, recruitment in billion individuals at 1 August) fitted the data quite well (76% of the variation explained) when all "herring years" were excluded from the analysis. Herring years were defined as years with more than about 100,000 tonnes of herring present in the Barents Sea. In the herring years the recruitment was considerably lower than that predicted by this model.

An alternative approach was to fit a model including two herring terms:

$$R = \frac{R_{max} SSB}{SSB + S_{1/2} + B_0 H_0 + B_1 H_{1+}}$$

where $S_{1/2}$ is now the spawning stock biomass value which in the absence of herring gives rise to a recruitment which is half of R_{max}, H_0 is the logarithmic 0-group index for herring (from the international 0-group survey in the Barents Sea in August, Table 3.3.4.3) and H_{1+} is the biomass (million tonnes) of one year and older herring in the Barents Sea (from the acoustic surveys on young herring in the Barents Sea during May-June). B_0 was not significantly different from zero at the 5% level, and consequently the following stock-recruitment relationship for capelin in the Barents Sea was proposed:

$$R = \frac{758SSB}{SSB + 74 + 2797H_{1+}} \quad \text{(Equation 4.6.1)}$$

This model explains 87% of the variation.

A closer analysis of the work by Gjøsæter and Bogstad (1998) indicates that the suggested limit between herring and non-herring years (100,000 tonnes of 1+ herring in the Barents Sea) is somewhat arbitrary and could be set almost anywhere in the interval 100,000-450,000 t (see text table below). Part of the reason for this is that the estimate of young herring in 1984 (311,000 t) is an underestimate (see Section 3.3.4) as that was obtained with the old analogue echosounder equipment. Given that the 1983 year class of herring was stronger than the 1991-1992 year classes as 0-group and is about at the same size at age 3 according to the assessment, it is likely that it was at least as strong as the 1991 year class at age 1. This would imply raising the estimate by at least a factor of 1.5.

Year	Biomass 1+ Herring (million tonnes)	Herring year	Comment
1984	0.311	Yes	Underestimate, old equipment
1985	0.869	Yes	Underestimate, old equipment
1986	0.255	No	Migrated out of Barents Sea in June
1987	0	No	
1988	0	No	
1989	0.015	No	Underestimate, old equipment
1990	0.047	No	Underestimate, old equipment
1991	0.487	Yes	
1992	1.666	Yes	
1993	1.519	Yes	
1994	2.864	Yes	
1995	0.633	Yes	
1996	0.094	No	
1997	0.012	No	
1998	0.146	?	

Dividing years into herring and non-herring years is, however, a simplification. A more consistent approach would be to make B_{lim} a function of the herring abundance by using equation 4.6.1 and defining B_{lim} as the spawning stock biomass at which the recruitment according to equation 4.6.1 gives a recruitment of e.g. 90 % of the maximum recruitment. B_{lim} will then have to be calculated each autumn based on a prognosis of the biomass of young herring in the Barents Sea the coming year. A method for predicting the abundance of 1+ herring in the Barents Sea in June, based on the abundance of 0-group and 1+ herring the previous year, is then needed. This approach could be improved by taking into account also the degree of spatial overlap between herring and capelin, which, however, is difficult to predict.

Further work should be undertaken to shed light on the recruitment processes. Cannibalism may be an important factor and on occasions this has been observed in the field (A. Dommasnes, pers. comm., H. Vilhjalmsson, pers. comm.). However, the information is anecdotal only. It is a possibility that Russian data (WD by Shleinik, Ushakov and Tjelmeland) may shed some light on this problem.

4.8 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 1999 ACFM autumn meeting.

4.9 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 is done on the Norwegian vessels. Intercalibrations of age readers were made e.g. during the USSR-Norwegian capelin symposium in 1984 (Gjøsæter 1985), and the conclusion was reached that no major differences existed between the age readers. However, differences in the age distribution obtained during the Norwegian and Russian capelin investigations during winter have been reported recently (ICES 1998/ACFM:18, WD by Ushakov and Prozorkievitch, WD by Gjøsæter). During the joint survey in 1998 a few Russian samples previously found to contain 35% capelin older than 5 years (ICES 1998/ACFM:18) were read independently by 5 Norwegian age readers. The results showed a very high agreement between the readers and practically very few otoliths were given an age of more than five years. However, Norwegian age-readers have noted that the capelin otoliths have become more difficult to read during later years. To investigate this further, and to try to reconcile the differences between Norwegian and Russian age readings, work is now done to set up a reference material of capelin otoliths, and an age reading workshop will be arranged in Murmansk in autumn 1999.

4.10 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 1998 (Norway)	130	9327	4831
Acoustic survey 1998 (Russia)	39	2885	608
Norwegian bottom trawl survey winter 1999	162	3694	1328
Russian investigations winter 1999	45	14615	2116
Norwegian fishery winter 1999*	29	2987	789
Russian fishery winter 1999	74	31394	3750

* 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*	48	32	0	80				

- **preliminary data**

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

[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 1998. 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)			1	2	3	4	5+	Sum	Biomass	Mean
			1997	1996	1995	1994	1993	(10^6)	(10^3 t)	weight (g)
6.0	-	6.5	445					445	0.4	0.9
6.5	-	7.0	577					577	0.6	1.0
7.0	-	7.5	1145					1145	1.2	1.0
7.5	-	8.0	1516					1516	1.6	1.0
8.0	-	8.5	12990					12990	17.3	1.3
8.5	-	9.0	9039					9039	19.3	2.1
9.0	-	9.5	12982	153				13135	35.1	2.7
9.5	-	10.0	19353	186				19539	66.3	3.4
10.0	-	10.5	27427	883				28310	114.7	4.1
10.5	-	11.0	30325	1639				31964	154.9	4.8
11.0	-	11.5	25852	1588				27440	153.4	5.6
11.5	-	12.0	22098	3627				25725	165.5	6.4
12.0	-	12.5	9486	5527	77			15090	113.8	7.5
12.5	-	13.0	4073	6433	75			10581	91.9	8.7
13.0	-	13.5	1171	7570	47			8788	89.2	10.2
13.5	-	14.0	417	8056	58			8531	99.2	11.6
14.0	-	14.5	79	9015	255			9349	126.5	13.5
14.5	-	15.0	51	8260	590			8901	137.0	15.4
15.0	-	15.5		7117	579	43		7739	135.3	17.5
15.5	-	16.0		5223	973	9		6205	122.8	19.8
16.0	-	16.5		3366	1866	135		5367	117.5	21.9
16.5	-	17.0		2667	2404	35		5106	126.0	24.7
17.0	-	17.5		609	1588	156	51	2404	67.2	27.9
17.5	-	18.0		574	1113	128	25	1840	56.6	30.7
18.0	-	18.5		99	538	75		712	25.0	35.1
18.5	-	19.0		53	261	28	9	351	13.6	38.9
19.0	-	19.5			94			94	3.8	40.5
19.5	-	20.0				11		11	0.5	41.0
TSN (10^6)			179026	72645	10518	620	85	262894		
TSB (10^3 t)			807.1	975.7	254.1	16.8	2.5		2056.2	
Mean length (cm)			10.45	13.97	16.55	17.18	17.56	11.69		
Mean weight (g)			4.5	13.4	24.2	27.1	29.4			7.8
SSN (10^6)			130	36983	10261	620	85	48079		
SSB (10^3 t)			1.9	656.6	253.5	17.2	2.5		931.8	

Age/Year class spans columns 1–5+.

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

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	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	194.6	707.7	415.0	396.2	3.1	29.5	8.3	88.9	111.8	188.4
2	18.2	179.4	601.0	224.2	73.0	5.1	9.4	12.5	44.2	76.5
3	3.5	16.4	36.8	163.1	25.3	6.4	1.6	2.2	2.2	12.1
4	0.0	0.1	1.4	1.6	3.7	0.3	0.4	0.1	0.1	0.7
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Sum	216.3	903.7	1054.1	785.1	105.1	41.4	19.7	103.7	158.3	277.8
Biomass	503	2918	4750	3862	729	180	126	309	539	1197

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	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.4	0.3	0.5	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	24.0	23.8	4.8	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	8.2	17.3	26.8	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	2.7	2.1	1.4	0.0	0.0	0.0	0.0	0.0
Sum	0.0	0.0	35.3	43.4	33.5	0.0	0.0	0.0	0.0	0.0
Landings	0	0	704	891	586	0	0	0	0	0

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	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	0.0	0.0	2.2	0.9	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	9.3	5.8	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	3.1	7.9	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.9	0.8	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sum	0.0	0.0	15.5	15.3	0.0	0.0	0.0	0.0	0.0	0.0
Landings	0	0	226	232	0	0	0	0	0	0

Table 4.4.4 Barents Sea CAPELIN. Fishing mortality coefficients by age group and weighted average for age groups 2-4 in the autumn fishing season.

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.02	0.03	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.10	0.06	0.00	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	1.20	0.85	0.00	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	N/A	N/A	0.00	0.00	0.00	0.00	0.00	0.00
Wavr (2-4)	0.00	0.00	0.02	0.05	0.00	0.00	0.00	0.00	0.00	0.00

Table 4.4.5 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.

	1989		1990		1991		1992		1993	
Age	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}
1	0.014	0.042	0.005	0.016	0.015	0.046	0.059	0.178	0.157	0.471
2	0.014	0.042	0.005	0.016	0.015	0.045	0.059	0.176	0.157	0.471
3	0.158	0.474	0.005	0.016	0.051	0.154	0.109	0.326	0.190	0.571
4	0.117	0.350	0.005	0.016	0.051	0.154	0.071	0.212	0.214	0.642
5	0.117	0.350	0.005	0.016	0.051	0.154	0.071	0.212	0.214	0.642
Avr	0.084	0.251	0.005	0.016	0.037	0.111	0.074	0.221	0.186	0.559

Table 4.4.5 (Continued)

	1994		1995		1996		1997		1998	
Age	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}
1	0.201	0.602	0.073	0.219	0.041	0.122	0.062	0.185	0.026	0.077
2	0.201	0.602	0.073	0.219	0.041	0.122	0.062	0.185	0.026	0.077
3	0.201	0.602	0.019	0.058	0.041	0.122	0.062	0.185	0.071	0.212
4	0.282	0.847	0.044	0.133	0.050	0.149	0.014	0.041	0.071	0.212
5	0.282	0.847	0.044	0.133	0.050	0.149	0.014	0.041	0.071	0.212
Avr	0.221	0.700	0.052	0.152	0.043	0.133	0.042	0.127	0.053	0.158

Table 4.4.6 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	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	214.7	734.0	462.4	600.1	9.2	120.3	13.8	118.2	172.0	225.5
2	19.6	181.4	689.5	382.0	293.7	1.4	10.8	5.7	72.5	82.2
3	26.8	17.0	174.8	548.4	162.3	33.3	1.9	6.5	10.2	32.5
4	0.2	1.6	16.0	25.7	88.9	9.8	2.4	1.4	1.8	1.6
5	0.0	0.0	0.1	0.3	0.5	1.3	0.1	0.3	0.1	0.1
Sum	261.3	934.0	1342.8	1556.6	554.6	166.0	28.9	132.2	256.6	341.9
Biomass	718	2011	7011	8297	4363	737	156	313	779	1240

Table 4.4.7 Barents Sea CAPELIN. Mean weight (g) by age group and weighted average for the whole stock by 1. January.

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	1.30	1.52	1.51	1.42	1.38	1.76	2.66	1.16	1.68	1.80
2	3.78	3.57	4.18	4.15	3.91	3.79	4.83	7.31	3.19	4.62
3	13.48	12.67	16.88	9.66	9.48	9.94	12.36	15.19	20.46	12.65
4	18.70	19.86	29.87	21.31	18.54	16.64	18.18	18.43	26.29	25.19
5	0.00	22.00	22.00	33.18	32.50	20.62	20.30	24.83	29.37	28.82
Avr	2.75	2.15	5.22	5.33	7.87	4.44	5.41	2.36	3.04	3.63

Table 4.4.8 Barents Sea CAPELIN. Estimated proportion of maturing stock by 1. January.

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.00	0.00
3	0.41	0.46	0.65	0.16	0.12	0.10	0.44	0.59	0.82	0.37
4	0.68	1.00	1.00	0.89	0.74	0.71	0.86	0.92	0.95	0.95
5	1.00	1.00	1.00	0.86	0.99	0.92	0.87	1.00	1.00	1.00
Avr	0.04	0.01	0.10	0.07	0.15	0.07	0.10	0.04	0.04	0.04

Table 4.4.9 Barents Sea CAPELIN. Estimated spawning stock biomass ('000 t) by 1. April.

Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	0	0	0	0	0	0	0	0	0	0
2	0	2	19	0	0	0	1	3	1	1
3	139	140	1421	915	129	34	15	71	175	217
4	2	37	142	80	329	60	38	24	49	34
5	0	0	0	0	0	11	1	7	2	2
Sum	141	179	1582	996	458	105	55	105	228	254

Table 4.4.10 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	Recruitment Age 1	Spawning stock biomass	Landings
1965			224
1966			389
1967			409
1968			537
1969			680
1970			1314
1971			1392
1972			1592
1973	1140	1242	1336
1974	737	343	1149
1975	494	90	1439
1976	433	1147	2587
1977	830	890	2987
1978	855	460	1916
1979	551	193	1783
1980	592	87	1648
1981	466	1731	1986
1982	611	546	1760
1983	612	47	2358
1984	183	165	1477
1985	47	88	868
1986	9	12	123
1987	46	16	0
1988	22	11	0
1989	195	141	0
1990	708	179	0
1991	415	1582	929
1992	396	996	1123
1993	3	458	586
1994	30	105	0
1995	8	55	0
1996	89	105	0
1997	112	228	0
1998	188	254	0

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 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.

5.1.2 The fishery in the 1998/1999 season

In accordance with a previously determined procedure, ACFM recommended that the preliminary TAC should not exceed 946,667 t. This is 2/3 of the total TAC predicted for the season, i.e. 1,420,000 tonnes. This advice was accepted by all parties concerned.

The season opened on 20 June and the fishery began in deep waters near the shelf edge off the eastern north coast and northeast of Iceland. The fishing grounds gradually shifted to the northwest and for most of July the main fishing area was located between approximately 68°N and 69°15'N, 18°-22°W. Most of the time, catch rates were comparatively low during the summer months. Indeed, by early August the capelin had become so scattered that the fishery was abandoned. The total catch in June-August 1998 amounted to 359,000 tonnes, almost all of it taken in June and July.

Fishing was not resumed until October. Again, catch rates were low in the October-December period, except off the eastern north coast of Iceland for a short time around mid-November and in the third week of December. A total of 81,000 tonnes of capelin was caught during October–December 1998.

The total catch in the 1998 summer and autumn season thus amounted to about 440,000 tonnes, of which almost 80% was taken in June and July.

Due to stormy weather and scattered condition of capelin east of Iceland, catch rates were low in January and the first week of February 1999. However, in the second week of February, large schools of adult capelin appeared in the shallow waters off the eastern south coast. The capelin remained stationary in this general area (east of approximately 18°W) during the second and third weeks of February and were fished intensively.

In the last week of February the capelin resumed their migration west along the south coast of Iceland. However, their progress was slow and few schools managed to round the Reykjanes peninsula (22°W). The capelin arriving later made an even slower progress westward and in 1999 practically no capelin spawned on the traditional grounds in Faxafloi and Breidafjordur on the west coast. This anomalous behaviour was apparently caused by irregularities in the flow of ocean currents south of Iceland and the condition of the capelin. The main features were a generally strong easterly flow of Atlantic water of unusually high temperature that reached almost to the coast and a very low weight at age of the capelin. These small capelin seemed to find it difficult to move against the current, tended to stay in the colder waters very close inshore for long periods of time and matured quickly whenever they ventured out into the deeper and warmer waters.

For the fishery, the practical result of the situation just described was that after about 20 February the capelin were only sporadically available to purse-seining and catch rates became extremely variable. Furthermore, as stated above, maturation was accelerated by the high temperatures. Therefore, most of the capelin had spawned by mid-March and the winter fishery came to a close earlier than usual.

The total catch during the 1999 winter season amounted to about 660,000 t, of which about 50,000 t were taken in January and the remainder during a 6 week period in February and March.

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 1979–1998 and winter 1980–1999 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 1998 and winter 1999 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 1983–1998 is given in Table 5.3.1.2.

5.3.2 Stock abundance in autumn 1998 and winter 1999

An acoustic survey was carried out by two research vessels in the period 13-30 November 1998 (Working Document by Hjálmar Vilhjálmsson). The distribution of the stock was fairly wide and 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 and north of the NW-peninsula of Iceland.

In general terms, the November 1998 survey was carried out under good conditions. There was not much drift ice in the Denmark Strait and there was little interference by aeration or sea swell in any part of the area so adjustments for losses of echo intensity for these reasons were minimal. 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. The distribution and behaviour of the fish were, therefore, about as favourable as could be for acoustic estimation of total echo abundance. However, many of the dense concentrations, recorded north of the Vestfirdir peninsula and the western north coast of Iceland, consisted of a mixture of adults and 1-group juveniles. Due to gear selection, such recordings are difficult to classify correctly and in all probability the 1-group contribution in that area is somewhat underestimated.

According to the autumn 1998 survey, the immature stock component amounted to 121.0 and $6.2 * 10^9$ fish, belonging to age groups 1 and 2 respectively. With the qualifications described in the previous paragraph, the estimated total fishable/spawning stock abundance was $23.8 * 10^9$ fish in late November 1998. The observed mean weight in the fishable stock was 14.7 g and the fishable/spawning stock biomass, therefore, about 342,000 t.

However, because both total adult stock biomass and the contribution of the older age group (13%) were much below expectations, it was concluded that the autumn 1998 survey must have failed to locate and assess part of the adult fishable stock. Details of the November 1998 stock estimate are given in Table 5.3.2.1.

In January 1999 a survey of capelin abundance in the traditional distribution area east of Iceland was carried out. The survey results were inconclusive, mainly due to adverse weather conditions.

During 6-16 February 1999, the abundance of mature capelin was assessed off the eastern south coast and southeast of Iceland. The survey was carried out under favourable weather conditions and near-surface as well as near-shore schooling, common at later stages of capelin spawning migrations, were not pronounced. Furthermore, the observed age distribution and total stock by number were not far removed from that predicted by the WGNPBW in May 1998 when natural mortality and the fishery earlier in the season had been accounted for. On the other hand, the lower than usual biomass of the total number of some 50.5 billion individuals, recorded by the survey, results from the extremely low mean weight of 16.7 g in the 1999 spawning stock.

Details of the stock estimate obtained in February 1999 are given in Table 5.3.2.2.

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 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 1978/79–1998/99 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 1979–1999.

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 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 1981–1998 (year classes 1978–1996) 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 1998/1999 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 94.4 and 30.8 billion maturing 2- and 3-group capelin on 1 August 1998.

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 $R^2 = 0.72$ and 0.83 for age groups 2 and 3 respectively. Applying the appropriate regression equations, $y = -0.027x + 18.8$ for the younger component and $y = -0.059x + 28.4$ for the older one and using the predicted abundance of age groups 2 and 3 on 1 August 1997 combined, *i.e.* $114.7 * 10^9$ fish, resulted in estimated mean weights of 15.4 and 20.6 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 1999 assuming a monthly $M = 0.035$ and a remaining spawning stock of 400,000 tonnes. This gave a predicted TAC of 1,420,000 tonnes spread evenly over August 1998–March 1999 (Table 5.5.1.3). Using the same approach as in previous years, *i.e.* that the preliminary TAC be set at approximately 2/3 of the predicted tota for the season, the Working Group recommended that a preliminary TAC for the 1998/99 capelin fishery be set at 950,000 t.

According to the February 1999 survey, the estimated fishable/spawning stock was $50.6 * 10^9$ fish on 11 February 1999. At that time the observed mean weight in the fishable stock was 16.7 g and the stock biomass therefore about 835,000 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 435,000 t in the time remaining of the 1999 winter fishery. Counting the catch taken in June 1988–10 February 1999 (765,000 t), this corresponded to a total TAC of some 1,200,000 t for all of the 1998/99 season as compared to the May 1998 prediction of 1,420,000 t.

Although the contribution of the older age group was somewhat smaller than anticipated, the difference between the predicted and advised TACs for the 1998/99 season is mainly due to the unusually low mean weight in the stock. Since about 100,000 t of the allocated TAC remained at the end of the winter fishery, it follows that some 500,000 t of capelin remained to spawn in 1999.

5.5.3 Stock prognosis and assessment for the 1999/2000 season

Calculations of expected TAC for the 1999/2000 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 $y = 0.578x + 19.3$; $R^2 = 0.83$, $p < 0.05$. Similarly for the older stock component, where N_{2tot} is regressed on N_{3mat}, gives $y = 0.294x - 7.0$; $R^2 = 0.55$, $p < 0.05$. The two regression plots are shown in Figure 5.5.3.1.

The Working Group decided that the November 1998 estimate of the abundance of 1-group capelin (year class 1997) was realistic and could be used for predicting the abundance of maturing capelin of the 1997 year class on 1 August 1999.

The predictive figures for the 1997 and 1996 year classes are given in Table 5.5.1.1 These gave an estimate of 89.2 and 23.3 billion mature fish, belonging to the 1997 and 1996 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 $R^2 = 0.76$ and 0.86 for age groups 2 and 3 respectively. These two regression plots are shown in Figure 5.5.3.2. Applying the appropriate regression equations, $y = -0.032x + 19.1$ 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, results in estimated mean weights of 15.5 and 21.6 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 about 1,285,000 t if spread evenly over the period August 1999–March 2000. This corresponds to a preliminary TAC of 856,667 t. As in previous years, decisions on the final TAC for the 1999/2000 season should be based on surveys carried out in October/November 1999 and/or January/February 2000.

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 have been 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, 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 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 >1,500,000 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 1,100,000 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 the southern part of the3 feeding area in August, the fishable stock becomes more scattered and sometimes mixed with juveniles.

The Working Group recommends that the 1999 summer/autumn season is 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 1978–1998 is given in Table 5.7.1.

5.8 Sampling

Investigation	No. of samples	Length meas. individuals	Aged individuals
Fishery 1997	20	2000	1990
Survey 1998	76	7565	7500
Fishery 1999	48	4800	4750
Survey 1999	61	6100	6065

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 1986/87–1997/98 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
Prelim. TAC	500	900	900	600	0	500	900	950	800	1100	850	950
Rec. TAC	1115	1065	-	250	740	900	1250	850	1390	1600	1265	1200
Landings	1116	1036	808	314	677	788	1179	842	930	1571	1245	1100
Spawn. stock	400	445	115	330	475	460	460	420	830	550	500	500

Table 5.2.1 The international capelin catch 1964–1999 (thousand tonnes).

Year	Winter season					Summer and autumn season						
	Iceland	Norway	Faroes	Greenland	Season total	Iceland	Norway	Faroes	Greenland	EU	Season total	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	1,561.5
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							

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) 1979–1998.

					Year					
Age	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
1	0.6	4.9	0.6	-	0.6	0.5	0.8	+	+	0.3
2	29.4	17.2	27.9	-	7.2	9.8	25.6	10.0	27.7	13.6
3	6.1	5.4	2.0	-	0.8	7.8	15.4	23.3	6.7	5.4
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
Total weight	588.0	527.6	613.0	-	133.4	548.5	919.7	772.9	458.6	371.4

					Year					
Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
1	1.7	0.8	0.3	1.7	0.2	0.6	1.5	0.2	1.8	0.9
2	6.0	5.9	2.7	14.0	24.9	15.0	9.7	25.2	33.4	25.1
3	1.5	1.0	0.4	2.1	5.4	2.8	1.1	12.7	10.2	2.9
4	+	+	+	+	0.2	+	+	0.2	0.4	+
Total number	9.2	7.7	3.4	17.8	30.7	18.4	12.3	38.4	45.8	28.9
Total weight	121.0	111.2	56.0	298.1	611.6	324.1	205.7	773.7	763.6	440.5

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) 1980–1999.

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

						Year				
Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2	1.4	0.5	2.7	0.2	0.6	1.3	0.6	0.9	0.3	0.5
3	24.8	7.4	29.4	20.1	22.7	17.6	27.4	29.1	20.4	31.2
4	9.6	1.5	2.8	2.5	3.9	5.9	7.7	11.0	5.4	7.5
5	0.1	+	+	+	+	+	+	+	+	+
Total number	35.9	9.4	34.9	22.8	27.2	24.8	35.7	41.0	26.1	39.2
Total weight	686.8	202.4	621.1	489.6	567.1	539.8	723.6	797.6	481.3	658.9

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 1998 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	-	15	-	-	15	0.1
10	18	-	-	-	18	0.1
10.5	-	-	-	-	-	0.0
11	-	15	-	-	15	0.1
11.5	18	252	-	-	270	0.9
12	35	964	-	-	999	3.5
12.5	106	1957	24	-	2087	7.2
13	159	3677	122	-	3957	13.7
13.5	194	4299	73	-	4567	15.8
14	265	4907	292	-	5464	18.9
14.5	53	4299	500	-	4852	16.8
15	35	2491	707	-	3233	11.2
15.5	18	1497	548	10	2073	7.2
16	-	563	317	-	880	3.0
16.5	-	148	195	-	343	1.2
17	-	15	97	-	112	0.4
17.5	-	-	24	-	24	0.1
Total number	900	25100	2900	10	28910	
Percentage	3.1	86.8	10.0	+	100.0	100.0
Total weight	12.8	371.1	56.5	0.1	440.5	

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 1999 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	45	49	-	-	94	0.2
12.5	227	277	-	-	504	1.3
13	182	1391	17	-	1589	4.1
13.5	38	3270	34	-	3341	8.5
14	-	4864	143	-	5007	12.8
14.5	-	6068	530	-	6598	16.8
15	-	5970	1145	-	7115	18.1
15.5	-	4799	1448	-	6254	16.0
16	-	2904	1684	-	4587	11.7
16.5	-	1261	1263	-	2523	6.4
17	-	317	758	8	1085	2.8
17.5	-	16	370	-	387	1.0
18	-	8	109	-	118	0.3
18.5	-	-	-	-	-	0.0
19	-	-	-	-	-	0.0
19.5	-	8	-	-	8	0.0
Total number	500	31200	7500	8	39208	
Percentage	1.3	79.6	19.1	+	100.0	100.0
Total weight	4.5	496.1	158.1	0.2	658.9	

Table 5.3.1.1 Abundance indices of 0-group capelin 1970–1998 and their division by areas.

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

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

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

Table 5.3.1.2 Estimated numbers, mean length and weight of age 1 capelin in the August surveys of 1983–1998.

	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
Number (10^9)	143	87
Mean length (cm)	9.3	9.0
Mean weight (g)	2.8	2.9

Table 5.3.2.1 Acoustic assessment of total abundance of capelin age groups 1-3, November 1998.

Length (cm)	Age/Year class 1 1997	2 1996	3 1995	Number mature (10^9)	Total number (10^9)	Weight (10^3 t)	Mean weight (g)
7.5	0.1	0.0	0.0	0.0	0.1	0.2	1.3
8	1.1	0.0	0.0	0.0	1.1	1.7	1.6
8.5	3.8	0.0	0.0	0.0	3.8	7.6	2.0
9	13.4	0.0	0.0	0.0	13.4	31.9	2.4
9.5	26.5	0.0	0.0	0.0	26.5	75.1	2.8
10	29.4	0.0	0.0	0.0	29.4	98.6	3.4
10.5	23.7	0.0	0.0	0.0	23.7	91.4	3.9
11	12.1	0.0	0.0	0.0	12.1	53.7	4.4
11.5	5.7	0.2	0.0	0.0	5.9	31.1	5.3
12	2.7	0.7	0.0	0.1	3.5	22.3	6.5
12.5	1.0	1.5	0.0	0.6	2.6	20.1	7.8
13	1.1	2.9	0.0	1.6	4.0	35.0	8.8
13.5	0.2	3.7	0.1	2.8	4.0	41.1	10.3
14	0.1	4.1	0.0	3.2	4.2	50.3	11.9
14.5	0.0	4.4	0.3	4.1	4.7	62.1	13.3
15	0.0	4.4	0.6	4.6	5.0	75.1	15.0
15.5	0.0	2.9	0.6	3.4	3.4	58.8	17.2
16	0.0	1.1	0.7	1.8	1.8	35.7	19.5
16.5	0.0	0.4	0.6	1.0	1.0	21.4	21.3
17	0.0	0.1	0.3	0.4	0.4	10.0	24.5
17.5	0.0	0.0	0.1	0.2	0.2	4.4	28.0
18	0.0	0.0	0.1	0.1	0.1	2.3	30.3
18.5	0.0	0.0	0.0	0.0	0.0	0.4	31.0
Number (billions)	121.0	26.4	3.3	23.8	150.8	830.3	
Weight (thous. t)	429.2	338.3	62.8	341.5	830.3		
Mean length (cm)	10.1	14.2	15.8	14.7	10.9		
Mean weight (g)	3.5	12.8	18.8	14.4	5.5		

Table 5.3.2.2 Assessment of abundance of adult capelin of age groups 2-4, February 1999.

Length (cm)	Age/Year class 2 1997	3 1996	4 1995	Total number (10^9)	Weight (10^3 t)	Mean weight (g)
12	0.1	0.0	0.0	0.1	0.6	6.3
12.5	0.1	0.0	0.0	0.1	0.8	7.4
13	0.5	0.3	0.0	0.7	5.8	8.0
13.5	0.3	1.6	0.0	2.0	17.9	9.1
14	0.2	3.5	0.0	3.7	38.9	10.5
14.5	0.0	5.3	0.0	5.3	63.2	11.8
15	0.1	7.0	0.3	7.4	100.0	13.6
15.5	0.0	7.5	1.0	8.5	130.9	15.4
16	0.0	6.7	1.2	7.9	139.8	17.7
16.5	0.0	3.9	1.7	5.6	111.6	19.9
17	0.0	2.2	2.3	4.4	99.3	22.4
17.5	0.0	0.4	2.3	2.7	66.6	24.6
18	0.0	0.1	1.3	1.5	39.5	27.1
18.5	0.0	0.0	0.5	0.6	17.6	30.3
19	0.0	0.0	0.1	0.1	2.0	31.6
19.5	0.0	0.0	0.0	0.0	0.5	34.3
Number (billions)	1.2	38.4	10.9	50.6	835.0	
Weight (thousand t)	14.2	592.1	228.7	835.0		
Mean length (cm)	13.0	14.3	17.2	14.7		
Mean weight (g)	11.7	15.4	22.0	16.7		

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	144.6	224.0	196.9	191.0	*190.8
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	242.0	219.7	225.4[1)]
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	[1)]1010
Weight mature	1663	1173	751	1273	11311	1585	1268	1819	1900	1590

	Year	
Age/maturity	1998	1999
1 juvenile	*139.2	
2 immature	*35.5	
2 mature	89.5	** 89.2
3 mature	23.1	** 23.3
4 mature	+	
Number immat.	*174.7	
Number mature	112.6	** 112.5
Weight immat	*842	
Weight mature	1576	** 1687

* Preliminary
** Predicted

Table 5.4.2 The calculated number (billions) of capelin on 1 January 1979–1999 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	1003.0	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	*220.9	*170.3
3 immature	20.1	8.6	8.6	8.1	13.9	16.9	29.5	37.9	25.1	*41.1
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	*246.0	*211.4
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	*900	891
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
2 juvenile	*116.9
3 immature	*29.8
3 mature	53.2
4 mature	16.0
5 mature	+
Number immat.	*146.7
Number mature	69.2
Weight immat.	*710
Weight mature	1171.3
Number sp.st.	29.5
Weight sp. st.	490

*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
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	**102.7	
1997	121.0				

* 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
Age 2	14.3	13.5
Age 3	20.3	17.5

Table 5.5.1.3 Predictions of fishable stock abundance and TACs for the 1982/83–1998/99 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
Year classes	81-80	82-81	83-82	84-83	85-84	86-85	87-86	88-87
Age 2	63.0	43.4	67.8	34.9	55.5	64.8	43.2	31.1
Age 3	0.0	26.3	20.2	55.0	13.7	29.0	25.5	8.2
Fishable stock	1065	1373	1637	1926	1268	1800	1350	724
Calculated TAC	465	733	963	1215	642	1105	713	170
Advised TAC	573	897	1311	1333	1115	1036	550	265

Season	91/92	92/93	93/94	94/95	95/96	96/97	97/98	98/99
Year classes	89-88	90-89	91-90	92-91	93-92	94-93	95-94	96-95
Age 2	39.4	56.4	93.1	89.6	92.5	90.0	83.8	94.4
Age 3	3.7	18.3	22.6	27.0	14.9	35.0	30.9	30.8
Fishable stock	755	1398	2123	2170	1916	2352	2019	2088
Calculated TAC	197	755	1385	1427	1200	1635	1265	1420
Advised TAC	740	*900	1250	850	1390	1600	1265	1200

* 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	145	2363	1179	460
1994	224	2287	864	420
1995	197	3174	929	830
1996	263	3310	1571	423
1997	203	3014	1245	423
1998	*139	2418	1100	490

* Preliminary

Figure 5.5.3.1. The relationship between the measured 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).

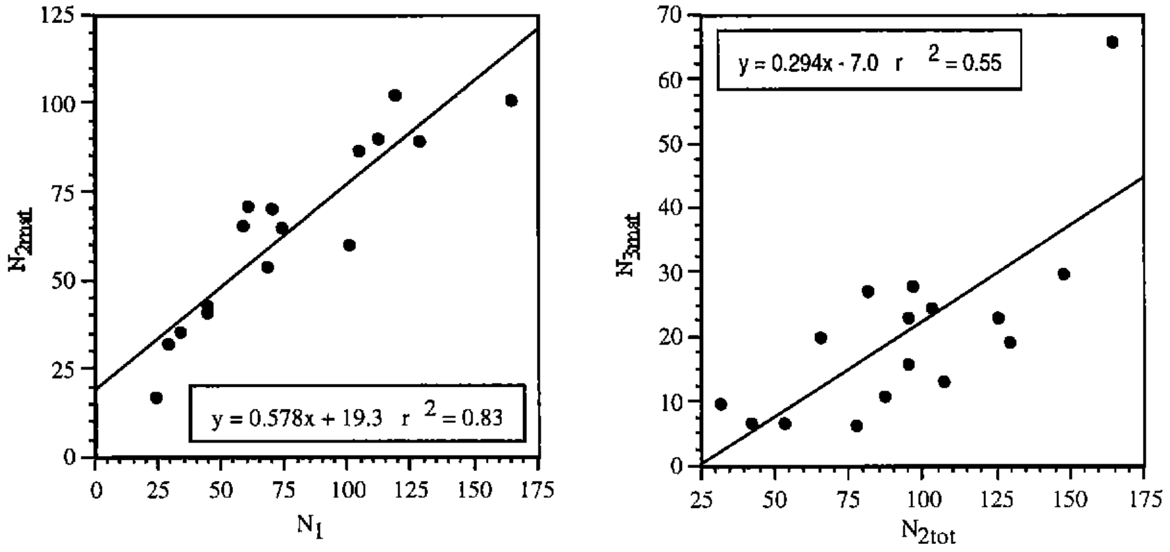
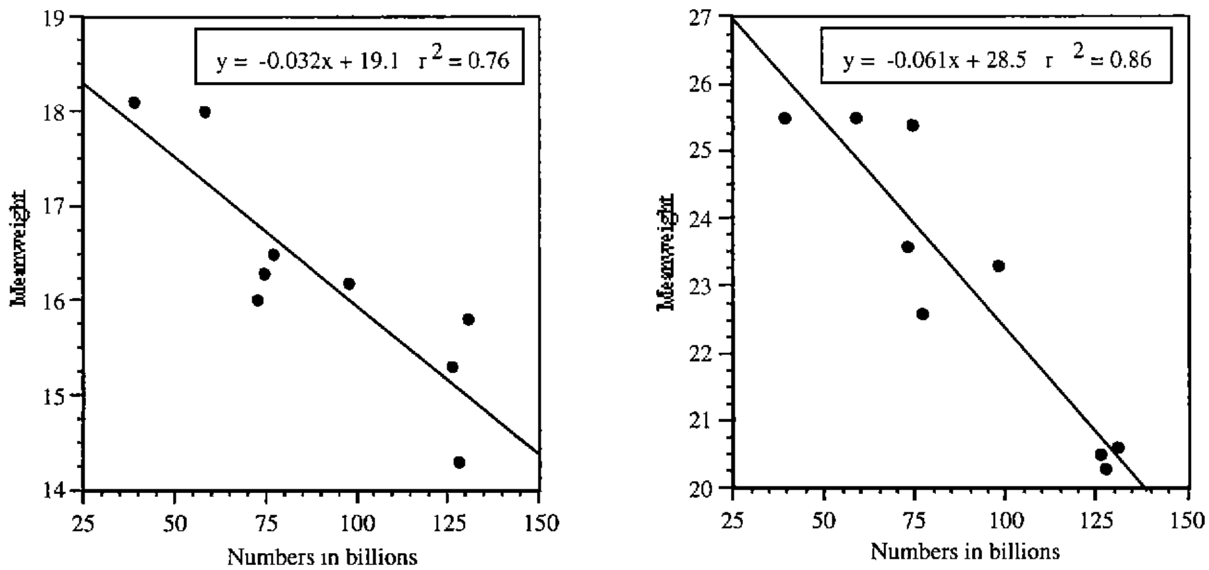


Figure 5.5.3.2. The relationship between the mean weight of maturing 2-group capelin in autumn and the total numbers in the maturing stock (left hand figure) and the total numbers in maturing stock and the mean weight of maturing 3-group capelin (right hand figure).



6 BLUE WHITING

6.1 Stock identity and Stock Separation

This topic has been dealt with in previous Working Group reports, and until 1994 the two stocks, i.e. the northern one and the southern one, have been treated as one for the assessment purpose (ICES 1996/Assess:14). Russia and Norway continued the study on the morphology, physiology and genetics. Preliminary results of the genetic analysis indicate that two main components of the blue whiting stock might appear in the spawning area west of the British Isles (Jarle Mork, pers. comm.). Further genetic and more detailed physiological analysis will, however, be continued.

6.2 Fisheries in 1998

Estimates of the total landings of blue whiting in 1998 from the fisheries by countries are given in Tables 6.2.2 - 6.2.5 and summarised in Table 6.2.1. The total landings from all blue whiting fisheries in 1998 were 1,125,151 tonnes, almost the double of the landings in 1997 and the highest landings since 1980. It exceeded the TAC of 650,000 tonnes by 73%.

The majority of the blue whiting catches was taken, as usual, in the spawning area and consisted of 827,194 tonnes, i.e. an increase of 69% from 1997. The spawning concentrations of blue whiting during winter and spring 1998 were distributed within a larger area and more to the west than usual, i.e. from the Irish shelf northwards to the Rockall Bank. About 50 % were thus landed from international water. Most countries increased their catch in these fisheries, but Norway was responsible for the bulk of the increase, landing 200,000 tonnes more than in 1997.

The landings in 1998 from the directed fisheries in the Norwegian Sea increased by 64 % from 1997 and consisted of 173,676 tonnes, of which Iceland had the highest increase from some 10,000 tonnes in 1997 to almost 65,000 tonnes in 1998.

Denmark, which together with Norway, is responsible for the majority of the blue whiting landings from the mixed industrial fisheries, almost doubled its catches in these fisheries to more than 56, 000 tonnes. The total catch, however, increased by 31% from 1997 and amounted to 94,881 tonnes in 1998.

The fisheries in the southern area, represented mainly by Spain and Portugal, were at an average level in 1998, with a total of 29,400 tonnes.

6.3 Biological Characteristics

6.3.1 Length composition of catches

Data on length composition of the 1998 commercial catches of the blue whiting stock by ICES divisions and quarter of the year were presented by Norway, Russia, Spain, Portugal, Ireland, Iceland, Denmark, The Netherlands and Faroe Islands (Table 6.3.1.1).

The majority of the Norwegian and Russian catches from the directed fisheries in the Norwegian sea consisted of fishes with length range 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.

Spain and Portugal caught blue whiting in the areas with length range 13 - 40 cm and modal length of 19 – 20 cm. Icelandic catches from the directed fisheries consisted of blue whiting with lengths from 19 - 39 cm, mode 25 - 26 cm and from the mixed fisheries 9 - 29 cm with modal lengths of 12 -13 cm and 24 - 25 cm.

Compared to last years length compositions for all ICES divisions in question, the 1999 lengths were reduced by 1 -2 cm, except for the catches in the Icelandic zone, which remained as in 1997. Most of the fishes in the catches belonged to the 1995 - 1997 year classes.

6.3.2 Age composition of catches

For the directed fisheries in the northern area in 1998, age compositions were provided by Norway, Russia, The Faroes and Ireland, which together accounted for 78 % of the catches. Appropriate Norwegian and Russian age compositions were used to allocate the landings of other nations, which had no samples themselves. Russian data were used for Estonia, and Norwegian data used for Germany, France and Scotland. In addition, Norwegian age-length keys were used for the Netherlands, Iceland, Sweden and Denmark, which had incomplete length samples. The age compositions in the directed fisheries are given in Table 6.3.2.1.

Age compositions for the mixed industrial fisheries in 1998 were provided by Norway, which accounted for 30 % of the 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, which 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 from the blue whiting stock. The catch numbers at age used in the stock assessment are given in Table 6.3.2.4.

6.3.3 Weight at age

Data on mean weight at age were available from Norway, Russia, the Faroes, Spain and Portugal. Mean weight for length samples converted by Norwegian age-length -weight keys, were given by Iceland and the Netherlands. Landings from other countries were assumed to have the same weight at age as the sampled catches. Table 6.3.3.1 shows the mean weight-at-age for the total catch during 1991- 1998 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

In Table 6.5.1 the maturity at age is given together with the other input data for prediction. The values, the same as used every year since 1994, were obtained by combining the maturity ogive from the southern and the northern areas, weighted by catch in number by age (ICES 1995/Assess:7).

6.4 Stock Estimates

6.4.1 Acoustic surveys

6.4.1.1 Surveys in the spawning season

In 1999 Norway carried out an acoustic survey on the blue whiting stock in the spawning area to the west of the British Isles. From 24 March - 26 April the R.V. "Johan Hjort" monitored the blue whiting stock in the shelf edge area and the banks from south of Ireland to the Faroes (WD Monstad *et al.* 1999). The objectives of the survey were to record the distribution of the stock and to ascertain the compositions of age, length and maturity, and to estimate the spawning stock size and study the hydrographic situation in the area. This type of survey has been carried out by one or more nations since early 1970's.

The area was surveyed from south to north. The shelf edge area from latitude 49°00' N was criss-crossed northwards to the Shetland-Faroe waters at latitude 61°30'N, including the slope around the Rockall Bank, over the Bill Bailey Bank and to the Faroe Bank (Figure 6.4.1.1.1).

A 38 kHz echo sounder (Simrad EK 500), which was pre-calibrated and connected to the Bergen Echo Integrator-system (BEI), was operated throughout the survey. For identification and collection of biological samples, a pelagic trawl (Åkratrål) with 500m circumference in front and a Rock-hopper bottom trawl with 4 x 18m opening were used. For the acoustic assessment of biomass and abundance of the blue whiting stock the surveyed area was treated on maps as 5 subareas, which further were divided into the ICES-rectangle system. The method used for the calculations was the same as used for previous blue whiting surveys.

Recordings of blue whiting were made along the whole shelf edge area surveyed, i.e. from south of Ireland (49°00'N) to the Faroe/Shetland-area (61°30'N), including the Rockall Bank and Bill Bailey Bank (Figure 6.4.1.1.2). The blue whiting was concentrated in a narrow "belt" at the slope south of the Porcupine bank with good concentrations at the western and north-western part of the bank. From 56° N and onwards, however, the concentrations were rather high, and observed as a 25 m thick layer around 500m depth. The highest concentrations were observed west of St. Kilda, where the distribution extended westwards almost uninterrupted to the Rockall Bank, where the best recordings were made at the western slope of the bank. From the slope north-west and north of The Hebrides blue whiting was recorded over a rather wide area, extending well into the Faroes zone, where the limit of the distribution was not located neither to the north-west nor to the east.

The observed biomass of blue whiting was estimated at 8.9 million tonnes representing the abundance of 120.2 x 10^9 individuals. The immature part of the stock was calculated to be 0.5 mill tonnes or 10.6 x 10^9 individuals. The spawning stock size estimated at 8.5 million tonnes or 109.6 x 10^9 individuals, was almost the double of the last years' acoustic estimate (WD Monstad, 1998).

The length and age distributions for each of the sub-areas (marked on Figure 6.4.1.1.2) are shown on Figure 6.4.1.1.3. In the slope area south of Ireland 1 and 2 years olds dominated the stock, which together made up 82% in numbers. In the Porcupine Bank area 1 - 3 years olds were evenly represented making up most of the concentrations.

The 3 years olds (1996 year-class) were the most prominent ones in the Hebrides area and was first recorded in significant numbers at approximately 65°N. This subarea contained the highest abundance and biomass of the stock, which was comprised of mostly 3-year-olds. In the Rockall Bank area, where the largest individuals were found, the 1996 year class dominated.

The total distributions of length and age are given on Figure 6.4.1.1.4, showing the contribution of the 1996 year class at 50%, while the 1995 and 1997 year classes contributed with 22% and 16% respectively. The year classes from 1994 and older seemed to be more or less out of the stock.

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, with the results published in a common report as Holst *et al.* (1998).

In 1998 blue whiting was recorded in the following surveys in the feeding area:

	Period	Vessel	Country
a)	21 April-17 May	R.V. "G.O.Sars"	Norway
b)	1 - 19 May	R.V. "Magnus Heinason"	Faroes
c)	20 May-5 July	R.V. "F. Nansen"	Russia
d)	17 June-27 July	R.V. "Árni Fridriksson"	Iceland
e)	30 June-29 July	R.V. "Johan Hjort"	Norway

a) In April and May the Norwegian R.V. "G.O.Sars" recorded blue whiting distributed over a large part of the surveyed area (Figures 6.4.1.2.1a and b). As opposed to 1997, blue whiting and herring had a fairly strong overlap in geographical distribution. The length and age composition of blue whiting samples are shown in Figure 6.4.1.2.2 for the subareas: a) South of 65° N, b) 65° - 68° N and c) North of 68° N. The strong 1996 year-class constituted most of the blue whiting biomass, reflecting that the adults were out of the area on their southern spawning migration. Since 1997 much of the strong 1995 year-class had matured and was out of the area at this time of the year (WD Monstad and Holst, 1999).

b) The survey tracks and stations for the Faroese R.V. "Magnus Heinason" in May are shown on Figure 6.4.1.2.3. The investigations south of the Faroes were an attempt to map the post spawning migration of blue whiting. The observations of blue whiting were found to be distinctively different compared to the surveys in 1996 and 97 (Jákupsstovu et al., 1998). The integrated values (S_A) allocated to blue whiting were significantly lower compared to 1997. The total biomass of blue whiting in the area surveyed south of the Faroes was estimated to 297 000 tonnes (Figure 6.4.1.2.4).

c) The survey track with stations of the Russian R.V. "F. Nansen" in June is shown in Figure 6.4.1.2.5. Blue whiting was found distributed over most of the observed area with the main concentrations to the south of 65°N and eastwards from 06° W (Krysov, 1998). The echo recordings were registered mainly as a scattered layer at various depths from 150 to 300m. The echo density distribution is presented on Figure 6.4.1.2.6. The 1996 year-class dominated in most of the catches. Only in the north-western part of the observed area older and larger fish was found. There prevailed 6 and 7 years old fish. The total biomass was estimated to 5.6 mill tonnes and 48.8 x 10^9 individuals.

d) In the beginning of July an Icelandic research vessel recorded dense concentrations of blue whiting to the southeast of Iceland between 63° 30' and 64° 00' N. These fish migrated to the north and their biomass was estimated at about 0.5 million tonnes. During the survey conducted by R.V. "Árni Fridriksson" from 17 June-27 July south and east of Iceland, high concentrations were recorded in a narrow region near the shelf edge along the entire south coast as well as southeast of Iceland, south of 64° N (Figure 6.4.1.2.7). In the westernmost part of the area, these concentrations consisted of blue whiting of the 1998 year-class while farther east larger fish of the 1996 year-class dominated. The biomass was estimated at about 1 million tonnes, giving a total biomass estimate of the two Icelandic surveys in the area west of 8° W of 1.5 million tonnes (Holst *et al.* 1998).

e) During the survey of the Norwegian R.V. "Johan Hjort" in July, recordings of blue whiting were made over vast areas in the Norwegian Sea, with echo recordings obtained more or less throughout the whole area surveyed (Figures 6.4.1.2.8a and b)(WD Monstad and Holst, 1999). The concentrations, which varied in density, were mostly observed at depths from 200-400m during daytime. At night it dispersed and in some areas ascended towards the upper surface layer.

   To the west the limit of distribution was found in the polar-front area, i.e. at position 69° N and 07° W and further north and north-eastwards, while to the east it was only found in the area off the southern part of the Lofoten Isles. Highest concentrations were found in the mid part of the southern Norwegian Sea. Rather high values were also recorded in the northern part of the area surveyed, and the distribution continued eastwards into the Barents Sea. The biomass was estimated at 6.6 million tonnes with a corresponding abundance of 89.6 x 10^9 individuals, which is almost the double the 1997 result.

   The age and length distributions for the total recordings are given in Figure 6.4.1.2.9. Young fish predominated the concentrations, and the 2 year olds (1996 year-class) constituted more than half of the measured abundance. The relationship between the 3 major year-classes, 1995-97, was rather similar for all sub-areas except for the south-eastern part. There, in sub-area I, the one-year-olds (1997 year-class) were the most numerous.

6.4.1.3 Discussion

The various acoustic surveys in the Norwegian Sea with special emphasis on Norwegian spring spawning herring in 1998 also gave valuable information on the blue whiting stock in its feeding area. The 1995-97 year-classes have been rather dominant in these surveys the last few years.

During the July-August survey in 1997, the one-year-olds contributed more than 50% of the total numbers, and hence this was the first sign of the 1996 year-class' outstanding strength. Together with the very strong 1995 year-class, it also made up greater parts of the blue whiting catch in the mixed industrial fisheries both as 0-group in the autumn of 1996 and as one year old in 1997.

During the spawning area survey in spring 1998, the 1995 year-class dominated and made up 44% in number of the total concentrations recorded. As part of the 2-year-olds in the stock also was mature and hence occurred in the spawning area, the 1996 year-class contributed with 23% of the total. In all the Norwegian Sea surveys that followed in 1998, except for the one in the Faroese waters in May (Jákupsstovu et al., 1998) the abundance of the 1996-year-class was observed to be abundant. However, in Faroese waters there were greater concentrations of blue whiting on the eastern post-spawning migration line, and this along with the preliminary salinity analysis showed that the migration pattern would concentrate in the Shetland Channel, as suggested by Hansen and Jákupsstovu (1992).

In April/May, when most of the adults are in the spawning area or further south, the young ones were found distributed with its best concentrations in the central part of the Norwegian Sea and off the Northern Norwegian coast. In June the survey area was enlarged westward and likewise the blue whiting distribution found over a corresponding larger area. The estimate of 5,6 mill tonnes, which consisted mainly of the 1996-year-class (Holst *et al.*, 1998), was significantly higher than earlier estimates in the feeding area, made since 1980.

The Norwegian survey in July confirmed this high abundance of young blue whiting observed in the Norwegian Sea, estimating the stock at 6.6 mill tonnes or 89.6 x 10^9. specimens. This result is almost double the 1997 result when

Norway measured 3.9 million tonnes, which again was significantly higher than the results of 1996 and 1995. It is the highest value obtained for blue whiting in the Norwegian Sea since 1980 when Norway measured the stock at 9.1 mill tonnes (Monstad, 1990), and more than half of it consisted of the 1996 year-class. The abundance estimate obtained in 1998 was about 50% higher than that in 1997, and both the overall mean length and mean weight were higher than in 1997.

The two Icelandic surveys in July, observed 1.5 mill tonnes of blue whiting in the Icelandic waters, which resulted in an industrial fishery off the eastern south coast and in the area south-east of Iceland. Such a fishery also developed in 1989 when the strong 1989 year-class spread into the Icelandic water during the summer.

The combined result of these three surveys gives a total of 8.1 million tonnes in the Norwegian Sea and Icelandic waters in July 1998 (Holst *et al.* 1998).

Estimates of total biomass and spawning biomass of blue whiting in the spawning area since 1983 are given in Table 6.4.1.3.1. The difference in the estimates, which have been discussed several times in previous Working Group reports, may be caused by differences in the acoustic equipment, bad weather causing poor echo recording conditions, size of the survey area and timing of the surveys in respect to progress of spawning and hence migration, as well as variation of the abundance of recruitment of new year-classes to the spawning stock.

The estimates as discussed in earlier reports, do not coincide with the assessment. They are, however, to be taken as indices, and for most years they present valuable indications of trends in stock size. There has been a downward trend in the spawning stock size from 1988/89 to 1992, but in 1993 the strong 1989 year class was fully recruited, increasing the spawning stock. Except for a clear underestimate in 1994, the acoustic survey indicated a spawning stock increase up to 1995. After the very strong 1989 year-class was out of the stock, the spawning stock decreased. The year-classes 1995 and 1996 were rich and by 1998 the spawning stock had increased due to the entrance of the 1995 year class. Further, as expected from the summer surveys, the 1996 year-class dominated in the spawning area in 1999.

The abundance and biomass of blue whiting in spring 1999 were the highest recorded by Norway since 1972 when this stock monitoring started. This observation applies to the total stock in the area as well as for the spawning stock. The highest estimate before that was in 1988, when 7.1 million tonnes were recorded of which 6.8 million tonnes belonged to the spawning stock biomass.

In spring 1999 the biomass of the 1996 year-class alone amounted to 4.4 million tonnes, which is the same level as the whole spawning stock measured in 1998 (Monstad, 1998b). However, the estimate 1998 is considered an underestimate, and in 1999 the area of distribution was found to be notably larger than observed in previous years, especially for the inclusion of larger parts of the Rockall Bank in the survey.

Both the 1995 and 1996 year-classes are considered very strong year-classes. The first one dominated the stock in the spawning area last year with 35 x 10^9 individuals, but is reduced to 26 x 10^9 individuals observed this year. The biomass, however, was only slightly reduced due to increased mean weight. The very strong 1996 year-class was represented in the spawning area in 1998 with a number of 18 x 10^9 individuals, compared to 60 x 10^9 in 1999 (ICES1998/ACFM:18). This is due to first time maturity for a great part of this year-class, which was outside the spawning area last year and hence not surveyed.

Due to the higher abundance of the stock than usual the latest years, the stock occupied a wider distribution towards the west and as a result the fleet operated more in international waters. Up to mid April the Norwegian fleet alone had already landed more than 350 000 tonnes from the Porcupine Bank area, the area west of the Hebrides and also further westwards to the Rockall Bank. Of these, some 220 000 tonnes were reported landed from international waters. The observation of rather high concentrations west of the Rockall Bank, which has not been the case earlier, and the successful fishery to date in 1999, are generally consistent with the increase of spawning stock biomass recorded in the acoustic surveys.

6.4.2 Bottom trawl surveys in the southern area

Bottom trawl surveys have been conducted off both the Galician (NW Spain) and Portuguese coast 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 the Spanish waters in Division VIIIc. The area covered in the Portuguese survey was also extended in 1989 to 750m contour. Stratified mean catch and standard error in Spanish and Portuguese surveys are shown in Tables 6.4.2.1 and 6.4.2.2. In both areas, the larger mean catch rate is observed in the 100-500 m depth range. In general, higher mean catch rates were observed prior to 1991 and lower catch rates observed afterwards. A satisfactory agreement is observed between the three series although the series from the Portuguese autumn surveys presents a larger inter-annual variability (Figure 6.4.2.1).

6.4.3 Catch per unit effort

No data on catch per unit of effort were presented to the Working Group in 1999. The overall aggregated CPUE values across areas in the Norwegian blue whiting directed fishery 1982-1998 and for CPUE for Galician single and pair-trawlers are shown in last years WG-report on Figures 6.4.3.1 and 6.4.3.2 respectively (CM 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 survey 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 Last year 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.

It was pointed out in the 1998 Working Group report that the proportion of the fishing mortality rate and natural mortality before spawning were all set to zero. This is changed in this year's assessment. All proportion values are set to 0.25.

Last year it was decided by the working group to change assessment tools from XSA to ICA.

ICA-runs

A first run was made with the same options as last year's final run, but with all fleets and all data points included (run 1 in Table 6.4.4.2). The impression from last year was confirmed, several data points made large contributions to the variance. As last year, the Portuguese and the Spanish bottom trawl survey indices together with a few age groups in the other index series were excluded. The data used in the following runs (if nothing else is claimed) are shown within the squares in Table 6.4.4.1.

Several runs were made with different options in the separability model. The reference age and the number of years with the separability constraint were changed until a satisfactory fit was obtained (Figure 6.4.4.2). The main results from this run are shown as run 2 in Table 6.4.4.2. Although the statistics of the run showed an acceptable model fit, the working group was not content with the results. With a fishing mortality rate (F_{3-7}) of 0.72 and spawning stock biomass of 2.2 million tonnes, one would conclude that the stock was in a bad condition. However, the 1999 Norwegian acoustic survey index on the spawning grounds suggests the stock to be in a good condition, giving one of its highest indices in this series. The working group made several suggestions on improvements of the assessment:

- to split up some of the tuning series because of new equipment
- to include the 1999 data point in the assessment
- remove the 3-year olds from the survey indices on the spawning grounds
- to use the biomass indices instead of age aggregated indices in some of the tuning fleets

Last year the working group decided to split up the tuning series on the Norwegian Spring Spawning herring where there had been a change to Simrad EK-500 echo sounder (ICES 1998/ACFM:18). For the same reasons, the Norwegian survey on the spawning grounds and the Norwegian Sea survey were split, the last series beginning at 1991. The Russian survey changed echo sounder the following year, thus this series was also split up. The resulting assessment differed quite a lot, achieving an F of 0.52 compared to 0.72 from the run before the split (run 3 in Table 6.4.4.2).

Two runs were made including the 1999 data points from the Norwegian survey on the spawning grounds. The first run was based on the split tuning series and gave a higher F of 0.61 (run 4 in Table 6.4.4.2). The other run was based on the original tuning series and gave an F of 0.77 (run 6 in the same Table).

It was suggested to remove the 3-year olds from the survey indices on the spawning grounds, because they are not well represented in that area at that time. A run was made with the split tuning series where these data points were left out. The F of 1998 resulted in 0.53 (run 7) and didn't make much of a difference from run 3.

A run was made where the biomass indices of the Norwegian acoustic survey were used instead of the age-aggregated indices. This series was also split. The differences in the results were small, it was decided not to choose this option nor present it in the working group report.

For exploratory reasons, a run with the shrinkage option was made with split tuning files. The F was reduced to 0.45 (run 6 in Table 6.4.4.2). However, the WG recognised that it was not appropriate to use shrinkage when new trends in the stock are expected to have taken place the latest year or two. Since the catch was almost doubled from 1997 to 1998, the highest catch recorded, it was decided not to go any further with this option.

As Table 6.4.4.2 shows, the total variance is much the same for most of the runs. From the statistical diagnostics, it was not obvious what run would be the appropriate to choose, except to exclude run 1 where all data points are included. The further reasoning for choosing was as follows:

- Since the indices before and after the change in echo sounder are not likely to be comparable, it was decided to choose a run with split index series (run 3, 4 and 7).
- Leaving out the 2-year olds in the Norwegian survey on the spawning stock did not make any considerable change, which gave no reason to choose this run (run 7).
- To include the 1999 indices would change common practise for this stock. The extra data points made the F increase and the SSB decrease, the opposite of what was expected. It is somewhat uncertain how and how well these data points are utilised in ICA. Since the working group's impression is that the indices from the Norwegian survey on the spawning ground and the Norwegian Sea surveys are closer to the stock level than the ICA-runs suggest, the run without the 1999 data points were found most reliable (run 4 and 6).

Based on the above reasoning, run 3 with split index series (otherwise the same data points as last year) was chosen to be the final run. A stock summary is shown in Table 6.4.4.3 and the ICA output in Table 6.4.4.4, Fig. 6.4.4.1 and Fig. 6.4.4.2.

However, it is not a simple task to judge the different runs. The variance is similar for the runs and offers little discriminatory power. In future assessment, a more thorough examination of the error distribution, e.g. using a gamma distribution as used for NSS herring, instead of the lognormal distribution, should be explored.

Compared to last year's results, the final run in 1999 indicates a considerably stronger 1997 year class. The spawning stock is estimated to be 2.6 million tonnes and the total biomass estimate is 5.2 million tonnes. 1998 fishing mortality rate is estimated to be 0.5, which is among the highest in the period 1981-1998.

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 and the exploitation pattern were taken from the average of the last three years values. The recruitment in 1999-2001 was set as the geometric mean of the recruitment values in the period 1988-1997 in the ICA run, because the very low value in 1998 was considered unrealistic. Age 1 in 1999 was derived from the same average value, using the appropriate F provided by the ICA run. For ages 2 and older the output values from the ICA run were used. 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. Continuing fishing at the 1998 level predicts a catch of 1.2 million t. in 1999 and 1.1 million t. in 2000. This exploitation rate implies an increase of SSB to 2.9 million t. in 1999 and a decreasing trend afterwards, with 2.5 and 2.1 million t. in 2000 and 2001 respectively. The predicted total stock biomass also will decrease from 5.2 million t. in 1999 to 4.6 and 4.0 million t. in the following years.

6.6 Medium-Term Projection

Although it was not in the terms of references, an attempt was made to do a medium term stochastic projection using the ICP program. Input data were taken from the final ICA-run. Considerable effort was made to accomplish this. Due to discrepancies between the deterministic and the stochastic output from the ICP program, it was decided not to present the result in the Working Group report.

6.7 Precautionary Reference Points

Precautionary reference points were estimated using the PA Software (MRAG, 1997). Input data was extracted from the .SEN and .SUM files derived from the final ICA-run but entered into PASoft as an excel input. The terminal population was that estimated by ICA for the beginning of 1999. Due to uncertainties in the population numbers at age 0 and age 1 derived from the ICA, 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. In last year's report (ICES 1998/ACFM:18) 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. The results are summarised in Figures 6.7.1, 6.7.2, 6.7.3 and 6.7.4.

Several outputs on equilibrium based diagnostics were plotted and given in Figures 6.7.2 and 6.7.3. The estimated reference points are shown in fig. 6.7.4 (note the strange value of F_{bar}). Last year, the working group chose F_{pa} to be F_{med} = 0.32. The recalculated F_{med} this year are 0.33 (deterministic) and 0.31 (stochastic estimate). Since the F_{loss} calculated last year was low (0.32), the working group considered F_{loss} not to be appropriate for F_{lim}. This year's calculations, however, result in quite higher F_{loss}; 0.57 (deterministic) and 0.51 (stochastic estimate). Using the formula recommended by the PA working group (ICES 1998/Assess:7), we get a suggestion for F_{pa}: $F_{pa} = F_{loss}e^{-1.645\sigma} = 0.34$, when F_{loss} is stochastic, and F_{pa} = 0.38 when F_{loss} is deterministic.

The Working Group recommends to keep the B_{lim}=1.5 million tonnes and B_{pa}=2.25 million tonnes calculated last year. Further, we recommend to use the stochastic estimate of F_{loss} as F_{lim} (=0.51), resulting in an F_{pa} of 0.34.

As Figure 6.7.4 shows, the stock has had an F higher than 0.34 in almost 40% of the years recorded. Figure 6.7.1 shows that in 1996, 1997 and 1998 the fishery has not been precautionary according to the chosen reference points.

6.8 Spatial, temporal and Zonal distribution

A description of the monthly distribution of the fisheries for blue whiting by ICES rectangles is given here (Figs 8.1.3.1-12). Figure 8.1.3.13 shows the overall catch distribution in 1998.

January (Fig. 8.1.3.1): The main wintering_concentrations of blue whiting were distributed in the southeastern part of the Faroese EEZ.

February (Fig. 8.1.3.2): The fishery on the pre-spawning concentrations took place in the Porcupine bank area and in international waters west of the Irish EEZ.

March (Fig. 8.1.3.3): The spawning concentrations of blue whiting were distributed inside the Irish EEZ and in international waters along the Irish EEZ.

April (Fig. 8.1.3.4): In the first half of the month, the fishery was based on post-spawning blue whiting which was concentrated in the Irish and UK EEZs as well as international waters around the Rockall Bank. In the second part of April, the blue whiting migrated to the southern part of the Faroese EEZ.

May (Fig. 8.1.3.5): The main post-spawning concentrations of the fish were observed in the UK and Faroes EEZs. In late April, blue whiting were found in Icelandic waters and a fishery in this continued during May. In late May, blue whiting migrated into the Norwegian EEZ.

June (Fig. 8.1.3.6): The main fishery was in the Faroes EEZ.

July (Fig. 8.1.3.7): A fishery on feeding blue whiting took place in several areas:

a) The eastern part of the Icelandic EEZ.

b) The northern part of the Faroese EEZ.

c) In a mixed industrial fishery along the Norwegian coast.

August (Fig. 8.1.3.8): The main catches of blue whiting were taken in the eastern part of the Icelandic EEZ, in international waters and also in mixed industrial fisheries in the northern part of the North Sea.

September (Fig. 8.1.3.9): Feeding concentrations of blue whiting were observed in the eastern and southern parts of the Icelandic EEZ, in international waters (up to 72° 30' N) and in a mixed industrial fishery in the Norwegian and EU EEZs.

October (Fig. 8.1.3.10): The main catches were taken from the Icelandic, Faroese and Norwegian EEZs.

November (Fig. 8.1.3.11): The fishery was based on wintering concentrations of blue whiting, which were distributed in the Icelandic, Faroese and Norwegian EEZs. Dense concentrations were also located in the Jan-Mayen EEZ.

December (Fig. 8.1.3.12): The main fishing grounds were located in the Faroes EEZ.

The fishery in the southernmost distribution area (Spain and Portugal) is a coastal fishery where blue whiting are fished throughout the year by vessels that operate at short distance from the ports were they are located. This fishery has two main components:

a) Spanish bottom pair trawlers targeted for blue whiting and a fishery which is conducted in the area off Cape Finisterre (NW Spain).

b) Spanish and Portuguese bottom trawlers, fishing blue whiting as a by-catch along the Atlantic coast of the Iberian Peninsula.

One acoustic survey of the spawning area and several surveys of the Norwegian Sea were carried out in 1988 and an acoustic survey of the spawning grounds was carried out in 1999. These observations of blue whiting as well as the fishery during 1998/99 indicate that blue whiting were distributed over a wide area, reaching from west of the Rockall Bank eastward to the spawning grounds and from there north up to 74°N in the Norwegian Sea.

Investigations in 1998 and winter/spring 1999 clearly show that the 1995 and 1996 year classes are very strong (in particular the 1996 year class) and in the coming years these year classes will constitute by far the largest part of the spawning stock.

The directed fishery of blue whiting is pursued with pelagic trawls, operating at depths between 200 and 500m. Bottom trawl is used in the mixed industrial fishery.

The total international catch of blue whiting in 1978-1998, divided on areas within and beyond national fisheries jurisdiction as defined by NEAFC is given in Table 6.8.1.

6.9 Management consideration

The catch in 1998 was the highest since 1980, reaching 1.1 million tonnes. In correspondence with this, and also the successful fishery at present (so far up to May 1999), the acoustic estimate of the spawning stock was measured at 8.5 million tonnes, in spring 1999. This biomass is among the highest ever observed in the spawning area, and almost doubled since 1998, which was, however, considered an underestimate. The acoustic measurements are considered to be indices, and they indicate trends in the stock size.

By use of ICA the spawning stock biomass in 1998 was estimated at 2.6 million tonnes and the F = 0.52. Assuming the same F in 1999 (F-factor =1) the short-term projection shows an increase of the spawning stock size to 2.9 million tonnes in 1999. The fishing intensity of the stock seems so far in 1999 (May) to be at least at the same level as in 1998, and hence the chosen F- factor seems appropriate. However, keeping the same F-factor of 1 also in year 2000 the spawning stock is predicted to decrease to 2.5 million tonnes and further decrease in 2001 to 2.1 million tonnes. Fishing at F_{PA} (0.34) in year 2000, the spawning stock will remain at the present level.

Although the acoustic measurement of the stock in 1999 was record-high and the stock therefore seems to be in good shape. Based on the trend in the ICA run results and the short-term projection the Working Group therefore recommends that the fishing level should be reduced to F_{PA} (0.34). This generates a catch of 800,000 tonnes in year 2000, which should keep the stock at the same level as in 1998-99.

6.10 Sampling

Nine countries reported length samples of blue whiting in 1998, and six of those had also age readings (Table 6.10.1).

Table 6.2.1 Landings (tonnes) of BLUE WHITING from the main fisheries, 1985-1998, as estimated by the Working Group.

Area	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Norwegian Sea fishery (Subareas I+II and Divisions Va,XIVa-b)	90,742	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
Fishery in the spawning area (Divisions Vb, VIa, VIb and VIIb-c)	464,265	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
Industrial mixed fishery (Divisions IVa-c, Vb and IIIa)	97,769	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
Subtotal northern fishery	652,776	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
Southern fishery (Subareas VIII+IX, Divisions VIId,e,g-k)	42,820	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
Grand total	695,596	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

Table 6.2.2 Landings (tonnes) of BLUE WHITING from the directed fisheries in the Norwegian Sea (Subareas I and II, Division Va, XIVa and XIVb) 1985-1998, as estimated by the Working Group.

Country	1985	1986	1987	1988	1989 3)	1990	1991	1992	1993	1994 2)	1995 3)	1996	1997	1998
Faroes	-	-	9,290	-	1,047	-	-	-	-	-	-	345	-	44,594
Germany	1,764	3,647	1,010	3	1,341	-	-	-	-	2	3	32	-	78
Greenland	-	10	-	-	-	-	-	-	-	-	-	-	-	
Iceland	-	-	-	-	4,977	-	-	-	-	-	369	302	10,464	64,863 4)
Netherlands	-	-	-	-	-	-	-	-	-	-	72	25	-	63
Norway	-	-	-	-	-	566	100	912	240	-	-	58	1,386	12,132
Poland	-	-	56	10	-	-	-	-	-	-	-	-	-	
UK (Eng.&Wales)	-	-	-	-	-	-	-	-	-	-	-	-	-	
USSR/Russia 1)	88,978	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
Estonia	-	-	-	-	-	-	-	-	-	-	-	377	161	904
Latvia	-	-	-	-	-	-	-	-	-	422	-	-	-	
Total	90,742	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

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 6.2.3 Landings (tonnes) of BLUE WHITING from directed fisheries in the spawning area (Division Vb,VIa,b, VIIb,c. VIIg-k and Sub-aea XII) 1985 - 1998, as estimated by the Working Group.

Country	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Denmark	21,104	11,364	2,655	797	25	-	-	3,167	-	770	-	269		5051 1)
Faroes	72,316	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
France	-	-	-	-	2,190	-	-	-	1,195	-	720	6,442	12,446	7,984
Germany	7,465	2,750	3,850	5,263	4,073	1,699	349	1,307	91	-	6,310	6,844	4,724	17,891
Ireland	668	16,440	3,300	245	-	-	-	-	-	3	-	-		45635
Netherland	1,801	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
Norway	234,137	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
UK (Scotland)	2	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
USSR/Russia 2)	126,772	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
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	464,265	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

1) Including some direced fishery also in Division IVa.
2) From 1992 only Russia

Table 6.2.4 Landings (tonnes) of BLUE WHITING from the mixed industrial fisheries and caught as by-catch in ordinary fisheries in Divisions IIIa, IVa 1985-1998, as estimated by the WG.

Country	1985	1986	1987	1988	1989	1990	1991	1992	1993 3)	1994	1995	1996	1997	1998
Denmark	35,843	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 2)
Faroes	3,606	5,678	7,051	492	3,325	5,281	355	705	1,522	1,794	-	6,068	6,066	296
Germany 1)	52	-	115	280	3	-	-	25	9	-	-	-	-	
Netherland	130	1,114	-	-	-	20	-	2	46	-	-	-	793	
Norway	54,522	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
Sweden	3,616	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
UK	-	-	-	100	7	-	335	18	252	-	-	1	-	
Total	97,769	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

1) Including directed fishery also in Division IVa.
2) Including mixed industrial fishery in the Norwegian Sea
3) Unprecise 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 6.2.5 Landings (tonnes) of BLUE WHITING from the Southern areas (Subareas VIII and IX and Divisions VIIg-k and VIId,e) 1985-1998, as estimated by the Working Group.

Country	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Netherlands	-	-	-	-	-	450	10	-	-	-	-	-	-	10 1)
Norway	-	-	4	-	-	-	-	-	-	-	-	-	-	
Portugal	6,989	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
Spain	35,828	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
UK	3	1	23	12	29	13	-	-	-	5	-	-	-	
France	-	-	-	-	1	-	-	-	-	-	-	-	-	
Total	42,820	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

1) Directed fisheries in VIIIa

Table 6.3.1.1 Length distribution of commercial catches by ICES division and fleet as provided by Iceland, Norway, Russia, Spain, Portugal, Denmark, Netherland and Ireland.

Country : **Norway** Fleet : **Directed Div. IIa**
Species : **Blue Whiting** Unit : **'000**
Year : **1998**

Length (cm)	Quarter 1	Quarter 2	Quarter 3	Quarter 4
10				
11				
12				
13				
14				
15				
16				
17				
18				
19		380	446	
20		2 533	3 274	329
21		5 954	8 928	1 425
22		8 740	12 797	1 864
23		14 567	20 832	2 741
24		12 287	20 088	4 166
25		5 700	11 755	3 727
26		887	2 976	1 535
27		127	1 488	987
28		253	893	658
29		127	149	
30		380	446	329
31				
32		127	149	110
33		127	149	110
34			298	219
35		127	149	110
36				
37				
38				
39				
40				
41				
42				
43				
44				
45				
TOTAL		52 315	84 818	18 307
Catch (t)		3 970	6 582	1 580

Country : **Norway** Fleet : **Directed Div. IVa**
Species : **Blue Whiting** Unit : **'000**
Year : **1998**

Length (cm)	Quarter 1	Quarter 2	Quarter 3	Quarter 4
10				
11				
12				
13				
14				
15				
16	294			
17	1 030			
18	736			25
19	1 177			8
20	442			34
21	1 472			110
22	1 325			357
23	294			526
24	147			399
25	147			272
26				221
27				136
28				42
29	294			51
30				17
31				8
32				17
33				8
34				25
35				
36				
37				
38				
39				
40				
41				
42				
43				
44				
45				
TOTAL	7 359			2 259
Catch (t)	346			203

Table 6.3.1.1 continued

Country : **Norway** Fleet : **Directed Div. VIa**
Species : **Blue Whiting** Unit : **'000**
Year : **1998**

Length (cm)	Quarter 1	Quarter 2	Quarter 3	Quarter 4
10				
11				
12				
13				
14				
15				
16				
17				
18				
19	20			
20		13 684		
21	199	35 579		
22	419	123 159		
23	558	208 001		
24	997	240 844		
25	917	131 369		
26	379	125 896		
27	458	84 843		
28	179	114 948		
29	179	106 738		
30	239	134 106		
31	159	106 738		
32	80	79 369		
33	80	38 316		
34	40	49 263		
35	40	13 684		
36		13 684		
37	20	8 211		
38		8 211		
39	20			
40				
41				
42				
43				
44				
45				
TOTAL	4 984	1 636 643		
Catch (t)	460	167 968		

Country : **Norway** Fleet : **Directed Div. Vb**
Species : **Blue Whiting** Unit : **'000**
Year : **1998**

Length (cm)	Quarter 1	Quarter 2	Quarter 3	Quarter 4
10				
11				
12				
13				
14				
15				
16				
17				818
18				
19				
20		1 970		
21		6 566		
22		17 729		2 453
23		24 295		11 447
24		33 487		18 805
25		32 174		15 535
26		21 668		8 994
27		18 385		10 629
28		12 476		8 176
29		8 536		1 635
30		19 042		1 635
31		16 415		1 635
32		17 729		
33		8 536		
34		10 506		
35		7 879		
36		3 940		
37		657		
38				
39		657		
40				
41				
42				
43				
44				
45				
TOTAL		262 646		81 762
Catch (t)		27 160		8 618

Table 6.3.1.1 Cont.

Country : **Norway** Fleet : **Directed Div. VIb**
Species : **Blue Whiting** Unit : **'000**
Year : **1998**

Length (cm)	Quarter 1	Quarter 2	Quarter 3	Quarter 4
10				
11				
12				
13				
14				
15				
16				
17				
18				
19	967			
20				
21	14 505	2 408		
22	25 142	9 632		
23	47 382	24 081		
24	93 798	54 182		
25	99 600	56 590		
26	59 953	54 182		
27	45 448	40 937		
28	29 010	31 305		
29	22 241	32 509		
30	22 241	26 489		
31	27 076	20 469		
32	13 538	24 081		
33	10 637	21 673		
34	9 670	10 836		
35	1 934	7 224		
36	2 901	2 408		
37	5 802	2 408		
38	967			
39	1 934			
40				
41				
42				
43				
44				
45				
TOTAL	534 744	421 414		
Catch (t)	53 288	51 509		

Country : **Norway** Fleet : **Directed Div. VIIb,c**
Species : **Blue Whiting** Unit : **'000**
Year : **1998**

Length (cm)	Quarter 1	Quarter 2	Quarter 3	Quarter 4
10				
11				
12				
13				
14		1 185		
15		10 189		
16		30 092		
17		16 349		
18		12 321		
19		2 606		
20	2 224	3 554		
21	11 860	4 739		
22	57 076	5 687		
23	189 017	3 080		
24	343 937	2 369		
25	295 015	1 422		
26	200 136	474		
27	117 858	474		
28	97 844	237		
29	82 278			
30	68 194			
31	62 264			
32	59 299			
33	45 957			
34	44 475			
35	25 943			
36	26 685			
37	8 154			
38	4 447			
39	4 447			
40	1 482			
41	741			
42				
43				
44				
45				
TOTAL	1 749 333	94 778		
Catch (t)	207 011	3 059		

Table 3.6.1.1 continued

Country : **Norway** Fleet : **Mixed Div. IIa**
Species : **Blue Whiting** Unit : **'000**
Year : **1998**

Length (cm)	Quarter 1	Quarter 2	Quarter 3	Quarter 4
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				196
23				849
24				1 110
25				1 632
26				2 481
27				2 220
28				914
29				588
30				392
31				
32				196
33				
34				65
35				65
36				131
37				65
38				
39				
40				
41				
42				
43				
44				
45				
TOTAL				10 903

Catch (t)				941

Country : **Norway** Fleet : **Mixed Div. IVa**
Species : **Blue Whiting** Unit : **'000**
Year : **1998**

Length (cm)	Quarter 1	Quarter 2	Quarter 3	Quarter 4
10				
11				
12				
13				
14				
15				
16	3 139	6 255		
17	10 987	13 404		
18	7 848	19 660	1 147	1 358
19	12 556	25 915	4 587	453
20	4 709	20 553	8 027	1 810
21	15 695	23 234	5 733	5 883
22	14 126	30 383	9 173	19 008
23	3 139	16 085	6 880	28 059
24	1 570	8 936	12 613	21 271
25	1 570	4 468	5 733	14 482
26		6 255	1 147	11 767
27		894		7 241
28		894	1 147	2 263
29	3 139	894	1 147	2 715
30				905
31		894		453
32				905
33				453
34				1 358
35				
36				
37				
38				
39				
40				
41				
42				
43				
44				
45				
TOTAL	78 477	178 724	57 332	120 383

Catch (t)	3 690	9 778	3 585	10 820

Table 6.3.1.1 Cont.

Country : **Russia** Fleet : **Directed Div. IIa**
Species : **Blue Whiting** Unit : **'000**
Year : **1998**

Length (cm)	Quarter 1	Quarter 2	Quarter 3	Quarter 4
10				
11				
12				
13				
14				
15				
16		26		
17		281		
18		485		320
19		1 711	752	320
20		7 202	4 137	959
21		12 437	22 375	4 583
22		18 566	48 135	18 547
23		30 774	105 484	31 285
24		30 339	86 117	35 655
25		18 643	50 391	24 996
26		7 968	9 025	12 258
27		4 061	2 256	5 969
28		2 222		3 891
29		970		1 386
30		843		959
31		460		533
32		485		586
33		638		693
34		587		853
35		536		266
36		664		693
37		306		266
38		230		53
39		102		53
40		153		
41				53
42				
43				
44				
45				
TOTAL		140 690	328 672	145 177

Catch (t)	6 279	10 880	22 365	11 518

Country : **Russia** Fleet : **Directed Div. Vb**
Species : **Blue Whiting** Unit : **'000**
Year : **1998**

Length (cm)	Quarter 1	Quarter 2	Quarter 3	Quarter 4
10				
11				
12				
13				
14	468	92		
15	584	917		
16	1 753	2 566		
17	3 506	7 241		
18	5 844	12 007		
19	11 104	19 798		
20	24 779	59 212		
21	44 999	119 615		
22	47 570	147 113		
23	32 376	114 482		
24	24 077	81 485		
25	12 740	52 062		
26	8 182	27 498		
27	3 857	14 757		
28	1 987	6 508		
29	468	3 758		
30	468	4 858		
31	351	3 483		
32	468	3 483		
33	117	3 025		
34		3 391		
35		2 291		
36		1 283		
37		550		
38		367		
39		183		
40		92		
41				
42				
43				
44				
45				
TOTAL	225 697	692 118		

Catch (t)	14 033	48 150		14 282

Table 6.3.1.1 continued

Country : **Spain** Fleet : **Southern fishery**
Species : **Blue whiting** **Div. VIIIc+Ixa**
Year : **1998** Unit : **'000**

Length (cm)	Quarter 1	Quarter 2	Quarter 3	Quarter 4
10				
11				
12				
13				
14	12		32	
15	400	10	228	12
16	2 138	99	1 173	1 011
17	7 860	2 944	2 722	4 222
18	5 737	8 727	6 843	14 074
19	2 719	13 773	11 713	19 846
20	3 437	11 777	17 252	13 866
21	6 826	12 614	16 689	10 011
22	13 757	12 348	14 762	6 278
23	13 737	13 990	11 455	6 545
24	10 811	8 571	7 756	6 967
25	9 226	5 517	5 282	6 068
26	4 528	2 459	3 745	3 763
27	2 374	1 278	2 363	2 304
28	842	885	1 884	728
29	397	462	953	304
30	130	211	263	116
31	50	127	174	75
32	33	76	400	61
33	15	28	41	28
34	10	25	78	11
35	7	16	2	2
36	7	8	1	8
37	8	3	1	8
38	2	5		1
39	1	1		
40		1		
41				
42				
43				
44				
45				
TOTAL	85 063	95 955	105 813	96 310
Catch (t)	6 564	6 792	7 694	6 385

Country : **Portugal** Fleet : **Southern fishery**
Species : **Blue whiting** **Div. IXa**
Year : **1998** Unit : **'000**

Length (cm)	Quarter 1	Quarter 2	Quarter 3	Quarter 4
10				
11				
12				
13	4	9		1
14		41		
15	95	42	12	7
16	202	92	104	56
17	183	375	317	426
18	186	854	1 307	3 071
19	226	833	3 456	6 753
20	496	474	2 559	3 817
21	1 431	971	1 077	1 175
22	1 558	902	676	204
23	638	478	410	64
24	161	244	299	16
25	31	68	123	7
26	4	51	48	8
27		38	24	
28		18	9	
29		5	9	
30		8	9	
31		6	4	
32		6	5	
33		8	4	
34		6	4	
35		7	2	
36		4	1	
37				
38				
39				
40				
41				
42				
43				
44				
45				
TOTAL	5 215	5 541	10 459	15 606
Catch (t)	275	297	577	750

Table 6.3.1.1 Cont.

Country : **Denmark** Fleet : **Mixed Div. IVa**
Species : **Blue whiting** Unit : **'000**
Year : **1998**

Length (cm)	Quarter 1	Quarter 2	Quarter 3	Quarter 4
10				
11				
12		316		
13				
14				
15	5 490			
16	32 615	4 746		
17	51 991	4 746		
18	34 230	7 277		1 524
19	15 177	2 531	2 378	
20	15 177	3 164	11 892	762
21	27 448	3 164	52 323	4 573
22	20 344	1 898	64 215	20 580
23	8 719	1 898	54 701	24 392
24	4 521	633	38 053	26 678
25	5 167	316	49 945	16 007
26	4 521		30 918	4 573
27	2 583	316	23 783	3 811
28	969		4 757	4 573
29	646		2 378	762
30	969		4 757	
31	646			
32	969			762
33	323		2 378	
34	969			
35				
36				
37				
38		316		
39				
40				
41				
42				
43				
44				
45				
TOTAL	233 474	31 321	342 478	108 997

Catch (t)	10 381	1 326	28 352	8 675

Country : **Denmark** Fleet : **Mixed Div.IIIa**
Species : **Blue whiting** Unit : **'000**
Year : **1998**

Length (cm)	Quarter 1	Quarter 2	Quarter 3	Quarter 4
10				
11				
12				
13				
14				
15				
16				
17			107	
18		31	107	
19		185		
20		216	1 175	
21		741	3 311	65
22		1 389	6 408	261
23		2 345	8 331	326
24		1 234	8 758	488
25		648	7 156	293
26		247	4 486	651
27		185	3 738	391
28		62	2 029	163
29		62	1 175	98
30		31	641	33
31			1 389	
32			1 175	33
33			534	33
34			427	33
35			320	33
36			320	
37			320	
38				
39				
40			214	33
41				
42				
43				
44				
45				
TOTAL		7 376	52 121	2 934

Catch (t)		589	5 709	321

Table 6.3.1.1 continued

Country : Netherland Fleet : **Pelagic Trawl**
Species : Blue Whiting Div. IIa, VIa, VIIb,c,j
Year : 1998 Unit : '000

Length (cm)	Quarter 1	Quarter 2	Quarter 3	Quarter 4
10				
11				
12				
13				
14	298	1 625	19	
15	1 899	10 358	123	
16	1 614	8 226	98	
17	472	1 422	17	
18	74	406	5	
19	56	305	4	
20	342	711	8	
21	1 379	962	7	
22	4 429	4 642	13	
23	9 014	9 191	2	
24	12 673	9 340		
25	7 498	10 574		
26	4 013	7 578		
27	2 535	5 287		
28	1 690	5 111		
29	2 535	8 811		
30	1 267	10 221		
31	317	15 860		
32	528	18 680		
33	106	12 336		
34	106	10 574		
35	317	7 402		
36	211	6 697		
37		3 348		
38	211	2 115		
39		2 291		
40		1 234		
41	106	1 057		
42				
43				
44				
45				
46	106	48		
TOTAL	53 794	176 409	296	

Catch (t)	4 628	23 058	7	

Country : **Ireland** Fleet : **Directed**
Species : Blue whiting **Div. VIa, VIIb,c,j**
Year : 1998 Unit : '000

Length (cm)	Quarter 1	Quarter 2	Quarter 3	Quarter 4
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20		12 490		
21		35 907		
22		32 785		
23		90 549		
24		95 233		
25		67 133		
26		45 275		
27		32 785		
28		14 051		
29		14 051		
30		23 418		
31		15 612		
32		10 928		
33		12 490		
34		7 806		
35		10 928		
36		4 684		
37		624		
38				
39				
40				
41				
42				
43				
44				
45				
46		1 561		
TOTAL		528 310		

Catch (t)		45 635		

Table 6.3.1.1 Cont.

Country : **Iceland** Fleet : **Directed Div. Va**
Species : **Blue Whiting** Unit : **'000**
Year : **1998**

Length (cm)	Quarter 1	Quarter 2	Quarter 3	Quarter 4
10				
11				
12				
13				
14				
15				
16				
17				
18				
19			2 103	
20		306	3 304	
21		815	8 410	
22		1 935	11 113	
23		2 750	24 930	7 613
24		3 259	47 156	37 433
25		3 565	64 878	54 563
26		2 139	52 563	31 723
27		1 630	46 856	10 151
28		1 426	24 029	5 076
29		1 222	12 915	1 269
30		2 546	8 410	
31		2 444	3 905	
32		2 037	3 304	
33		1 018	1 201	
34		1 120	601	
35		1 018	300	
36		204		
37		102		
38			300	
39		102		
40				
41				
42				
43				
44				
45				
TOTAL		29 637	316 278	147 827
Catch (t)		3 123	33 359	15 013

Country : **Iceland** Fleet : **Directed Div. Vb**
Species : **Blue Whiting** Unit : **'000**
Year : **1998**

Length (cm)	Quarter 1	Quarter 2	Quarter 3	Quarter 4
10				
11				
12				
13				
14				
15				
16				
17				
18				
19			104	
20		420	163	
21		1 120	414	
22		2 659	548	
23		3 779	1 229	2 622
24		4 479	2 324	12 891
25		4 899	3 197	18 790
26		2 939	2 590	10 924
27		2 239	2 309	3 496
28		1 960	1 184	1 748
29		1 680	637	437
30		3 499	414	
31		3 359	192	
32		2 799	163	
33		1 400	59	
34		1 540	30	
35		1 400	15	
36		280		
37		140		
38			15	
39		140		
40				
41				
42				
43				
44				
45				
TOTAL		40 730	15 587	50 907
Catch (t)		4 292	1 644	5 170

Table 6.3.1.1 continued

Country : **Iceland** Fleet : **Mixed Div. Va**
Species : **Blue Whiting** Unit : '000
Year : 1998

Length (cm)	Quarter 1	Quarter 2	Quarter 3	Quarter 4
9			54	
10			214	
11			964	
12			1 820	
13			1 767	
14			375	
15			107	9
16			161	26
17			268	56
18			696	95
19			375	52
20			482	47
21			54	
22			54	4
23			589	52
24			2 195	255
25			3 266	371
26			1 660	216
27			482	69
28			375	35
29			107	9
30				
31				
32				
33				
34				
35				
36				
37				
38				
39				
40				
41				
42				
43				
44				
45				
TOTAL			16 062	1 295

Catch (t)			977	131

Country : **Faroes** Fleet : **Directed Div. Va**
Species : **Blue Whiting** Unit : '000
Year : 1998

Length (cm)	Quarter 1	Quarter 2	Quarter 3	Quarter 4
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20			367	
21			367	
22			6 611	
23			17 998	
24			34 527	
25			47 015	
26			56 565	
27			48 851	
28			32 323	
29			17 631	
30			15 427	
31			7 713	
32			4 040	
33			1 837	
34			367	
35			735	
36				
37			367	
38				
39				
40				
41				
42				
43				
44				
45				
TOTAL			292 741	

Catch (t)			34 223	

Table 6.3.1.1 Cont.

Country : **Faroes** Fleet : **Directed Div. Vb**
Species : **Blue Whiting** Unit : **'000**
Year : **1998**

Length (cm)	Quarter 1	Quarter 2	Quarter 3	Quarter 4
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21		762		283
22		2 286		1 543
23		5 333		3 755
24		5 485		7 587
25		5 181		7 664
26		1 676		6 147
27		2 438		4 295
28		2 133		2 495
29		1 981		1 286
30		1 828		592
31		2 590		309
32		2 438		283
33		1 219		26
34		1 067		26
35		914		51
36		609		26
37		609		26
38		457		26
39		305		
40		152		26
41				
42				
43				
44				
45				
TOTAL		39 463		36 446
Catch (t)		4 103		3 707

Country : **Faroes** Fleet : **Directed Div. IIa**
Species : **Blue Whiting** Unit : **'000**
Year : **1998**

Length (cm)	Quarter 1	Quarter 2	Quarter 3	Quarter 4
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19			95	
20			1 330	
21			2 660	
22			4 370	
23			7 696	
24			8 076	
25			4 750	
26			1 330	
27			475	
28			475	
29			95	
30			285	
31				
32			95	
33			95	
34			95	
35			95	
36				
37				
38				
39				
40				
41				
42				
43				
44				
45				
TOTAL			32 017	
Catch (t)			2 561	

Table 6.3.1.1 continued

Country : **Faroes** Fleet : **Directed Div. VIa**
Species : **Blue Whiting** Unit : '000
Year : 1998

Length (cm)	Quarter 1	Quarter 2	Quarter 3	Quarter 4
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20		1 062		
21		2 922		
22		6 375		
23		20 452		
24		22 577		
25		22 577		
26		11 687		
27		8 499		
28		8 234		
29		10 624		
30		7 968		
31		12 749		
32		17 796		
33		9 562		
34		8 234		
35		5 578		
36		5 312		
37		2 922		
38		1 594		
39		797		
40				
41				
42				
43				
44				
45				
TOTAL		187 521		

Catch (t)		21 109		

Country : **Faroes** Fleet : **Directed Div. VIIc**
Species : **Blue Whiting** Unit : '000
Year : 1998

Length (cm)	Quarter 1	Quarter 2	Quarter 3	Quarter 4
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22	387			
23	484			
24	2 227			
25	1 743			
26	1 259			
27	1 355			
28	1 452			
29	484			
30	968			
31	871			
32	2 420			
33	1 452			
34	2 033			
35	1 452			
36	1 355			
37	1 259			
38	968			
39	775			
40	290			
41	194			
42	97			
43				
44				
45				
TOTAL	23 525			

Catch (t)	5 219			

Table 6.3.1.1 Cont.

Country : **Faroes** Fleet : **Mixed Div. IVa**
Species : **Blue Whiting** Unit : **'000**
Year : **1998**

Length (cm)	Quarter 1	Quarter 2	Quarter 3	Quarter 4
9				
10				
11				
12				
13				
14				
15				
16		85		
17		170		
18		349		
19		570		
20		561		
21		765		
22		1 131		
23		774		
24		323		
25		187		
26		102		
27		17		
28		9		
29		9		
30		9		
31		9		
32		9		
33		9		
34		9		
35		9		
36				
37				
38				
39				
40				
41				
42				
43				
44				
45				
TOTAL		5 106		

Catch (t)		296		

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, IVXa+b, Vb,VIa+b, VIIbc and VIIjg-k, 1988 - 1998.

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	3.6	36.5	8.4	63.6	-	-	-	0.7	3.8	167.0	15
1	93.2	86.4	537.8	33.4	82.4	36.8	43.6	99.4	497.1	1,351.9	984
2	403.2	359.4	353.1	533.2	52.2	130.1	31.2	142.7	327.1	1,078.6	3535
3	416.2	1,176.7	565.7	384.4	1,508.5	334.5	190.0	337.7	450.5	750.6	3211
4	611.2	696.2	709.1	243.9	510.4	1,348.2	361.9	416.2	424.7	526.5	929
5	1,238.9	785.7	489.2	329.9	200.1	375.7	1,242.4	565.9	248.4	268.2	346
6	584.9	680.7	562.1	235.3	138.8	196.1	294.2	769.0	429.9	238.0	311
7	77.8	127.2	291.7	149.9	92.0	107.9	201.3	245.5	619.4	269.9	298
8	50.7	44.8	75.5	39.9	86.7	59.8	102.5	154.1	213.9	391.2	257
9	32.4	23.8	26.6	4.3	84.6	37.9	88.3	57.7	87.8	101.2	209
10+	48.9	37.0	91.8	14.0	14.5	13.6	32.1	40.0	70.2	163.9	85.0
Total	3,561.0	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
Tonnes	477,552	521,415	465,601	297,649	379,549	389,010	401,378	447,015	493,373	545,058	994,709

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, 1988-1998.

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	12.3	1871.6	0.5	24.9	-	132.2	94.8	3,303.0	811.8	29.4	11.0
1	185.1	578.9	874.8	8.4	159.8	166.9	33.1	100.7	1,334.4	621.0	576
2	84.3	183.7	167.6	397.9	63.9	38.8	20.7	88.3	71.2	268.7	524
3	83.4	70.0	49.5	42.3	167.1	90.8	17.5	28.7	58.4	50.3	259
4	40.2	33.5	11.8	11.4	75.1	97.3	36.7	11.0	71.3	14.0	47
5	44.0	24.1	7.0	11.3	25.2	15.0	6.1	6.0	38.8	14.3	6
6	24.0	12.2	3.8	11.2	16.7	6.7	3.0	11.4	45.4	5.1	4
7	3.3	5.9	4.9	6.2	6.7	8.3	1.2	1.8	32.6	3.7	3
8	2.1	2.1	0.6	3.4	2.7	-	0.6	2.0	14.3	6.0	4
9	1.0	0.8	0.4	0.7	0.9	-	0.1	1.2	9.0	0.7	4
10+	0.2	1.0	-	0.2	0.6	-	-	0.8	11.4	1.6	
Total	455.9	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
Tonnes	45,110	75,978	63,195	39,872	66,174	55,215	28,563	104,004	119,359	65,091	101,040

Table 6.3.2.3 BLUE WHITING. Catch in number (millions) by age group in the Southern area, 1988-1998.

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	30	41	74	70	19	25	13	3	9	11	18
1	147	200	198	181	139	41	12	96	43	118	97
2	233	175	182	182	205	146	56	123	131	143	122
3	114	93	57	70	95	181	149	55	117	86	71
4	32	61	25	39	43	62	72	38	36	26	69
5	10	27	24	17	12	12	27	44	33	8	32
6	9	15	11	8	6	7	9	20	17	4	7
7	3	6	2	3	2	2	5	6	5	3	2
8+	0	3	2	3	1	1	4	5	3	3	4
Total	578	621	575	573	522	477	347	390	394	402	422
Tonnes	30,838	33,695	32,817	32,003	28,722	32,256	29,468	27,664	25,099	30,122	29,400

Table 6.3.2.4. Blue Whiting. Total catch in numbers at age (millions) 1981-1998.

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	48	3512	437	584	1174	84	341	46	1949	83	161	19	198	42	3307	824	208	43
1	258	148	2283	2291	1305	650	838	425	865	1611	267	408	263	307	296	1875	2091	1657
2	348	274	567	2331	2044	816	578	721	718	703	1024	654	305	108	354	529	1490	4181
3	681	326	270	455	1933	1862	728	614	1340	672	514	1642	621	368	422	626	887	3541
4	334	548	286	260	303	1717	1897	683	791	753	302	569	1571	389	465	532	567	1045
5	548	264	299	285	188	393	726	1303	837	520	363	217	411	1222	616	320	290	384
6	559	276	304	445	321	187	137	618	708	577	258	154	191	281	800	492	247	323
7	466	266	287	262	257	201	105	84	139	299	159	110	107	174	254	657	277	303
8	634	272	286	193	174	198	123	53	50	78	49	80	65	90	160	230	399	264
9	578	284	225	154	93	174	103	33	25	27	5	32	38	79	60	97	102	212
10+	1460	673	334	255	259	398	195	50	38	95	10	12	17	31	42	82	166	86
Total	5914	6843	5578	7515	8051	6680	5771	4630	7460	5418	3112	3896	3788	3091	6775	6264	6722	12039
Tonnes	909556	576419	570072	641776	695596	826986	664434	553413	625433	561610	369525	474245	480672	459414	578693	637825	634206	1,125,149

Table 6.3.3.1 Blue Whiting. Mean weights at age for the total catch 1981-1998.

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
0	0.038	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
1	0.052	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
2	0.065	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
3	0.103	0.111	0.118	0.089	0.097	0.108	0.106	0.097	0.103	0.106	0.107	0.119	0.109	0.108	0.118	0.102	0.102	0.094
4	0.125	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
5	0.141	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
6	0.155	0.177	0.176	0.161	0.177	0.199	0.177	0.157	0.158	0.168	0.190	0.193	0.177	0.189	0.167	0.170	0.166	0.178
7	0.170	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
8	0.178	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
9	0.187	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
10+	0.213	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

Table 6.4.1.3.1. 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				
Mean	4.8	4.4	5.3	4.9	4.4	2.0	5.3	4.9

* with calibration factor 1.38

Table 6.4.2.1 BLUE WHITING. Stratified mean catch (Kg/haul and Number/haul) and standard error of 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	6.20	3.63	44.21	10.61	60.18	17.54	42.81	7.78
1998	14.13	4.17	42.78	8.13	78.88	22.01	47.14	7.58

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	1647.36	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	183	99.28	1425	359.12	1254	330.37	1194	228.06
1998	351	105.96	1463	320.26	2012	590.04	1387	234.82

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).

Year	Month	20-100 m		100-200 m		200-500 m		500-750 m		TOTAL: 20-500 m		TOTAL: 20-750 m	
		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

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 1991-98

1991	1998								
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

Norwegian Sea acoustic 1981-90

1981	1990											
1	1	0.6	0.75									
1	10											
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	23676	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 1991-98

1991	1998											
1	1	0.6	0.75									
1	10											
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

Table 6.4.4.1 continued

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	5860	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 1992-98

1992	1998							
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	4897	6940	1482	653	85	0
1	-1	-1	-1	-1	-1	-1	-1	-1
1	-1	-1	-1	-1	-1	-1	-1	-1

CPUE Spanish Pair Trawlers

1983	1998					
1	1	0	1			
1	6					
1	7196	16392	9311	7476	6326	1718
1	13710	27286	14845	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	6833	4551	1990	623
1	3905	14557	14449	3931	3639	1834
1	8742	15875	11134	3698	1046	450
1	5884	13236	9803	10844	5229	1153

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. Summary of the main ICA results.

Run No.	Survey Data	SSB mill t		F(3-7)	F(3-7)	Total variance
		1997	1998	1997	1998	
	1998 WG assessment	*2.2		0.41		0.015
1	All fleets and age groups included. 4 yrs of separable constraint	1.5	1.4	0.38	0.95	
2	1998 WG but 5 yrs of separability and 1998 data included	1.7	2.2	0.41	0.72	0.015
3 (final)	As run 2, but with splitted tuning series	2.0	2.6	0.32	0.52	0.014
4	As run 3, but with 1999 survey data	1.9	2.4	0.36	0.61	0.014
5	As run 3, but with shrinkage	1.9	2.5	0.35	0.45	
6	As run 2, but 1999 survey data included	1.6	2.1	0.42	0.77	0.015
7	As run 3, but without 2 year olds in survey	2.0	2.5	0.33	0.53	0.014

* Would have been lower if the same proportion of M and F before spawning as those used in the 1999 assessment had been used in 1998.

Table 6.4.4.3. BLUE WHITING. Stock summary table.

Year	Recruits Age 0 billions	Total biomass '000 t.	Spawning biomass '000t.	Landings '000 t.	Mean F Ages 3-7
1981	5.50	4371	3211	910	0.25
1982	24.33	3621	2435	576	0.19
1983	24.05	3373	1701	570	0.22
1984	13.58	3309	1504	642	0.27
1985	11.99	3347	1764	696	0.34
1986	10.60	3637	2058	827	0.49
1987	8.90	3167	1755	664	0.41
1988	11.46	2894	1491	553	0.50
1989	27.07	2954	1408	625	0.53
1990	11.28	3194	1342	562	0.49
1991	7.63	3677	1771	370	0.25
1992	5.95	3712	2317	474	0.18
1993	7.83	3490	2220	481	0.21
1994	10.26	3471	2152	459	0.18
1995	31.24	3780	1931	579	0.27
1996	44.70	4207	1791	638	0.33
1997	18.84	5302	2001	634	0.32
1998	*1.30	5175	2597	1125	0.52

* Considered to be unreliable

Table 6.4.4.4. BLUE WHITING Final ica-run WG99

Output Generated by ICA Version 1.4

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

x 10 ^ 6

Predicted Catch in Number

AGE	1994	1995	1996	1997	1998
0	121.1	546.1	944.9	392.4	43.0
1	229.0	448.7	1634.5	2295.2	1516.4
2	164.9	317.4	498.2	1466.0	3262.4
3	357.3	428.0	651.8	826.0	3726.8
4	502.0	481.1	445.5	541.6	1035.7
5	773.5	575.8	421.0	309.3	561.4
6	282.4	855.5	480.8	277.7	300.9
7	164.1	304.4	687.4	303.8	254.9
8	77.1	178.9	242.8	428.5	268.1
9	80.2	54.2	91.0	95.3	244.2

x 10 ^ 6

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

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

Weights at age in the stock (Kg)

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

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
0	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
2	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
4	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
6	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
8	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
10	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000	0.20000

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	0.00[illegible]	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
0	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
2	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
4	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
6	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
8	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
10	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.

Norway Spawning Area/Acoustic 1991-98

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

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 1992-98

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

CPUE Spanish Pair Trawlers

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

Norwegian Sea acoustic - Blue Wh. 1981-9

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 - Blue Wh. 1991-9

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

Fishing Mortality (per year)

AGE	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0	0.0097	0.1729	0.0202	0.0486	0.1141	0.0088	0.0431	0.0044	0.0826	0.0082
1	0.0843	0.0373	0.1624	0.1401	0.1457	0.0853	0.1135	0.0694	0.1075	0.0910
2	0.1006	0.1210	0.1952	0.2479	0.1788	0.1276	0.1017	0.1349	0.1603	0.1195
3	0.1652	0.1290	0.1681	0.2372	0.3349	0.2454	0.1605	0.1494	0.3952	0.2214
4	0.1191	0.1942	0.1596	0.2421	0.2455	0.5620	0.4233	0.2222	0.2915	0.4044
5	0.2955	0.1302	0.1542	0.2361	0.2768	0.5771	0.4942	0.5816	0.4636	0.3170
6	0.3367	0.2378	0.2173	0.3596	0.4543	0.4879	0.4056	1.0744	0.7386	0.6828
7	0.3292	0.2652	0.4155	0.2945	0.3643	0.5779	0.5635	0.4687	0.7600	0.8279
8	0.3924	0.3257	0.5061	0.5485	0.3253	0.5317	0.8720	0.6275	0.5692	1.4766
9	0.3819	0.3055	0.4909	0.5672	0.5620	0.6297	0.5897	0.6125	0.6978	0.7026
10	0.3819	0.3055	0.4909	0.5672	0.5620	0.6297	0.5897	0.6125	0.6978	0.7026

Fishing Mortality (per year)

AGE	1991	1992	1993	1994	1995	1996	1997	1998
0	0.0236	0.0035	0.0283	0.0131	0.0195	0.0236	0.0232	0.0372
1	0.0326	0.0765	0.0617	0.0414	0.0615	0.0745	0.0734	0.1174
2	0.0769	0.1045	0.0755	0.0499	0.0742	0.0899	0.0885	0.1416
3	0.1204	0.1698	0.1367	0.1188	0.1766	0.2140	0.2108	0.3372
4	0.1462	0.1897	0.2435	0.1561	0.2320	0.2812	0.2770	0.4431
5	0.3480	0.1492	0.2038	0.1814	0.2696	0.3267	0.3218	0.5149
6	0.2566	0.2433	0.1896	0.2101	0.3122	0.3783	0.3726	0.5962
7	0.4027	0.1648	0.2661	0.2468	0.3667	0.4444	0.4377	0.7003
8	0.3044	0.3614	0.1386	0.3123	0.4640	0.5623	0.5539	0.8861
9	0.3183	0.3300	0.2940	0.2540	0.3774	0.4574	0.4505	0.7208
10	0.3183	0.3300	0.2940	0.2540	0.3774	0.4574	0.4505	0.7208

Population Abundance (1 January)

AGE	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0	5497.	24333.	24047.	13584.	11992.	10602.	8904.	11463.	27072.	11276.
1	3517.	4457.	16759.	19293.	10595.	8760.	8604.	6983.	9344.	20406.
2	4005.	2647.	3516.	11664.	13731.	7498.	6586.	6289.	5333.	6870.
3	4920	2965.	1920.	2368.	7453.	9401.	5403.	4871.	4499.	3720.
4	3276.	3415.	2134.	1329.	1529.	4365.	6022.	3768.	3434.	2481.
5	2352.	2381.	2302.	1489.	854.	980.	2037.	3229.	2470.	2101.
6	2146.	1433.	1711.	1616.	963.	530.	450.	1018.	1478.	1272.
7	1823.	1255.	925.	1128.	923.	500.	266.	246.	285.	578.
8	2141.	1074.	788.	500.	688.	525.	230.	124.	126.	109.
9	1996	1184.	635.	389.	236.	407.	253.	79.	54.	58.
10	5043.	2806.	942.	644.	659.	930.	478.	119.	83.	205.

x 10 ^ 6

Population Abundance (1 January)

AGE	1991	1992	1993	1994	1995	1996	1997	1998	1999
0	7628.	5947.	7826.	10264.	31242.	44699	18844.	1299.	11580.
1	9157.	6100.	4852.	6229.	8294.	25085.	35743.	15074.	1025.
2	15254.	7256.	4626.	3735.	4893.	6386.	19064.	27193.	10974.
3	4991.	11565.	5351.	3512.	2909.	3720.	4779.	14286.	19324.
4	2441.	3623.	7990.	3822.	2553.	1996.	2459.	3169.	8348.
5	1356.	1726.	2454.	5128.	2677.	1658.	1234.	1526.	1666.
6	1253.	784.	1218.	1639.	3502.	1673.	979.	732.	747.
7	526.	794.	503.	825.	1087.	2098.	939.	552.	330.
8	207.	288.	551.	316.	528.	617.	1101.	496.	224.
9	20.	125.	164.	393.	189.	272.	288.	518.	167.
10	39.	46.	75.	150.	146.	246.	511.	182.	279.

x 10 ^ 6

Weighting factors for the catches in number

AGE	1994	1995	1996	1997	1998
0	0.1000	0.1000	0.1000	0.1000	0.1000
1	0.5000	0.5000	0.5000	0.5000	0.5000
2	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	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	2581.	999990.	2221.	7289.	999990.	4805.	4244.	4024.	3395.	4410.
3	7818.	999990.	3049.	3706.	999990.	14689.	8594.	7765.	6812.	5841.
4	6736.	999990.	4350.	2662.	999990.	8178.	11616.	7582.	6810.	4805.
5	5259.	999990.	5303.	3371.	999990.	2064.	4369.	6798.	5332.	4676.
6	4536.	999990.	3710.	3399.	999990.	1086.	938.	1842.	2871.	2501.
7	3949.	999990.	1968.	2461.	999990.	1029.	550.	517.	563.	1128.
8	4699.	999990.	1688.	1061.	999990.	1119.	456.	259.	266.	190.
9	3368.	999990.	1047.	631.	999990.	651.	408.	126.	86.	92.
10	2474.	999990.	452.	304.	999990.	433.	225.	56.	38.	94.

Norway Spawning Area/Acoustic 1991-98 Predicted

AGE	1991	1992	1993	1994	1995	1996	1997	1998
2	10707.	5064.	3248.	2636.	3437.	4470.	999990.	18829.
3	7995.	18335.	8543.	5628.	4605.	5843.	999990.	21866.
4	5728.	8425.	18371.	8950.	5885.	4553.	999990.	6987.
5	2326.	3089.	4340.	9112.	4669.	2857.	999990.	2528.
6	1936.	1215.	1909.	2558.	5350.	2521.	999990.	1054.
7	807.	1280.	794.	1307.	1681.	3191.	999990.	796.
8	357.	492.	986.	545.	882.	1010.	999990.	759.
9	35.	211.	280.	675.	317.	447.	999990.	808.
10	23.	27.	45.	89.	85.	141.	999990.	98.

Russian Spawning Area/Acoustic 1982-91 Predicted

AGE	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
3	3745.	2405.	2923.	9014.	11587.	6779.	6125.	5373.	4608.	6315.
4	5864.	3691.	2259.	2598.	6939.	9855.	6433.	5778.	4076.	4234.
5	4762.	4582.	2913.	1656.	1784.	3775.	5874.	4607.	4040.	2590.
6	3281.	3935.	3606.	2106.	1152.	995.	1954.	3045.	2653.	2857.
7	3231.	2309.	2887.	2329.	1207.	645.	607.	661.	1323.	1317.
8	3183.	2249.	1414.	2039.	1491.	608.	346.	355.	254.	616.
9	4273.	2203.	1328.	808.	1371.	859.	266.	180.	194.	73.
10	3304.	1067.	718.	735.	1023.	530.	132.	89.	222.	45.

Russian Spawning Area/Acoustic 1992-98 Predicted

AGE	1992	1993	1994	1995	1996	1997	1998
3	26446.	12322.	999990.	6642.	8428.	999990.	999990.
4	10162.	22159.	999990.	7099.	5492.	999990.	999990.
5	3550.	4988.	999990.	5367.	3284.	999990.	999990.
6	1060.	1665.	999990.	4667.	2200.	999990.	999990.
7	798.	496.	999990.	1049.	1991.	999990.	999990.
8	248.	497.	999990.	445.	509.	999990.	999990.
9	999990.	133.	999990.	151.	213.	999990.	999990.
10	999990.	33.	999990.	63.	999990.	999990.	999990.

CPUE Spanish Pair Trawlers Predicted

AGE	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	11323.	13182.	7218.	6151.	5958.	4942.	6489.	14289.	6602.	4302.
2	6989.	22583.	27520.	15418.	13718.	12884.	10788.	14183.	32171.	15094.
3	4467.	5322.	15950.	21041.	12618.	11437.	9343.	8426.	11891.	26881.
4	3861.	2307.	2651.	6460.	9551.	6609.	5818.	3973.	4446.	6458.
5	2522.	1565.	880.	868.	1882.	2856.	2318.	2121.	1348.	1895.
6	1106.	972.	552.	299.	265.	428.	736.	651.	793.	500.

CPUE Spanish Pair Trawlers Predicted

AGE	1993	1994	1995	1996	1997	1998
1	3447.	4471.	5894.	17711.	25249.	10416.
2	9763.	7983.	10334.	13380.	39972.	55524.
3	12646.	8374.	6738.	8458.	10882.	30539.
4	13865.	6928.	4456.	3399.	4196.	4977.
5	2621.	5540.	2767.	1665.	1242.	1396.
6	798.	1062.	2157.	997.	585.	391.

Norwegian Sea acoustic - Blue Wh. 1981- Predicted

AGE	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	1204.3	1575.5	5443.9	6362.5	3480.7	2997.6	2888.9	2415.1	3149.7	*******
2	1544.3	1006.7	1271.9	4072.2	5022.9	2839.3	2537.8	2369.7	1975.4	*******
3	2765.0	1707.4	1076.9	1267.6	3734.9	5004.8	3046.3	2766.5	2164.8	*******
4	2201.9	2181.9	1395.4	821.9	943.8	2175.9	3296.3	2362.5	2054.8	*******
5	1469.1	1662.7	1582.0	968.2	540.2	505.9	1112.8	1662.6	1377.5	*******
6	1090.3	778.5	942.7	808.4	451.9	243.2	218.4	314.3	572.5	*******
7	959.3	689.4	459.3	607.5	474.5	222.7	119.7	117.7	112.0	*******
8	881.2	462.2	300.3	185.1	296.1	196.7	68.4	43.6	46.0	*******
9	1137.3	710.3	335.9	195.5	119.3	196.0	125.1	38.4	*******	*******
10	791.4	463.7	137.4	89.2	91.5	123.5	65.2	*******	10.5	*******

Norwegian Sea acoustic - Blue Wh. 1991- Predicted

AGE	1991	1992	1993	1994	1995	1996	1997	1998
1	999990.	3270.	2627.	999990.	4492.	13467.	19204.	7861.
2	999990.	2260.	1469.	999990.	1556.	2009.	6002.	8260.
3	999990.	5215.	2468.	999990.	1306.	1628.	2096.	5754.
4	999990.	1292.	2748.	999990.	885.	669.	827.	953.
5	999990.	514.	704.	999990.	735.	438.	327.	355.
6	999990.	221.	357.	999990.	945.	432.	254.	163.
7	999990.	201.	119.	999990.	240.	439.	197.	97.
8	999990.	22.	50.	999990.	38.	42.	75.	27.
9	999990.	21.	28.	999990.	30.	41.	44.	66.
10	999990.	8.	13.	999990.	23.	37.	78.	23.

Fitted Selection Pattern

AGE	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
0	0.0328	1.3281	0.1313	0.2056	0.4121	0.0152	0.0873	0.0076	0.1783	0.0257
1	0.2852	0.2865	1.0531	0.5932	0.5263	0.1478	0.2296	0.1194	0.2320	0.2870
2	0.3405	0.9296	1.2660	1.0499	0.6461	0.2211	0.2057	0.2320	0.3459	0.3771
3	0.5592	0.9911	1.0900	1.0045	1.2099	0.4253	0.3247	0.2568	0.8525	0.6984
4	0.4031	1.4914	1.0348	1.0253	0.8870	0.9739	0.8565	0.3821	0.6289	1.2757
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.1395	1.8267	1.4088	1.5230	1.6412	0.8454	0.8206	1.8473	1.5934	2.1538
7	1.1143	2.0367	2.6943	1.2473	1.3160	1.0013	1.1401	0.8059	1.6395	2.6116
8	1.3281	2.5018	3.2819	2.3228	1.1752	0.9213	1.7644	1.0789	1.2279	4.6580
9	1.2925	2.3468	3.1834	2.4019	2.0304	1.0910	1.1931	1.0531	1.5053	2.2163
10	1.2925	2.3468	3.1834	2.4019	2.0304	1.0910	1.1931	1.0531	1.5053	2.2163

Fitted Selection Pattern

AGE	1991	1992	1993	1994	1995	1996	1997	1998
0	0.0677	0.0237	0.1386	0.0722	0.0722	0.0722	0.0722	0.0722
1	0.0938	0.5129	0.3026	0.2280	0.2280	0.2280	0.2280	0.2280
2	0.2209	0.7006	0.3704	0.2751	0.2751	0.2751	0.2751	0.2751
3	0.3458	1.1384	0.6708	0.6549	0.6549	0.6549	0.6549	0.6549
4	0.4201	1.2715	1.1948	0.8606	0.8606	0.8606	0.8606	0.8606
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	0.7373	1.6312	0.9307	1.1579	1.1579	1.1579	1.1579	1 1579
7	1.1571	1.1048	1.3060	1.3602	1.3602	1.3602	1.3602	1.3602
8	0.8746	2.4228	0.6801	1.7211	1.7211	1.7211	1.7211	1.7211
9	0.9146	2.2121	1.4428	1.4000	1.4000	1.4000	1.4000	1.4000
10	0.9146	2.2121	1.4428	1.4000	1.4000	1.4000	1.4000	1.4000

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	5497210	4371010	3211396	909556	0.2832	0.2491	98
1982	24332830	3620828	2435411	576419	0.2367	0.1913	93
1983	24047000	3372999	1700869	570072	0.3352	0.2229	101
1984	13584230	3309121	1503990	641776	0.4267	0.2739	101
1985	11992020	3346698	1763954	695596	0.3943	0.3352	99
1986	10601950	3637055	2058404	826986	0.4018	0.4901	97
1987	8904470	3166658	1754732	664434	0.3787	0.4094	100
1988	11463160	2893581	1491376	553413	0.3711	0.4993	99
1989	27071940	2954111	1407916	625433	0.4442	0.5298	95
1990	11275910	3194265	1341822	561610	0.4185	0.4907	100
1991	7627760	3677168	1771474	369525	0.2086	0.2548	99
1992	5946670	3711594	2316548	474245	0.2047	0.1834	99
1993	7826350	3490341	2220451	480672	0.2165	0.2079	99
1994	10263990	3471413	2152484	459414	0.2134	0.1827	100
1995	31241740	3780125	1930773	578693	0.2997	0.2714	100
1996	44699160	4207298	1791173	637825	0.3561	0.3289	100
1997	18843660	5301504	2000522	634206	0.3170	0.3240	98
1998	1298810	5174843	2597355	1125149	0.4332	0.5183	99

No of years for separable analysis : 5
Age range in the analysis : 0 . . . 10
Year range in the analysis : 1981 . . . 1998
Number of indices of SSB : 0
Number of age-structured indices : 7

Parameters to estimate : 87
Number of observations : 538

Conventional single selection vector model to be fitted.

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	1994	0.1814	17	0.1298	0.2537	0.1529	0.2153	0.1841
2	1995	0.2696	16	0.1960	0.3709	0.2291	0.3172	0.2732
3	1996	0.3267	16	0.2364	0.4515	0.2770	0.3853	0.3312
4	1997	0.3218	17	0.2281	0.4541	0.2700	0.3836	0.3268
5	1998	0.5149	21	0.3385	0.7832	0.4157	0.6377	0.5268
Separable Model: Selection (S) by age								
6	0	0.0722	50	0.0269	0.1940	0.0436	0.1196	0.0820
7	1	0.2280	25	0.1380	0.3769	0.1765	0.2947	0.2357
8	2	0.2751	20	0.1842	0.4109	0.2242	0.3376	0.2809
9	3	0.6549	19	0.4478	0.9577	0.5395	0.7951	0.6673
10	4	0.8606	18	0.5964	1.2420	0.7137	1.0377	0.8758
	5	1.0000	Fixed : Reference Age					
11	6	1.1579	17	0.8184	1.6382	0.9701	1.3822	1.1762
12	7	1.3602	17	0.9742	1.8992	1.1472	1.6127	1.3800
13	8	1.7211	16	1.2473	2.3749	1.4604	2.0284	1.7445
	9	1.4000	Fixed : Last true age					
Separable model: Populations in year 1998								
14	0	1298816	106	159789	10557181	445925	3782975	2299968
15	1	15073520	37	7185732	31619743	10329035	21997311	16189684
16	2	27193386	25	16484460	44859234	21064481	35105553	28094805
17	3	14285588	20	9522444	21431265	11615176	17569945	14594766
18	4	3169001	18	2210398	4543329	2636938	3808419	3222982
19	5	1526165	17	1092009	2132929	1286561	1810391	1548585
20	6	732095	16	529292	1012603	620431	863855	742189
21	7	552123	17	391435	778775	463258	658034	560690
22	8	496010	19	341186	721091	409810	600342	505131
23	9	518281	22	334256	803621	414361	648264	531422

Separable model: Populations at age

24	1994	392711	31	212143	726971	286828	537680	412580
25	1995	189105	23	119373	299571	149543	239133	194386
26	1996	271557	21	179750	410255	220007	335186	277642
27	1997	287846	21	190109	435831	232939	355695	294366

Age-structured index catchabilities

Norway Spawning Area/Acoustic 1981-90

Linear model fitted. Slopes at age :

28	2	Q	.6865E-03	31	.5091E-03	.1726E-02	.6865E-03	.1280E-02	.9839E-03
29	3	Q	.1716E-02	31	.1272E-02	.4313E-02	.1716E-02	.3198E-02	.2459E-02
30	4	Q	.2199E-02	31	.1630E-02	.5527E-02	.2199E-02	.4099E-02	.3151E-02
31	5	Q	.2481E-02	31	.1840E-02	.6237E-02	.2481E-02	.4625E-02	.3556E-02
32	6	Q	.2366E-02	31	.1755E-02	.5948E-02	.2366E-02	.4411E-02	.3391E-02
33	7	Q	.2421E-02	31	.1795E-02	.6086E-02	.2421E-02	.4513E-02	.3470E-02
34	8	Q	.2485E-02	31	.1843E-02	.6247E-02	.2485E-02	.4633E-02	.3561E-02
35	9	Q	.1906E-02	31	.1414E-02	.4792E-02	.1906E-02	.3554E-02	.2732E-02
36	10	Q	.5544E-03	31	.4111E-03	.1394E-02	.5544E-03	.1034E-02	.7946E-03

Norway Spawning Area/Acoustic 1991-98

Linear model fitted. Slopes at age :

37	2	Q	.7439E-03	33	.5372E-03	.2030E-02	.7439E-03	.1466E-02	.1106E-02
38	3	Q	.1713E-02	33	.1239E-02	.4652E-02	.1713E-02	.3365E-02	.2542E-02
39	4	Q	.2524E-02	33	.1826E-02	.6840E-02	.2524E-02	.4950E-02	.3741E-02
40	5	Q	.1925E-02	33	.1393E-02	.5215E-02	.1925E-02	.3775E-02	.2853E-02
41	6	Q	.1701E-02	33	.1231E-02	.4614E-02	.1701E-02	.3338E-02	.2522E-02
42	7	Q	.1741E-02	33	.1258E-02	.4739E-02	.1741E-02	.3425E-02	.2586E-02
43	8	Q	.1922E-02	34	.1385E-02	.5278E-02	.1922E-02	.3803E-02	.2866E-02
44	9	Q	.1891E-02	34	.1354E-02	.5296E-02	.1891E-02	.3792E-02	.2845E-02
45	10	Q	.6564E-03	34	.4731E-03	.1802E-02	.6564E-03	.1299E-02	.9787E-03

Russian Spawning Area/Acoustic 1982-91

Linear model fitted. Slopes at age :

46	3	Q	.1353E-02	26	.1052E-02	.2944E-02	.1353E-02	.2288E-02	.1[illegible]21E-02
47	4	Q	.1865E-02	26	.1450E-02	.4058E-02	.1865E-02	.3154E-02	.2511E-02
48	5	Q	.2144E-02	26	.1666E-02	.4664E-02	.2144E-02	.3625E-02	.2885E-02
49	6	Q	.2510E-02	26	.1951E-02	.5461E-02	.2510E-02	.4244E-02	.3378E-02
50	7	Q	.2840E-02	26	.2207E-02	.6179E-02	.2840E-02	.4802E-02	.3823E-02
51	8	Q	.3310E-02	26	.2573E-02	.7202E-02	.3310E-02	.5597E-02	.4456E-02
52	9	Q	.4012E-02	26	.3118E-02	.8729E-02	.4012E-02	.6784E-02	.5400E-02
53	10	Q	.1309E-02	26	.1017E-02	.2848E-02	.1309E-02	.2214E-02	.1762E-02

Russian Spawning Area/Acoustic 1992-98

Linear model fitted. Slopes at age :

54	3	Q	.2471E-02	41	.1654E-02	.8526E-02	.2471E-02	.5706E-02	.4099E-02
55	4	Q	.3044E-02	41	.2038E-02	.1049E-01	.3044E-02	.7025E-02	.5047E-02
56	5	Q	.2213E-02	41	.1481E-02	.7630E-02	.2213E-02	.5107E-02	.3669E-02
57	6	Q	.1484E-02	41	.9932E-03	.5120E-02	.1484E-02	.3427E-02	.2461E-02
58	7	Q	.1086E-02	41	.7265E-03	.3755E-02	.1086E-02	.2512E-02	.1803E-02
59	8	Q	.9691E-03	42	.6469E-03	.3370E-02	.9691E-03	.2249E-02	.1613E-02
60	9	Q	.9003E-03	49	.5591E-03	.3911E-02	.9003E-03	.2429E-02	.1672E-02
61	10	Q	.4884E-03	59	.2767E-03	.2816E-02	.4884E-03	.1595E-02	.1052E-02

CPUE Spanish Pair Trawlers

Linear model fitted. Slopes at age :

62	1	Q	.8099E-03	18	.6776E-03	.1404E-02	.8099E-03	.1174E-02	.9922E-03
63	2	Q	.2422E-02	18	.2031E-02	.4170E-02	.2422E-02	.3496E-02	.2960E-02
64	3	Q	.2796E-02	18	.2347E-02	.4802E-02	.2796E-02	.4030E-02	.3413E-02
65	4	Q	.2166E-02	18	.1818E-02	.3716E-02	.2166E-02	.3119E-02	.2643E-02
66	5	Q	.1307E-02	18	.1098E-02	.2242E-02	.1307E-02	.1882E-02	.1595E-02
67	6	Q	.7959E-03	18	.6679E-03	.1366E-02	.7959E-03	.1147E-02	.9713E-03

Norwegian Sea acoustic - Blue Wh. 1981-

Linear model fitted. Slopes at age :

68	1	Q	.4149E-03	30	.3082E-03	.1037E-02	.4149E-03	.7704E-03	.5931E-03
69	2	Q	.4724E-03	30	.3510E-03	.1181E-02	.4724E-03	.8772E-03	.6753E-03
70	3	Q	.7191E-03	30	.5342E-03	.1797E-02	.7191E-03	.1335E-02	.1028E-02
71	4	Q	.8337E-03	30	.6194E-03	.2084E-02	.8337E-03	.1548E-02	.1192E-02
72	5	Q	.8727E-03	30	.6484E-03	.2181E-02	.8727E-03	.1621E-02	.1248E-02
73	6	Q	.7300E-03	30	.5424E-03	.1825E-02	.7300E-03	.1356E-02	.1044E-02
74	7	Q	.7522E-03	30	.5589E-03	.1880E-02	.7522E-03	.1397E-02	.1075E-02
75	8	Q	.6138E-03	30	.4560E-03	.1534E-02	.6138E-03	.1140E-02	.8775E-03
76	9	Q	.8438E-03	32	.6157E-03	.2229E-02	.8438E-03	.1627E-02	.1236E-02
77	10	Q	.2324E-03	32	.1696E-03	.6142E-03	.2324E-03	.4482E-03	.3406E-03

Norwegian Sea acoustic - Blue Wh. 1991-

Linear model fitted. Slopes at age :

78	1	Q	.6461E-03	39	.4414E-03	.2092E-02	.6461E-03	.1429E-02	.1040E-02
79	2	Q	.3825E-03	39	.2630E-03	.1214E-02	.3825E-03	.8348E-03	.6098E-03
80	3	Q	.5788E-03	38	.3988E-03	.1825E-02	.5788E-03	.1258E-02	.9198E-03
81	4	Q	.4640E-03	38	.3200E-03	.1460E-02	.4640E-03	.1007E-02	.7366E-03
82	5	Q	.3769E-03	38	.2600E-03	.1184E-02	.3769E-03	.8170E-03	.5980E-03
83	6	Q	.3812E-03	38	.2627E-03	.1201E-02	.3812E-03	.8276E-03	.6055E-03
84	7	Q	.3234E-03	39	.2224E-03	.1026E-02	.3234E-03	.7056E-03	.5154E-03
85	8	Q	.1137E-03	39	.7767E-04	.3676E-03	.1137E-03	.2512E-03	.1828E-03
86	9	Q	.2355E-03	40	.1599E-03	.7765E-03	.2355E-03	.5273E-03	.3822E-03
87	10	Q	.2361E-03	39	.1615E-03	.7615E-03	.2361E-03	.5209E-03	.3793E-03

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1994	1995	1996	1997	1998
0	-1.059	1.801	-0.127	-0.617	0.000
1	0.293	-0.416	0.147	-0.074	0.089
2	-0.424	0.109	0.070	0.036	0.248
3	0.029	-0.015	-0.030	0.090	-0.051
4	-0.254	-0.033	0.187	0.064	0.009
5	0.457	0.067	-0.264	-0.045	-0.381
6	-0.005	-0.067	0.034	-0.099	0.070
7	0.060	-0.182	-0.036	-0.074	0.173
8	0.159	-0.113	-0.044	-0.052	-0.015
9	-0.015	0.096	0.078	0.090	-0.139

AGE-STRUCTURED INDEX RESIDUALS

Norway Spawning Area/Acoustic 1981-90

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
2	-0.084	*******	-2.012	0.772	*******	-1.567	0.156	0.881	0.693	1.167
3	-0.031	*******	-0.369	-0.767	*******	-0.924	-0.021	0.158	1.185	0.774
4	-0.728	*******	-0.468	-0.499	*******	-0.685	0.665	0.489	0.381	0.849
5	-0.366	*******	0.205	-0.674	*******	-1.196	0.080	1.098	0.678	0.178
6	0.016	*******	0.007	-0.604	*******	-1.561	-1.202	1.384	1.000	0.964
7	0.161	*******	0.618	-0.780	*******	-1.623	-0.276	0.335	0.505	1.066
8	-0.251	*******	0.625	-0.627	*******	-1.499	-0.170	0.837	0.096	0.997
9	-0.262	*******	0.778	-0.361	*******	-1.559	-0.942	0.947	0.725	0.687
10	-0.326	*******	0.962	0.136	*******	-0.935	-2.119	1.966	0.194	0.137

Norway Spawning Area/Acoustic 1991-98

Age	1991	1992	1993	1994	1995	1996	1997	1998
2	0.040	-1.413	0.324	-0.497	0.910	0.675	*******	-0.033
3	-0.232	0.354	-0.945	-0.646	0.763	0.241	*******	0.470
4	0.394	-0.580	0.377	-0.693	0.295	0.609	*******	-0.397
5	1.158	-0.674	-0.496	0.220	0.385	-0.175	*******	-0.412
6	0.856	0.132	-0.407	-0.384	0.571	0.569	*******	-1.329
7	0.917	-0.457	-0.355	0.255	0.066	0.253	*******	-0.670
8	0.422	0.225	-0.839	0.511	0.206	0.174	*******	-0.689
9	1.022	0.196	-0.953	0.132	0.420	0.026	*******	-0.833
10	-0.349	-0.345	-0.706	0.839	0.564	0.141	*******	-0.133

Russian Spawning Area/Acoustic 1982-91

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
3	-1.936	-0.032	-0.008	0.383	0.481	-0.414	-0.501	0.796	0.749	0.489
4	-0.757	-0.231	-1.038	-1.027	1.206	0.665	-0.346	0.209	1.091	0.234
5	-1.268	0.717	-0.974	-1.049	0.353	0.440	0.382	0.370	0.351	0.683
6	-0.866	-0.014	0.153	-0.168	-0.635	0.072	0.748	0.828	-0.028	-0.083
7	-0.722	-0.159	-0.272	-0.996	-0.666	-0.254	0.739	1.936	0.105	0.296
8	-0.303	-0.496	-0.164	-1.207	-0.687	0.287	0.329	2.048	-0.142	0.346
9	-0.904	-1.038	0.247	-0.332	-0.762	0.001	-0.063	2.344	-0.884	1.409
10	-0.940	-0.480	0.514	-0.308	-0.365	0.234	0.681	2.203	-3.102	1.582

Russian Spawning Area/Acoustic 1992-98

Age	1992	1993	1994	1995	1996	1997	1998
3	-0.279	-0.958	*******	0.645	0.595	*******	*******
4	-0.417	-0.586	*******	0.345	0.660	*******	*******
5	-0.967	0.061	*******	0.511	0.400	*******	*******
6	-0.879	0.301	*******	-0.566	1.149	*******	*******
7	-0.717	0.977	*******	0.041	-0.295	*******	*******
8	-0.378	0.222	*******	-0.086	0.248	*******	*******
9	*******	1.063	*******	-0.141	-0.918	*******	*******
10	*******	1.509	*******	-1.505	*******	*******	*******

CPUE Spanish Pair Trawlers

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
1	-0.453	0.039	0.703	-0.503	1.447	0.453	0.856	0.406	0.880	0.844
2	0.852	0.189	-0.144	-0.087	-0.042	0.511	0.539	0.314	-0.739	0.474
3	0.735	1.026	-0.121	-0.356	-0.638	0.477	0.608	-0.484	-0.869	-1.022
4	0.661	0.740	0.859	0.096	-1.179	-0.034	0.364	-0.790	-0.647	-0.403
5	0.920	0.114	0.337	0.387	-0.604	-0.787	0.484	-0.447	-0.254	-0.462
6	0.441	0.588	-0.934	0.524	-0.467	0.601	0.310	-0.367	-0.590	-0.078

CPUE Spanish Pair Trawlers

Age	1993	1994	1995	1996	1997	1998
1	0.158	-2.108	0.433	-1.512	-1.061	-0.571
2	0.360	-0.275	0.332	0.084	-0.923	-1.434
3	0.576	0.642	0.014	0.536	0.023	-1.136
4	-0.553	0.076	0.021	0.145	-0.126	0.779
5	-0.661	-0.617	-0.330	0.782	-0.172	1.321
6	-0.192	-0.007	-1.242	0.609	-0.263	1.081

Norwegian Sea acoustic - Blue Wh. 1981-

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1	-1.890	-2.147	1.413	1.563	0.539	-0.255	1.044	0.726	-0.989	*******
2	-0.752	-0.783	-1.167	1.229	1.559	-0.176	0.463	0.195	-0.563	*******
3	0.496	-0.318	-0.833	-0.420	1.208	0.367	0.531	-0.047	-0.981	*******
4	0.565	0.771	-0.613	-0.740	-0.361	1.160	0.525	0.387	-1.690	*******
5	0.600	0.776	-0.119	-0.586	-0.244	1.311	0.079	-0.600	-1.212	*******
6	0.955	1.391	-0.493	-0.405	-0.877	1.365	0.025	-0.963	-0.993	*******
7	1.128	1.215	0.019	-0.572	-0.703	0.411	0.339	-0.204	-1.627	*******
8	1.140	1.290	0.364	-1.329	-0.742	0.448	-0.201	-0.597	-0.363	*******
9	0.591	0.207	-0.036	-1.384	1.148	-0.336	-0.398	0.224	*******	*******
10	0.496	-0.113	0.453	-0.599	0.432	0.462	-0.846	*******	-0.268	*******

Norwegian Sea acoustic - Blue Wh. 1991-

Age	1991	1992	1993	1994	1995	1996	1997	1998
1	*******	-1.418	-1.152	*******	0.440	0.555	0.454	1.126
2	*******	-0.690	-2.464	*******	0.592	-0.642	1.452	1.756
3	*******	0.286	-0.836	*******	0.426	-0.594	-0.319	1.040
4	*******	-0.523	0.844	*******	0.312	-0.031	-0.060	-0.538
5	*******	-0.733	0.551	*******	0.792	-0.004	-0.086	-0.516
6	*******	-0.253	0.315	*******	-0.198	0.157	0.473	-0.489
7	*******	-0.802	0.736	*******	-0.327	0.542	0.276	-0.418
8	*******	-0.712	0.152	*******	0.466	0.499	0.599	-0.996
9	*******	-0.133	1.155	*******	-3.406	-0.001	1.035	1.358
10	*******	-2.021	1.718	*******	-0.441	0.293	0.300	0.159

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 1994	to 1998
Variance	0.0700
Skewness test stat.	0.7808
Kurtosis test statistic	2.4538
Partial chi-square	0.1250
Significance in fit	0.0000
Degrees of freedom	23

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	0.1547	0.0573	0.0479	0.0598	0.1284	0.0830	0.0766	0.0955	0.1640
Skewness test stat.	-0.9576	0.3999	0.0899	-0.1856	-0.1720	-0.8619	-0.5580	-0.5894	-0.1835
Kurtosis test statisti	-0.4946	-0.5172	-1.0187	-0.4478	-0.7662	-0.2406	-0.3761	-0.6623	-0.1442
Partial chi-square	0.1334	0.0454	0.0384	0.0510	0.1226	0.0826	0.0842	0.1163	0.2352
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

DISTRIBUTION STATISTICS FOR Norway Spawning Area/Acoustic 1991-98

Linear catchability relationship assumed

Age	2	3	4	5	6	7	8	9	10
Variance	0.0673	0.0435	0.0320	0.0452	0.0644	0.0326	0.0322	0.0533	0.0333
Skewness test stat.	-0.7630	-0.4121	-0.2812	0.8387	-0.6476	0.4431	-0.8513	-0.1706	0.3956
Kurtosis test statisti	-0.2032	-0.6752	-0.9151	-0.2724	-0.3973	-0.4268	-0.5894	-0.5122	-0.5984
Partial chi-square	0.0483	0 0293	0.0216	0.0342	0.0526	0.0287	0.0294	0.0667	0.0492
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0 0000	0.0000	0.0000	0.0000
Number of observations	7	7	7	7	7	7	7	7	7
Degrees of freedom	6	6	6	6	6	6	6	6	6
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	0.0831	0.0843	0.0745	0.0342	0.0905	0.0947	0.1516	0.2653
Skewness test stat.	-1.7425	0.1859	-1.0354	0.0834	1.4704	1.4804	1.4342	-0.7698
Kurtosis test statisti	0.7666	-0.8215	-0.7499	-0.3304	0.4706	0.8470	0.0650	0.2487
Partial chi-square	0.0891	0.0909	0.0832	0.0397	0.1193	0.1338	0.2515	0.4796
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 1992-98

Linear catchability relationship assumed

Age	3	4	5	6	7	8	9	10
Variance	0.0736	0.0447	0.0566	0.1043	0.0648	0.0109	0 1246	0.5680
Skewness test stat.	-0.2935	0.0823	-0.7288	0.2821	0.4527	-0 3469	0.1842	0.0021
Kurtosis test statisti	-0.6241	-0.7243	-0.3692	-0 5861	-0.4283	-0.5860	-0.5298	-0.5773
Partial chi-square	0.0239	0.0146	0.0206	0.0416	0.0303	0.0056	0.0490	0.1497
Significance in fit	0.0010	0.0005	0.0008	0.0022	0.0014	0.0001	0.0242	0.3011
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	0.1559	0.0605	0.0788	0.0602	0.0681	0.0671
Skewness test stat.	-1.1049	-1.5567	-0.4120	-0.4078	0.9883	-0.4168
Kurtosis test statisti	-0.2708	0.2089	-1.0180	-0.6507	-0.6487	-0.5837
Partial chi-square	0.2632	0.0896	0.1259	0.1062	0.1348	0.1530
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	16	16	16	16	16	16
Degrees of freedom	15	15	15	15	15	15
Weight in the analysis	0.1667	0.1667	0.1667	0.1667	0.1667	0.1667

DISTRIBUTION STATISTICS FOR Norwegian Sea acoustic - Blue Wh. 1981-

Linear catchability relationship assumed

Age	1	2	3	4	5	6	7	8	9	10
Variance	0.1946	0.0885	0.0507	0.0825	0.0617	0.0975	0.0818	0.0768	0.0564	0.0287
Skewness test stat.	-0.5571	0.5990	0.2053	-0.6744	0.2418	0.5683	-0.3322	0.1793	-0.4206	-0.5117
Kurtosis test statisti	-0.7806	-0 6408	-0.5866	-0.4452	-0.5116	-0.8811	-0.3949	-0.6559	-0.0825	-0.7846
Partial chi-square	0.2010	0 0901	0.0523	0.0874	0.0720	0.1262	0.1167	0.1098	0.0763	0.0448
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 - Blue Wh. 1991-

Linear catchability relationship assumed

Age	1	2	3	4	5	6	7	8	9	10
Variance	0.1063	0.2500	0.0500	0.0276	0.0348	0.0138	0.0367	0.0469	0.3174	0 1486
Skewness test stat.	-0.5205	-0.3808	0.2488	0.5033	0.1417	0.0021	-0.0433	-0.6175	-1.3316	-0.3890
Kurtosis test statisti	-0.6938	-0.5145	-0.6186	-0.4316	-0.6641	-0.7225	-0.7518	-0.6936	0 1789	-0 1177
Partial chi-square	0.0635	0.1580	0.0310	0.0185	0.0274	0.0126	0.0355	0.0679	0.4539	0 3295
Significance in fit	0.0001	0.0005	0.0000	0.0000	0.0000	0.0000	0.0000	0 0001	0 0063	0 0029
Number of observations	6	6	6	6	6	6	6	6	6	6
Degrees of freedom	5	5	5	5	5	5	5	5	5	5
Weight in the analysis	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0.1000	0 1000	0 1000

ANALYSIS OF VARIANCE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	321.2140	538	87	451	0.7122
Catches at age	6.0425	50	27	23	0.2627
Aged Indices					
Norway Spawning Area/Acoustic 1981-90	54.6355	72	9	63	0.8672
Norway Spawning Area/Acoustic 1991-98	21.8118	63	9	54	0.4039
Russian Spawning Area/Acoustic 1982-91	63.2270	80	8	72	0.8782
Russian Spawning Area/Acoustic 1992-98	15.0540	29	8	21	0.7169
CPUE Spanish Pair Trawlers	44.1528	96	6	90	0.4906
Norwegian Sea acoustic - Blue Wh. 1981	64.6817	88	10	78	0.8293
Norwegian Sea acoustic - Blue Wh. 1991	51.6087	60	10	50	1.0322

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	6.1661	538	87	451	0.0137
Catches at age	1.6098	50	27	23	0.0700
Aged Indices					
Norway Spawning Area/Acoustic 1981-90	0.6745	72	9	63	0.0107
Norway Spawning Area/Acoustic 1991-98	0.2693	63	9	54	0.0050
Russian Spawning Area/Acoustic 1982-91	0.9879	80	8	72	0.0137
Russian Spawning Area/Acoustic 1992-98	0.2352	29	8	21	0.0112
CPUE Spanish Pair Trawlers	1.2265	96	6	90	0.0136
Norwegian Sea acoustic - Blue Wh. 1981	0.6468	88	10	78	0.0083
Norwegian Sea acoustic - Blue Wh. 1991	0.5161	60	10	50	0.0103

Table 6.5.1 Blue whiting, combined stock. Input data for the deterministic short term prediction

11:00 Wednesday, May 5, 1999

Year: 1999

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	14209	0.2	0.00	0.25	0.25	0.027	0.037	0.027
1	11209	0.2	0.11	0.25	0.25	0.045	0.117	0.045
2	10974	0.2	0.40	0 25	0.25	0.075	0.142	0.075
3	19324	0.2	0.82	0.25	0.25	0.099	0.337	0.099
4	8348	0.2	0.86	0.25	0.25	0.121	0.443	0 121
5	1666	0.2	0.91	0.25	0.25	0.145	0.515	0.145
6	747	0.2	0.94	0 25	0.25	0.171	0.596	0.171
7	330	0.2	1.00	0.25	0.25	0.191	0.700	0.191
8	224	0.2	1.00	0.25	0.25	0.200	0.886	0.200
9	167	0.2	1.00	0.25	0.25	0.221	0.721	0.221
10+	279	0.2	1.00	0.25	0.25	0.253	0.721	0.253
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 2000

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	14209	0.2	0.00	0.25	0.25	0.027	0.037	0.027
1	.	0.2	0.11	0.25	0 25	0.045	0.117	0 045
2	.	0.2	0.40	0 25	0.25	0.075	0 142	0.075
3	.	0.2	0 82	0.25	0.25	0.099	0.337	0.099
4		0.2	0.86	0 25	0.25	0.121	0.443	0.121
5	.	0.2	0 91	0 25	0.25	0.145	0.515	0.145
6	.	0.2	0.94	0 25	0 25	0.171	0.596	0.171
7	.	0.2	1 00	0 25	0.25	0.191	0.700	0.191
8	.	0.2	1 00	0.25	0.25	0.200	0 886	0.200
9	.	0.2	1.00	0.25	0.25	0.221	0.721	0.221
10+	.	0.2	1.00	0.25	0.25	0.253	0.721	0.253
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	14209	0.2	0 00	0 25	0.25	0.027	0 037	0.027
1	.	0 2	0 11	0.25	0.25	0 045	0 117	0.045
2		0.2	0 40	0 25	0.25	0 075	0.142	0.075
3	.	0.2	0.82	0.25	0.25	0.099	0.337	0.099
4		0 2	0.86	0 25	0.25	0.121	0 443	0.121
5	.	0.2	0 91	0.25	0.25	0 145	0 515	0.145
6	.	0 2	0.94	0 25	0.25	0.171	0.596	0 171
7	.	0.2	1.00	0.25	0.25	0.191	0.700	0.191
8	.	0.2	1.00	0 25	0 25	0.200	0 886	0 200
9	.	0.2	1.00	0 25	0.25	0.221	0.721	0 221
10+		0.2	1 00	0 25	0.25	0.253	0 721	0 253
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : MANMM03

Date and time: 05MAY99:11:02

Table 6.5.2 Blue whiting, combined stock. Prediction with management option table.

Year: 1999					Year: 2000					Year: 2001	
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
1.0	0.5182	5226491	2918618	1237443	0.0	0.0000	4572479	2825996	0	5252849	3424042
.	.	.		.	0.1	0.0518	.	2796093	137557	5102098	3260284
.	.	.	.	.	0.2	0.1036		2766538	269444	4957607	3105602
.	.	.	.	.	0.3	0.1555	.	2737327	395926	4819085	2959450
.	.	.	.	.	0.4	0.2073	.	2708456	517254	4686252	2821316
.	.	.	.	.	0.5	0.2591	.	2679920	633667	4558846	2690721
.	.	.	.	.	0 6	0.3109	.	2651716	745389	4436615	2567216
.	.	.	.	.	0.7	0.3627	.	2623838	852637	4319321	2450382
.	.	.	.	.	0.8	0.4146	.	2596284	955615	4206738	2339824
.	.	.	.	.	0.9	0.4664	.	2569048	1054518	4098650	2235174
.	.	.	.	.	1.0	0.5182		2542128	1149529	3994854	2136086
.	.	.	.	.	1.1	0.5700	.	2515518	1240825	3895153	2042235
.	.	.	.	.	1.2	0.6218	.	2489216	1328573	3799363	1953316
.	.	.	.	.	1.3	0.6737		2463218	1412932	3707309	1869045
.	.	.	.	.	1.4	0.7255	.	2437519	1494054	3618821	1789154
.	.	.	.	.	1.5	0.7773	.	2412116	1572081	3533742	1713390
.	.	.	.	.	1.6	0.8291	.	2387006	1647151	3451918	1641519
.	.	.	.	.	1.7	0.8809	.	2362185	1719395	3373206	1573318
.	.	.	.		1.8	0.9328	.	2337648	1788937	3297468	1508580
.	.	.	.		1.9	0.9846	.	2313394	1855895	3224573	1447108
.	.		.		2.0	1.0364	.	2289417	1920381	3154396	1388719
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes· Run name MANMM03

Date and time : 05MAY99:11:02

Computation of ref. F: Simple mean, age 3 - 7

Basis for 1999 : F factors

Table 6.8.1 Total catches of BLUE WHITING in 1978–1998 divided into areas within and beyond areas of national fisheries jurisdiction of NEAFC contracting parties, as estimated by the Working Group members [1].

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 [1]	271,873	4770	105674	90649	-	129799	498399	1,101,670
	(24.7 %)	(0.4 %)	(9.6 %)	(8.2 %)	-	(11.8 %)	(45.2 %)	

1) 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 Tórshavn in 1999, where a database on zonal attachment was developed. The discrepancy between the total catch and that used in the assessment is due to incomplete reporting of catch by rectangles.

Table 6.10.1 BLUE WHITING. Sampling in fishery during 1998.

Country	Number of samples	Length mesurements	Aged individuals
Denmark	41	1926	0
Iceland	20	1886	0
Ireland	4	342	329
The Netherlands	9	1571	0
Norway	80	6827	4436
Portugal	248	28977	2314
Russia	116	24323	1099
Faroes	28	3422	1373
Spain	343	34975	1068
Total	889	104249	10619

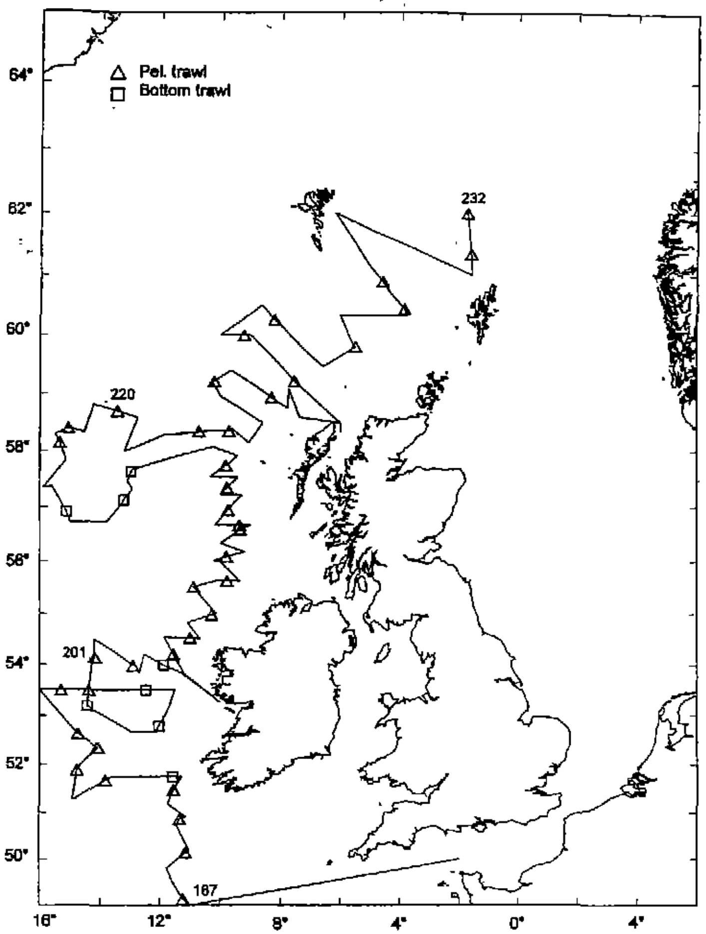


Fig. 6.4.1.1.1. Cruise track and trawls stations of RV Johan Hjort, 24/3 – 22/4 1999.

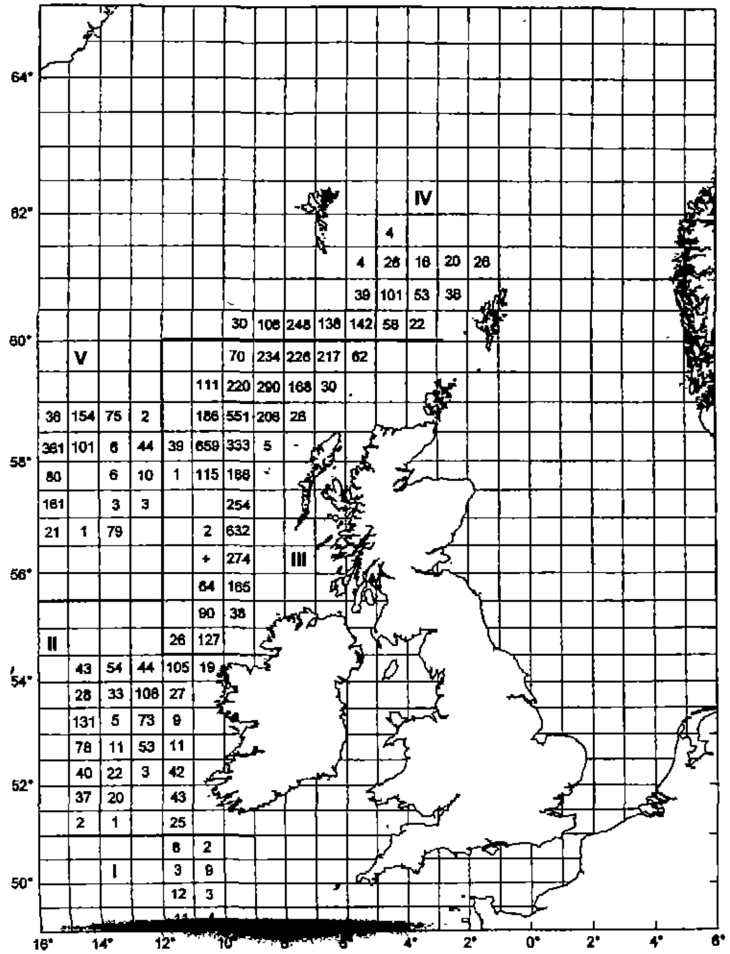


Fig. 6.4.1.1.2. Blue whiting biomass in 1000 tonnes by rectangle in spring survey 1999. Areas I-V used in the assessment are indicated.

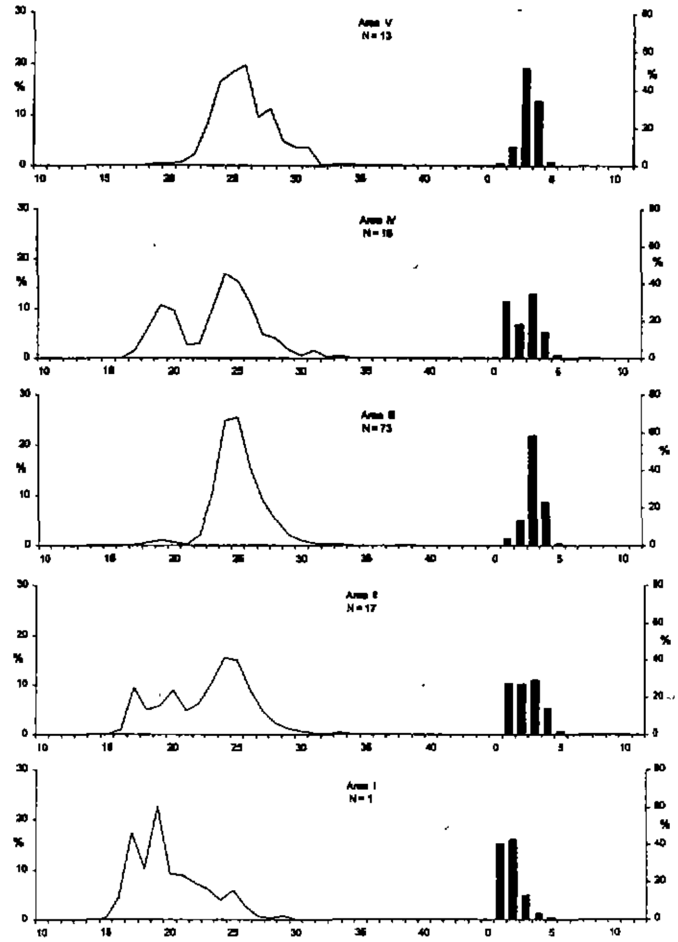


Fig. 6.4.1.1.3. Length and age distribution of blue whiting by subareas west of the Brithis Isles in spring 1999. N x 10^{-9}, weighted by abundance.

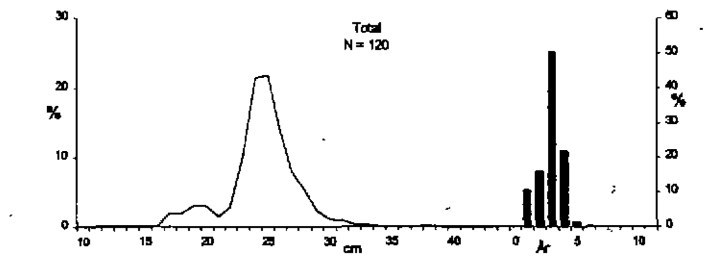


Fig. 6.4.1.1.4. Total length and age distribution of blue whiting in the area west of the Brithis Isles in spring 1999. N x 10^{-9}, weighted by abundance.

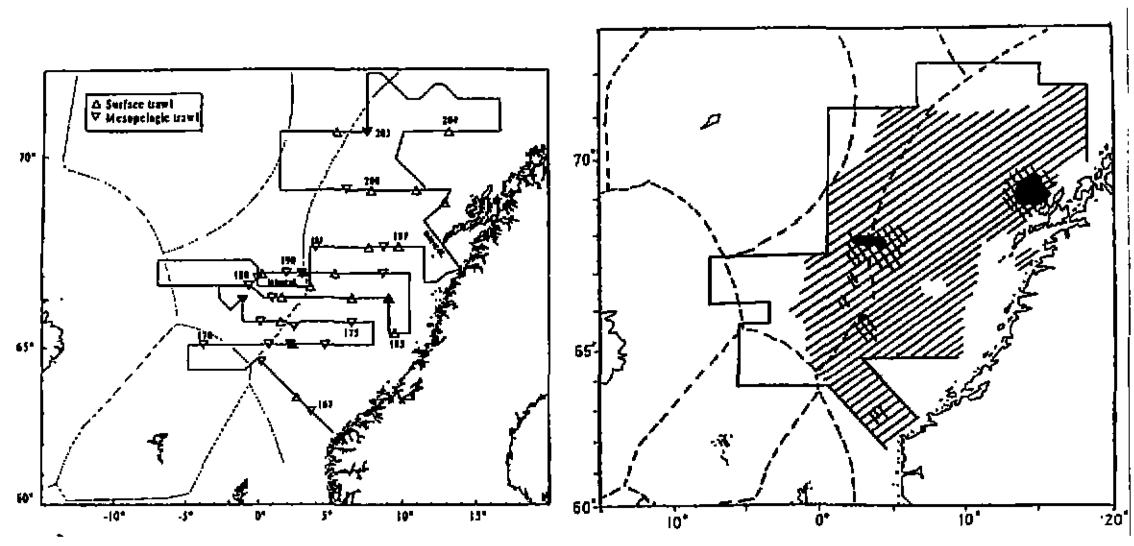


Fig. 6.4.1.2.1. a) Cruise tracks with fishing stations, RV G.O.Sars 21/4-21/5 1998. B) Distribution of blue whiting concentrations in 3 various densities, April/May 1998. Full line indicates the total area surveyed.

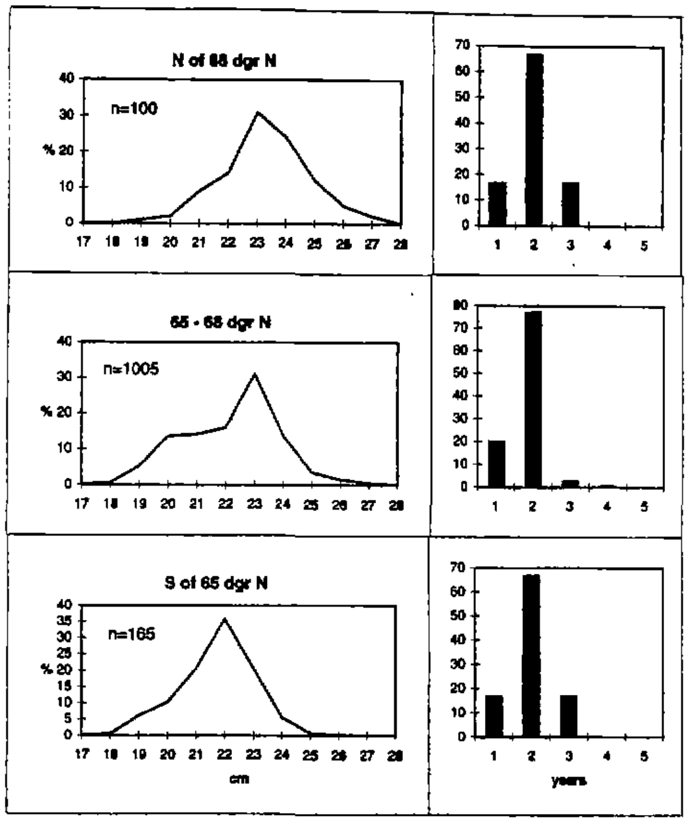


Fig. 6.4.1.2.2. Length and age distribution of blue whiting from 3 subareas in the Norwegian Sea during the survey in April/May 1998.

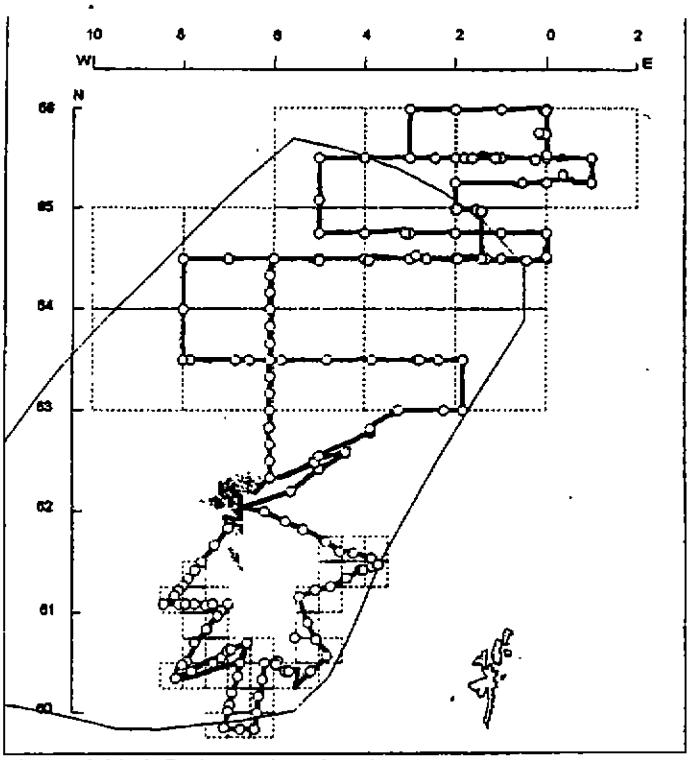


Fig. 6.4.1.2.3. Cruise track and stations (CDT and pelagic trawl) in the Faroese blue whiting survey (southern area) and the Norwegian spring-spawning herring survey (northern area) in May 1998.

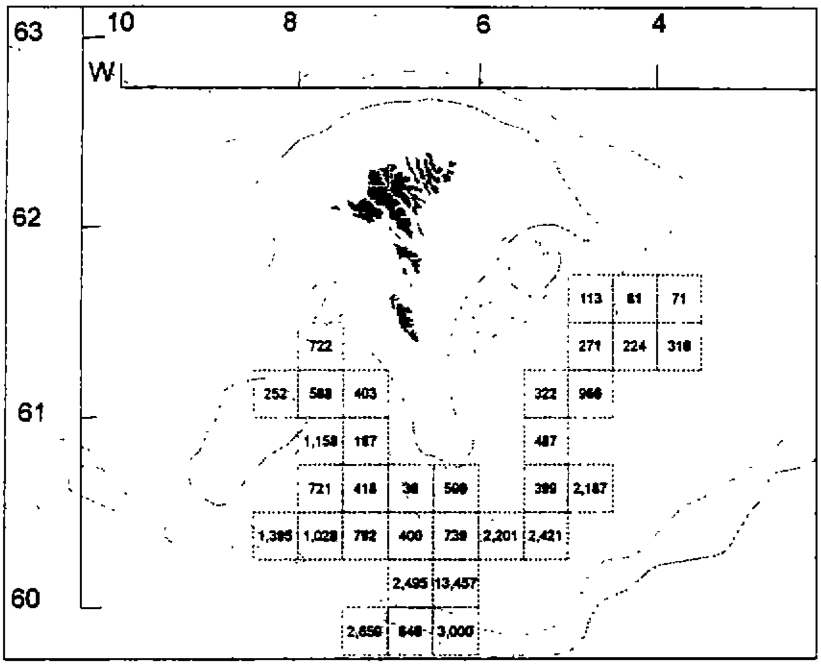


Fig. 6.4.1.2.4. Distribution of blue whiting by statistical rectangles in the Faroese blue whiting survey in May 1998.

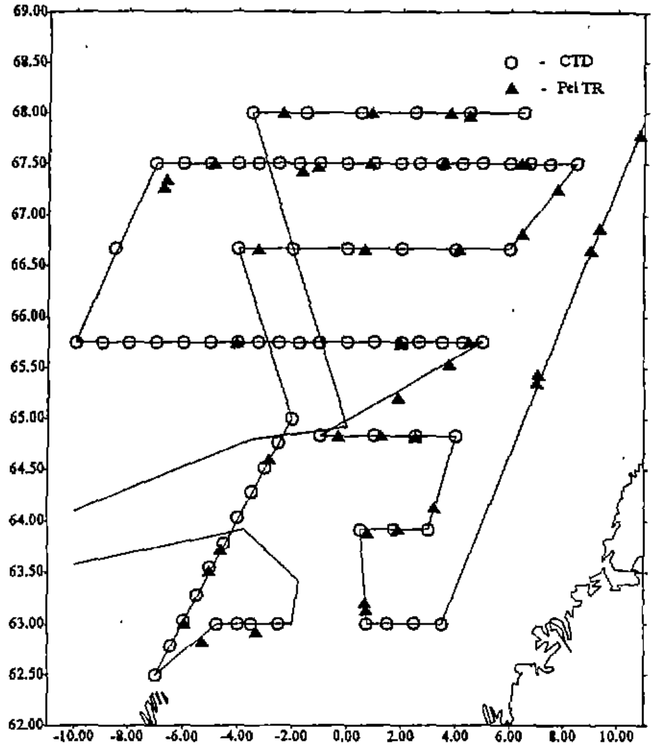


Fig. 6.4.1.2.5. Surey tracks, trawls and CTD stations for the Russian survey in the Norwegian Sea in June 1998.

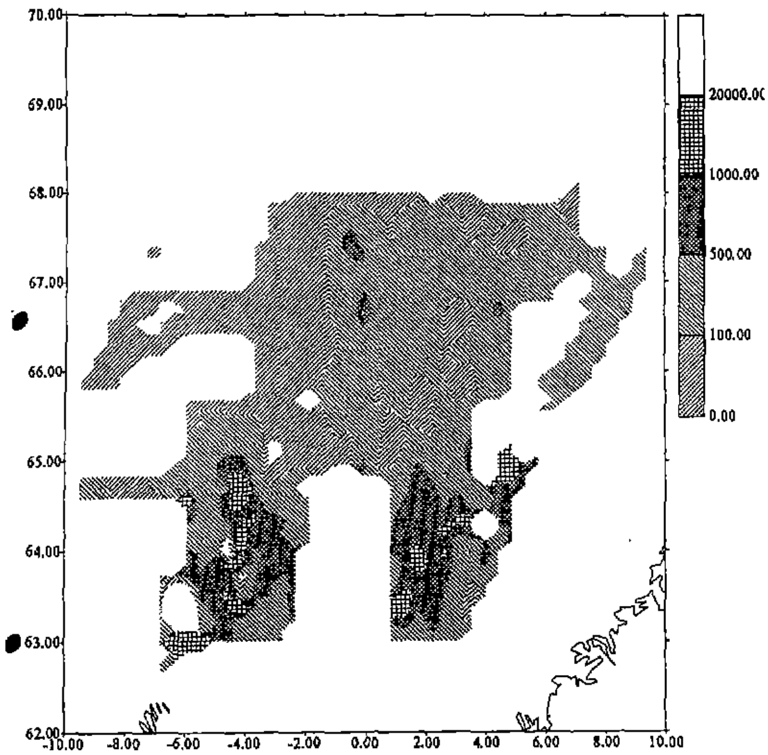


Fig. 6.4.1.2.6. Distribution of blue whiting in the Norwegian Sea, map os s_a values.

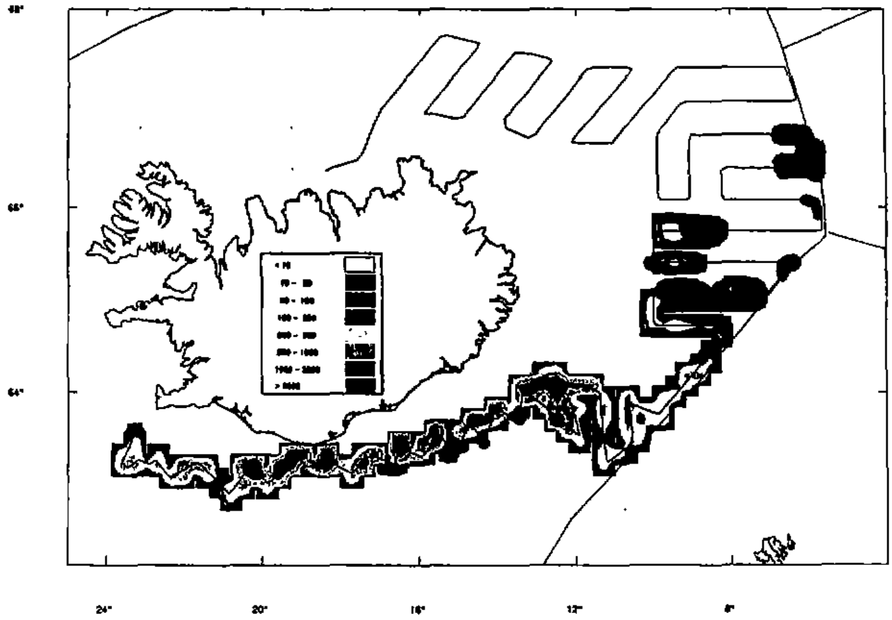


Fig. 6.4.1.2.7. Blue whiting distribution as observed by RV Árni Fridriksson during 17-26/7 1998.

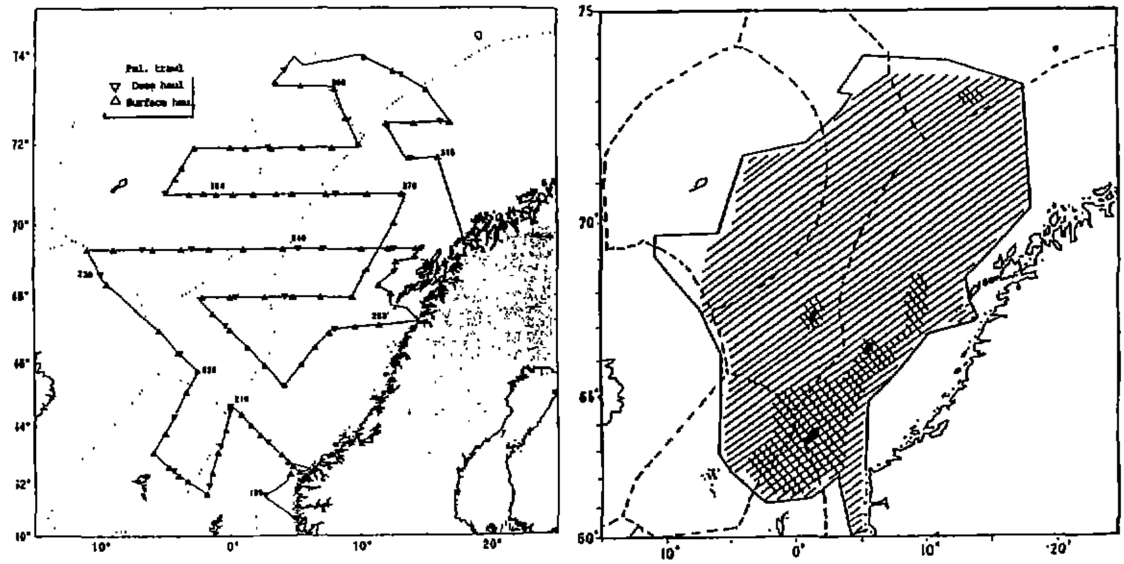


Fig. 6.4.1.2.8. a) Cruise tracks with fishing stations, RV Johan Hjort 30/6-29/7 1998. B) Distribution of blue whiting concentrations in 3 various densities, July 1998. Full line indicates the total area surveyed.

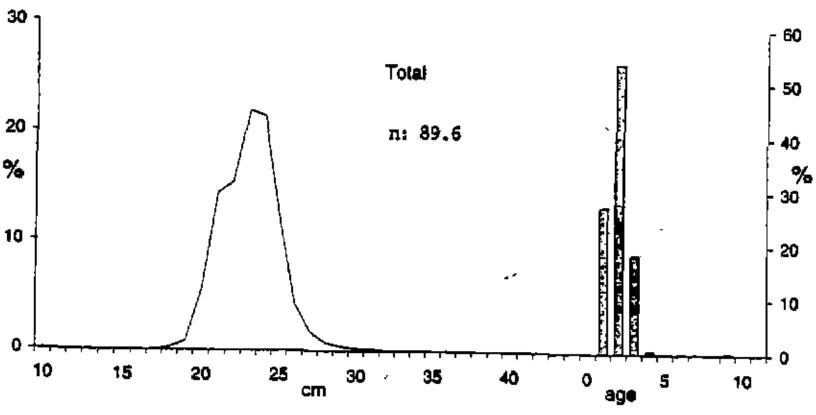


Fig. 6.4.1.2.9. Total length- and agedistribution of blue whiting in the Norwegian Sea July 1998. N x 10^{-9}, weighted by abundance.

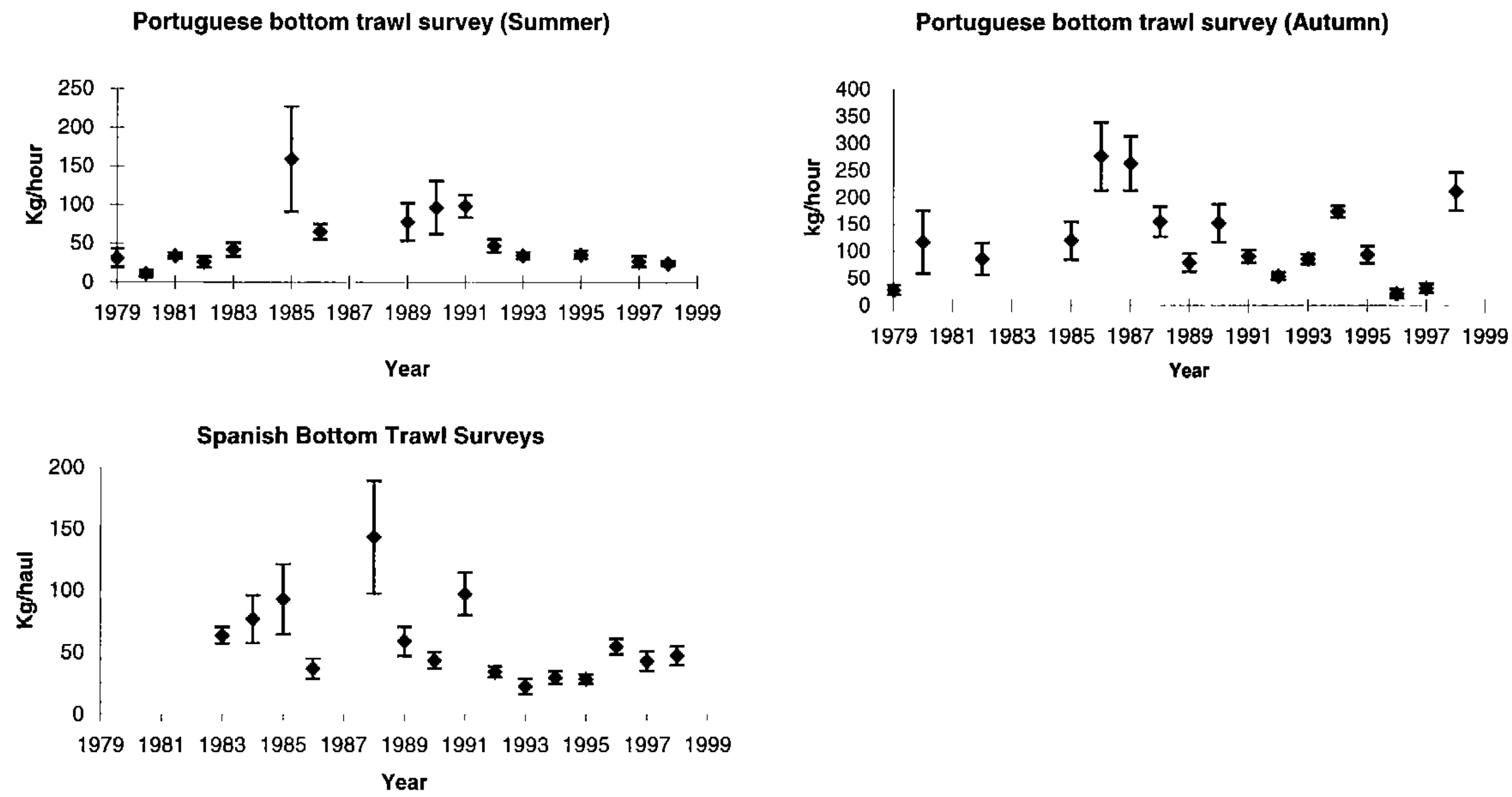


Figure 6.4.2.1 - Mean catch rates in the bottom trawl surveys from the southern area.

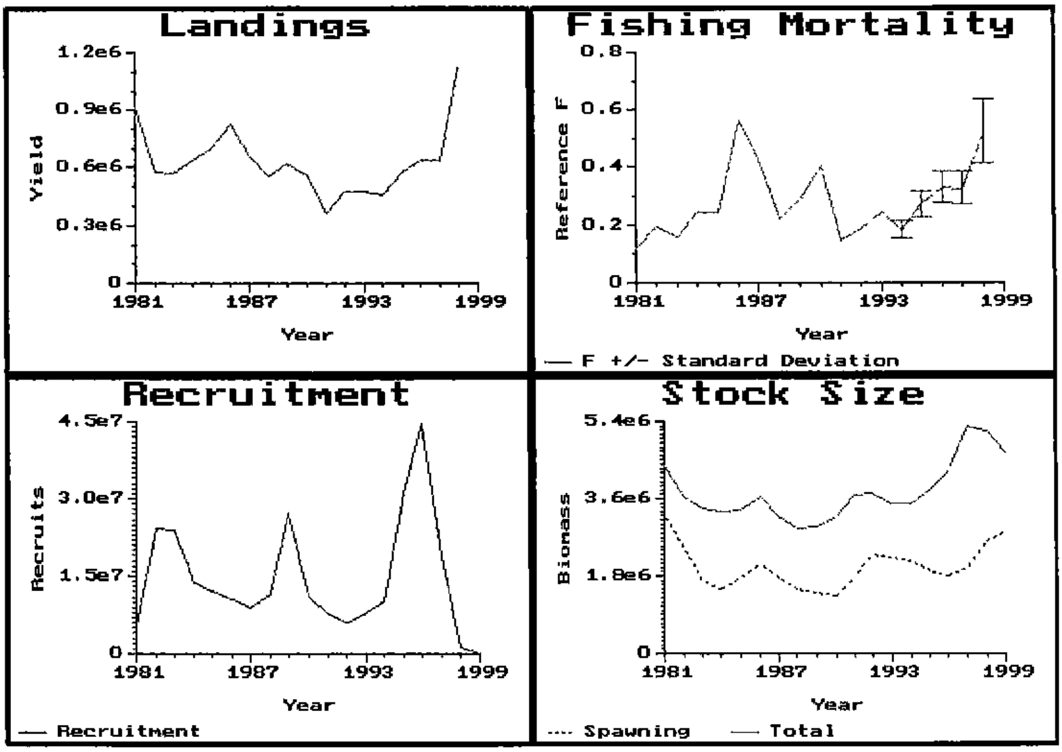


Figure 6.4.4.1. BLUE WHITING. Landings, fishing mortality, recruitment and stock size estimated by ICA.

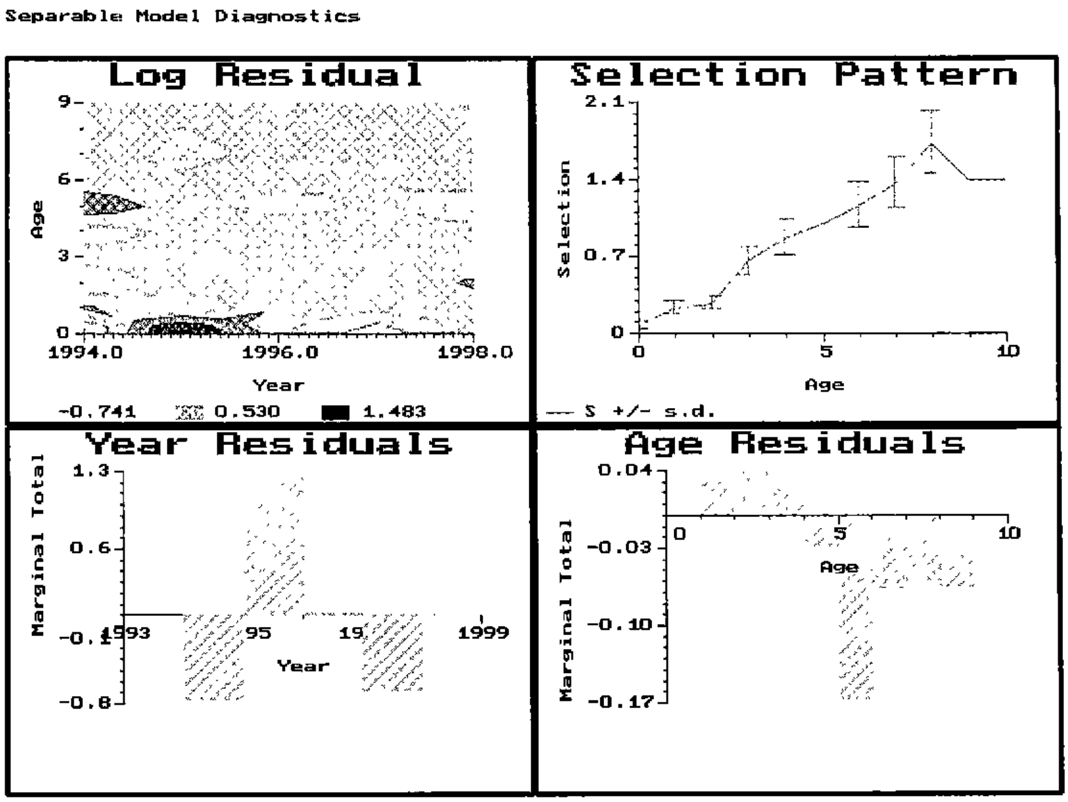
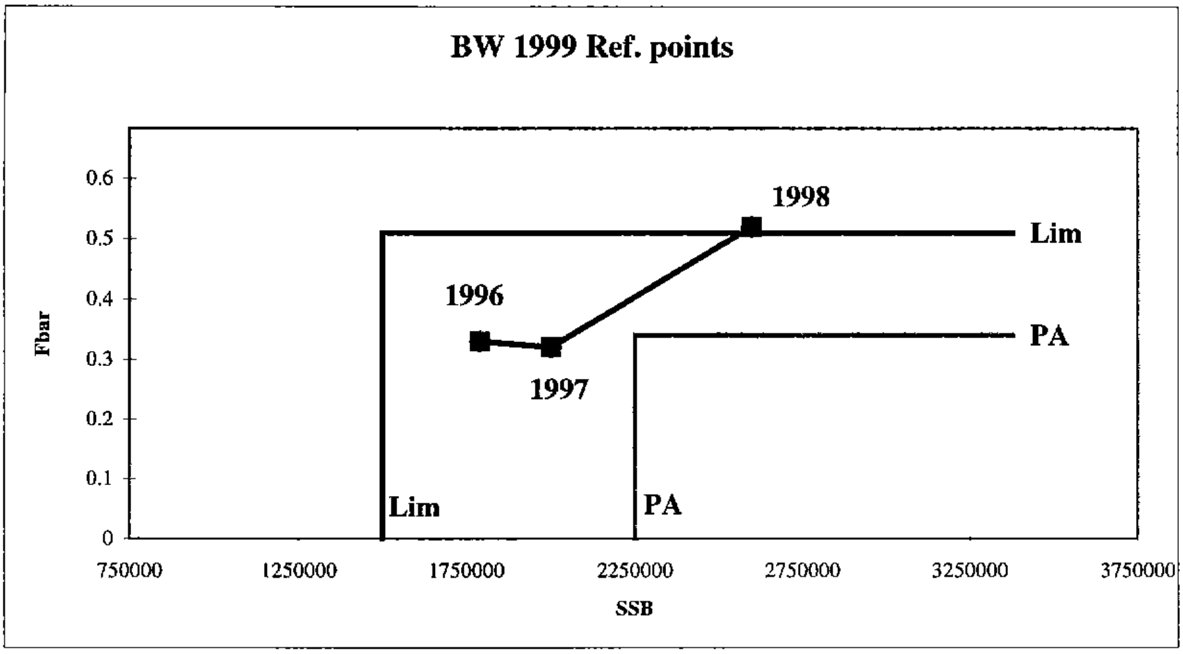


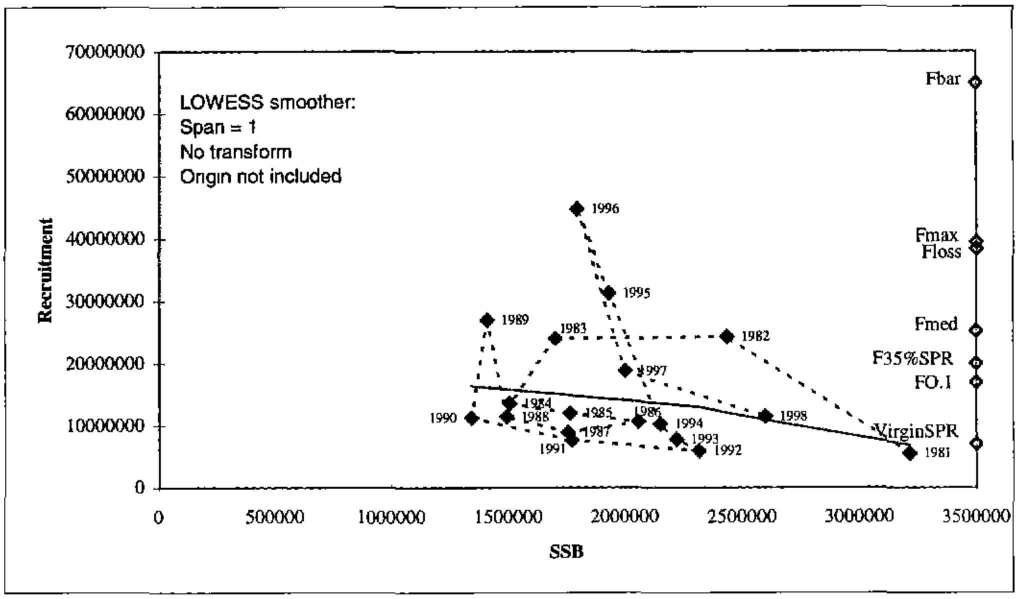
Figure 6.4.4.2. BLUE WHITING. Diagnostic plots showing the residuals estimated by ICA.

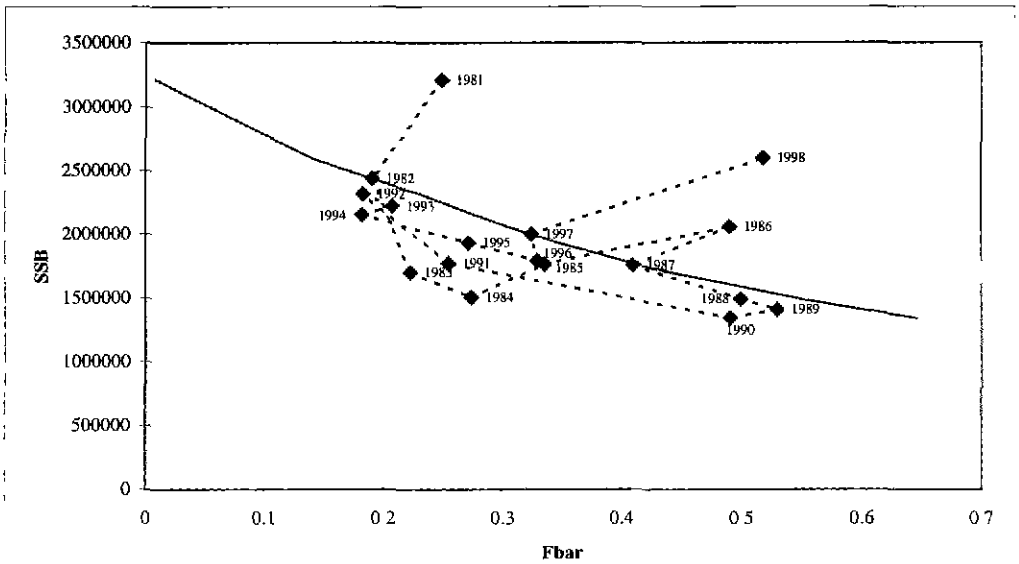
Figure 6.7.1



BW 1999 Ref. points
1998
Lim
1996
PA
1997
Lim
PA
Fbar
0.6
0.5
0.4
0.3
0.2
0.1
0
750000
1250000
1750000
2250000
2750000
3250000
3750000
SSB

Figure 6.7.2 A stock recruitment plot with a LOWESS smoother as a possible stock recruitment relationship. Some reference points are also indicated.
A plot of YPR and SPR curves with some reference points indicated.
A plot of historical SSB against Fbar with an equilibrium curve based on the LOWESS stock recruitment relationship.





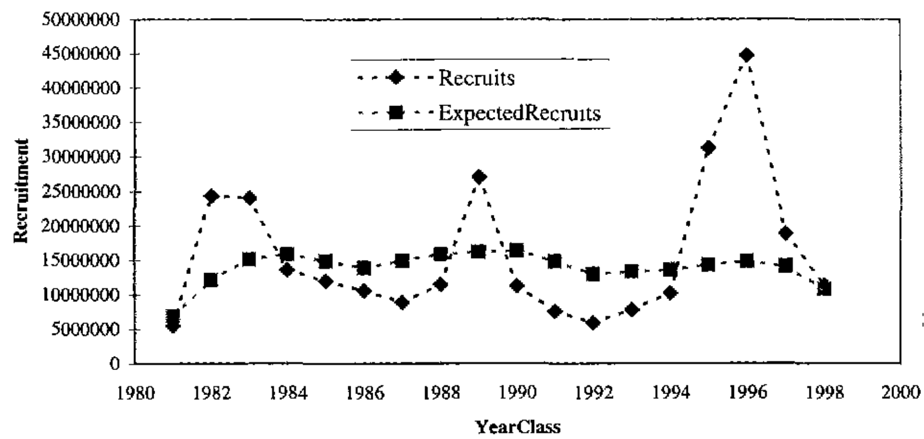


Figure 6.7.3 A plot of historical yield against Fbar with an equilibrium curve based on the LOWESS stock recruitment relationship.
A plot of the time series of stock and recruitment with expected recruits based on the LOWESS stock recruitment relationship.

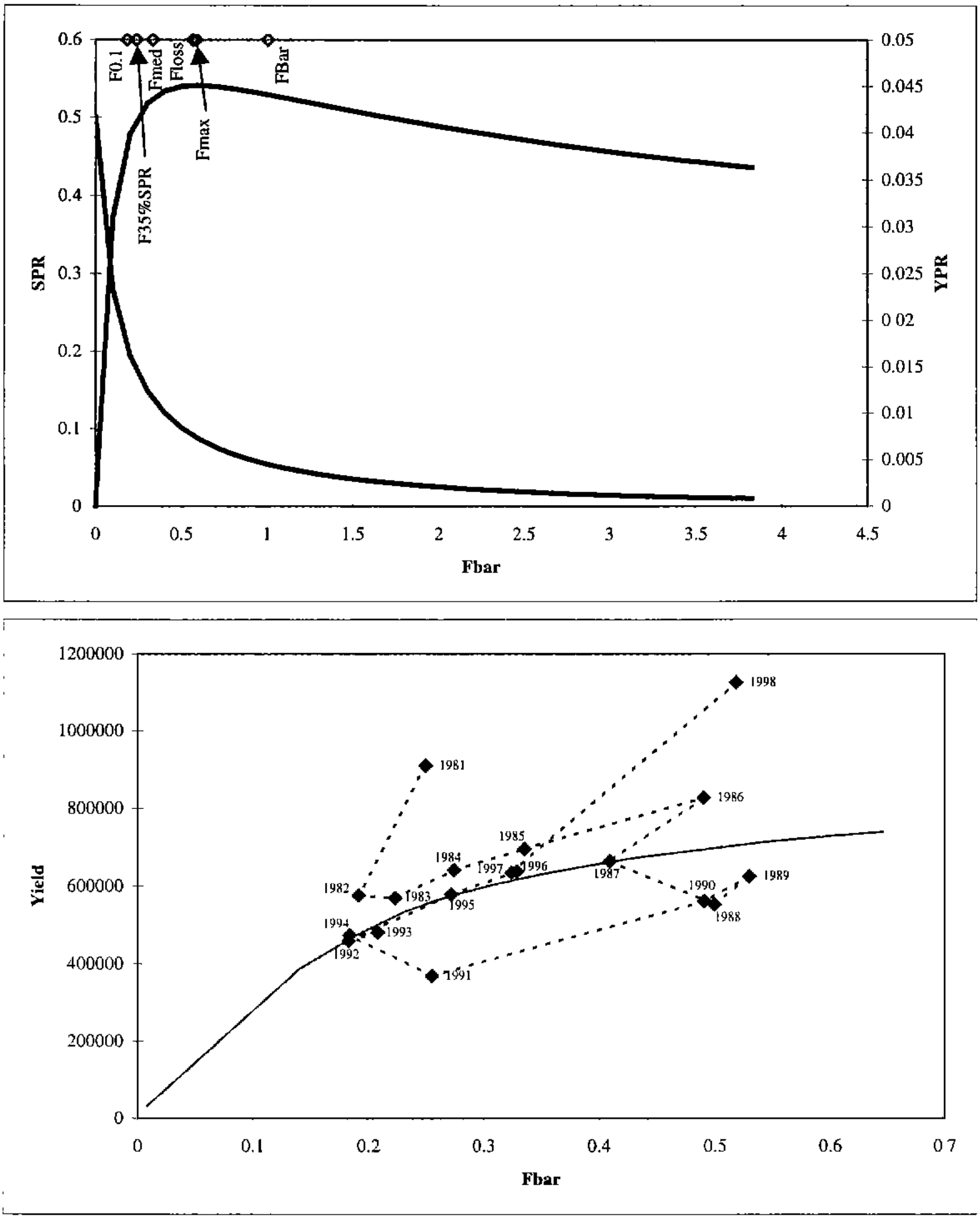
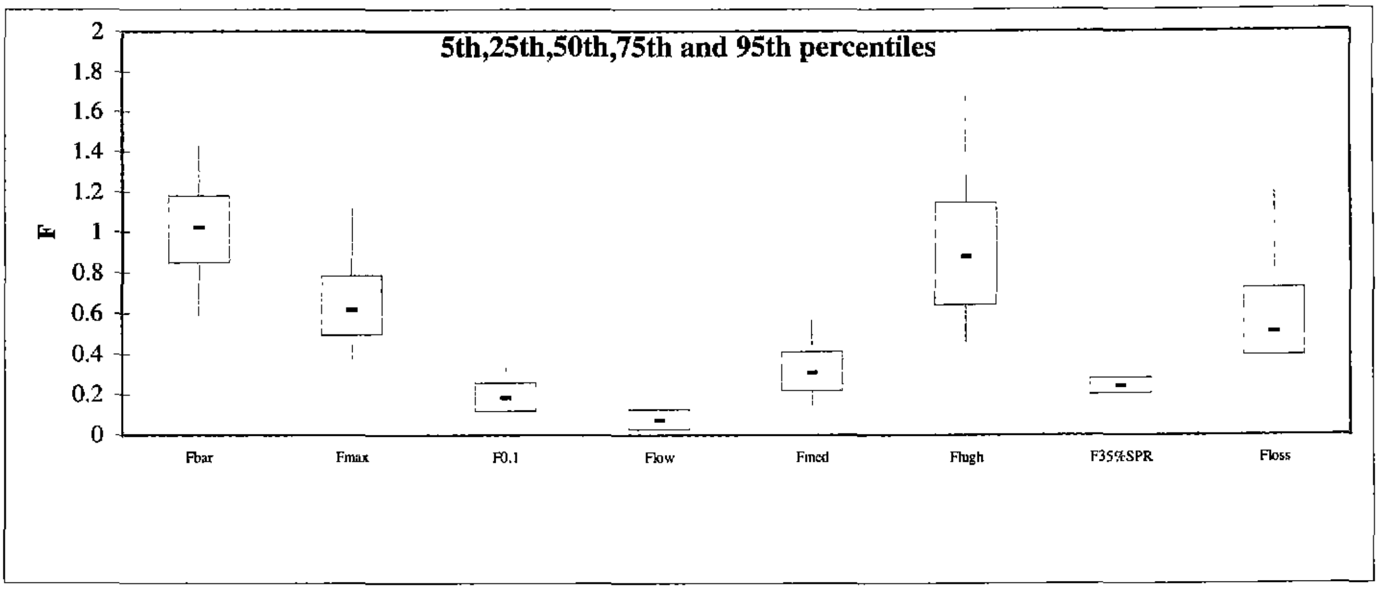


Figure 6.7.4 Reference points. Stochastic output in the form of a table of reference points and a chart summarising the distributions of some reference points.



Reference point	Deterministic	Median	95th percentile	80th percentile	Hist SSB < ref pt %
MedianRecruits	11446080	11446080	18815615	12523695	
MBAL	2250000				77.78
Bloss	1341822				
SSB90%R90%Surv	1667161	1750384	2228733	1949344	22.22
SPR%ofVirgin	10.79	11.15	18.37	14.21	
VirginSPR	0.50	0.49	0.70	0.58	
SPRloss	0.09	0.10	0.13	0.12	

	Deterministic	Median	5th percentile	20th percentile	Hist F > ref pt %
FBar	1.01	1.02	0.59	0.80	0.00
Fmax	0.59	0.62	0.35	0.46	0.00
F0.1	0.18	0.18	0.07	0.11	100.00
Flow	0.08	0.07	0.00	0.02	100.00
Fmed	0.33	0.31	0.15	0.20	38.89
Fhigh	0.92	0.88	0.43	0.60	0.00
F35%SPR	0.24	0.24	0.16	0.20	72.22
Floss	0.57	0.51	0.28	0.37	0.00

For estimation of Gloss and Floss:
A LOWESS smoother with a span of 0.5 was used.
Stock recruit data were log-transformed
A point representing the origin was included in the stock recruit data.
For estimation of the stock recruitment relationship used in equilibrium calculations:
A LOWESS smoother with a span of 1 was used.
Stock recruit data were un-transformed
No point representing the origin was included in the stock recruit data.

Steady state selection provided as input
FBar averaged from age 3 to 7

Number of iterations = 1000
Random number seed = -99

7 ICELANDIC SUMMER-SPAWNING HERRING

7.1 The Fishery

The catches of summer-spawning herring from 1978-1998 are given in Tables 7.1.1, 7.1.2 and 7.1.3. No estimate of discards was made for the 1998/99 season. The fishery started in September, when 9 200 t were taken off the southeast coast. The catch in October-January was almost 78 000 t, equally distributed over these four months. The purse-seine fishery took place off the east coast of Iceland in September and October, but west of Iceland in October -January. The pelagic trawl fishery started in November and took place both east and west of Iceland. In the 1997/98 season 59% of the catch was taken by purse seiners, but 78% in 1998/99. The remaining 41% and 22% 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 season and to 72% in 1998/99. 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 after that 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 1978–1998 are given in Table 7.1.3. As usual, age is given in rings where age in years equals the number of rings+1.

In the period 1989–1991, the 1983 year class predominated in the catch. The 1988 year class was also well represented in the 1991 catches and predominated during the 1992 season. In 1993 the age distribution was dominated by the strong 1989 year class, although the 1988 year class was also well represented. In 1994/95 the catches were distributed on 4 year classes, i.e. those of 1988–1991. The catch in numbers of 2-ringers has never been higher and yielded some 25% of the total numbers in the 1994/1995 season.

During the 1995/96 - 1997/98 seasons, the catches were again 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, being almost 40% of the total number.

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 15 October - 5 November 1998, an estimate was obtained of the adult stock in open waters, but no estimates were made of 1 year old herring in Icelandic coastal waters. The adult stock was located off the east coast of Iceland. The estimated stock size in that area was only 70 000 t, which is much less than was expected. On 30 October 1998, fishermen reported the large herring schools in a wide area approximately 70 nautical miles west of the Snæfellsnes peninsula on the central west coast. An acoustic survey of these herring concentrations was carried out in the beginning of November in the area between 64°20'N and 65°10'N, from approximately 24°W to 27°W. The total abundance of herring in this area was estimated to be 300 000 t. However, due to stormy weather and lack of vessel time it was not possible to attain a complete coverage of the entire herring distribution west of Iceland. Therefore, stock abundance in autumn 1998 is believed to be underestimated.

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. 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 and 1998.

According to the 1998 acoustic assessment surveys, the abundance of the 1992, 1993 and 1995 year classes is low. On the other hand, the abundance of the 1994 year class is above average and that of the 1996 year class very high. There is no assessment available for the 1997 year class.

The results of the autumn 1998 acoustic survey have been used as 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.

This year the number of 1 ringers (in Table 7.3.1) has been revised according to the modified target strength (see above) as this calculation had been overlooked in previous years.

7.4 Stock Assessment

As in previous years the estimation procedure from Halldórsson *et al.* (1986) was used to obtain stock size in the final year, based on all available acoustic data for the older part of the stock (5+ ringers on 1 January each year). The procedure minimizes the sum of squares of log-transformed rather than untransformed data, since there is increased variability in later years concurrent with increasing stock size.

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 was 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 0.179. The confidence intervals (0.14, 0.23) 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).

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 1979–1998 and stock in numbers at age and spawning stock biomass on 1 July 1979–1998 are given in Tables 7.4.2 and 7.4.3 respectively. In addition, another VPA was run, extending backwards to 1947. The standard stock summary, based on the longer VPA, 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 7.4.2. The resulting stock trend from VPA is plotted together with the acoustic estimates in Figure 7.4.3 and the relationship between the two estimates is shown in Figure 7.4.4. In the absence of reliable abundance estimates for the 1995 and 1996 year classes, the RCT3 programme was used. It estimated the sizes of these year classes as 471 and 974 million respectively (see Tables 7.4.5 and 7.4.6).

According to the present assessment, the spawning stock biomass was about 493 000 t on 1 July 1998 which is about 13 000 t higher than assumed 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 1988–1998 as starting years. For 1 ringers and 9+ ringers, a simple average of mean weights at age for the period 1994–1998 was used for the prediction. Weights at age for 2–8 ringers in the catch were obtained using the relationship:

$$W_{y+1} - W_y = -0.1937 * W_y + 79.933 \text{ (g)}$$

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 1994–1997 is used, assuming 1 on 4 ringers and older. In the absence of an estimate for 1 ringers in 1998, a value of 600 million is used, which is a VPA mean of 1-ringers for the years 1977-1996, derived from the RCT3 programme (see Table 7.4.6).

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 (thousand tonnes) for a range of values of Fs are given in Table 7.5.3.

In 1999, it is expected that the largest contribution in numbers (35%) at age will be herring of the 1994 year class, i.e 4-ringed herring. In 2000, both the 1996 and the 1994 year classes will contribute equally and will be about 50% of 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 (1979–1998) 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 1999/2000 season would result in a catch of about 100 000 t (Table 7.5.2 and 7.5.3). The spawning stock biomass in 1999 is expected to be 496 000 t and almost 520 000 t in the year 2000. 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 last year 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.

The present F for this stock is estimated to be 0.18 which is well below F_{pa}=0.22. Furthermore, the spawning stock is 493 000 t compared to B_{pa}=300 000 t. Therefore, the stock is in a healthy state and well above any "alarm level". For these reasons the WG did not make any medium term projections of the stock development.

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 1947–1995. 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	24	2502	2259
Acoustic, wintering area	15	7416	1898

7.9 Comments on the Assessment

The XSA was run trying several options regarding:

1. The ages at which catchability is independent of year class strength:

   This selection was based on a run considering ages < 2 as dependent on stock size. The result from looking at the regression statistics and the F-table is that all agegroups are independent of year class strength.

2. The age above which catchability is independent of age:

   This selection was based on a run considering catchability independent of ages ≥ 4. Examining the standard errors of log catchability indicated that a plus group for ages 10 and older should be used.

3. F shrinkage:

   Since the catch during the last 3 years is much lower than in the years before, it was decided to use 3 years in shrinkage, rather than 5.

4. Time series weighting:

   By using a tricubic time series tapered over 20 years, the acoustic surveys got the catchability equal to 1.26, F =0.3 and a spawning stock biomass of 364 000 t. On the other hand, by using no time series weights, the catchability of the acoustic survey amounted to 1.0, with F =0.24 and spawning stock biomass of 414 000 t. Since the catchability of the acoustic survey was equal to 1, the option of no time series weighting was chosen.

A summary of the results is given in Table 7.9.1. The XSA gives a spawning stock 17% lower in the last 2 years and about 10% lower in the 3 years before that, than the ADAPT-type of assessment which has been used so far. Retrospective plots were made and show more consistency using the ADAPT-type of assessment than obtained by the XSA (Figure 7.9.1). Therefore, it was decided to retain the method used in earlier assessments.

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

*Preliminary

Table 7.1.2 Icelandic summer spawners. Catch in tonnes by icelandic squares, ICES rectangles and months.

Icelandic squares	ICES rectangles	September 1998	October 1998	November 1998	December 1998	January 1999
316	55 D3		57			
317	55 D2		658			
319	55 D0				397	
320	55 C9				490	
324	55 C5		1925			
367	55 D2		181			
371	56 C8		12			
373	56 C6		47	1308	4297	
374	56 C5		385			
412	57 D7		147	20		501
413	57 D6	9240	23			178
414	57 D5		5438			
424	57 C5					968
425	57 C4			3792	95	
426	57 C3			7183	1284	
462	58 D7					713
472	58 C7				69	
473	58 C6					948
474	58 C5					11767
475	58 C4			25	3591	2
476	58 C3		992	180	5267	
477	58 C2		618			
511	59 D8					42
512	59 D7		408		10	432
513	59 D6		839			
561	60 D8		294		88	200
562	60 D7		8234	2622	1397	1737
563	60 D6		1843	3837	1859	
612	59 D7				168	
662	62 D7			26		

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	1978	1979	1980	1981	1982	1983	1984
1	2.634	0.929	3.147	2.283	0.454	1.475	0.421
2	22.551	15.098	14.347	4.629	19.187	22.499	18.015
3	50.995	47.561	20.761	16.771	28.109	151.718	32.244
4	13.846	69.735	60.727	12.126	38.280	30.285	141.354
5	8.738	16.451	65.328	36.871	16.623	21.599	17.043
6	39.492	8.003	11.541	41.917	38.308	8.667	7.113
7	7.253	26.040	9.285	7.299	43.770	14.065	3.916
8	6.354	3.050	19.442	4.863	6.813	13.713	4.113
9	1.616	1.869	1.796	13.416	6.633	3.728	4.517
10	0.926	0.494	1.464	1.032	10.457	2.381	1.828
11	0.400	0.439	0.698	0.884	2.354	3.436	0.202
12	0.017	0.032	0.001	0.760	0.594	0.554	0.255
13	0.025	0.054	0.110	0.101	0.075	0.100	0.260
14	0.051	0.006	0.079	0.062	0.211	0.003	0.003
Catch	37.333	45.072	53.268	39.544	56.528	58.867	50.304

Rings/year	1985	1986	1987	1988	1989	1990	1991
1	0.112	0.100	0.029	0.879	3.974	11.009	35.869
2	12.872	8.172	3.144	4.757	22.628	14.345	92.758
3	24.659	33.938	44.590	41.331	26.649	57.024	51.047
4	21.656	23.452	60.285	99.366	77.824	34.347	87.606
5	85.210	20.681	20.622	69.331	188.654	77.819	33.436
6	11.903	77.629	19.751	22.955	43.114	152.236	54.840
7	5.740	18.252	46.240	20.131	8.116	32.265	109.418
8	2.336	10.986	15.232	32.201	5.897	8.713	9.251
9	4.363	8.594	13.963	12.349	7.292	4.432	3.796
10	4.053	9.675	10.179	10.250	4.780	4.287	2.634
11	2.773	7.183	13.216	7.378	3.449	2.517	1.826
12	0.975	3.682	6.224	7.284	1.410	1.226	0.516
13	0.480	2.918	4.723	4.807	0.844	1.019	0.262
14	0.581	1.788	2.280	1.957	0.348	0.610	0.298
Catch	49.368	65.500	75.439	92.828	101.000	105.097	109.489

Rings/Year	1992	1993	1994	1995	1996	1997	1998
1	12.006	0.869	6.225	7.411	1.100	9.323	16.161
2	79.782	35.560	110.079	26.221	18.723	27.072	37.787
3	131.543	170.106	99.377	159.170	45.304	28.397	151.853
4	43.787	87.363	150.310	86.940	92.948	29.451	42.833
5	56.083	25.146	90.824	105.542	69.878	42.267	19.872
6	41.932	28.802	23.926	74.326	86.261	35.285	30.280
7	36.224	18.306	20.809	20.076	37.447	28.506	22.572
8	44.765	24.268	19.164	13.797	13.207	21.828	32.779
9	9.244	14.318	17.973	8.873	6.854	8.160	14.366
10	2.259	3.639	16.222	9.140	4.012	3.815	4.802
11	0.582	0.878	2.955	7.079	1.672	1.696	2.199
12	0.305	0.300	1.433	2.376	4.179	6.570	1.084
13	0.203	0.200	0.345	0.927	1.672	1.378	5.081
14	0.102	0.100	0.345	0.124	0.100	1.802	3.036
Catch	108.504	102.741	134.003	125.851	95.882	64.682	86.998

Table 7.2.1 Icelandic summer spawners. Weight at age (g). Age in years is number of rings+1.

Rings/Year	1978	1979	1980	1981	1982	1983	1984
1	73	75	69	61	65	59	49
2	128	145	115	141	141	132	131
3	196	182	202	190	186	180	189
4	247	231	232	246	217	218	217
5	295	285	269	269	274	260	245
6	314	316	317	298	293	309	277
7	339	334	352	330	323	329	315
8	359	350	360	356	354	356	322
9	360	367	380	368	385	370	351
10	376	368	383	405	389	407	334
11	380	371	393	382	400	437	362
12	425	350	390	400	394	459	446
13	425	350	390	400	390	430	417
14	425	450	390	400	420	472	392

Rings/Year	1985	1986	1987	1988	1989	1990	1991
1	53	60	60	75	63	75	74
2	146	140	168	157	130	119	139
3	219	200	200	221	206	198	188
4	266	252	240	239	246	244	228
5	285	282	278	271	261	273	267
6	315	298	304	298	290	286	292
7	335	320	325	319	331	309	303
8	365	334	339	334	338	329	325
9	388	373	356	354	352	351	343
10	400	380	378	352	369	369	348
11	453	394	400	371	389	387	369
12	469	408	404	390	380	422	388
13	433	405	424	408	434	408	404
14	447	439	430	437	409	436	396

Rings/Year	1992	1993	1994	1995	1996	1997	1998	1999*
1	63	74	67	69	78	62	78	71
2	144	150	135	129	140	137	147	143
3	190	212	204	178	166	197	184	198
4	232	245	249	236	208	234	213	228
5	276	288	269	276	258	270	246	252
6	317	330	302	292	294	299	286	278
7	334	358	336	314	312	323	314	311
8	346	373	368	349	324	342	341	334
9	364	387	379	374	360	358	351	364
10	392	401	398	381	349	363	354	369
11	444	425	387	400	388	373	350	380
12	399	387	421	409	403	412	372	404
13	419	414	402	438	385	394	400	404
14	428	420	390	469	420	429	437	424

* Predicted

Table 7.2.2 Icelandic summer spawners. Proportion mature at age.
Age in years is number of rings+1.

Rings/Year	1978	1979	1980	1981	1982	1983	1984
1	0.000	0.000	0.000	0.000	0.020	0.000	0.000
2	0.040	0.070	0.050	0.030	0.050	0.000	0.010
3	0.780	0.650	0.920	0.650	0.850	0.640	0.820
4	1.000	0.980	1.000	0.990	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	1985	1986	1987	1988	1989	1990	1991
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.030	0.010	0.045	0.060	0.000	0.013
3	0.900	0.890	0.870	0.900	0.930	0.780	0.720
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	1992	1993	1994	1995	1996	1997	1998	1999*
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.020	0.049	0.054	0.157	0.049	0.160	0.265	0.158
3	0.930	0.999	1.000	0.982	0.990	0.925	0.935	0.950
4	1.000	1.000	0.992	0.998	1.000	0.989	0.995	0.995
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 96-98)

Table 7.3.1 Acoustic estimates (in millions) of the Icelandic summer spawning herring, 1974-1999. 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
1	406	370	-	710	465	1418	183	-	845	266	1629	-
2	126	725	178	805	745	254	234	-	98	792	237	-
3	352	181	593	227	850	858	533	-	165	65	716	188
4	836	249	177	304	353	687	860	-	515	139	100	790
5	287	381	302	137	273	160	443	-	316	459	116	240
6	53	171	538	176	94	99	55	-	361	280	240	101
7	37	42	185	387	81	87	69	-	166	410	161	73
8	76	23	-	40	210	44	43	-	110	150	130	47
9	25	30	-	10	32	92	86	-	52	101	97	77
10	21	16	-	2	11	39	55	-	29	50	35	47
11	14	10	18	-	-	-	2	-	16	35	15	10
12	17	9	-	-	17	-	-	-	27	15	11	10
13	8	5	-	-	-	-	-	-	19	65	43	-
14	6	3	-	-	-	-	-	-	8	32	8	22
15	3	2	-	-	-	-	-	-	2	-	15	-
5+	547	692	1043	752	718	521	753	-	1105	1597	870	627

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 1998. F_{98} is the F in 1998 and F_{p98} is the exploitation pattern in 1998 (used in prognosis).

Rings in 1998	Year class	Acoustic estimate Nov. 98	Catch 1998/1999	F_{ac}	F_{98}	F_{p98}
1	1996	1131	16.161	0.017	0.017	0.029
2	1995	362	37.787	0.100	0.100	0.280
3	1994	790	151.853	0.179	0.179	0.760
4+	1993	240	42.833	0.179	0.179	1.000

Table 7.4.2 Icelandic summer spawners. Fishing mortality at age M=0.1. Age in year is number of rings+1.

Run title : Herring Summer-spawn (run: SVPAGB09/V09)

At 30-Apr-99 17:37:18

Traditional vpa using file input for terminal F

Table 8 Fishing mortality (F) at age

YEAR, AGE	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988
1,	.0039,	.0131,	.0027,	.0020,	.0071,	.0009,	.0001,	.0001,	.0001,	.0019,
2,	.0953,	.0697,	.0217,	.0257,	.1163,	.1007,	.0302,	.0076,	.0052,	.0161,
3,	.1612,	.1646,	.0979,	.1588,	.2574,	.2172,	.1745,	.0934,	.0471,	.0788,
4,	.2379,	.2832,	.1228,	.2997,	.2291,	.3597,	.1985,	.2235,	.2133,	.1263,
5,	.2117,	.3255,	.2482,	.2204,	.2459,	.1746,	.3402,	.2635,	.2787,	.3593,
6,	.1556,	.2019,	.3185,	.3901,	.1533,	.1071,	.1593,	.5233,	.3826,	.5021,
7,	.3161,	.2430,	.1701,	.5657,	.2156,	.0864,	.1063,	.3457,	.6022,	.7413,
8,	.1640,	.3662,	.1736,	.2122,	.3064,	.0810,	.0614,	.2704,	.4788,	1.0044,
9,	.4086,	.1233,	.4111,	.3360,	.1543,	.1401,	.1042,	.2967,	.5709,	.7958,
10,	.2425,	.5732,	.0870,	.5753,	.1727,	.0948,	.1614,	.3128,	.5998,	.9744,
11,	.5022,	.5576,	.7254,	.2599,	.3326,	.0179,	.1823,	.4193,	.8034,	1.0667,
12,	.1002,	.0017,	2.1832,	1.5429,	.0805,	.0330,	.1011,	.3468,	.6885,	1.3772,
13,	.1574,	.5094,	.2034,	1.9670,	1.1594,	.0445,	.0723,	.4316,	.8795,	1.8222,
14,	.2560,	.3220,	.5340,	.7310,	.3220,	.0760,	.1190,	.3680,	.6260,	1.0360,
FBAR 4-14,	.2502,	.3188,	.4707,	.6455,	.3065,	.1105,	.1460,	.3456,	.5567,	.8914,
W.Av 4-14	.238	.294	.246	.366	.224	.255	.227	.359	.374	.288

Table 8 Fishing mortality (F) at age

YEAR, AGE	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	FBAR 94-97
1,	.0108,	.0116,	.0283,	.0172,	.0011,	.0202,	.0180,	.0009,	.0210,	.0176,	.0151,
2,	.0547,	.0441,	.1147,	.0730,	.0586,	.1630,	.0999,	.0521,	.0261,	.1000,	.0853,
3,	.1061,	.1701,	.1951,	.2112,	.1964,	.2059,	.3320,	.2236,	.0938,	.1789,	.2138,
4,	.1870,	.1735,	.3772,	.2283,	.1895,	.2381,	.2498,	.2933,	.1986,	.1789,	.2449,
5,	.3314,	.2576,	.2279,	.3918,	.1778,	.2739,	.2340,	.2903,	.1880,	.1789,	.2465,
6,	.3526,	.4310,	.2598,	.4371,	.3180,	.2288,	.3352,	.2718,	.2084,	.1789,	.2610,
7,	.2948,	.4300,	.5579,	.2441,	.3076,	.3550,	.2722,	.2509,	.1213,	.1789,	.2498,
8,	.4409,	.5208,	.1870,	.4127,	.2291,	.5376,	.3743,	.2581,	.2031,	.1789,	.3433,
9,	.5701,	.6155,	.3995,	.2574,	.1996,	.2366,	.4534,	.2869,	.2246,	.1789,	.3004,
10,	.7351,	.6908,	.8158,	.3901,	.1368,	.3234,	.1627,	.3382,	.2288,	.1789,	.2633,
11,	.9509,	.9955,	.6325,	.3697,	.2300,	.1411,	.2037,	.0364,	.2085,	.1789,	.1474,
12,	.5181,	.9774,	.4912,	.1785,	.2944,	.6244,	.1446,	.1596,	.1754,	.1789,	.2760,
13,	.4816,	.7787,	.4992,	.3232,	.1528,	.5692,	.9630,	.1290,	.0652,	.1789,	.4316,
14,	.5430,	.6800,	.4810,	.3270,	.2330,	.3770,	.3640,	.2160,	.1790,	.1789,	.2840,
FBAR 4-14,	.4914,	.5955,	.4481,	.3236,	.2244,	.3550,	.3415,	.2300,	.1819,	.1789,	
W.Av 4-14	.295	.338	.364	.325	.212	.264	.263	.267	.179	.179	

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: SVPAGB09/V09)

At 30-Apr-99 17:37:18

Traditional vpa using file input for terminal F

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,	1988,
AGE										
1,	248295,	254098,	880756,	238201,	219848,	503268,	1253076,	703086,	345124,	494510,
2,	174486,	223783,	226925,	794771,	215101,	197524,	454976,	1133724,	636084,	312254,
3,	335164,	143537,	188854,	200930,	700898,	173260,	161612,	399443,	1018066,	572563,
4,	345495,	258107,	110164,	154948,	155117,	490249,	126169,	122820,	329187,	878803,
5,	90458,	246441,	175939,	88163,	103896,	111615,	309592,	93605,	88875,	240641,
6,	58274,	66235,	161041,	124210,	63996,	73514,	84812,	199339,	65076,	60854,
7,	100709,	45129,	48977,	105965,	76084,	49676,	59761,	65438,	106877,	40163,
8,	21164,	66431,	32023,	37386,	54458,	55494,	41228,	48621,	41906,	52958,
9,	5836,	16254,	41679,	24359,	27361,	36270,	46305,	35085,	33571,	23492,
10,	2406,	3509,	13001,	25000,	15751,	21217,	28528,	37753,	23594,	17163,
11,	1164,	1708,	1790,	10783,	12725,	11992,	17462,	21965,	24985,	11719,
12,	352,	637,	885,	784,	7524,	8256,	10659,	13166,	13068,	10124,
13,	389,	288,	576,	90,	152,	6281,	7228,	8717,	8422,	5940,
14,	28,	301,	157,	425,	11,	43,	5436,	6084,	5123,	3162,
TOTAL,	1384222,	1326461,	1882770,	1806017,	1652927,	1738672,	2606852,	2888849,	2739960,	2724348,
TOTSBIO	198441,	212811,	186274,	193097,	219903,	233050,	250527,	263902,	373378,	443668,

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,
AGE									
1,	389913,	1004383,	1352627,	738043,	849770,	326604,	436290,	1220620,	470558,
2,	446616,	349030,	898337,	1189810,	656395,	768076,	289605,	387726,	1103417,
3,	278016,	382609,	302180,	724735,	1000772,	560136,	590459,	237135,	333034,
4,	478803,	226243,	292055,	224966,	530912,	744058,	412502,	383342,	171572,
5,	700793,	359357,	172102,	181224,	162002,	397453,	530614,	290754,	258700,
6,	152015,	455219,	251325,	123993,	110826,	122711,	273468,	379962,	196803,
7,	33328,	96675,	267664,	175377,	72467,	72966,	88327,	176969,	261969,
8,	17316,	22457,	56906,	138634,	124315,	48210,	46295,	60876,	124597,
9,	17551,	10082,	12071,	42708,	83023,	89454,	25481,	28811,	42552,
10,	9592,	8980,	4930,	7325,	29873,	61529,	63885,	14651,	19568,
11,	5861,	4161,	4072,	1973,	4487,	23574,	40291,	49127,	9453,
12,	3649,	2049,	1391,	1957,	1233,	3226,	18524,	29737,	42863,
13,	2311,	1967,	698,	770,	1482,	831,	1563,	14505,	22939,
14,	869,	1292,	817,	383,	505,	1151,	426,	540,	11537,
TOTAL,	2536636,	2924505,	3617179,	3551905,	3628065,	3219982,	2817736,	3274762,	3069567,
TOTSBIO	412070,	371443,	319646,	380532,	522732,	531646,	509239,	414511,	417144,

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR,	1998,	1999,	GMST 79-96	AMST 79-96
AGE				
1,	973290,	0,	534607,	636584,
2,	416916,	865304,	433239,	519735,
3,	972677,	341342,	367910,	442798,
4,	274362,	735943,	291484,	347997,
5,	127288,	207586,	196678,	241307,
6,	193955,	96308,	127023,	157048,
7,	144582,	146750,	80168,	93475,
8,	209962,	109393,	46828,	53704,
9,	92020,	158861,	27069,	33300,
10,	30759,	69624,	15312,	21594,
11,	14085,	23272,	8181,	13880,
12,	6943,	10657,	3550,	7068,
13,	32546,	5254,	1482,	3456,
14,	19447,	24625,	517,	1486,
TOTAL,	3508840,	2809638,		
TOTSBIO	493545,			

Table 7.4.4

Run title : Herring Summer-spawn (run: SVPAGB10/V10) ,

At 30-Apr-99 17:46:24

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,	185806,	139636,	47800,	.3423,	.9923,	.3641,
1948,	68007,	145568,	112448,	56800,	.5051,	.9343,	1.6950,
1949,	77472,	104100,	86207,	5400,	.0626,	.9479,	.0799,
1950,	197367,	162385,	119851,	13600,	.1135,	1.3783,	.1742,
1951,	116475,	129882,	88394,	15800,	.1787,	1.0075,	.2071,
1952,	323928,	117214,	79459,	10500,	.1321,	.7904,	.3858,
1953,	197295,	215686,	134014,	17600,	.1313,	1.2380,	.3833,
1954,	167414,	165085,	124397,	11000,	.0884,	.8459,	.1406,
1955,	191196,	162663,	127307,	20500,	.1610,	.7515,	.1194,
1956,	469184,	236683,	165691,	20400,	.1231,	.9755,	.2495,
1957,	791378,	247236,	139749,	22800,	.1631,	.7770,	.2522,
1958,	369217,	328225,	197382,	33500,	.1697,	.9887,	.2422,
1959,	555110,	374149,	272138,	35000,	.1286,	.9781,	.2493,
1960,	712881,	231612,	161363,	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,	147523,	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,	16435,	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,	31566,	12354,	370,	.0300,	1.1931,	.1959,
1973,	418014,	73514,	28587,	254,	.0089,	.9979,	.0541,
1974,	131897,	121538,	45933,	1275,	.0278,	1.0010,	.0379,
1975,	198545,	162827,	116948,	13280,	.1136,	1.0000,	.1176,
1976,	554282,	224980,	129376,	17168,	.1327,	1.0000,	.1808,
1977,	436287,	257845,	133016,	28925,	.2175,	1.0000,	.2940,
1978,	195604,	266185,	175699,	37333,	.2125,	1.0000,	.4073,
1979,	248295,	273717,	198441,	45072,	.2271,	1.0001,	.2502,
1980,	254098,	267995,	212811,	53268,	.2503,	.9994,	.3188,
1981,	880756,	293370,	186274,	39544,	.2123,	.9988,	.4707,
1982,	238201,	330579,	193097,	56528,	.2927,	1.0003,	.6455,
1983,	219848,	317862,	219903,	58867,	.2677,	.9989,	.3065,
1984,	503268,	301124,	233050,	50304,	.2159,	.9992,	.1105,
1985,	1253076,	399784,	250527,	49368,	.1971,	1.0002,	.1460,
1986,	703086,	482351,	263902,	65500,	.2482,	.9999,	.3456,
1987,	345124,	545475,	373378,	75439,	.2020,	.9999,	.5567,
1988,	494511,	562675,	443668,	92828,	.2092,	.9994,	.8914,
1989,	389913,	516742,	412070,	101000,	.2451,	.9997,	.4914,
1990,	1004383,	523979,	371443,	105097,	.2829,	.9991,	.5955,
1991,	1352627,	575552,	319646,	109489,	.3425,	9996,	.4481,
1992,	738043,	623946,	380532,	108504,	.2851,	.9994,	.3236,
1993,	849770,	705813,	522732,	102741,	.1965,	.9991,	.2244,
1994,	326604,	681178,	531647,	134003,	.2521,	1.0003,	.3550,
1995,	436290,	598976,	509239,	125851,	.2471,	1.0006,	.3415,
1996,	1220620,	582918,	414511,	95882,	.2313,	.9999,	.2300,
1997,	470558,	599691,	417144,	64395,	.1544,	1.0001,	.1819,
1998,	973289,	650837,	493545,	86999,	.1763,	1.0001,	.1789,
Arith. Mean ,	431292,	299218,	207061,	53023,	.3061		.4604,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),			

1

Table 7.4.5 Icelandic summer spawners. Input data for the RCT3 program.

```
Iceland Herring: VPA and acoustic survey data
3 20 2
'Yearcl'   'VPAage2'  'Surv4''Surv3''Surv2'
1977    248 462 19  -11
1978    254 75  361 -11
1979    881 -11 17  625
1980    238 310 -11 -11
1981    220 67  171 -11
1982    504 208 28  -11
1983    1255    -11 652 -11
1984    705 352 -11 201
1985    346 181 126 -11
1986    495 593 725 406
1987    392 227 178 370
1988    1009    850 805 -11
1989    1362    858 745 710
1990    744 533 254 465
1991    857 -11 234 1418
1992    331 165 -11 183
1993    444 65  98  -11
1994    1247    716 792 845
1995    -11 188 237 266
1996    -11 -11 -11 1629
```

Table 7.4.6 Icelandic summer spawners.
Analysis by RCT3 ver3.1 of data from file :

adapt.dat

Iceland Herring: VPA and acoustic survey data

Data for 3 surveys over 20 years : 1977 - 1996

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.

Yearclass = 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	
Surv4	.81	1.71	.47	.626	15	5.24	5.95	.560	.339
Surv3	.87	1.61	.79	.359	15	5.47	6.38	.924	.124
Surv2	1.04	.12	.55	.518	9	5.59	5.92	.714	.208
					VPA Mean =		6.44	.568	.329

Yearclass = 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	
Surv4									
Surv3									
Surv2	1.03	.17	.54	.531	9	7.40	7.78	.814	.321
					VPA Mean =		6.46	.559	.679

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1995	471	6.16	.33	.14	.18		
1996	974	6.88	.46	.62	1.80		

Table 7.5.1

The SAS System

12:24 Tuesday, May 4, 1999

Herring Icelandic Summer-spawning (Fishing Area Va)

Single option prediction: Input data

Year: 1999								
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	600.000	0.1000	0.0000	0.0000	0.5000	0.071	0.0052	0.071
2	865.304	0.1000	0.1580	0.0000	0.5000	0.143	0.0502	0.143
3	341.342	0.1000	0.9500	0.0000	0.5000	0.198	0.1360	0.198
4	735.943	0.1000	0.9950	0.0000	0.5000	0.229	0.1789	0.229
5	207.586	0.1000	1.0000	0.0000	0.5000	0.252	0.1789	0.252
6	96.308	0.1000	1.0000	0.0000	0.5000	0.278	0.1789	0.278
7	146.750	0.1000	1.0000	0.0000	0.5000	0.311	0.1789	0.311
8	109.393	0.1000	1.0000	0.0000	0.5000	0.334	0.1789	0.334
9	158.861	0.1000	1.0000	0.0000	0.5000	0.364	0.1789	0.364
10	69.624	0.1000	1.0000	0.0000	0.5000	0.369	0.1789	0.369
11	23.272	0.1000	1.0000	0.0000	0.5000	0.380	0.1789	0.380
12	10.657	0.1000	1.0000	0.0000	0.5000	0.404	0.1789	0.404
13	5.254	0.1000	1.0000	0.0000	0.5000	0.404	0.1789	0.404
14	24.625	0.1000	1.0000	0.0000	0.5000	0.424	0.1789	0.424
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 2000								
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	600.000	0.1000	0.0000	0.0000	0.5000	0.071	0.0052	0.071
2	.	0.1000	0.1580	0.0000	0.5000	0.143	0.0502	0.143
3	.	0.1000	0.9500	0.0000	0.5000	0.198	0.1360	0.198
4	.	0.1000	0.9950	0.0000	0.5000	0.229	0.1789	0.229
5	.	0.1000	1.0000	0.0000	0.5000	0.252	0.1789	0.252
6	.	0.1000	1.0000	0.0000	0.5000	0.278	0.1789	0.278
7	.	0.1000	1.0000	0.0000	0.5000	0.311	0.1789	0.311
8	.	0.1000	1.0000	0.0000	0.5000	0.334	0.1789	0.334
9	.	0.1000	1.0000	0.0000	0.5000	0.364	0.1789	0.364
10	.	0.1000	1.0000	0.0000	0.5000	0.369	0.1789	0.369
11	.	0.1000	1.0000	0.0000	0.5000	0.380	0.1789	0.380
12	.	0.1000	1.0000	0.0000	0.5000	0.404	0.1789	0.404
13	.	0.1000	1.0000	0.0000	0.5000	0.404	0.1789	0.404
14	.	0.1000	1.0000	0.0000	0.5000	0.424	0.1789	0.424
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Herring Icelandic Summer-spawning (Fishing Area Va)

Single option prediction: Input data

(cont.)

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	600.000	0.1000	0.0000	0.0000	0.5000	0.071	0.0052	0.071
2	.	0.1000	0.1580	0.0000	0.5000	0.143	0.0502	0.143
3	.	0.1000	0.9500	0.0000	0.5000	0.198	0.1360	0.198
4	.	0.1000	0.9950	0.0000	0.5000	0.229	0.1789	0.229
5	.	0.1000	1.0000	0.0000	0.5000	0.252	0.1789	0.252
6	.	0.1000	1.0000	0.0000	0.5000	0.278	0.1789	0.278
7	.	0.1000	1.0000	0.0000	0.5000	0.311	0.1789	0.311
8	.	0.1000	1.0000	0.0000	0.5000	0.334	0.1789	0.334
9	.	0.1000	1.0000	0.0000	0.5000	0.364	0.1789	0.364
10	.	0.1000	1.0000	0.0000	0.5000	0.369	0.1789	0.369
11	.	0.1000	1.0000	0.0000	0.5000	0.380	0.1789	0.380
12	.	0.1000	1.0000	0.0000	0.5000	0.404	0.1789	0.404
13	.	0.1000	1.0000	0.0000	0.5000	0.404	0.1789	0.404
14	.	0.1000	1.0000	0.0000	0.5000	0.424	0.1789	0.424
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	600.000	0.1000	0.0000	0.0000	0.5000	0.071	0.0052	0.071
2	.	0.1000	0.1580	0.0000	0.5000	0.143	0.0502	0.143
3	.	0.1000	0.9500	0.0000	0.5000	0.198	0.1360	0.198
4	.	0.1000	0.9950	0.0000	0.5000	0.229	0.1789	0.229
5	.	0.1000	1.0000	0.0000	0.5000	0.252	0.1789	0.252
6	.	0.1000	1.0000	0.0000	0.5000	0.278	0.1789	0.278
7	.	0.1000	1.0000	0.0000	0.5000	0.311	0.1789	0.311
8	.	0.1000	1.0000	0.0000	0.5000	0.334	0.1789	0.334
9	.	0.1000	1.0000	0.0000	0.5000	0.364	0.1789	0.364
10	.	0.1000	1.0000	0.0000	0.5000	0.369	0.1789	0.369
11	.	0.1000	1.0000	0.0000	0.5000	0.380	0.1789	0.380
12	.	0.1000	1.0000	0.0000	0.5000	0.404	0.1789	0.404
13	.	0.1000	1.0000	0.0000	0.5000	0.404	0.1789	0.404
14	.	0.1000	1.0000	0.0000	0.5000	0.424	0.1789	0.424
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : SPRAGB01
Date and time: 04MAY99:12:42

Table 7.5.2

Herring Icelandic Summer-spawning (Fishing Area Va)

Single option prediction: Detailed tables

Year: 1999 F-factor: 1.2297 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	0.0064	3619	256	600000	42420	0	0	0	0
2	0.0617	49284	7038	865304	123565	136718	19523	130050	18571
3	0.1672	50082	9931	341342	67688	324275	64304	308460	61168
4	0.2200	138558	31661	735943	168163	732263	167322	696550	159162
5	0.2200	39083	9845	207586	52291	207586	52291	197462	49741
6	0.2200	18132	5039	96308	26764	96308	26764	91611	25459
7	0.2200	27629	8582	146750	45581	146750	45581	139593	43358
8	0.2200	20596	6869	109393	36483	109393	36483	104058	34703
9	0.2200	29909	10896	158861	57873	158861	57873	151113	55051
10	0.2200	13108	4833	69624	25670	69624	25670	66228	24418
11	0.2200	4381	1664	23272	8839	23272	8839	22137	8408
12	0.2200	2006	810	10657	4300	10657	4300	10137	4090
13	0.2200	989	400	5254	2122	5254	2122	4998	2019
14	0.2200	4636	1964	24625	10434	24625	10434	23424	9925
Total		402014	99786	3394919	672192	2045586	521505	1945822	496071
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 2000 F-factor: 1.2297 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	0.0064	3619	256	600000	42420	0	0	0	0
2	0.0617	30725	4388	539462	77035	85235	12172	81078	11578
3	0.1672	108005	21417	736123	145973	699317	138675	665211	131911
4	0.2200	49197	11241	261305	59708	259999	59410	247318	56512
5	0.2200	100614	25345	534404	134616	534404	134616	508341	128051
6	0.2200	28380	7887	150738	41890	150738	41890	143387	39847
7	0.2200	13167	4090	69934	21721	69934	21721	66523	20662
8	0.2200	20063	6691	106562	35539	106562	35539	101365	33805
9	0.2200	14956	5448	79436	28938	79436	28938	75561	27527
10	0.2200	21719	8008	115357	42532	115357	42532	109731	40458
11	0.2200	9519	3615	50557	19202	50557	19202	48092	18265
12	0.2200	3182	1284	16899	6819	16899	6819	16075	6486
13	0.2200	1457	588	7739	3126	7739	3126	7361	2973
14	0.2200	718	304	3815	1616	3815	1616	3629	1538
Total		405319	100562	3272331	661136	2179991	546255	2073672	519614
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

(cont.)

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The SAS System                                    12:24 Tuesday, May 4, 1999
   Herring Icelandic Summer-spawning (Fishing Area Va)

                                   Single option prediction: Detailed tables
    (cont.)
```

Year: 2001 F-factor: 1.2297 Reference F: 0.2200 1 January Spawning time

Age	Absolute 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)
1	0.0064	3619	256	600000	42420	0	0	0	0
2	0.0617	30725	4388	539462	77035	85235	12172	81078	11578
3	0.1672	67334	13352	458926	91005	435979	86455	414716	82238
4	0.2200	106095	24243	563519	128764	560702	128120	533356	121872
5	0.2200	35724	8999	189747	47797	189747	47797	180492	45466
6	0.2200	73061	20304	388057	107841	388057	107841	369131	102582
7	0.2200	20608	6401	109458	33998	109458	33998	104120	32340
8	0.2200	9561	3189	50782	16936	50782	16936	48306	16110
9	0.2200	14569	5307	77380	28190	77380	28190	73606	26815
10	0.2200	10860	4004	57682	21267	57682	21267	54869	20230
11	0.2200	15771	5990	83766	31814	83766	31814	79681	30263
12	0.2200	6912	2789	36712	14813	36712	14813	34922	14091
13	0.2200	2310	933	12271	4956	12271	4956	11673	4715
14	0.2200	1058	448	5619	2381	5619	2381	5345	2265
Total		398207	100602	3173382	649218	2093391	536740	1991295	510563
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 2002 F-factor: 1.2297 Reference F: 0.2200 1 January Spawning time

Age	Absolute 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)
1	0.0064	3619	256	600000	42420	0	0	0	0
2	0.0617	30725	4388	539462	77035	85235	12172	81078	11578
3	0.1672	67334	13352	458926	91005	435979	86455	414716	82238
4	0.2200	66144	15114	351318	80276	349562	79875	332513	75979
5	0.2200	77041	19407	409199	103077	409199	103077	389242	98050
6	0.2200	25941	7209	137784	38290	137784	38290	131064	36423
7	0.2200	53053	16478	281787	87523	281787	87523	268044	83254
8	0.2200	14965	4991	79483	26508	79483	26508	75607	25215
9	0.2200	6943	2529	36876	13434	36876	13434	35077	12779
10	0.2200	10579	3900	56189	20717	56189	20717	53449	19707
11	0.2200	7886	2995	41886	15908	41886	15908	39843	15132
12	0.2200	11452	4621	60827	24544	60827	24544	57860	23347
13	0.2200	5019	2027	26658	10767	26658	10767	25358	10242
14	0.2200	1678	711	8911	3775	8911	3775	8476	3591
Total		382378	97978	3089305	635280	2010376	523045	1912328	497535
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

```
Notes: Run name              : SPRAGB01
       Date and time         : 04MAY99:12:42
       Computation of ref. F: Weighted mean, age 4 - 14
       Prediction basis      : F factors
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Table 7.5.2 (cont.)

The SAS System 12:24 Tuesday, May 4, 1999

Herring Icelandic Summer-spawning (Fishing Area Va)

Single option prediction: Summary table

Year	F Factor	Reference F	Catch in numbers	Catch in weight	1 January Stock size	1 January Stock biomass	1 January Sp.stock size	1 January Sp.stock biomass	Spawning time Sp.stock size	Spawning time Sp.stock biomass
1999	1.2297	0.2200	402014	99786	3394919	672192	2045586	521505	1945822	496071
2000	1.2297	0.2200	405319	100562	3272331	661136	2179991	546255	2073672	519614
2001	1.2297	0.2200	398207	100602	3173382	649218	2093391	536740	1991295	510563
2002	1.2297	0.2200	382378	97978	3089305	635280	2010376	523045	1912328	497535
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRAGB01
Date and time : 04MAY99:12:42
Computation of ref. F: Weighted mean, age 4 - 14
Prediction basis : F factor

Table 7.5.3 The SAS System 12:24 Tuesday, May 4, 1999 Herring Icelandic Summer-spawning (Fishing Area Va)

Prediction with management option table

Year: 1999					Year: 2000					Year: 2001	
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
1.2327	0.2205	672192	496071	100000	0.0000	0.0000	660915	519405	0	754997	610404
.	.	.	.	.	0.0500	0.0089	.	519405	4487	750266	605935
.	.	.	.	.	0.1000	0.0179	.	519405	8938	745573	601503
.	.	.	.	.	0.1500	0.0268	.	519405	13353	740917	597107
.	.	.	.	.	0.2000	0.0358	.	519405	17733	736299	592747
.	.	.	.	.	0.2500	0.0447	.	519405	22077	731719	588422
.	.	.	.	.	0.3000	0.0537	.	519405	26387	727175	584132
.	.	.	.	.	0.3500	0.0626	.	519405	30662	722668	579877
.	.	.	.	.	0.4000	0.0716	.	519405	34903	718197	575656
.	.	.	.	.	0.4500	0.0805	.	519405	39110	713762	571469
.	.	.	.	.	0.5000	0.0894	.	519405	43283	709363	567317
.	.	.	.	.	0.5500	0.0984	.	519405	47422	705000	563198
.	.	.	.	.	0.6000	0.1073	.	519405	51529	700671	559112
.	.	.	.	.	0.6500	0.1163	.	519405	55602	696378	555060
.	.	.	.	.	0.7000	0.1252	.	519405	59643	692119	551040
.	.	.	.	.	0.7500	0.1342	.	519405	63651	687894	547053
.	.	.	.	.	0.8000	0.1431	.	519405	67628	683703	543098
.	.	.	.	.	0.8500	0.1521	.	519405	71573	679546	539175
.	.	.	.	.	0.9000	0.1610	.	519405	75486	675422	535284
.	.	.	.	.	0.9500	0.1700	.	519405	79368	671331	531424
.	.	.	.	.	1.0000	0.1789	.	519405	83219	667273	527595
.	.	.	.	.	1.0500	0.1878	.	519405	87039	663248	523797
.	.	.	.	.	1.1000	0.1968	.	519405	90828	659255	520030
.	.	.	.	.	1.1500	0.2057	.	519405	94588	655294	516293
.	.	.	.	.	1.2000	0.2147	.	519405	98317	651364	512587
.	.	.	.	.	1.2500	0.2236	.	519405	102017	647466	508910
.	.	.	.	.	1.3000	0.2326	.	519405	105687	643600	505263
.	.	.	.	.	1.3500	0.2415	.	519405	109328	639764	501645
.	.	.	.	.	1.4000	0.2505	.	519405	112940	635959	498056
.	.	.	.	.	1.4500	0.2594	.	519405	116523	632185	494497
.	.	.	.	.	1.5000	0.2684	.	519405	120078	628440	490965
.	.	.	.	.	1.5500	0.2773	.	519405	123604	624726	487463
.	.	.	.	.	1.6000	0.2862	.	519405	127102	621041	483988
.	.	.	.	.	1.6500	0.2952	.	519405	130573	617386	480542
.	.	.	.	.	1.7000	0.3041	.	519405	134016	613759	477123
.	.	.	.	.	1.7500	0.3131	.	519405	137432	610162	473731
.	.	.	.	.	1.8000	0.3220	.	519405	140820	606594	470367
.	.	.	.	.	1.8500	0.3310	.	519405	144182	603054	467030
.	.	.	.	.	1.9000	0.3399	.	519405	147517	599542	463720
.	.	.	.	.	1.9500	0.3489	.	519405	150825	596058	460436
.	.	.	.	.	2.0000	0.3578	.	519405	154107	592602	457178
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Date and time : 04MAY99:13:15 Computation of ref. F: Weighted mean, age 4 - 14 Basis for 1999 : TAC constraints

Table 7.5.4

14:50 Sunday, May 2, 1999
Herring Icelandic Summer-spawning (Fishing Area 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	600.000	0.1000	0.0000	0.0000	0.5000	0.067	0.0330	0.071
2	.	0.1000	0.0610	0.0000	0.5000	0.140	0.2400	0.143
3	.	0.1000	0.8680	0.0000	0.5000	0.195	0.6730	0.198
4	.	0.1000	0.9970	0.0000	0.5000	0.234	0.8590	0.229
5	.	0.1000	1.0000	0.0000	0.5000	0.269	1.0000	0.252
6	.	0.1000	1.0000	0.0000	0.5000	0.299	1.0000	0.278
7	.	0.1000	1.0000	0.0000	0.5000	0.325	1.0000	0.311
8	.	0.1000	1.0000	0.0000	0.5000	0.345	1.0000	0.334
9	.	0.1000	1.0000	0.0000	0.5000	0.365	1.0000	0.364
10	.	0.1000	1.0000	0.0000	0.5000	0.376	1.0000	0.369
11	.	0.1000	1.0000	0.0000	0.5000	0.393	1.0000	0.380
12	.	0.1000	1.0000	0.0000	0.5000	0.405	1.0000	0.404
13	.	0.1000	1.0000	0.0000	0.5000	0.407	1.0000	0.404
14	.	0.1000	1.0000	0.0000	0.5000	0.425	1.0000	0.424
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : YLDAGB05
Date and time: 02MAY99:15:05

Table 7.9.1

Run title : Icelandic summer spawning herring in 5a. Plúsgrúppa 10, 3 ár í shrinkage, tunfil,

At 22/03/1999 9:05

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

,	RECRUITS, Age 1	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 4- 9,
1979,	248284,	255911,	187768,	45072,	0.2400,	0.2473,
1980,	260796,	248991,	194695,	53268,	0.2736,	0.3001,
1981,	905114,	273146,	165018,	39544,	0.2396,	0.2741,
1982,	235304,	304360,	165702,	56528,	0.3411,	0.4784,
1983,	222893,	294563,	196647,	58867,	0.2994,	0.2925,
1984,	495312,	277171,	210125,	50304,	0.2394,	0.1829,
1985,	1239283,	383210,	236201,	49368,	0.2090,	0.1805,
1986,	630318,	460474,	249274,	65500,	0.2628,	0.3737,
1987,	365383,	541666,	379510,	75439,	0.1988,	0.4055,
1988,	536592,	563419,	439640,	92828,	0.2111,	0.5381,
1989,	417779,	519454,	408557,	101000,	0 2472,	0.3409,
1990,	975405,	518137,	363172,	105097,	0.2894,	0.4434,
1991,	1224625,	563307,	319675,	109489,	0.3425,	0.3376,
1992,	675154,	598205,	375224,	108504,	0.2892,	0.3334,
1993,	808099,	662814,	492504,	102741,	0.2086,	0.2399,
1994,	292745,	628436,	489400,	134003,	0.2738,	0.3111,
1995,	299816,	535060,	460628,	125851,	0.2732,	0.2889,
1996,	1144875,	508128,	365054,	95882,	0.2627,	0.2814,
1997,	509088,	520297,	347613,	64395,	0.1852,	0.2161,
1998,	1097433,	498473,	409105,	86999,	0.2127,	0.2440,
Arith. Mean ,	629215,	457761,	322776,	81034,	0.2550,	0.3155,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		

1

Figure 7.4.1 Icelandic summer spawners. Sum of squares used for fitting VPA to acoustic data, as a function of terminal fishing mortality.

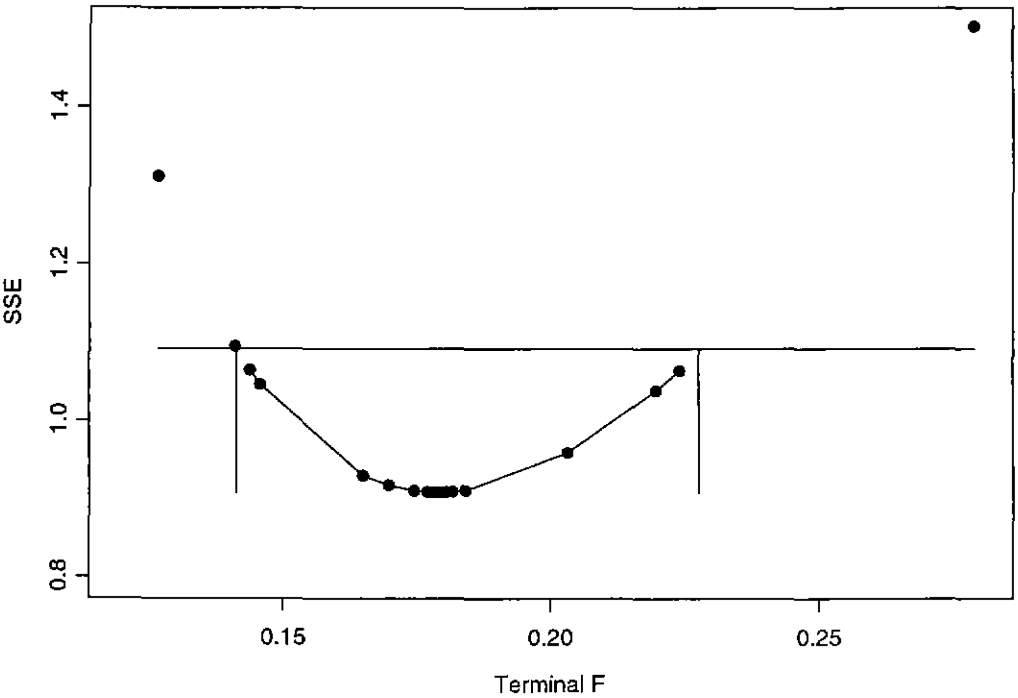


Figure 7.4.2 Fish stock summary. Herring Icelandic Summer-spawning (Fishing Area Va) 3-5-1999

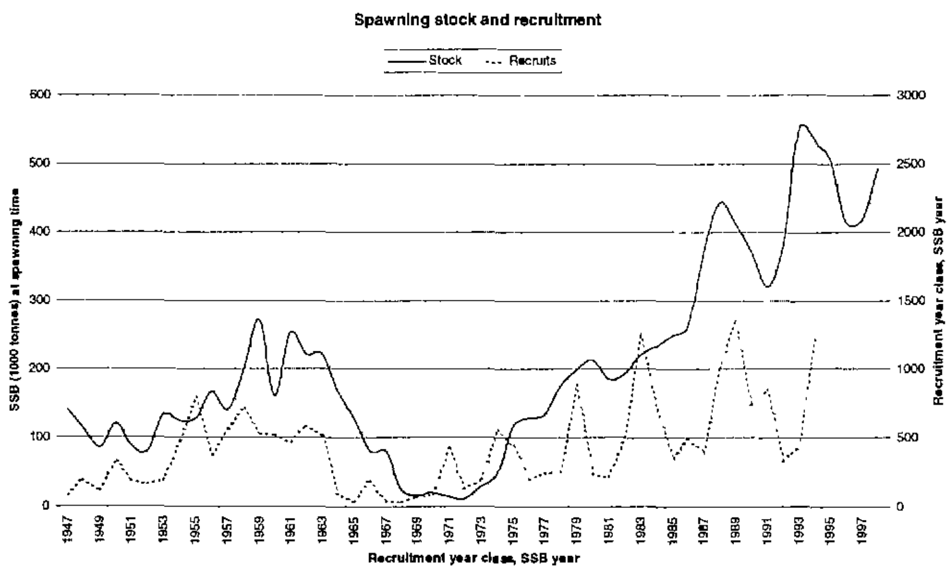


Figure 7.4.2 (cont.)

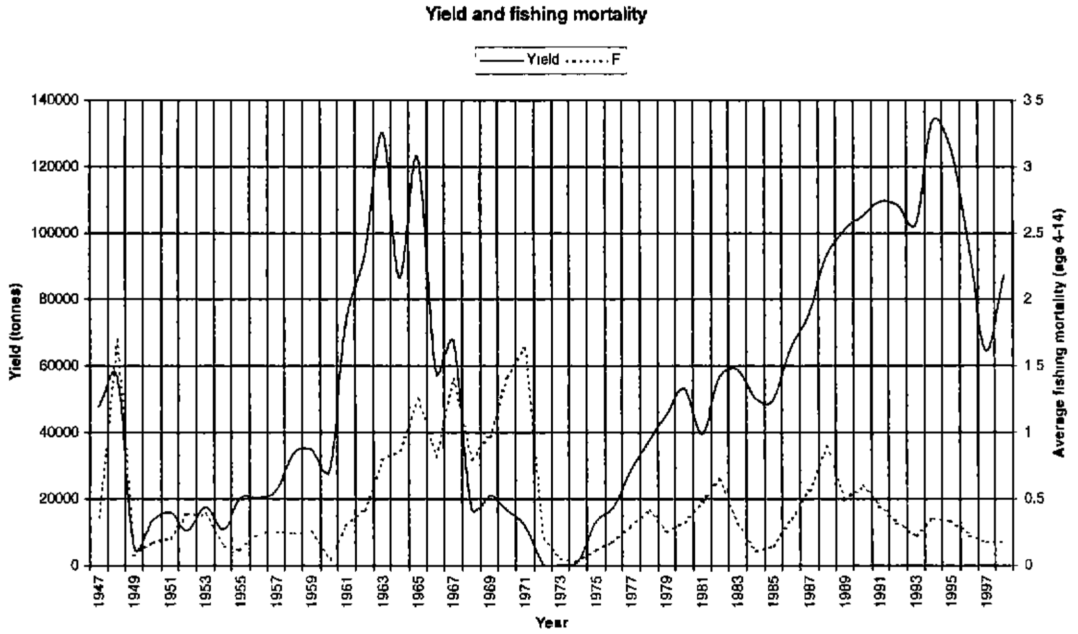


Figure 7.4.3 Icelandic summer spawners. Trend in acoustics and VPA stock numbers.

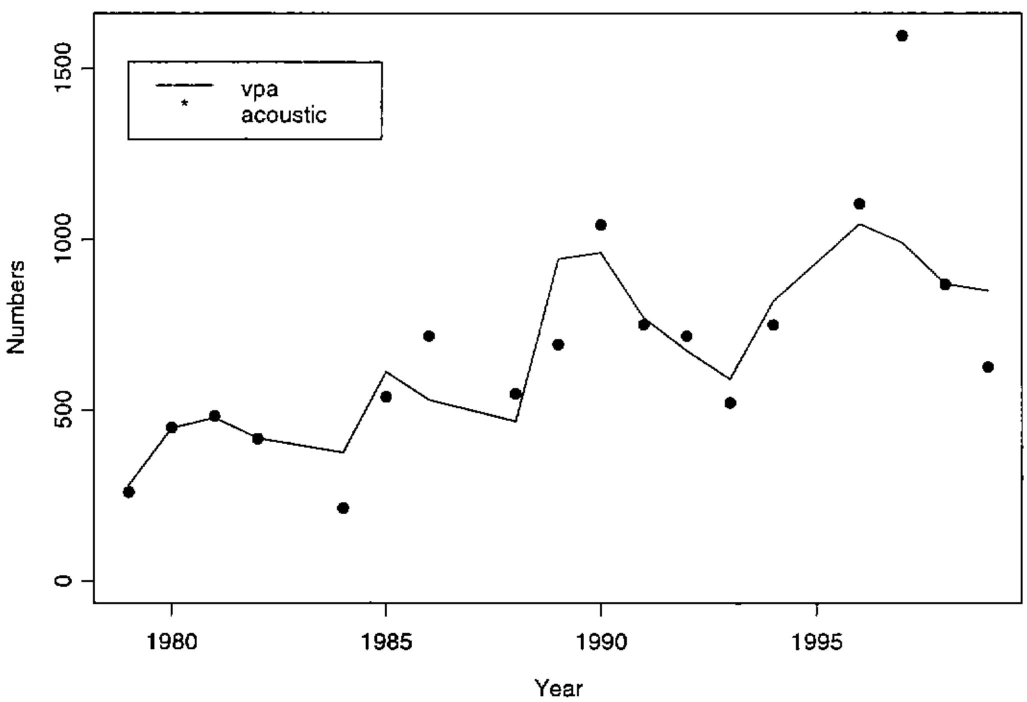


Figure 7.4.4 Icelandic summer spawners. Acoustic estimates vs VPA stock numbers (at the 1st of January).

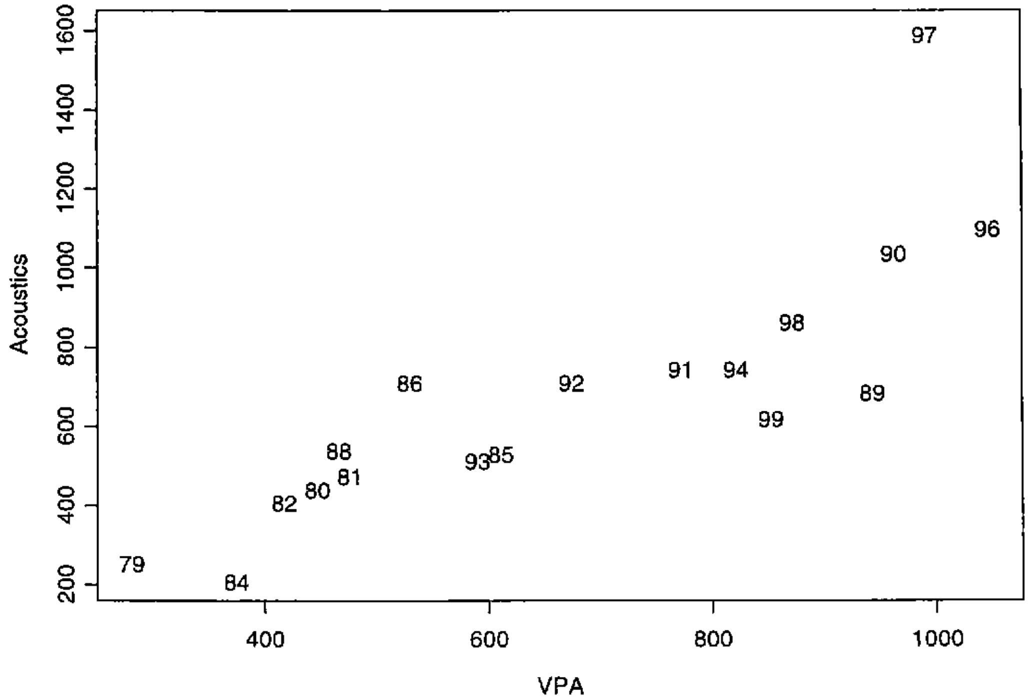


Figure 7.5.1 Fish stock summary. Herring Icelandic summer spawners (Fishing area Va). 2-5-1999

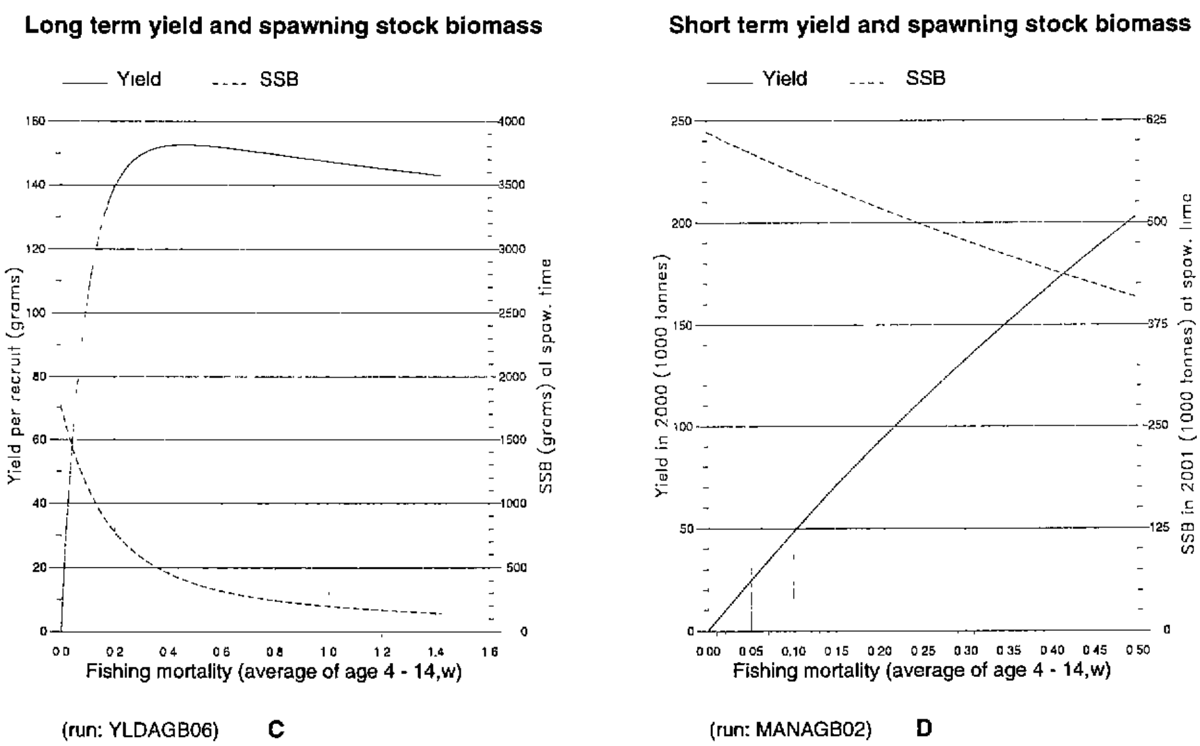


Figure 7.7.1 Herring Icelandic summer spawners (Fishing Area Va). 4-5-1999

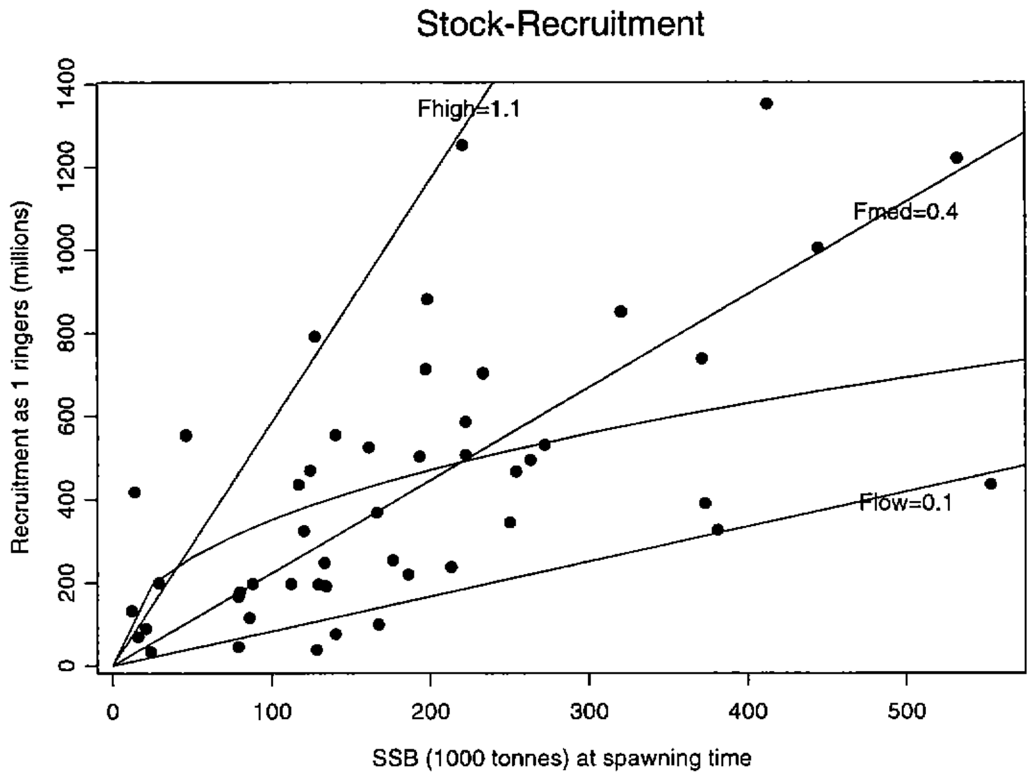
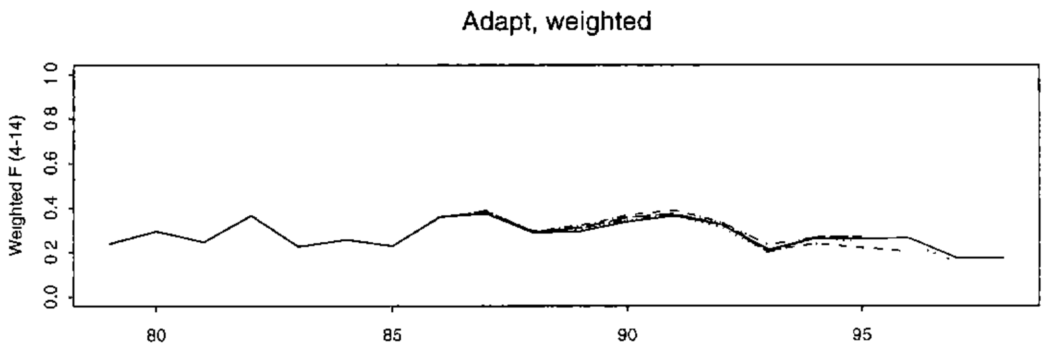
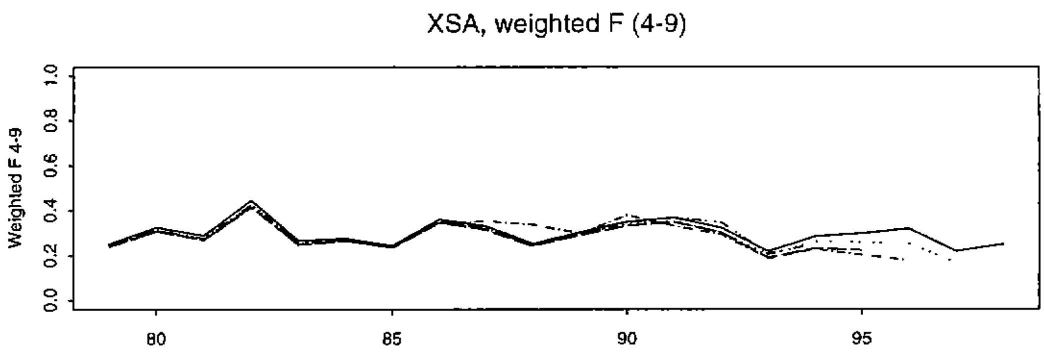


Figure 7.9.1 Icelandic summer spawners. Results of retrospective analysis.





8 OTHER

8.1 Spatial and Temporal Distribution of the Pelagic Fisheries in the Northeast Atlantic

The Working Group was asked to "update the information on the spatial and temporal distribution of the stock and fisheries on blue whiting" and to "describe the timing of pelagic fisheries in ICES areas I; IIa; IVa,b; Va; Vb1,2; VIa,b; VIIa,b, the gear used in those fisheries and catch per ICES statistical rectangle per month in relevant areas". These two questions are interrelated and were therefore grouped under one heading in the present section. For the pelagic species dealt with, a short description will be given of the fishery in 1998 accompanied by monthly, quarterly or yearly maps of the fishery by ICES rectangles.

8.1.1 Spatial and temporal distribution of the fishery for Norwegian spring-spawning herring in 1998

The catch per ICES statistical rectangle per quarter and for the whole year is shown in Figs 8.1.1.1-8.1.1.5. Data from France, Ireland and Netherlands were not available on statistical rectangles. A description of the herring fisheries in 1998 by country is given below. A general overview of the timing of the fisheries for herring in 1998 is given in Table 8.1.1.1. Figure 3.1.2.2.1 shows the main migration routes in 1998, together with dates (months) which are placed in the general area where the fisheries took place at that time.

The spawning stock this year wintered in the Vestfjorden area as it has done since 1987/1988. However, this year it seems to have been a two step immigration into Vestfjorden. The herring stopped up in the outer part of the fjord, and did not start migrating into the inner part of Vestfjorden and to Ofotfjorden before 1. November, almost one month later that usual. However, by the end of November large amounts of herring were located in the traditional wintering areas. (WD by Foote and Røttingen). In January the herring emigrated from the Vestfjorden area. The spawning in 1998 occurred a wide area along the Norwegian coast, from Lindesnes in the south (approx. 58°N) to north of Vesterålen (approx. 70°N). By and large no major changes have been observed in the spatial and temporal distribution of Norwegian spring-spawning herring in the wintering season 1998/1999 and spawning season in 1999 compared to the situation in the previous year.

Table 8.1.1.2 gives a overview of the gear (purse-seine and pelagic trawl) used in the national fisheries for Norwegian spring spawning herring. At present we have only limited information on the catch de| 'ls of the pelagic trawls used in the herring fishery. The purse-seines are operated from the surface down to approximately 200 m depth.

Denmark: The Danish fishery was carried out in spring (30,000 t), summer (10,000 t), and autumn (3,500 t), mainly in the international areas in the Norwegian Sea.

The Faroes: The Faroese fishery started in the Faroese EEZ in April. In May the fishery also took place in international waters and in the Jan Mayen EEZ. The summer fishery terminated in late June. The autumn fishery took place in the Norwegian EEZ, west of Lofoten, during September.

France: No information was received on the French fishery.

Germany: No information was received on the German fishery.

Iceland: The fishery started in late April and followed the part of the stock that migrated south-west and west into the Faroese EEZ. By mid-May no more catches could be made in that area du to the scattered condition of the herring. The Icelandic vessels then shifted the fishing area to a more northerly part of the stock, which was then migrating in a north-westerly direction towards the Jan Mayen area. By the end of May approximately 75,000 tonnes had been fished. From the later part of May to the later part of June the fishery took place in the border areas between the international, Jan Mayen and Icelandic waters. The catches taken within the Icelandic EEZ, to the east and north-east of Langanes, during the latter half of June, most likely derive from herring migrations northward from Faroese waters. In autumn, approximately 7,000 t was caught in Norwegian EEZ on herring returning to the wintering areas.

Ireland: The Irish fishery decreased in 1998 compared to earlier years, and only a few vessels participated in this fishery. A catch of 2,313 t was taken in February. Only 124 t were taken in the Norwegian Sea in spring, bringing the total to 2,437 t.

Netherlands: The Dutch fishery took part 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 occurs in easily available concentrations in the period September until March. The fishery is carried out by many size categories of vessels. In 1998 approximately 169,000 t were caught in the wintering area in Northern Norway, and 126,000 t in the spawning season. Less than 10,000 t were caught in the spring/summer fishery in the Norwegian Sea, approximately 441,000 t in autumn on the herring migrating to, and wintering in, the wintering areas in Northern Norway.

Russia: In 1998 the Russian fishery in spring started in the beginning of February within the shelf area of the Norwegian EEZ, in the area near Sklinna and Langrunnen Bank (approximately 65°N-62°N), and terminated on the Tren Bank (approximately 64°N) in late March. In February-March the catch was 82,497 t. In May-June a fishery was carried out in the Faroese EEZ where 5,000 t were caught. In the international area in the Norwegian Sea the Russian catches in July-September were 4,500t. At the beginning of September the fishery started within the Norwegian EEZ, in the area near Andøy and Malangen Banks (approximately 69°N-71°N). In September the catch was 31,552 t. All of the Russian catch was used for human consumption.

Sweden: No information was received on the Swedish fishery.

UK (Scotland): The decreasing trend in the UK fishery continued in 1998, the catch totalled 15,978 t.

8.1.2 Spatial and temporal distribution of the fishery for Icelandic summer-spawning herring in 1998/1999

The fishery of Icelandic summer-spawning herring for the 1998/99 season (Fig. 8.1.2.1) started in September 1998 off the southeast coast of Iceland. The catch in October-January was almost equally distributed over these four months. The purse-seine fishery took place off the east coast of Iceland in September and October, but west of Iceland in October-January. The pelagic trawl fishery started in November and took place both east and west of Iceland. In the 1997/98 season 59% of the catch was taken by purse-seiners, and 78% were taken in 1998/99. The remaining 41% and 22% respectively, were taken by pelagic trawl. Until 1990, the herring fishery took place during the last three months of the calendar year, but after that the autumn fishery has continued in January and early February of the following year.

8.1.3 Spatial, temporal and zonal distribution of the blue whiting fisheries in 1998

A description of the monthly distribution of the fisheries for blue whiting by ICES rectangles is given here (Figs 8.1.3.1-12). Figure 8.1.3.13 shows the overall catch distribution in 1998. Data from Portugal were not available on statistical rectangles. The directed fishery for blue whiting is pursued with pelagic trawls, operating at depths between 200 and 500m. Bottom trawl is used in the mixed industrial fishery.

January (Fig. 8.1.3.1): The main wintering_concentrations of blue whiting were distributed in the southeastern part of the Faroese EEZ.

February (Fig. 8.1.3.2): The fishery on the pre-spawning concentrations took place in the Porcupine bank area and in international waters west of the Irish EEZ.

March (Fig. 8.1.3.3): The spawning concentrations of blue whiting were distributed inside the Irish EEZ and in international waters along the Irish EEZ.

April (Fig. 8.1.3.4): In the first half of the month, the fishery was based on post-spawning blue whiting which was concentrated in the Irish and UK EEZs as well as international waters around the Rockall Bank. In the second part of April, the blue whiting migrated to the southern part of the Faroese EEZ.

May (Fig. 8.1.3.5): The main post-spawning concentrations of the fish were observed in the UK and Faroes EEZs. In late April, blue whiting were found in Icelandic waters and a fishery in this continued during May. In late May, blue whiting migrated into the Norwegian EEZ.

June (Fig. 8.1.3.6): The main fishery was in the Faroes EEZ.

July (Fig. 8.1.3.7): A fishery on feeding blue whiting took place in several areas:

a) The eastern part of the Icelandic EEZ.

b) The northern part of the Faroese EEZ.

c) In a mixed industrial fishery along the Norwegian coast, operated by vessels using bottom trawls.

August (Fig. 8.1.3.8): The main catches of blue whiting were taken in the eastern part of the Icelandic EEZ, in international waters and also in mixed industrial fisheries in the northern part of the North Sea.

September (Fig. 8.1.3.9): Feeding concentrations of blue whiting were observed in the eastern and southern parts of the Icelandic EEZ, in international waters (up to 72° 30' N) and in a mixed industrial fishery in the Norwegian and EU EEZs.

October (Fig. 8.1.3.10): The main catches were taken from the Icelandic, Faroese and Norwegian EEZs.

November (Fig. 8.1.3.11): The fishery was based on wintering concentrations of blue whiting, which were distributed in the Icelandic, Faroese and Norwegian EEZs. Dense concentrations were also located in the Jan-Mayen EEZ.

December (Fig. 8.1.3.12): The main fishing grounds were located in the Faroes EEZ.

The fishery in the southernmost distribution area (Spain and Portugal) is a coastal fishery where blue whiting are fished throughout the year by vessels that operate at short distance from the ports were they are located. This fishery has two main components:

a) Spanish bottom pair trawlers targeted for blue whiting and a fishery which is conducted in the area off Cape Finisterre (NW Spain).

b) Spanish and Portuguese bottom trawlers, fishing blue whiting as a by-catch along the Atlantic coast of the Iberian Peninsula.

One acoustic survey of the spawning area and several surveys of the Norwegian Sea were carried out in 1988 and an acoustic survey of the spawning grounds was carried out in 1999. These observations of blue whiting as well as the fishery during 1998/99 indicate that blue whiting were distributed over a wide area, reaching from west of the Rockall Bank eastward to the spawning grounds and from there north up to 74°N in the Norwegian Sea.

8.1.4 Spatial and temporal distribution of the fishery for capelin in the Iceland-East Greenland-Jan Mayen area in 1998/1999

The catches of capelin by quarter in the Iceland-East Greenland area is shown in Figs 8.1.4.1-4. The total catch in 1998 is shown in Fig. 8.1.4.5. The coastlines in the geographic mapping system used were approximate causing some of the catches close to the shore to appear on land in these maps.

The season opened on 20 June 1998 and the fishery began in deep waters near the shelf edge off the eastern north coast and northeast of Iceland. The fishing grounds gradually shifted to the northwest and for most of July the main fishing area was located between approximately 68°N and 69°15'N, 18°-22°W. Most of the time, catch rates were comparatively low during the summer months. Indeed, by early August the capelin had become so scattered that the fishery was abandoned. Almost all of the catch was taken in June and July.

Fishing was not resumed until October. Again, catch rates were low in the October-December period, except off the eastern north coast of Iceland for a short time around mid-November and in the third week of December.

Due to stormy weather and scattered condition of capelin east of Iceland, catch rates were low in January and the first week of February 1999. However, in the second week of February, large schools of adult capelin appeared in the shallow waters off the eastern south coast. The capelin remained stationary in this general area (east of approximately 18°W) during the second and third weeks of February and were fished intensively.

In the last week of February the capelin resumed their migration west along the south coast of Iceland. However, their progress was slow and few schools managed to round the Reykjanes peninsula (22°W). The capelin arriving later made an even slower progress westward and in 1999 practically no capelin spawned on the traditional grounds in Faxafloi and Breidafjordur on the west coast. This anomalous behaviour was apparently caused by irregularities in the flow of ocean currents south of Iceland and the condition of the capelin. The main features were a generally strong easterly flow of

Atlantic water of unusually high temperature that reached almost to the coast and a very low weight at age of the capelin. These small capelin seemed to find it difficult to move against the current, tended to stay in the colder waters very close inshore for long periods of time and matured quickly whenever they ventured out into the deeper and warmer waters.

For the fishery, the practical result of the situation just described was that after about 20 February the capelin were only sporadically available to purse-seining and catch rates became extremely variable. Furthermore, as stated above, maturation was accelerated by the high temperatures. Therefore, most of the capelin had spawned by mid-March and the winter fishery came to a close earlier than usual.

The total catch during the 1999 winter season amounted to about 660,000 t, of which about 50,000 t were taken in January and the remainder during a 6 week period in February and March.

8.1.5 Spatial and temporal distribution of the fishery for the Barents Sea capelin

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 autumn 1998 the fishery was again closed. The fishery was reopened in winter 1999 and Norwegian and Russian vessels participated. The gear used was purse-seine and pelagic trawl, with the majority of the catch taken by purse-seines. Thus the capelin fishery in the southeastern Barents Sea is operating during winter (march) close to the northern Norwegian coast.

8.2 Salmon Post-Smolts By-Catch in Pelagic Fisheries

NASCO requested the Working Group to "provide reviews of what is known on salmon by-catch in the fisheries dealt with".

Currently the Working Group has no information on possible by-catch of salmon post-smolts in the pelagic fisheries for the species covered, i.e. Norwegian spring-spawning herring, Icelandic summer-spawning herring, blue whiting, capelin in the Iceland-East Greenland-Jan Mayen area and Barents Sea capelin. Section 8.1 in the present report describes the temporal and spatial distribution of the various pelagic fisheries in 1998, in addition to a description of the gear used. It was attempted to give catch depths of the various fisheries in section 8.1, but the information is incomplete so far.

The NASCO request has, however, made the parties aware of the possibility of salmon by-catch in the pelagic fisheries, and it was felt that this would generate more information on by-catch in the future. At present the Working Group was unable to provide estimates of the by-catch of post-smolts in pelagic fisheries.

8.3 Capelin Symposium

The Co-convenors of this symposium, H. Vilhjalmsson and J. Carscadden, have completed a list of scientists to compose a Scientific steering committee. All potential candidates have not confirmed their acceptance, but the Committee is expected to be comprised of scientists from all areas where capelin occur as well as a participant from the NWWG.

The names of all Committee members plus the exact dates and location of the meeting should be available to the ICES Secretariat in time for the June Consultative Committee meeting. A preliminary description of the aims and objectives of the Symposium will be available by summer 1999 on the ICES website and a flyer will be available by winter/spring 2000.

Table 8.1.1.1 Timing of fisheries for Norwegian spring-spawning herring in ICES areas 1998.

ICES Area	Timing of fisheries for Norwegian spring-spawning herring
I	No fishery
IIa	*January*: Large fishery in fjord areas in Northern Norway. *February-March*: Fishery on spawning areas on the coastal banks off Western Norway. *April*: Minor international fishery in the Norwegian Sea. *May* : Large international fishery in the Norwegian Sea. *June*: International fishery in the Norwegian Sea. *July*: Minor international fishery in the Norwegian Sea. *August -September*: International fishery off Northern Norway. *September-December*: Large fishery in fjord areas in Northern Norway.
IVa	*February-March*: Fishery on the spawning areas in coastal waters off Western Norway. Some catches may be taken in northern areas in spring.
IVb	No fishery.
Va	*June*: Fishery mainly by Icelandic and Faroese vessels.
Vb1	*May*: International fishery.
Vb2	No fishery.
VIa-b	No fishery.
VIIa-b	No fishery.
IIIa	No fishery.
VIIc	No fishery.
VIIg-k	No fishery.
VIII	No fishery.
IX	No fishery.
XIVa	*June*: One catch by an Icelandic vessel.

Table 8.1.1.2 Gear used in the fisheries for Norwegian spring-spawning herring.

Nation	Gear used	Depths of fishing
Denmark	Mainly purse seine	Surface down to approximately 200m
Faroes	Purse seine	Surface down to approximately 200m
France	No information	
Germany	Pelagic trawl	?
Iceland	Purse seine	Surface down to approximately 200m
Ireland	Pelagic trawl	?
Netherlands	Pelagic trawl	?
Norway	Mainly purse seine	Surface down to approximately 200m
Russia	Pelagic trawl	Between 150-300 m depth
Sweden	Pelagic trawl and purse seine	?
UK (Scotland)	Pelagic trawl and purse seine	?

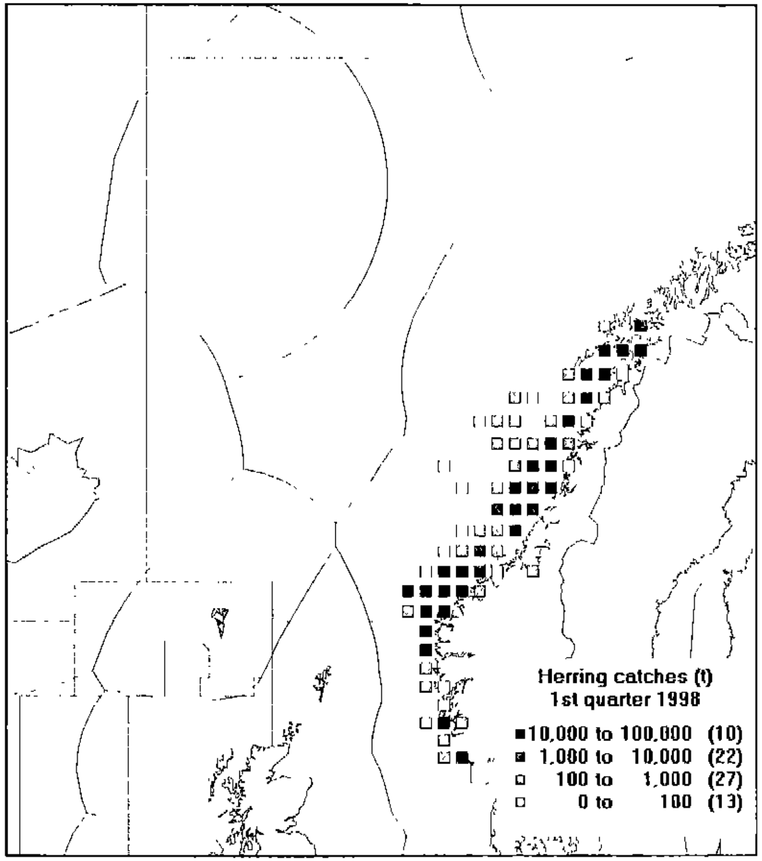


Fig 8.1.1.1. Catches of Norwegian spring-spawning herring 1'st quarter in 1998.

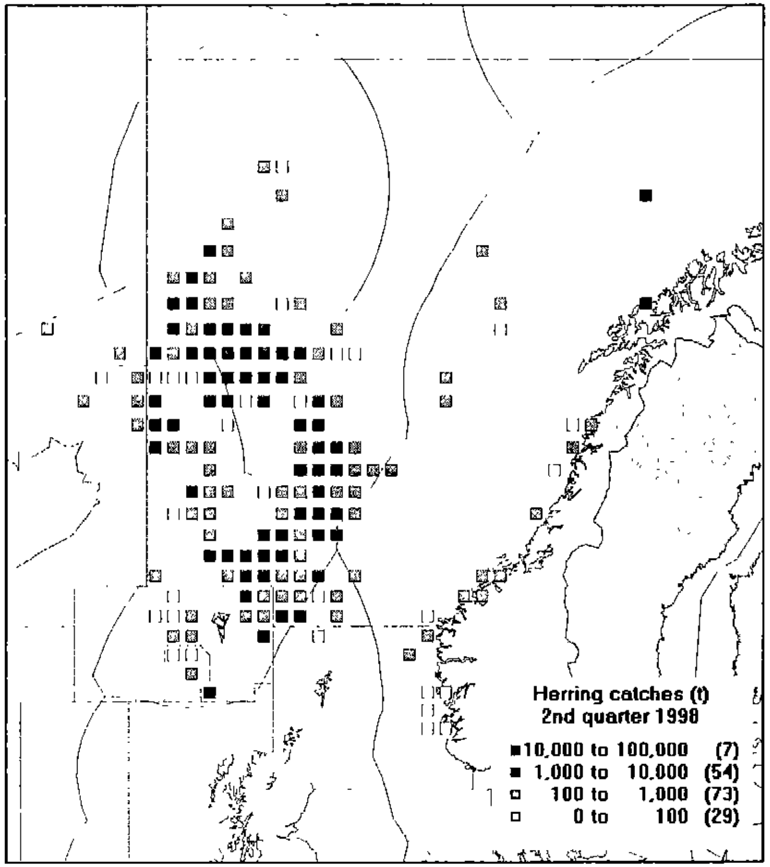


Fig 8.1.1.1.2. Catches of Norwegian spring-spawning herring 2'nd quarter in 1998.

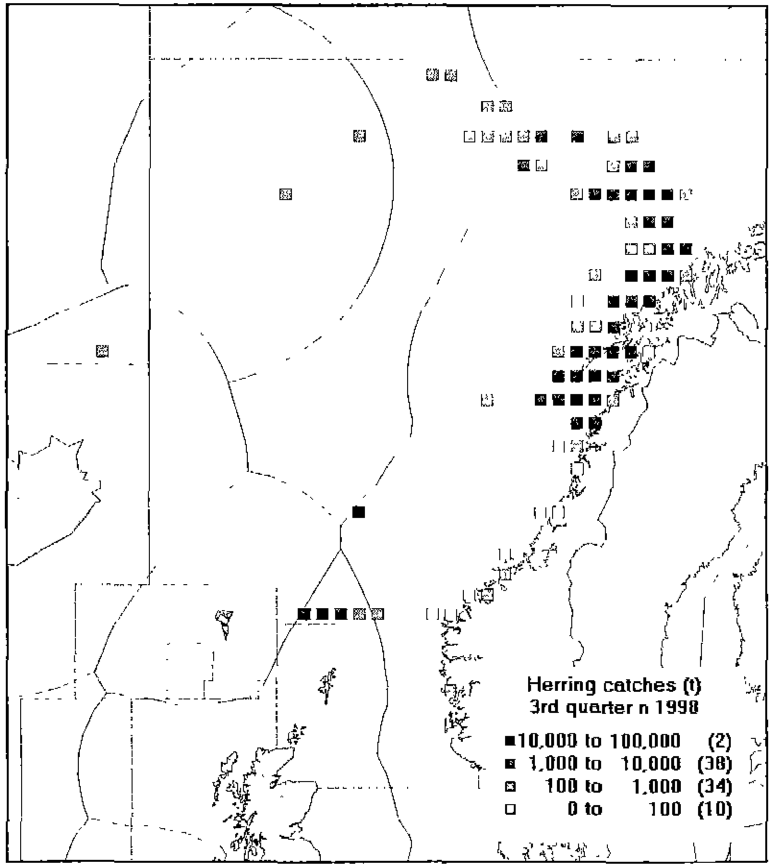


Fig 8.1.1.3. Catches of Norwegian spring-spawning herring 3'rd quarter in 1998.

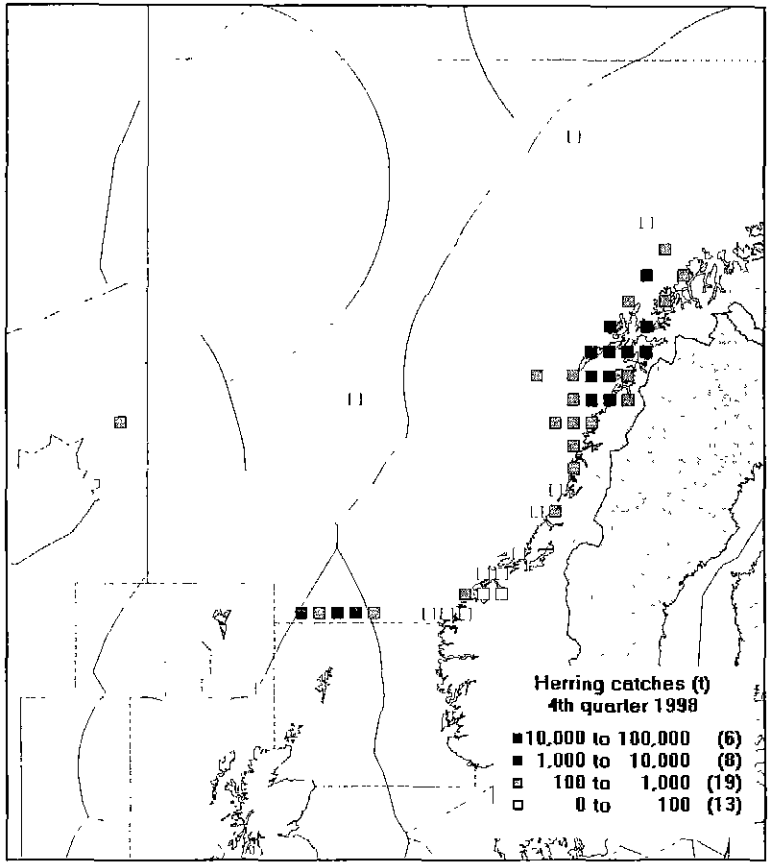


Fig 8.1.1.4. Catches of Norwegian spring-spawning herring 4'th quarter in 1998.

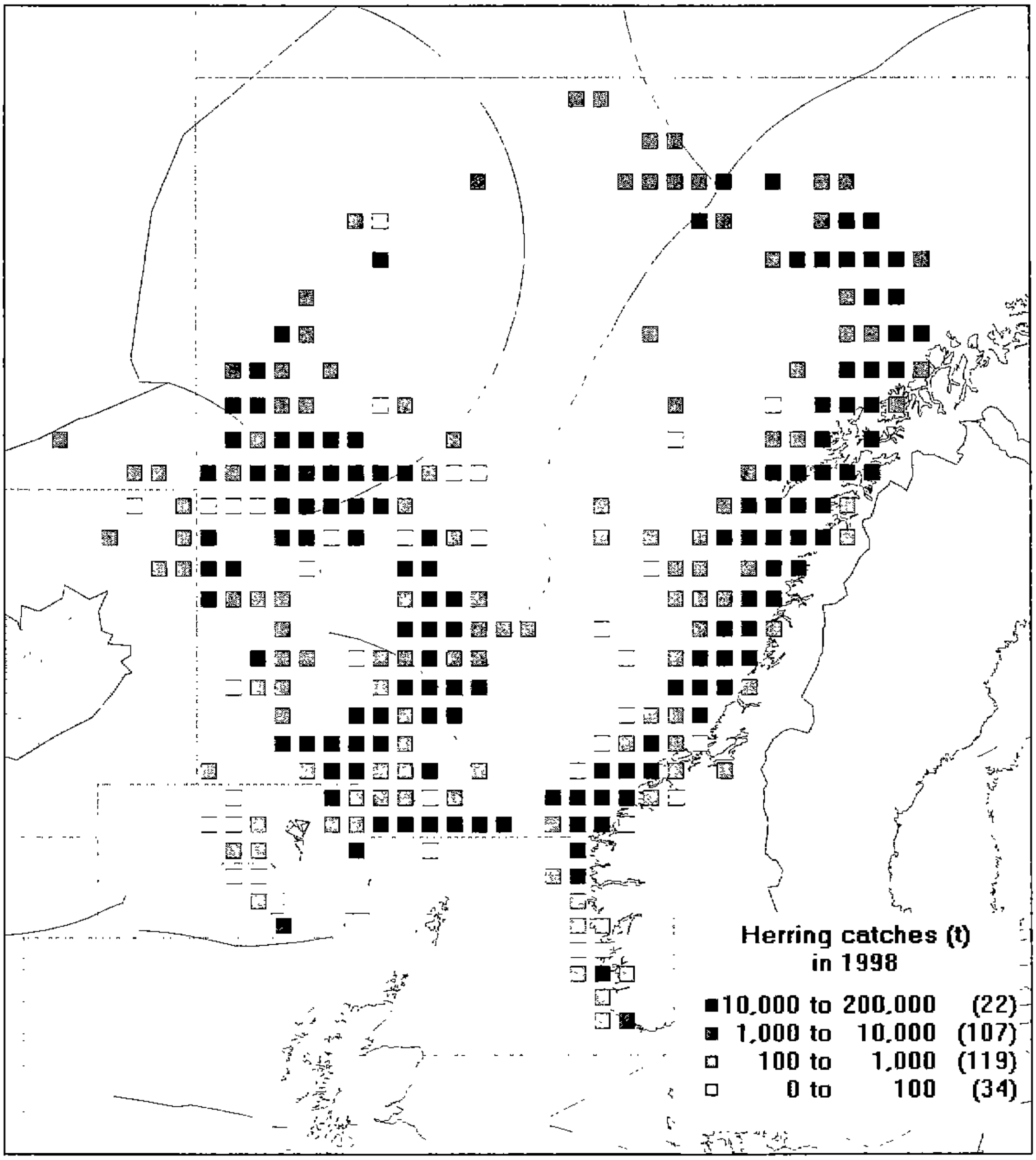


Fig 8.1.1.5. Catches of Norwegian spring-spawning herring in 1998 by ICES rectangles.

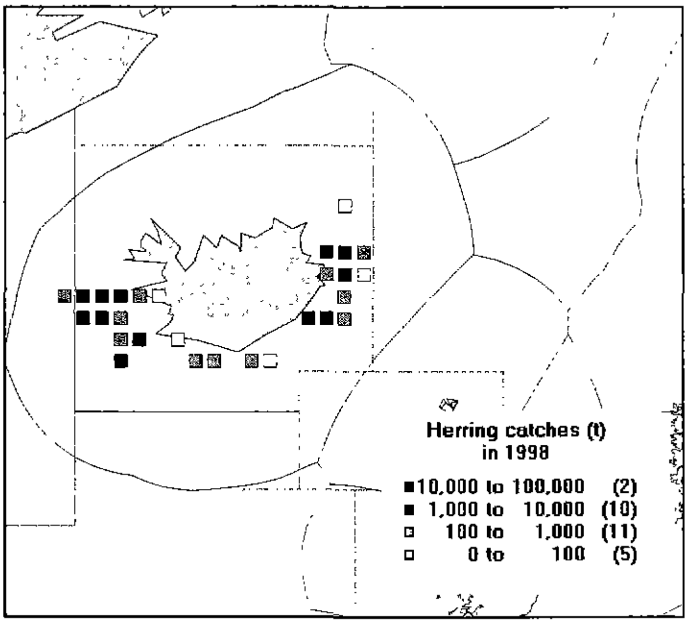


Fig. 8.1.2.1. Catches (t) of Icelandic summer-spawning herring during September-December 1998 and January 1999 by ICES rectangles.

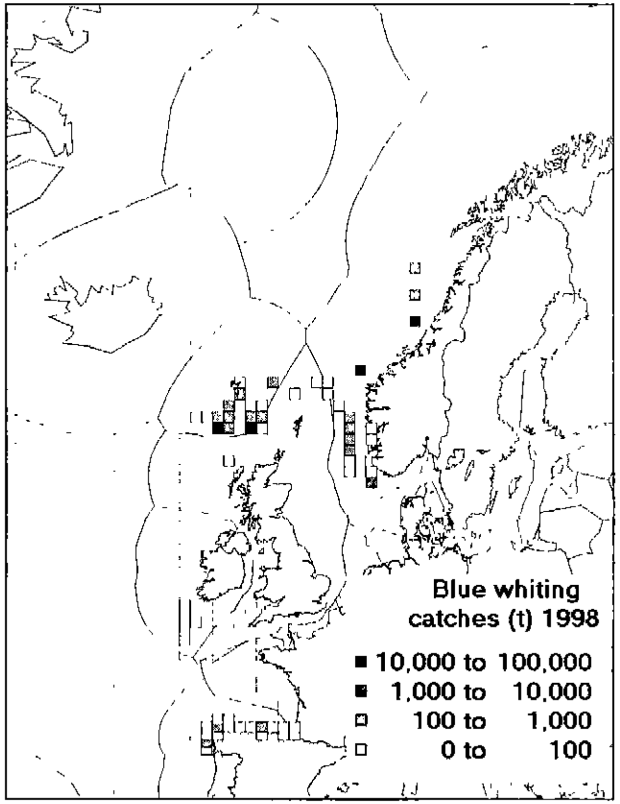


Fig. 8.1.3.1. Blue whiting catches (t) in January 1998.

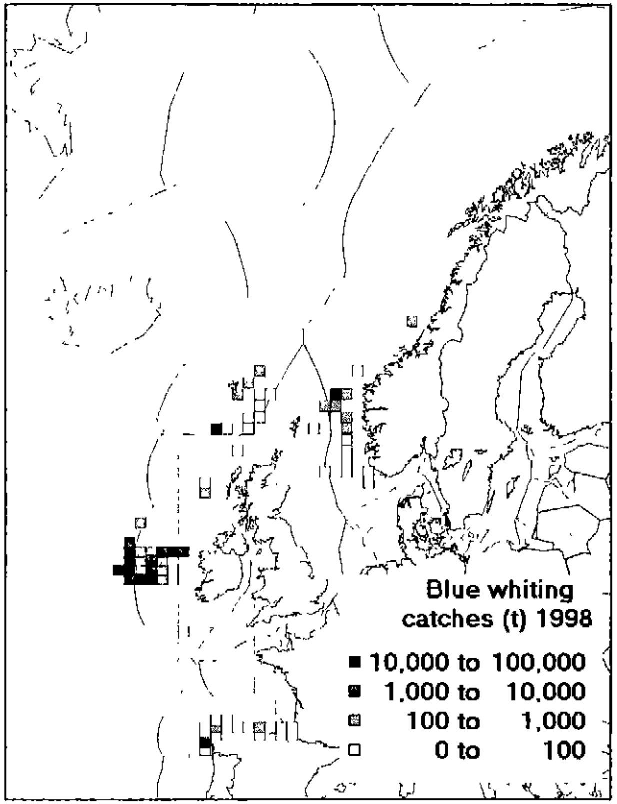


Fig. 8.1.3.2. Blue whiting catches (t) in February 1998.

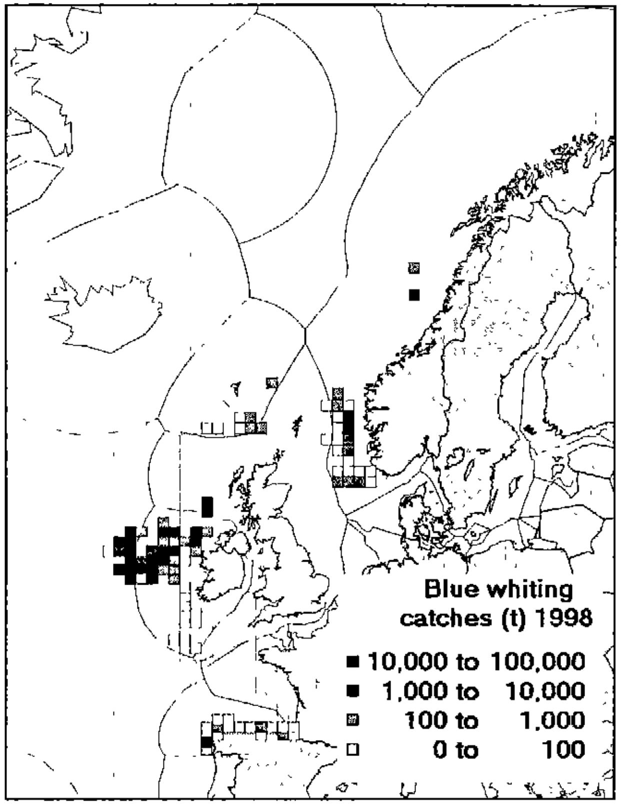


Fig. 8.1.3.3. Blue whiting catches (t) in March 1998.

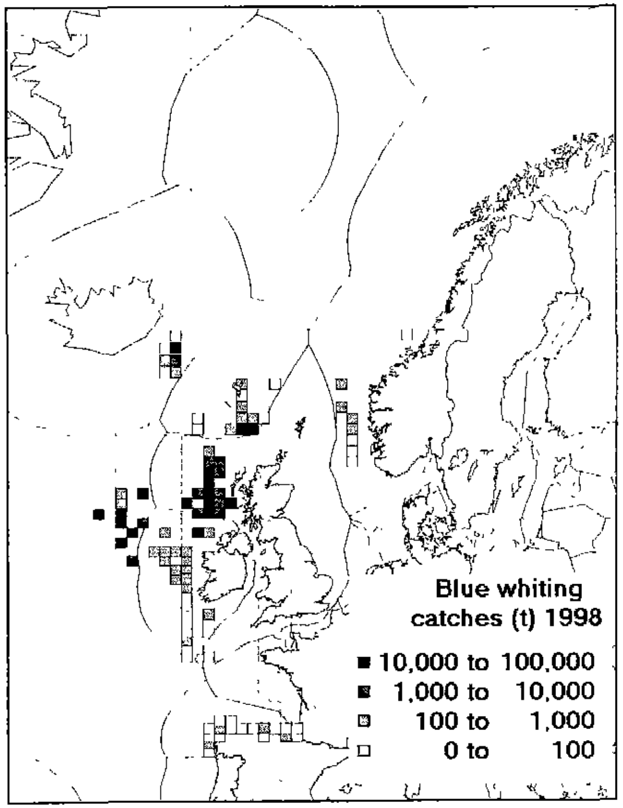


Fig. 8.1.3.4. Blue whiting catches (t) in April 1998.

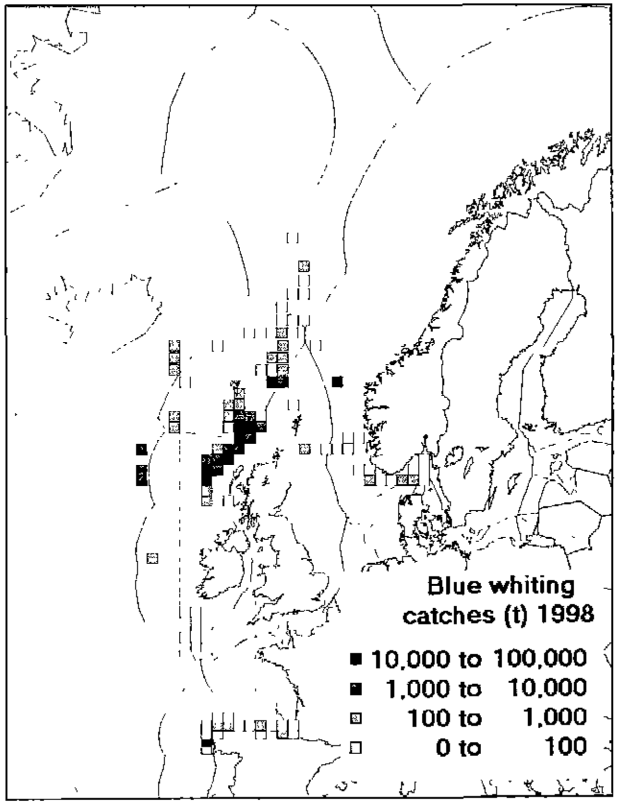


Fig. 8.1.3.5. Blue whiting catches (t) in May 1998.

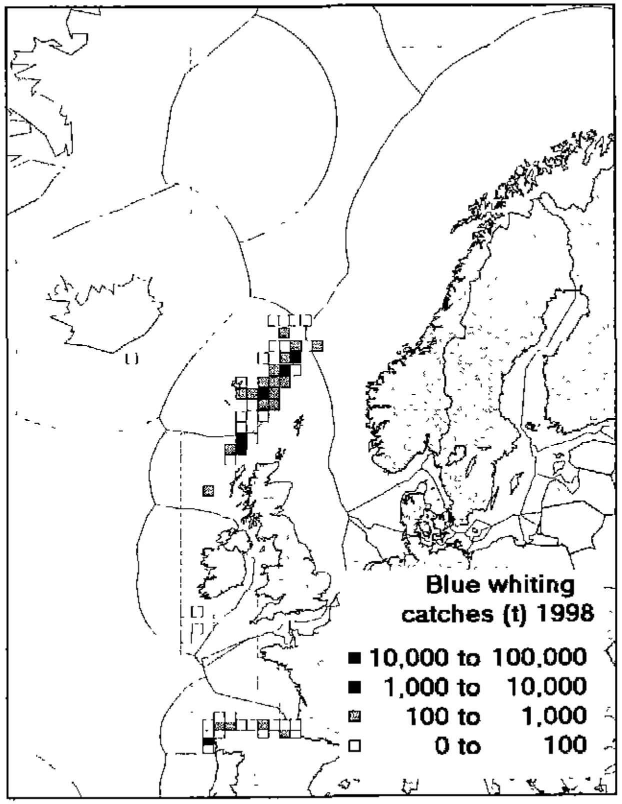


Fig. 8.1.3.6. Blue whiting catches (t) in June 1998.

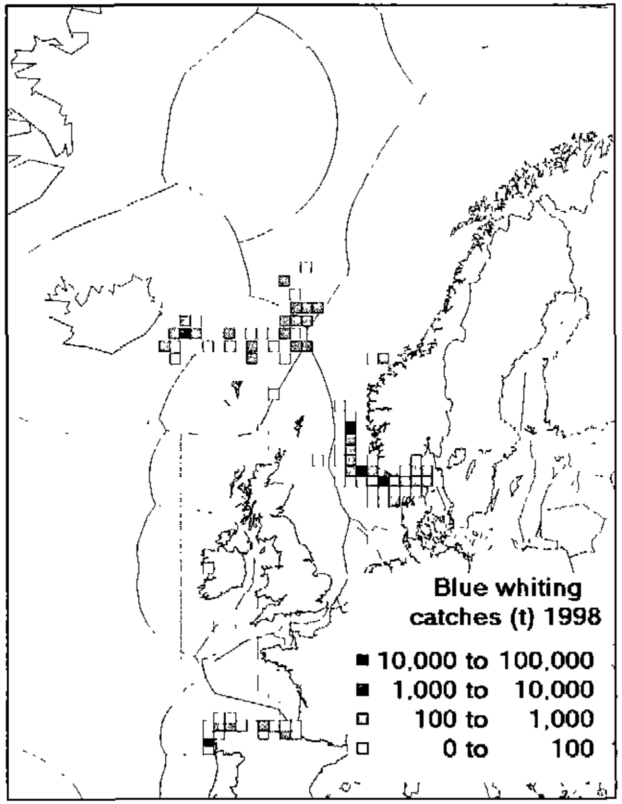


Fig. 8.1.3.7. Blue whiting catches (t) in July 1998.

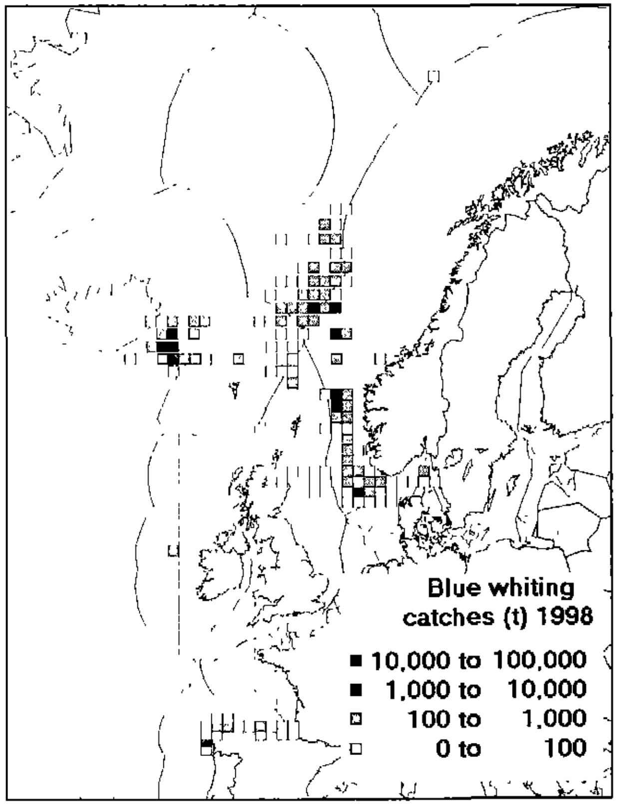


Fig. 8.1.3.8. Blue whiting catches (t) in August 1998.

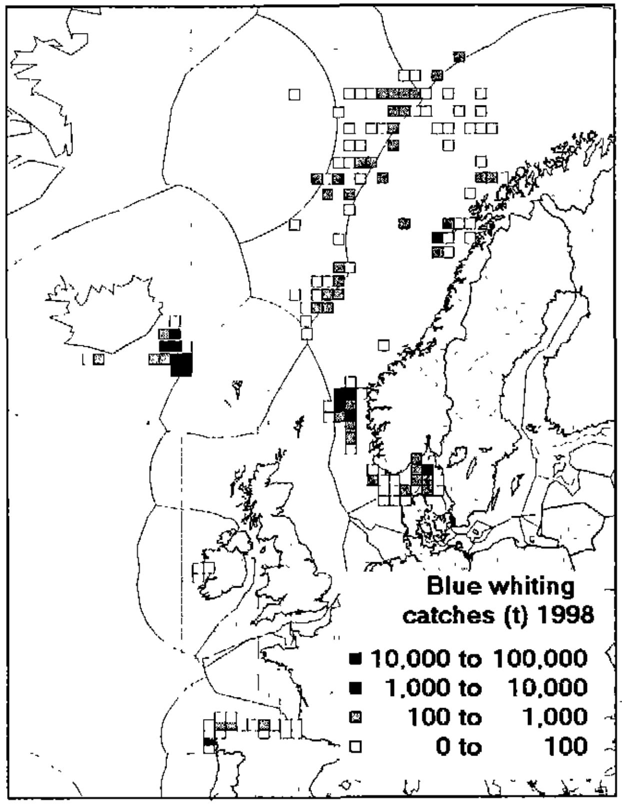


Fig. 8.1.3.9. Blue whiting catches (t) in September 1998.

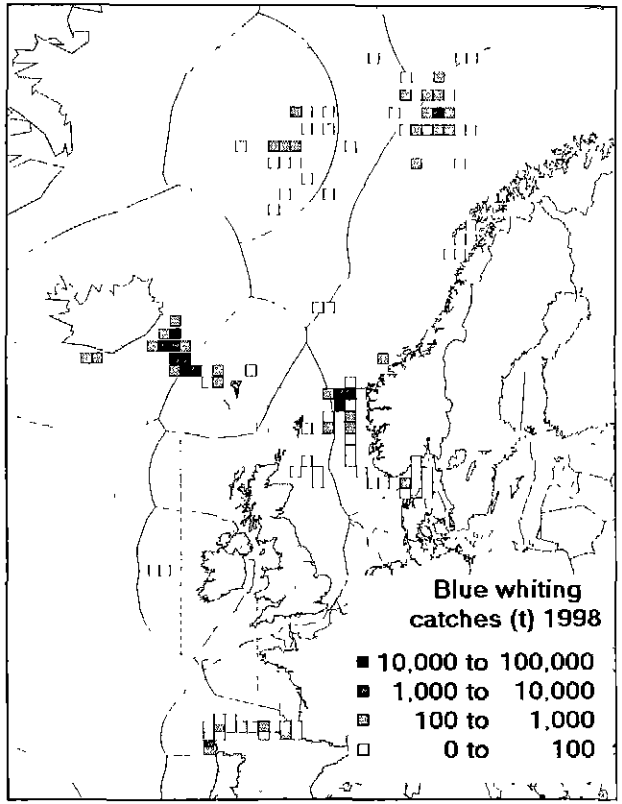


Fig. 8.1.3.10. Blue whiting catches (t) in October 1998.

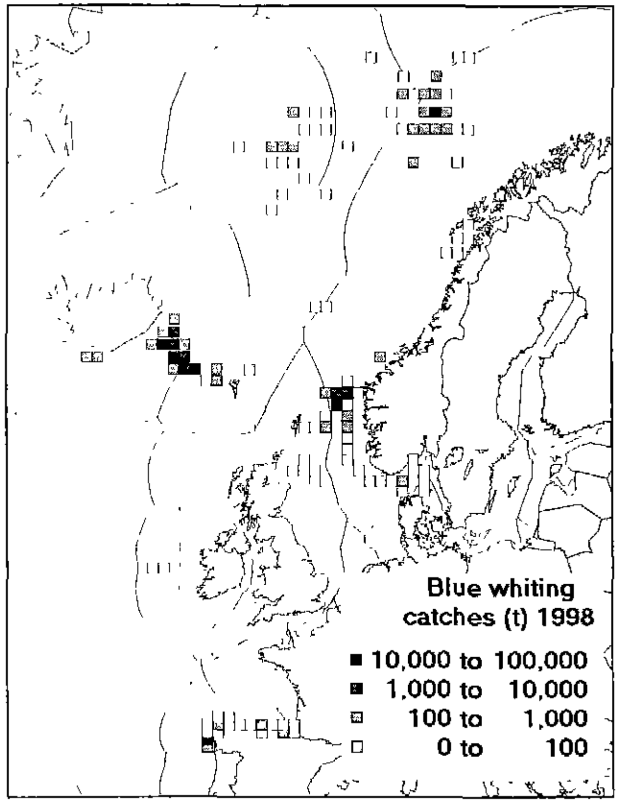


Fig. 8.1.3.11. Blue whiting catches (t) in November 1998.

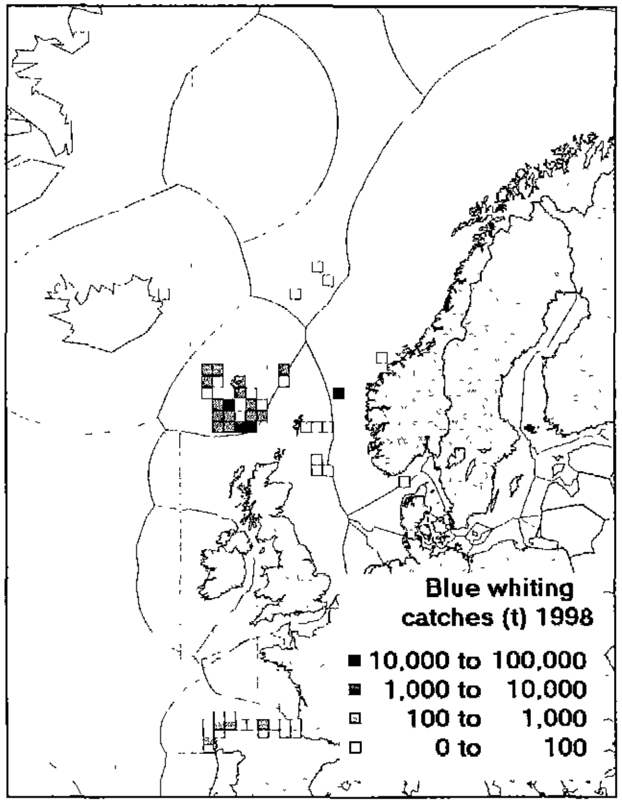


Fig. 8.1.3.12. Blue whiting catches (t) in December 1998.

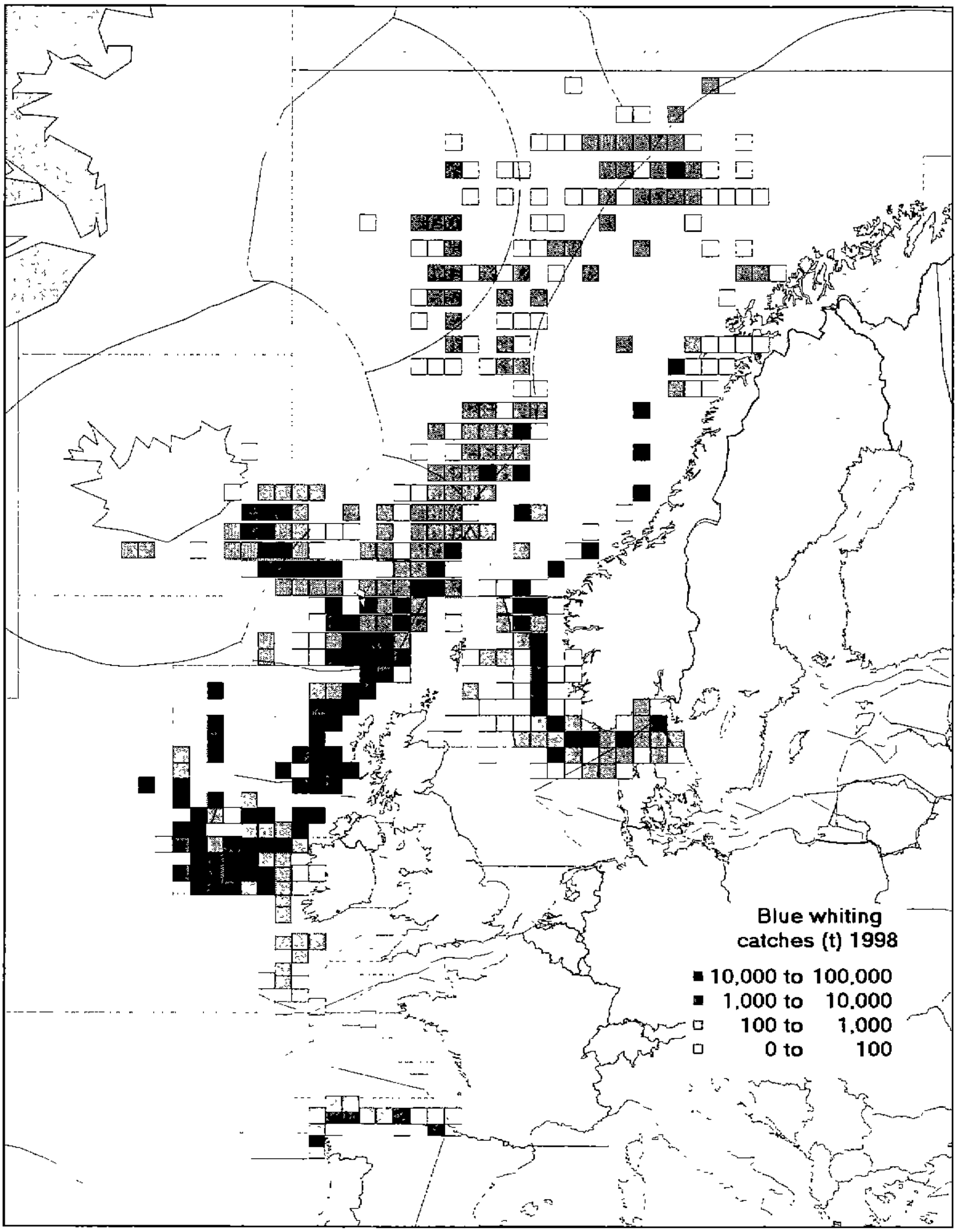


Fig. 8.1.3.13. Blue whiting catches (t) in 1998 by ICES rectangles. All countries except Portugal.

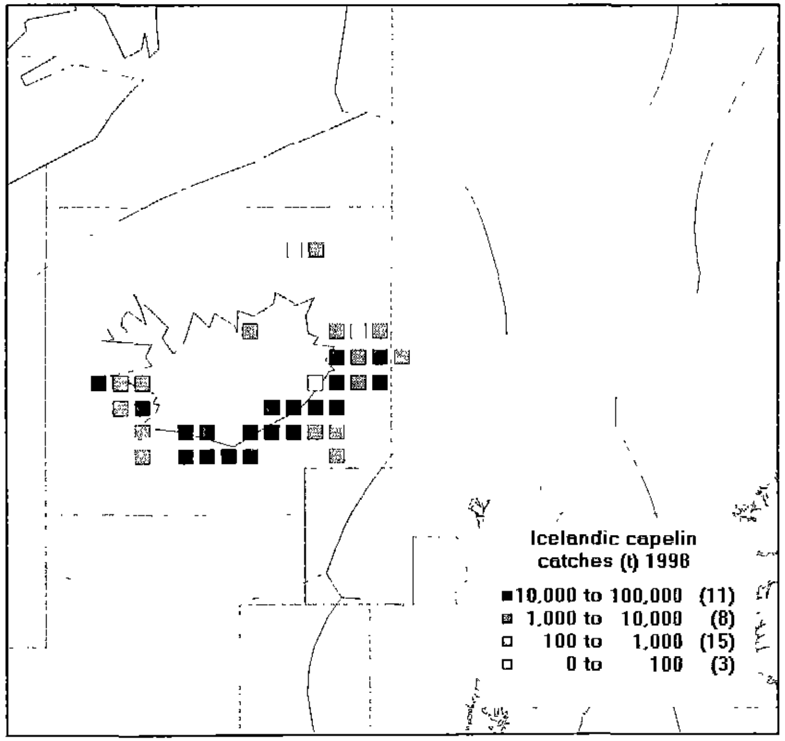


Fig. 8.1.4.1. Catches of capelin in the Icelandic-East Greenland-Jan Mayen area 1'st quarter in 1998.

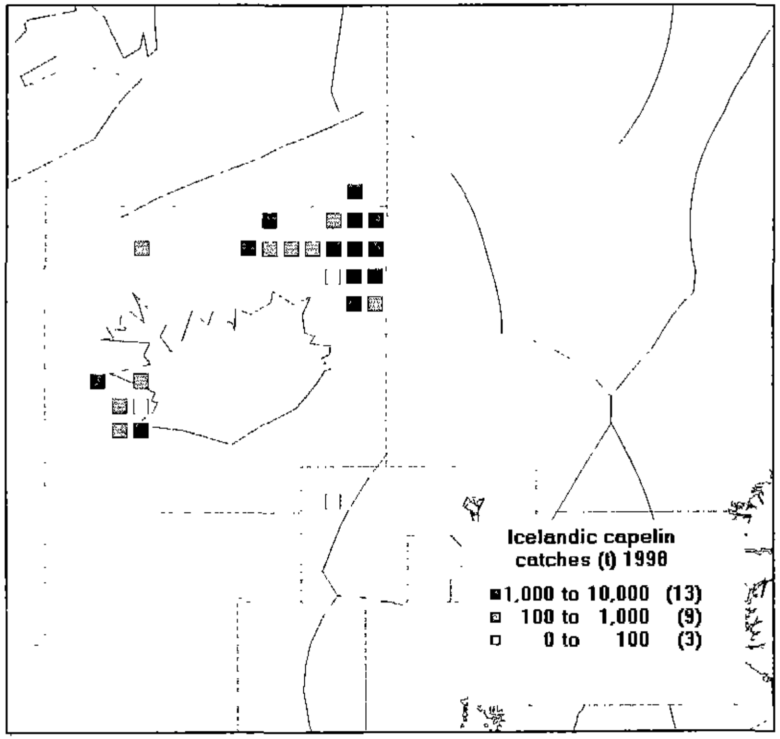


Fig. 8.1.4.2. Catches of capelin in the Icelandic-East Greenland-Jan Mayen area 2'nd quarter in 1998.

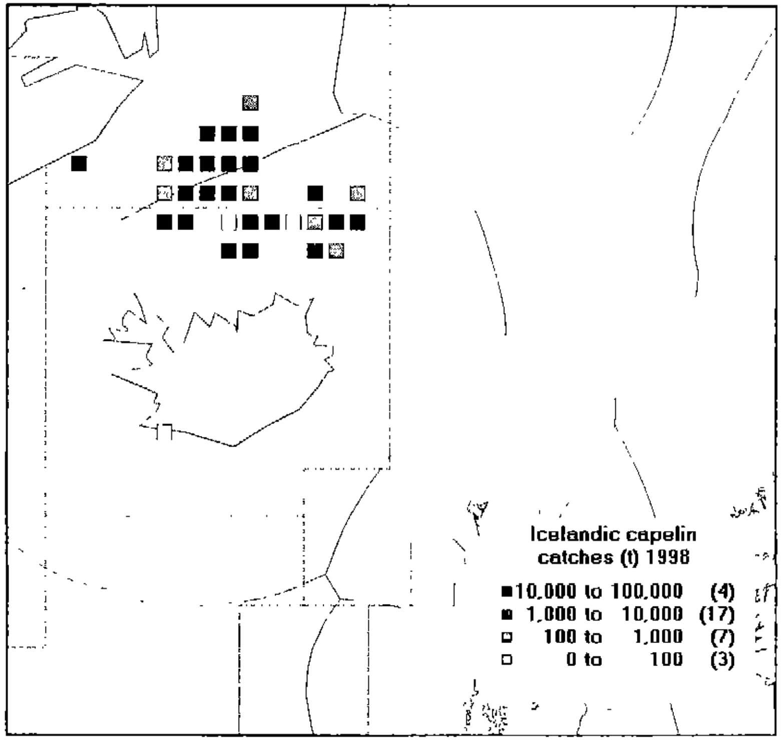


Fig. 8.1.4.3. Catches of capelin in the Icelandic-East Greenland-Jan Mayen area 3'rd quarter in 1998.

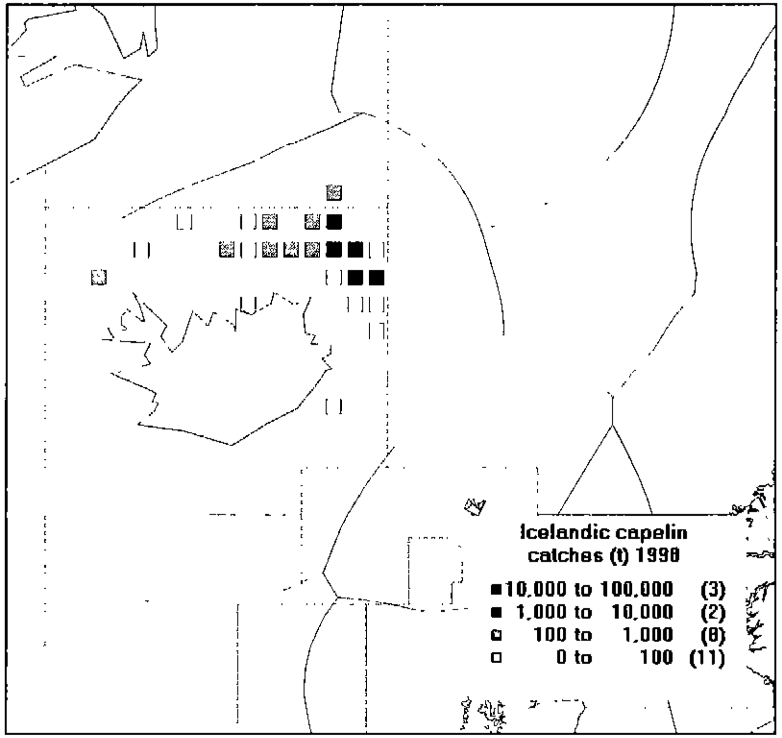


Fig. 8.1.4.4. Catches of capelin in the Icelandic-East Greenland-Jan Mayen area 4'th quarter in 1998.

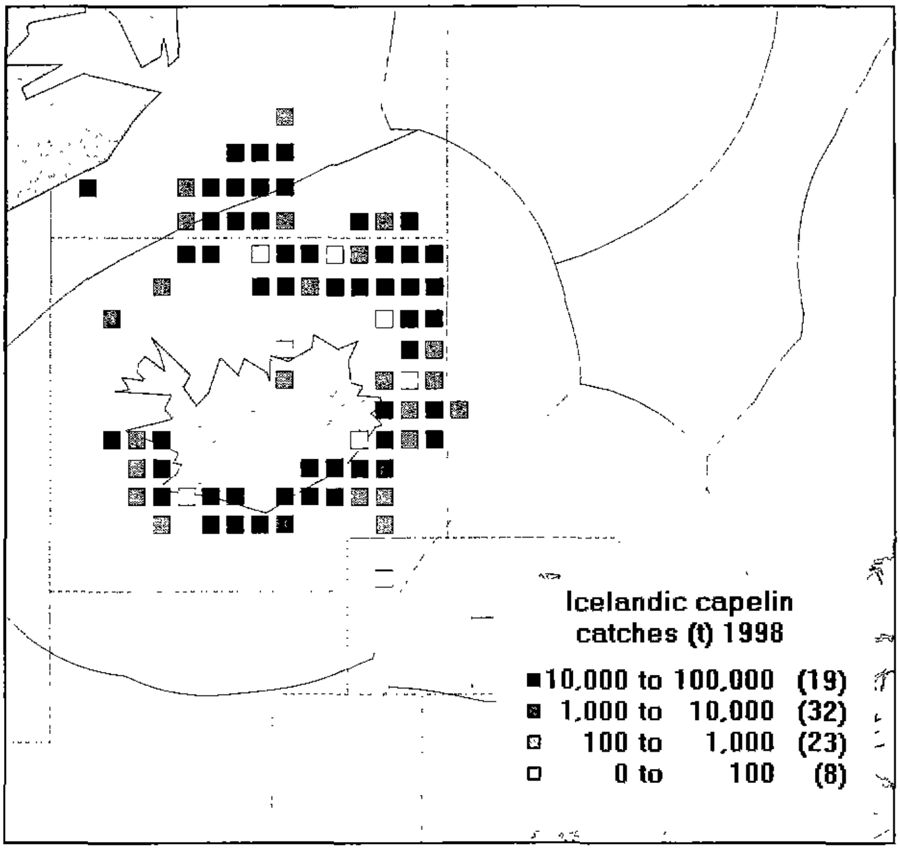


Fig. 8.1.4.5. Total catches of capelin in the Icelandic-East Greenland-Jan Mayen area in 1998 by ICES rectangles.

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