Advisory Committee on Fishery Management

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REPORT OF THE

NORTHERN PELAGIC AND BLUE WHITING FISHERIES WORKING GROUP

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International Council for the Exploration of the Sea
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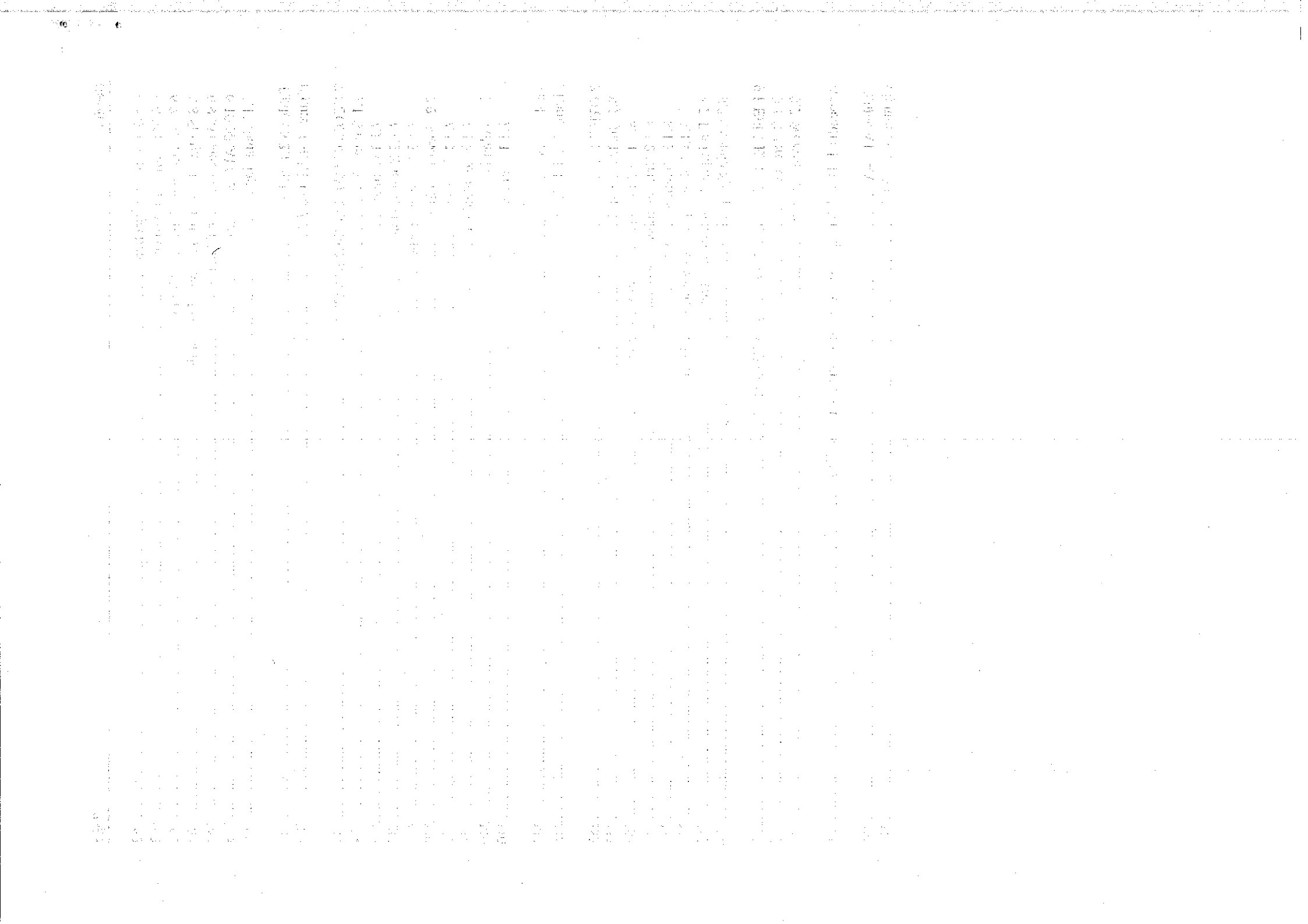

1 INTRODUCTION

1.1 Terms of Reference

The Northern Pelagic and Blue Whiting Fisheries Working Group [WGNPBW] (Chairman: Dr J. Carscadden, Canada) will meet at ICES Headquarters from 28 April to 6 May 1998 to:

a) assess the status of and provide catch options for 1999 for the Norwegian spring-spawning herring stock, and catch options for the 1998–1999 season for the Icelandic summer-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 capelin in Sub-areas V and XIV and provide catch options for the summer/autumn 1998 and winter 1999 seasons;

d) assess the status of and provide catch options for capelin in Sub-areas I and II (excluding Division IIa west of 5°W) in 1999;

e) consider further possibilities for the incorporation of biological interactions into the assessments of capelin, herring, and cod stocks;

f) assess the status of and provide catch options for 1999 and 2000 for the blue whiting stock;

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

h) consider the reference points proposed by the SGPAFM, adopting those reference points or presenting alternatives with reasons for the alternative selection;

i) consider the harvest control rules proposed by the SGPAFM, taking into account uncertainties in the data, in the assessments and in the biological processes, and assuming a stock-recruitment relationship, to estimate the probability of avoiding limit reference points;

j) update information on quantities of discards by gear type for the stocks and fisheries considered by this group using the format proposed by the WGECO with a view to establishing a time series.

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

WGNPBW will report to ACFM before its May 1998 meeting.

The following items were added on receipt of a request from NEAFC:

k) indicate new developments in the seasonal and area distribution of the total Norwegian spring-spawning herring stock;

l) ICES is requesting to provide for the Blue whiting stock:

- appropriate limit and reference points,
- short- and medium-term levels of catches and spawning stock biomass. The medium-term analysis should include 1–10 years stochastic projections of yield and spawning biomass at levels of fishing mortalities from 0.1 to Flim and subject to yearly catch ceilings up to 1,000,000 tonnes. The percentiles given of distribution of 5, 25, 50, 75 and 95%.
- appropriate harvest regimes including reference points at which remedial actions should be taken, which takes into account sustainable exploitation rates and appropriate biomass thresholds.

1.2 Participants

Jim Carscadden (Chairman)	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
Alexander Krysov	Russia
Manuel Meixide	Spain
Terje Monstad	Norway
Brian Nakashima	Canada
Kenneth Patterson	UK (Scotland)
Ingolf Røttingen	Norway
Iván Cedeño Sánchez	Denmark
Alexandra Silva	Portugal
Per J. Sparre	Denmark
Sigurd Tjelmeland	Norway
Hjalmar Vilhjalmsson	Iceland

2 ICELANDIC SUMMER-SPAWNING HERRING

2.1 The Fishery

The catches of summer-spawning herring from 1978–1997 are given in Table 2.1.1. No estimate of discards was made for the 1997/1998 season. The main fishery took place off the east coast of Iceland, but a small amount was also taken off the south west coast. The proportion used for reduction has continued to decrease from 74% in 1992/93 to 23% in 1996/1997, and increased slightly to 29% last 1997/1998. The remainder of the catch was either salted or frozen for human consumption. In the 1996/97 season 91% of the catch was taken by purse seiners, but only 59% in 1997/1998. The remaining 41% 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. In 1994 the fishery started in September. Therefore, all references to the years 1990–1993 refer to the season starting in October of that year but after that in September. Landings, catches and recommended TACs since 1984 are given in thousand tonnes in the text table below.

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*	64.4	64.4	90.0

*Preliminary

2.2 Catch in Numbers, Weight at Age and Maturity

The catches in numbers at age for the Icelandic summer-spawners for the period 1978–1997 are given in Table 2.1.1. As usual, age is given in rings where age in years equals the number of rings+1.

In the first years after the fishery was reopened in 1975, the 1971 year class was most abundant. During the period 1979–1982 the 1974 and 1975 year classes predominated in the catches. During the period 1983–1986, the fishery was dominated by the strong 1979 year class. On the other hand, the fishery in 1987 and 1988 was based on a number of year classes ranging from 3–10 ringed herring.

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.

In the 1995/96 and 1996/97 seasons, the catches were again mainly distributed on the 4 year classes from 1988–1991. In the 1997/98 season, the catches were again mainly distributed on these 4 year classes from 1988–1991. The catch in numbers of 2-ringers was 11% of the total numbers in the 1997/98 season. In the 1997/98 season the total catch numbered some 246 million herring, while in the previous season the numbers were 384 millions and 500 millions in the season there before. The reason for this reduction is the lower total catch in tonnes and a higher mean weight than in the preceding seasons.

The weight at age for each year is given in Table 2.2.1 and the proportion mature at age is given in Table 2.2.2. 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 parameters have remained relatively stable over a wide range of stock sizes and fluctuations in environmental conditions of Icelandic waters.

2.3 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, usually after the fishery had been closed. During surveys, which took place in November–December 1997, an estimate was obtained of the adult stock in open waters and of 1 year old herring in Icelandic coastal waters. The adult stock was located in an area off the east coast of Iceland. The estimated stock size in that area was only 200 thousand tonnes, which is much less than estimated in the year before. An additional 200 thousand tonnes were located southwest of Iceland, but this component consisted in part of immature herring. Because of the unexpectedly low estimate of adult herring, another survey was carried out in January, but no further concentrations were located. According to these assessment surveys the abundance of the 1992, 1993 and 1995 year classes are low. On the other hand, the abundance of the 1994 year class was above average and the abundance of the 1996 year class was very high.

The results of the autumn 1997 acoustic survey have been used as a basis for the present assessment of 4-ringed (5-ringed at 1 January) and older herring (Table 2.3.1).

Jakobsson *et al.* (1993) formally tested whether it was feasible to maintain an 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.

2.4 Stock Assessment

As in previous years the estimation procedure from Halldórsson *et al.* (1986) was used to estimate the 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 2.4.1 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 2.4.1. 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 0.154. The confidence intervals (0.12, 0.20) 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 2.4.1).

Using the catch data given in Table 2.1.1 and the fitted values of fishing mortalities given in Table 2.4.1, 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 1978–1997 and stock in numbers at age and spawning stock biomass on 1 July 1978–1998 are given in Tables 2.4.2 and 2.4.3 respectively. In addition, another VPA was run, extending backwards to 1947. The standard stock summary, based on the longer VPA, is given in Table 2.4.4 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 2.4.2. The resulting stock trend from VPA is plotted together with the acoustic estimates in Figure 2.4.3 and the relationship between the two estimates is shown in Figure 2.4.4. In the absence of reliable abundance estimates for the 1995 year class, the size of this year class was set at 400 million as 1-ringers in 1997.

According to the present assessment the spawning stock biomass was about 435,000 tonnes on 1 July 1997 which is about 50,000 tonnes lower than was assumed last year.

Including the catch during the 1997/1998 fishing season, the present stock estimate is about 20% lower than estimated by the Working Group in 1997. The most plausible explanation is as follows:

Starting in summer 1997, there have been large changes in the marine environment of Icelandic waters (cf. Section 7). The main feature is an increased flow of warm and saline Atlantic water to the north west of Iceland and eastwards off the north coast. Thus, the waters over and near the Icelandic shelf have warmed to such a degree that a comparable situation can not be found after 1963.

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 west and northwest of Iceland as well as off the western and central north coast during a groundfish survey in October 1997. During capelin surveys of deep waters off the shelf east of Iceland, small schools of herring were located in January and February 1998. Samples showed that these schools also consisted of Icelandic summer spawning herring.

Furthermore, the part of the fishable stock which was located in late 1997/early 1998 east of Iceland concentrated in a cold bottom layer, 20–30 m thick. Consequently, these herring were only rarely available to the purse-seine fleet. This phenomenon also explains the high proportion of the catch which was taken by pelagic trawl in the 1997/1998 season and that only 60% of the TAC for 1997/1998 was taken.

2.5 Catch and Stock Projections

The input data for the projections are given in Table 2.5.1. 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).

As in previous years, a regression of increase in weight on mean weight 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 1988–1997 as starting years. For 1 ringers and 9+ ringers, a simple average of mean weights at age

for the period 1993–1997 was used for the prediction. Weights at age for 2–8 ringers in the catch were obtained using the relationship:

$$W_{y+1} - W_y = -0.2013 * W_y + 82.535 \text{ (g)}$$

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 1992–1994 is used. A very large year class will recruit to the 1998 fishery as 3-ringed herring. This year class is widely distributed in coastal waters at west and north Iceland. Experience has shown that smaller proportions of such year classes recruits to the fishery as 3-ringers than is the rule for average year class sizes.

Output of the prediction, assuming catches corresponding to a fishing mortality rate of $F_{0.1}$=0.22, are given in Table 2.5.2, and projections of spawning stock biomass and catches (thousand tonnes) for a range of values of F are given in Table 2.5.3.

In 1998 and 1999 it is expected that the largest contribution in numbers at age will be herring of the 1994 year class, i.e. 3- and 4-ringed herring respectively. The remainder of the catch will be distributed on many older year classes. Furthermore, it is assumed that the strong 1996 year class will contribute significantly to the catch in 1999.

The abundance of 1-ringers in 1998 was estimated acoustically at 1,629 million individuals. For 1-ringers in 1997 a value of 400 million (see Section 2.4) is assumed.

Yield per recruit and spawning stock per recruit, and short-term yield and spawning stock biomass are shown in Figure 2.5.1, using the long-term average (1978–1997) values given in Table 2.5.4.

2.6 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 1998/99 season would result in a catch of about 90,000 tonnes (Table 2.5.3). The spawning stock biomass in 1999 would be similar to that in 1998, i.e. about 480,000 tonnes. 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 agrees with the SGPAFM of using $F_{pa}=F_{0.1}=0.22$, $B_{pa}= B_{lim}\ e^{1.645\ sigma}=300000$ where B_{lim}=200000. The stock is in a healthy state and well above any "alarm level". Thus, for the time being, further precautionary measures are not needed in the management of this stock.

However, investigations should be conducted in order to determine whether mortalities have increased with the recent change of fishing gear described in Section 2.1.

2.7 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. The Beverton-Holt, Ricker, Cushing and Schnute models for the SSB-R relationship were fitted to the data by minimising the residual sum of squares from each log-transformed relationship. A summary of the basic results is given in Table 2.7.1. A stock recruitment relationship is shown on Figure 2.7.1 along with the lines used to identify the parameters F_{high}, F_{med} and F_{low}. The relationship between the SSE from the model fits is unchanged from Jakobsson *et al.* (1993), who found that the data fit best to the Cushing model and used it for further analysis.

2.8 Medium-Term Prediction

In 1995 the Working Group carried out a medium-term prediction for the Icelandic summer-spawning herring, based on a fixed F strategy ($F_{0.1}$). Due to time constraints the medium-term prediction could not be run at the present meeting.

2.9 Sampling

Investigation	No. of samples	Length measured individuals	Aged individuals
Fishery	24	3003	2295
Acoustic, wintering area	15	3827	2023

2.10 Comments on the Assessment

In response to a request from ACFM, the Working Group ran an integrated catch analysis (ICA) on the Icelandic summer-spawning herring. A summary of the results is given in Table 2.10.1. The average F for 4–14 ringers is estimated to be 0.0984 and the SSB in July 1997 is 1,085,148 tonnes, compared to 435,000 tonnes and F=0.15 (Section 2.4). Furthermore, the selection pattern resulting from the ICA runs (Figure 2.10.1) increases linearly far beyond the age at which these herring are fully recruited to the fishable stock. The results from the method described in Section 2.4. give better agreement between runs made in different years. Therefore the method used in earlier assessments has been retained.

Since it was not possible to run the VPA with the oldest age group as a true oldest age group, VPA tables from runs made at the Icelandic MRI are also included in this report (Tables 2.10.1 and 2.10.2).

Table 2.1.1 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
1	12.006	0.869	6.225	7.411	1.100	9.323
2	79.782	35.560	110.079	26.221	18.723	27.072
3	131.543	170.106	99.377	159.170	45.304	28.397
4	43.787	87.363	150.310	86.940	92.948	29.451
5	56.083	25.146	90.824	105.542	69.878	42.267
6	41.932	28.802	23.926	74.326	86.261	35.285
7	36.224	18.306	20.809	20.076	37.447	28.506
8	44.765	24.268	19.164	13.797	13.207	21.828
9	9.244	14.318	17.973	8.873	6.854	8.160
10	2.259	3.639	16.222	9.140	4.012	3.815
11	0.582	0.878	2.955	7.079	1.672	1.696
12	0.305	0.300	1.433	2.376	4.179	6.570
13	0.203	0.200	0.345	0.927	1.672	1.378
14	0.102	0.100	0.345	0.124	0.100	1.802
Catch	108.504	102.741	134.003	125.851	95.882	64.395

Table 2.2.1 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*
1	63	74	67	69	78	62	70
2	144	150	135	129	140	137	132
3	190	212	204	178	166	197	192
4	232	245	249	236	208	234	240
5	276	288	269	276	258	270	269
6	317	330	302	292	294	299	298
7	334	358	336	314	312	323	322
8	346	373	368	349	324	342	340
9	364	387	379	374	360	358	372
10	392	401	398	381	349	363	378
11	444	425	387	400	388	373	395
12	399	387	421	409	403	412	406
13	419	414	402	438	385	394	407
14	428	420	390	469	420	429	426

* Predicted

Table 2.2.2 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*
1	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	0.122
3	0.930	0.999	1.000	0.982	0.990	0.925	0.966
4	1.000	1.000	0.992	0.998	1.000	0.989	0.996
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

* Predicted (mean of 95-97)

Table 2.3.1 Acoustic estimates (in millions) of the Icelandic summer spawning herring, 1974-1998. 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	3	-	-	-	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
1	392	285	5	478	410	1418	-	-	845	285	1629
2	126	725	178	805	745	254	332	-	-	792	380
3	352	181	593	227	850	858	533	-	-	320	716
4	836	249	177	304	353	687	860	-	515	139	100
5	287	381	302	137	273	160	443	-	316	459	116
6	53	171	538	176	94	99	55	-	361	280	240
7	37	42	185	387	81	87	69	-	166	410	161
8	76	23	-	40	210	44	43	-	110	150	130
9	25	30	-	10	32	92	86	-	52	101	97
10	21	16	-	2	11	39	55	-	29	50	35
11	14	10	18	-	-	-	2	-	16	35	15
12	17	9	-	-	17	-	-	-	27	15	11
13	8	5	-	-	-	-	-	-	19	65	43
14	6	3	-	-	-	-	-	-	8	32	8
15	3	2	-	-	-	-	-	-	2	-	15
5+	547	692	1043	752	718	521	753	-	1105	1597	870

Table 2.4.1 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 1997. F_{97} is the F in 1997 and F_{p97} is the exploitation pattern in 1997 (used in prognosis).

Rings in 1997	Year class	Acoustic estimate Nov. 97	Catch 1997/1998	F_{ac}	F_{97}	F_{p97}
1	1995	380	9.323	0.023	0.025	0.033
2	1994	716	27.072	0.035	0.035	0.300
3	1993	100	28.397	0.239	0.154	0.700
4+	1992	870	180.758	0.180	0.154	1.000

Table 2.4.2 Icelandic summer spawners. Fishing mortality at age M=0.1. Age in years is number of rings.

Table 8 Fishing mortality (F) at age YEAR,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,
RINGS										
1,	.0142,	.0039,	.0131,	.0027,	.0020,	.0069,	.0009,	.0001,	.0001,	.0001,
2,	.0621,	.0949,	.0697,	.0217,	.0257,	.1157,	.0978,	.0313,	.0079,	.0051,
3,	.1296,	.1615,	.1640,	.0979,	.1588,	.2580,	.2159,	.1689,	.0970,	.0488,
4,	.1292,	.2344,	.2839,	.1222,	.2996,	.2292,	.3607,	.1971,	.2148,	.2230,
5,	.1281,	.1997,	.3192,	.2489,	.2192,	.2458,	.1747,	.3416,	.2611,	.2650,
6,	.3303,	.1489,	.1880,	.3101,	.3917,	.1523,	.1071,	.1594,	.5266,	.3778,
7,	.3405,	.3357,	.2303,	.1562,	.5427,	.2168,	.0858,	.1062,	.3458,	.6089,
8,	.6787,	.2092,	.3991,	.1625,	.1916,	.2878,	.0815,	.0609,	.2702,	.4791,
9,	.4789,	.3805,	.1642,	.4681,	.3088,	.1367,	.1296,	.1049,	.2940,	.5704,
10,	.7584,	.2332,	.5116,	.1203,	.7198,	.1551,	.0827,	.1476,	.3155,	.5911,
11,	.5668,	.9012,	.5260,	.5896,	.3881,	.4837,	.0159,	.1561,	.3723,	.8158,
12,	.0624,	.0701,	.0037,	1.7436,	.9037,	.1319,	.0526,	.0893,	.2845,	.5643,
13,	.4680,	.2560,	.3220,	.5340,	.7310,	.3210,	.0760,	.1190,	.3680,	.6260,
+gp,	.4680,	.2560,	.3220,	.5340,	.7310,	.3210,	.0760,	.1190,	.3680,	.6260,
0 FBAR 4-13,	.3941,	.2969,	.2948,	.4456,	.4696,	.2360,	.1167,	.1482,	.3253,	.5121,

Table 8 Fishing mortality (F) at age YEAR,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	FBAR 92-94
RINGS											
1,	.0018,	.0098,	.0108,	.0304,	.0151,	.0010,	.0170,	.0277,	.0013,	.0248,	.0110,
2,	.0158,	.0524,	.0400,	.1064,	.0789,	.0510,	.1480,	.0831,	.0815,	.0353,	.0926,
3,	.0769,	.1034,	.1621,	.1746,	.1934,	.2147,	.1761,	.2939,	.1807,	.1535,	.1947,
4,	.1314,	.1818,	.1685,	.3542,	.1994,	.1704,	.2663,	.2059,	.2492,	.1535,	.2120,
5,	.3813,	.3483,	.2487,	.2198,	.3577,	.1510,	.2399,	.2702,	.2270,	.1535,	.2495,
6,	.4663,	.3842,	.4640,	.2483,	.4159,	.2800,	.1879,	.2811,	.3287,	.1535,	.2946,
7,	.7248,	.2647,	.4896,	.6318,	.2304,	.2865,	.2984,	.2128,	.1995,	.1535,	.2718,
8,	1.0301,	.4237,	.4447,	.2239,	.5088,	.2131,	.4831,	.2940,	.1893,	.1535,	.4016,
9,	.7968,	.6021,	.5757,	.3146,	.3242,	.2678,	.2161,	.3829,	.2080,	.1535,	.2693,
10,	.9724,	.7371,	.7678,	.7148,	.2787,	.1824,	.4841,	.1458,	.2657,	.1535,	.3151,
11,	1.0311,	.9457,	1.0023,	.7845,	.2954,	.1489,	.1979,	.3576,	.0323,	.1535,	.2141,
12,	1.4456,	.4824,	.9635,	.4981,	.2496,	.2180,	.3409,	.2163,	.3293,	.1535,	.2695,
13,	1.0350,	.5420,	.6820,	.4850,	.3300,	.2300,	.3700,	.3430,	.2080,	.1535,	.3100,
+gp,	1.0350,	.5420,	.6820,	.4850,	.3300,	.2300,	.3700,	.3430,	.2080,	.1535,	
0 FBAR 4-13,	.8015,	.4912,	.5807,	.4475,	.3190,	.2148,	.3085,	.2710,	.2237,	.1535,	

1

Table 2.4.3 Icelandic summer spawners. VPA stock size (thousands) and SSB (tonnes). Age in years is number of rings +1.

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Run title : Herring Summer-spawn (run: SVPAGB05/V05)

At  5-May-98  09:41:21

              Traditional vpa  using file input  for terminal F

   Table 10    Stock number at age (start of year)              Numbers*10**-3
   YEAR,         1978,     1979,     1980,     1981,     1982,     1983,     1984,     1985,     1986,     1987,

   RINGS
     1,        196235,   248349,   254052,   879182,   239341,   225823,   486012,  1210215,   719919,   353487,
     2,        393478,   175057,   223832,   226884,   793346,   216133,   202931,   439362,  1094942,   651315,
     3,        440383,   334602,   144054,   188898,   200892,   699610,   174193,   166504,   385315,   982975,
     4,        119905,   350040,   257599,   110632,   154988,   155083,   489084,   127013,   127245,   316404,
     5,         76278,    95343,   250552,   175480,    88586,   103932,   111584,   308539,    94368,    92877,
     6,        147129,    60719,    70654,   164757,   123795,    64379,    73546,    84784,   198387,    65766,
     7,         26336,    95680,    47341,    52974,   109325,    75708,    50022,    59790,    65413,   106017,
     8,         13476,    16953,    61884,    34024,    41002,    57490,    55154,    41541,    48647,    41883,
     9,          4445,     6186,    12445,    37570,    26169,    30632,    39011,    45998,    35368,    33596,
    10,          1819,     2491,     3826,     9555,    21288,    17388,    24176,    31009,    37475,    23851,
    11,           967,      771,     1785,     2075,     7665,     9378,    13472,    20139,    24209,    24734,
    12,           295,      496,      283,      955,     1041,     4705,     5232,    11998,    15588,    15095,
    13,            70,      251,      419,      255,      151,      382,     3731,     4491,     9929,    10612,
    +gp,          143,       28,      301,      157,      425,       11,       43,     5436,     6084,     5123,
     TOTAL,   1420958,  1386965,  1329026,  1883398,  1808014,  1660653,  1728192,  2556819,  2862890,  2723734,
   TOTSPBIO    175301,   198437,   213042,   186497,   193556,   220045,   233075,   252939,   264600,   367328,


Table 10    Stock number at age (start of year)              Numbers*10**-3
YEAR,         1988,     1989,     1990,     1991,     1992,     1993,     1994,     1995,     1996,     1997,     1998,     GMST 78-95    AMST 78-95

RINGS
  1,        515694,   429217,  1077805,  1258114,   842710,   928952,   388196,   285280,   906851,   400032,        0,     486042,       585477,
  2,        319821,   465784,   384593,   964772,  1104292,   731102,   839724,   345336,   251095,   819507,   353102,     446972,       532928,
  3,        586345,   284864,   399953,   334359,   784843,   923395,   645828,   655276,   287559,   209409,   715787,     389417,       462905,
  4,        847052,   481273,   232438,   307745,   254074,   585281,   674069,   490017,   441943,   217182,   162515,     279030,       338330,
  5,        229079,   672067,   370637,   177706,   195405,   188330,   446634,   467319,   360861,   311692,   168547,     185734,       230262,
  6,         84474,   141566,   429251,   261526,   129062,   123643,   146529,   317945,   322720,   260204,   241893,     124462,       148217,
  7,         40787,    36596,    87230,   244207,   184602,    77047,    84554,   109871,   217182,   210213,   201935,      74119,        86306,
  8,         52182,    17878,    25413,    48375,   117472,   132658,    52350,    56771,    80360,   160967,   163139,      43257,        50842,
  9,         23472,    16855,    10590,    14740,    34992,    63908,    97006,    29219,    38282,    60175,   124921,      24280,        31233,
 10,         17185,     9573,     8352,     5388,     9738,    22896,    44241,    70711,    18029,    28133,    46699,      13467,        20053,
 11,         11950,     5881,     4145,     3507,     2385,     6668,    17262,    24669,    55301,    12507,    21833,       6268,        10092,
 12,          9898,     3856,     2067,     1376,     1448,     1606,     5199,    12814,    15610,    48449,     9706,       2672,         5220,
 13,          7768,     2110,     2154,      714,      757,     1021,     1169,     3345,     9340,    10162,    37600,       1160,         2740,
 +gp,         3164,      870,     1289,      812,      380,      510,     1169,      447,      559,    13289,    18199,
  TOTAL,   2728872,  2570389,  3035915,  3623341,  3662160,  3807016,  3443924,  2869028,  3005692,  2761921,  2265877,
TOTSPBIO    437816,   407326,   369479,   322959,   396248,   527367,   551687,   540534,   451610,   435469,
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Table 2.4.4

Run title : Herring Summer-spawn (run: SVPAGB04/V04)

At 5-May-98 09:15:12

Table 17 Summary (with SOP correction)

Traditional vpa using file input for terminal F

	RECRUITS, Age 1	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	SOPCOFAC,	FBAR 4-13,
1947,	67491,	177486,	140763,	47800,	.3396,	.9923,	.3547,
1948,	164658,	138555,	112515,	56800,	.5048,	.9343,	1.7564,
1949,	80561,	98959,	69024,	5400,	.0782,	.9479,	.1057,
1950,	189406,	157709,	115699,	13600,	.1175,	1.3783,	.1562,
1951,	115839,	125922,	85734,	15800,	.1843,	1.0075,	.1612,
1952,	327453,	117143,	79240,	10500,	.1325,	.7904,	.2783,
1953,	197889,	216748,	134393,	17600,	.1310,	1.2380,	.1628,
1954,	170058,	165629,	124674,	11000,	.0882,	.8459,	.0933,
1955,	191370,	163761,	128080,	20500,	.1601,	.7515,	.1060,
1956,	469402,	237455,	166387,	20400,	.1226,	.9755,	.1499,
1957,	791290,	246512,	139044,	22800,	.1640,	.7770,	.2196,
1958,	369344,	327625,	196812,	33500,	.1702,	.9887,	.2323,
1959,	555092,	373933,	271919,	35000,	.1287,	.9781,	.2409,
1960,	712848,	230576,	160379,	28500,	.1777,	.6234,	.0447,
1961,	530948,	349306,	254888,	74000,	.2903,	.8878,	.3136,
1962,	525356,	295272,	222484,	92900,	.4176,	.7173,	.4305,
1963,	467080,	308149,	222833,	130300,	.5847,	.8319,	.7857,
1964,	585842,	230116,	167933,	86500,	.5151,	.8833,	.8200,
1965,	506787,	217802,	128751,	122900,	.9546,	.8198,	1.1852,
1966,	99720,	147802,	80647,	58400,	.7241,	.9593,	.7393,
1967,	38746,	94046,	79354,	67700,	.8531,	.8889,	1.2895,
1968,	178506,	41471,	24154,	16800,	.6955,	.8833,	.7863,
1969,	45232,	42516,	16294,	20913,	1.2835,	.9925,	.9735,
1970,	33993,	30834,	20370,	16445,	.8073,	1.0422,	1.3643,
1971,	71197,	24340,	13707,	11831,	.8631,	1.0780,	1.9517,
1972,	81215,	30366,	12037,	370,	.0307,	1.1931,	.2736,
1973,	408835,	71057,	27555,	254,	.0092,	.9979,	.0745,
1974,	135930,	118411,	44041,	1275,	.0290,	1.0010,	.0413,
1975,	205836,	160558,	113625,	13280,	.1169,	1.0000,	.1339,
1976,	560418,	223973,	126709,	17168,	.1355,	1.0000,	.2067,
1977,	435601,	257317,	131596,	28925,	.2198,	1.0000,	.3132,
1978,	196235,	265953,	175301,	37333,	.2130,	1.0000,	.3941,
1979,	248349,	273779,	198437,	45072,	.2271,	1.0001,	.2969,
1980,	254052,	268249,	213042,	53268,	.2500,	.9994,	.2948,
1981,	879182,	293508,	186437,	39544,	.2120,	.9988,	.4456,
1982,	239341,	330944,	193556,	56528,	.2920,	1.0003,	.4696,
1983,	225823,	318416,	220044,	58867,	.2675,	.9989,	.2360,
1984,	486012,	300986,	233025,	50304,	.2159,	.9992,	.1167,
1985,	1210215,	397874,	252939,	49368,	.1952,	1.0002,	.1482,
1986,	719919,	478517,	264600,	65500,	.2475,	.9999,	.3253,
1987,	353488,	541238,	367329,	75439,	.2054,	.9999,	.5121,
1988,	515695,	559543,	437816,	92828,	.2120,	.9994,	.8015,
1989,	429217,	516689,	407326,	101000,	.2480,	.9997,	.4912,
1990,	1077806,	532403,	369479,	105097,	.2844,	.9991,	.5807,
1991,	1258114,	582877,	322960,	109489,	.3390,	.9996,	.4475,
1992,	842711,	635795,	396247,	108504,	.2738,	.9994,	.3190,
1993,	928953,	730025,	527367,	102741,	.1948,	.9991,	.2148,
1994,	388196,	715390,	551687,	134003,	.2429,	1.0003,	.3085,
1995,	285288,	627724,	540534,	125851,	.2328,	1.0006,	.2710,
1996,	906851,	579361,	451610,	95882,	.2123,	.9999,	.2237,
1997,	400032,	580303,	435469,	64391,	.1479,	1.0000,	.1535,
Arith. Mean	414891,	293155,	203077,	52356,	.3087		.4470,
0 Units, 1	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),			

Table 2.5.1

The SAS System 12:55 Tuesday, May 5, 1998
Herring Icelandic Summer-spawning (Fishing Area Va)

Single option prediction: Input data

Year: 1998								
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	1629.000	0.1000	0.0000	0.0000	0.5000	0.070	0.0073	0.070
2	353.084	0.1000	0.1220	0.0000	0.5000	0.132	0.0660	0.132
3	715.706	0.1000	0.9657	0.0000	0.5000	0.192	0.1540	0.192
4	162.520	0.1000	0.9955	0.0000	0.5000	0.240	0.2200	0.240
5	168.552	0.1000	1.0000	0.0000	0.5000	0.269	0.2200	0.269
6	241.900	0.1000	1.0000	0.0000	0.5000	0.298	0.2200	0.298
7	201.941	0.1000	1.0000	0.0000	0.5000	0.322	0.2200	0.322
8	163.144	0.1000	1.0000	0.0000	0.5000	0.340	0.2200	0.340
9	124.925	0.1000	1.0000	0.0000	0.5000	0.372	0.2200	0.372
10	46.701	0.1000	1.0000	0.0000	0.5000	0.378	0.2200	0.378
11	21.834	0.1000	1.0000	0.0000	0.5000	0.395	0.2200	0.395
12	9.706	0.1000	1.0000	0.0000	0.5000	0.407	0.2200	0.407
13	37.601	0.1000	1.0000	0.0000	0.5000	0.407	0.2200	0.407
14	7.886	0.1000	1.0000	0.0000	0.5000	0.426	0.2200	0.426
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 1999								
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	0.070	0.0073	0.070
2	.	0.1000	0.1220	0.0000	0.5000	0.132	0.0660	0.132
3	.	0.1000	0.9657	0.0000	0.5000	0.192	0.1540	0.192
4	.	0.1000	0.9955	0.0000	0.5000	0.240	0.2200	0.240
5	.	0.1000	1.0000	0.0000	0.5000	0.269	0.2200	0.269
6	.	0.1000	1.0000	0.0000	0.5000	0.298	0.2200	0.298
7	.	0.1000	1.0000	0.0000	0.5000	0.322	0.2200	0.322
8	.	0.1000	1.0000	0.0000	0.5000	0.340	0.2200	0.340
9	.	0.1000	1.0000	0.0000	0.5000	0.372	0.2200	0.372
10	.	0.1000	1.0000	0.0000	0.5000	0.378	0.2200	0.378
11	.	0.1000	1.0000	0.0000	0.5000	0.395	0.2200	0.395
12	.	0.1000	1.0000	0.0000	0.5000	0.407	0.2200	0.407
13	.	0.1000	1.0000	0.0000	0.5000	0.407	0.2200	0.407
14	.	0.1000	1.0000	0.0000	0.5000	0.426	0.2200	0.426
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	0.070	0.0073	0.070
2	.	0.1000	0.1220	0.0000	0.5000	0.132	0.0660	0.132
3	.	0.1000	0.9657	0.0000	0.5000	0.192	0.1540	0.192
4	.	0.1000	0.9955	0.0000	0.5000	0.240	0.2200	0.240
5	.	0.1000	1.0000	0.0000	0.5000	0.269	0.2200	0.269
6	.	0.1000	1.0000	0.0000	0.5000	0.298	0.2200	0.298
7	.	0.1000	1.0000	0.0000	0.5000	0.322	0.2200	0.322
8	.	0.1000	1.0000	0.0000	0.5000	0.340	0.2200	0.340
9	.	0.1000	1.0000	0.0000	0.5000	0.372	0.2200	0.372
10	.	0.1000	1.0000	0.0000	0.5000	0.378	0.2200	0.378
11	.	0.1000	1.0000	0.0000	0.5000	0.395	0.2200	0.395
12	.	0.1000	1.0000	0.0000	0.5000	0.407	0.2200	0.407
13	.	0.1000	1.0000	0.0000	0.5000	0.407	0.2200	0.407
14	.	0.1000	1.0000	0.0000	0.5000	0.426	0.2200	0.426
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

(cont.)

Table 2.5.1 (continued)

12:55 Tuesday, May 5, 1998
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	0.070	0.0073	0.070
2	.	0.1000	0.1220	0.0000	0.5000	0.132	0.0660	0.132
3	.	0.1000	0.9657	0.0000	0.5000	0.192	0.1540	0.192
4	.	0.1000	0.9955	0.0000	0.5000	0.240	0.2200	0.240
5	.	0.1000	1.0000	0.0000	0.5000	0.269	0.2200	0.269
6	.	0.1000	1.0000	0.0000	0.5000	0.298	0.2200	0.298
7	.	0.1000	1.0000	0.0000	0.5000	0.322	0.2200	0.322
8	.	0.1000	1.0000	0.0000	0.5000	0.340	0.2200	0.340
9	.	0.1000	1.0000	0.0000	0.5000	0.372	0.2200	0.372
10	.	0.1000	1.0000	0.0000	0.5000	0.378	0.2200	0.378
11	.	0.1000	1.0000	0.0000	0.5000	0.395	0.2200	0.395
12	.	0.1000	1.0000	0.0000	0.5000	0.407	0.2200	0.407
13	.	0.1000	1.0000	0.0000	0.5000	0.407	0.2200	0.407
14	.	0.1000	1.0000	0.0000	0.5000	0.426	0.2200	0.426
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : SPRAGB04
Date and time: 05MAY98:13:09

Table 2.5.2

12:55 Tuesday, May 5, 1998
Herring Icelandic Summer-spawning (Fishing Area Va)

Single option prediction: Detailed tables

Year: 1998 F-factor: 1.0000 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	0.0073	11316	791	1629000	113867	0	0	0	0
2	0.0660	21472	2843	353084	46748	43076	5703	40975	5425
3	0.1540	97335	18717	715706	137630	691157	132910	657449	126427
4	0.2200	30598	7350	162520	39037	161789	38862	153898	36966
5	0.2200	31734	8549	168552	45408	168552	45408	160332	43193
6	0.2200	45543	13576	241900	72110	241900	72110	230102	68594
7	0.2200	38020	12223	201941	64924	201941	64924	192092	61758
8	0.2200	30716	10449	163144	55502	163144	55502	155187	52795
9	0.2200	23520	8738	124925	46410	124925	46410	118832	44146
10	0.2200	8793	3325	46701	17662	46701	17662	44423	16801
11	0.2200	4111	1623	21834	8620	21834	8620	20769	8200
12	0.2200	1827	743	9706	3945	9706	3945	9233	3753
13	0.2200	7079	2880	37601	15296	37601	15296	35767	14550
14	0.2200	1485	632	7886	3355	7886	3355	7501	3192
Total		353547	92440	3884500	670516	1920212	510707	1826562	485800
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 1999 F-factor: 1.0000 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	0.0073	4168	291	600000	41940	0	0	0	0
2	0.0660	88983	11781	1463221	193730	178513	23635	169807	22482
3	0.1540	40674	7822	299078	57513	288820	55540	274734	52831
4	0.2200	104523	25106	555167	133351	552669	132751	525715	126277
5	0.2200	22219	5986	118014	31793	118014	31793	112258	30242
6	0.2200	23043	6869	122394	36486	122394	36486	116425	34706
7	0.2200	33071	10632	175655	56473	175655	56473	167089	53719
8	0.2200	27608	9392	146639	49887	146639	49887	139488	47454
9	0.2200	22304	8286	118467	44010	118467	44010	112689	41864
10	0.2200	17079	6459	90714	34308	90714	34308	86290	32635
11	0.2200	6385	2521	33912	13388	33912	13388	32258	12735
12	0.2200	2985	1213	15855	6445	15855	6445	15081	6131
13	0.2200	1327	540	7048	2867	7048	2867	6704	2727
14	0.2200	5141	2187	27304	11618	27304	11618	25972	11051
Total		399509	99087	3773469	713810	1876004	499202	1784510	474855
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

(cont.)

Table 2.5.2 (continued)

12:55 Tuesday, May 5, 1998
Herring Icelandic Summer-spawning (Fishing Area Va)

Single option prediction: Detailed tables

(cont.)

Year: 2000 F-factor: 1.0000 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	0.0073	4168	291	600000	41940	0	0	0	0
2	0.0660	32775	4339	538940	71356	65751	8705	62544	8281
3	0.1540	168558	32414	1239416	238340	1196904	230165	1138530	218939
4	0.2200	43678	10491	231993	55725	230949	55474	219685	52768
5	0.2200	75899	20447	403134	108604	403134	108604	383473	103308
6	0.2200	16134	4810	85696	25546	85696	25546	81516	24300
7	0.2200	16733	5380	88876	28574	88876	28574	84542	27180
8	0.2200	24015	8170	127552	43393	127552	43393	121331	41277
9	0.2200	20048	7448	106482	39558	106482	39558	101289	37629
10	0.2200	16196	6125	86025	32535	86025	32535	81829	30948
11	0.2200	12402	4896	65872	26006	65872	26006	62659	24738
12	0.2200	4636	1885	24625	10010	24625	10010	23424	9522
13	0.2200	2168	882	11513	4683	11513	4683	10951	4455
14	0.2200	964	410	5118	2178	5118	2178	4868	2071
Total		438372	107988	3615241	728447	2498496	615431	2376643	585416
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Year: 2001 F-factor: 1.0000 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	0.0073	4168	291	600000	41940	0	0	0	0
2	0.0660	32775	4339	538940	71356	65751	8705	62544	8281
3	0.1540	62084	11939	456507	87786	440849	84775	419348	80641
4	0.2200	181006	43478	961405	230929	957079	229890	910401	218678
5	0.2200	31717	8544	168461	45383	168461	45383	160245	43170
6	0.2200	55114	16429	292735	87264	292735	87264	278459	83009
7	0.2200	11716	3767	62228	20006	62228	20006	59193	19031
8	0.2200	12151	4134	64537	21956	64537	21956	61390	20885
9	0.2200	17438	6478	92622	34409	92622	34409	88105	32731
10	0.2200	14558	5506	77322	29243	77322	29243	73551	27817
11	0.2200	11761	4643	62467	24662	62467	24662	59420	23459
12	0.2200	9006	3661	47833	19444	47833	19444	45500	18496
13	0.2200	3367	1370	17881	7274	17881	7274	17009	6919
14	0.2200	1574	670	8360	3557	8360	3557	7952	3384
Total		448432	115248	3451298	725210	2358124	616570	2243117	586500
Unit	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRAGB04
Date and time : 05MAY98:13:09
Computation of ref. F: Weighted mean, age 4 - 14
Prediction basis : F factors

Herring Icelandic Summer-spawning (Fishing Area Va)

Single option prediction: Summary table

							1 January		Spawning time	
Year	F Factor	Reference F	Catch in numbers	Catch in weight	Stock size	Stock biomass	Sp.stock size	Sp.stock biomass	Sp.stock size	Sp.stock biomass
1998	1.0000	0.2200	353547	92440	3884500	670516	1920212	510707	1826562	485800
1999	1.0000	0.2200	399509	99087	3773469	713810	1876004	499202	1784510	474855
2000	1.0000	0.2200	438372	107988	3615241	728447	2498496	615431	2376643	585416
2001	1.0000	0.2200	448432	115248	3451298	725210	2358124	616570	2243117	586500
Unit	-	-	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes	Thousands	Tonnes

Notes: Run name : SPRAGB04
Date and time : 05MAY98:13:09
Computation of ref. F: Weighted mean, age 4 - 14
Prediction basis : F factors

Table 2.5.3

The SAS System 22:13 Wednesday, May 6, 1998

Herring Icelandic Summer-spawning (Fishing Area Va)

Prediction with management option table

Year: 1998					Year: 1999					Year: 2000	
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
0.9714	0.2137	670178	485604	90000	0.0000	0.0000	715653	477057	0	835203	686148
.	.	.	.	.	0.1000	0.0220	.	477057	10836	823731	675339
.	.	.	.	.	0.2000	0.0440	.	477057	21464	812475	664734
.	.	.	.	.	0.3000	0.0660	.	477057	31888	801431	654331
.	.	.	.	.	0.4000	0.0880	.	477057	42113	790596	644125
.	.	.	.	.	0.5000	0.1100	.	477057	52143	779964	634112
.	.	.	.	.	0.6000	0.1320	.	477057	61982	769531	624288
.	.	.	.	.	0.7000	0.1540	.	477057	71633	759294	614650
.	.	.	.	.	0.8000	0.1760	.	477057	81101	749248	605194
.	.	.	.	.	0.9000	0.1980	.	477057	90389	739390	595915
.	.	.	.	.	1.0000	0.2200	.	477057	99501	729715	586811
.	.	.	.	.	1.1000	0.2420	.	477057	108440	720220	577877
.	.	.	.	.	1.2000	0.2640	.	477057	117211	710902	569111
.	.	.	.	.	1.3000	0.2860	.	477057	125816	701756	560508
.	.	.	.	.	1.4000	0.3080	.	477057	134259	692779	552066
.	.	.	.	.	1.5000	0.3300	.	477057	142544	683968	543781
.	.	.	.	.	1.6000	0.3520	.	477057	150673	675319	535650
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANAGB03
Date and time : 06MAY98:22:18
Computation of ref. F: Weighted mean, age 4 - 14
Basis for 1998 : TAC constraints

Table 2.5.4

The SAS System 22:13 Wednesday, May 6, 1998

Herring Icelandic Summer-spawning (Fishing Area Va)

Yield per recruit: Input data

Age	Recruitment	Natural mortality	Maturity ogive	Prop.of F bef.spaw.	Prop.of M bef.spaw.	Weight in stock	Exploit. pattern	Weight in catch
1	1.000	0.1000	0.0000	0.0000	0.5000	0.066	0.0290	0.066
2	.	0.1000	0.0450	0.0000	0.5000	0.138	0.2280	0.138
3	.	0.1000	0.6560	0.0000	0.5000	0.195	0.6050	0.195
4	.	0.1000	0.9970	0.0000	0.5000	0.236	0.7920	0.236
5	.	0.1000	1.0000	0.0000	0.5000	0.273	1.0000	0.273
6	.	0.1000	1.0000	0.0000	0.5000	0.302	1.0000	0.302
7	.	0.1000	1.0000	0.0000	0.5000	0.327	1.0000	0.327
8	.	0.1000	1.0000	0.0000	0.5000	0.346	1.0000	0.346
9	.	0.1000	1.0000	0.0000	0.5000	0.366	1.0000	0.366
10	.	0.1000	1.0000	0.0000	0.5000	0.377	1.0000	0.377
11	.	0.1000	1.0000	0.0000	0.5000	0.395	1.0000	0.395
12	.	0.1000	1.0000	0.0000	0.5000	0.408	1.0000	0.408
13	.	0.1000	1.0000	0.0000	0.5000	0.409	1.0000	0.409
14	.	0.1000	1.0000	0.0000	0.5000	0.425	1.0000	0.425
Unit	Numbers	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : YLDAGB03
Date and time: 06MAY98:22:25

Table 2.7.1 Icelandic summer spawners. Basic statistics from stock recruitment model fits.

Model	Parameter α	Parameter K	Parameter β	Parameter γ	SSE	Model formulae
Beverton & Holt	5.127	126.817			29.509	$R=\alpha*SSB/(1+SSB/K)$
Ricker	3.322	468.895			31.059	$R=\alpha*SSB*e^{-SSB/K}$
Cushing	20.289		0.551		26.239	$R=\alpha*SSB^{\beta}$
Schnute	633.000	0.00047		0.449	26.239	$R=\alpha*SSB/(1+SSB/K)^{\gamma}$

Table 2.10.1 Icelandic summer spawners. Fishing mortality at age. M=0.1.
Age in years is number of rings+1.

Rings/Year	1978	1979	1980	1981	1982	1983	1984
1	0.014	0.004	0.013	0.003	0.002	0.007	0.001
2	0.062	0.095	0.070	0.022	0.026	0.116	0.101
3	0.131	0.161	0.165	0.098	0.159	0.257	0.217
4	0.136	0.238	0.283	0.123	0.300	0.229	0.360
5	0.133	0.212	0.325	0.248	0.220	0.246	0.175
6	0.316	0.156	0.202	0.319	0.390	0.153	0.107
7	0.281	0.316	0.243	0.170	0.566	0.216	0.086
8	0.708	0.164	0.366	0.174	0.212	0.306	0.081
9	0.492	0.408	0.123	0.411	0.336	0.154	0.140
10	0.561	0.242	0.573	0.087	0.575	0.173	0.095
11	0.729	0.502	0.558	0.725	0.259	0.333	0.018
12	0.041	0.100	0.002	2.183	1.540	0.080	0.033
13	0.614	0.157	0.509	0.203	1.966	1.158	0.044
14	0.468	0.256	0.322	0.534	0.731	0.322	0.076
W.Av 4-14	0.244	0.238	0.294	0.246	0.366	0.224	0.255
Ave 4-14	0.407	0.250	0.319	0.471	0.645	0.306	0.110

Rings/Year	1985	1986	1987	1988	1989	1990	1991
1	0.000	0.000	0.000	0.002	0.010	0.011	0.030
2	0.030	0.008	0.005	0.016	0.052	0.040	0.106
3	0.174	0.092	0.049	0.077	0.103	0.162	0.175
4	0.198	0.223	0.210	0.131	0.182	0.168	0.354
5	0.340	0.263	0.279	0.352	0.348	0.249	0.220
6	0.159	0.523	0.382	0.502	0.342	0.464	0.248
7	0.106	0.346	0.602	0.740	0.294	0.411	0.632
8	0.061	0.270	0.479	1.003	0.440	0.520	0.176
9	0.104	0.297	0.571	0.795	0.569	0.613	0.398
10	0.161	0.313	0.600	0.975	0.734	0.688	0.808
11	0.182	0.419	0.804	1.068	0.953	0.992	0.628
12	0.101	0.347	0.688	1.378	0.519	0.982	0.488
13	0.072	0.431	0.879	1.821	0.482	0.782	0.504
14	0.119	0.368	0.626	1.035	0.542	0.682	0.485
W.Av 4-14	0.227	0.359	0.372	0.294	0.298	0.342	0.363
Ave 4-14	0.146	0.346	0.556	0.891	0.491	0.596	0.449

Rings/Year	1992	1993	1994	1995	1996	1997	1989-1992
1	0.015	0.001	0.017	0.028	0.001	0.025	0.017
2	0.079	0.051	0.148	0.083	0.082	0.035	0.069
3	0.193	0.215	0.176	0.294	0.181	0.154	0.158
4	0.199	0.170	0.266	0.206	0.249	0.154	0.226
5	0.358	0.151	0.240	0.270	0.227	0.154	0.294
6	0.416	0.280	0.188	0.281	0.329	0.154	0.368
7	0.230	0.286	0.298	0.213	0.200	0.154	0.392
8	0.509	0.213	0.483	0.294	0.189	0.154	0.411
9	0.239	0.268	0.216	0.383	0.208	0.154	0.455
10	0.388	0.125	0.484	0.146	0.266	0.154	0.655
11	0.363	0.228	0.127	0.358	0.032	0.154	0.734
12	0.176	0.287	0.618	0.129	0.329	0.154	0.541
13	0.320	0.151	0.548	0.943	0.113	0.154	0.522
14	0.330	0.230	0.370	0.343	0.208	0.154	0.510
W.Av 4-14	0.311	0.195	0.262	0.246	0.241	0.154	0.382
Ave 4-14	0.321	0.217	0.349	0.324	0.214	0.154	0.464

Table 2.10.2 Icelandic summer spawners. VPA stock size (millions) and SSB (tonnes). Age in years is number of rings+1.

Rings/Year	1978	1979	1980	1981	1982	1983	1984
1	195.583	248.275	254.118	880.816	238.280	219.912	509.733
2	394.094	174.467	223.765	226.944	794.824	215.173	197.582
3	435.363	335.159	143.520	188.838	200.947	700.947	173.324
4	114.504	345.498	258.103	110.149	154.934	155.132	490.293
5	73.580	90.457	246.444	175.935	88.149	103.883	111.629
6	152.685	58.279	66.234	161.043	124.207	63.984	73.502
7	31.041	100.703	45.133	48.976	105.967	76.080	49.665
8	13.089	21.207	66.425	32.028	37.385	54.460	55.491
9	4.350	5.837	16.292	41.674	24.363	27.361	36.271
10	2.255	2.406	3.510	13.036	24.995	15.755	21.217
11	0.807	1.164	1.708	1.791	10.815	12.721	11.995
12	0.448	0.352	0.637	0.885	0.785	7.552	8.253
13	0.057	0.389	0.288	0.576	0.090	0.152	6.307
14	0.143	0.028	0.301	0.157	0.425	0.011	0.043
SSB	175.716	198.434	212.797	186.255	193.400	219.966	233.054

Rings/Year	1985	1986	1987	1988	1989	1990	1991
1	1210.214	719.922	353.488	515.696	429.220	1077.814	1258.124
2	460.825	1094.941	651.317	319.821	465.785	384.597	964.780
3	161.665	404.735	982.974	586.347	284.864	399.954	334.362
4	126.227	122.868	333.975	847.051	491.275	232.439	307.746
5	309.632	93.657	88.918	244.972	672.066	370.638	177.707
6	84.825	199.375	65.123	60.894	155.930	429.251	261.527
7	59.751	65.450	106.910	40.206	33.363	100.213	244.207
8	41.218	48.612	41.917	52.988	17.355	22.489	60.103
9	46.302	35.075	33.564	23.502	17.578	10.117	12.100
10	28.530	37.751	23.586	17.156	9.600	9.004	4.961
11	17.461	21.967	24.983	11.711	5.855	4.169	4.094
12	10.661	13.166	13.070	10.122	3.642	2.044	1.399
13	7.225	8.720	8.423	5.942	2.309	1.961	0.692
14	5.460	6.082	5.126	3.163	0.870	1.290	0.811
SSB	250.508	264.768	368.903	439.977	410.459	372.336	326.242

Rings/Year	1992	1993	1994	1995	1996	1997	1998
1	842.722	928.964	388.204	285.295	906.752	400.013	1629.000
2	1104.301	751.112	839.735	345.343	251.101	819.417	353.084
3	784.850	923.404	645.837	655.286	287.565	209.415	715.706
4	254.076	585.287	674.076	490.025	441.952	217.188	162.520
5	195.406	188.333	446.640	467.326	360.869	311.700	168.552
6	129.062	123.644	146.531	317.950	322.726	260.211	241.900
7	184.603	77.047	84.555	109.873	217.186	210.219	201.941
8	117.471	132.659	52.351	56.772	80.362	160.972	163.144
9	45.600	63.907	97.002	29.220	38.283	60.176	124.925
10	7.352	32.488	44.242	70.712	18.029	28.134	46.701
11	2.002	4.511	25.940	24.669	55.303	12.507	21.834
12	1.978	1.259	3.248	20.665	15.610	48.451	9.706
13	0.777	1.500	0.855	1.583	16.442	10.162	37.601
14	0.379	0.510	1.167	0.447	0.558	13.289	7.886
SSB	398.853	530.048	554.997	542.688	454.180	435.202	

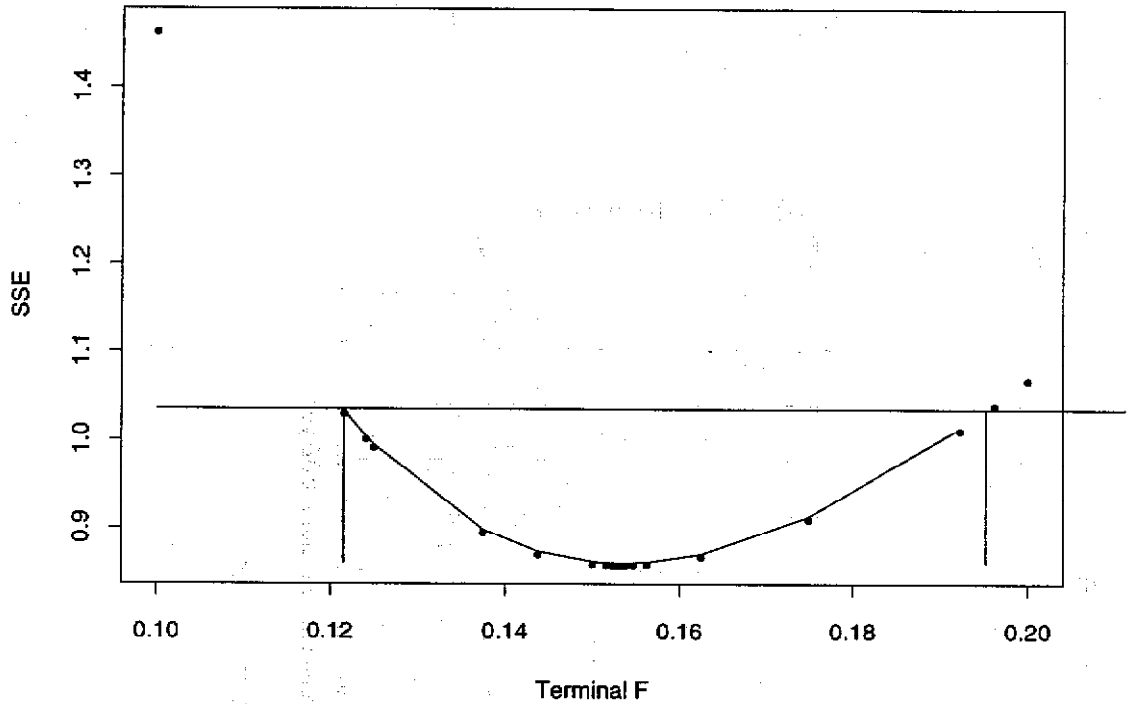
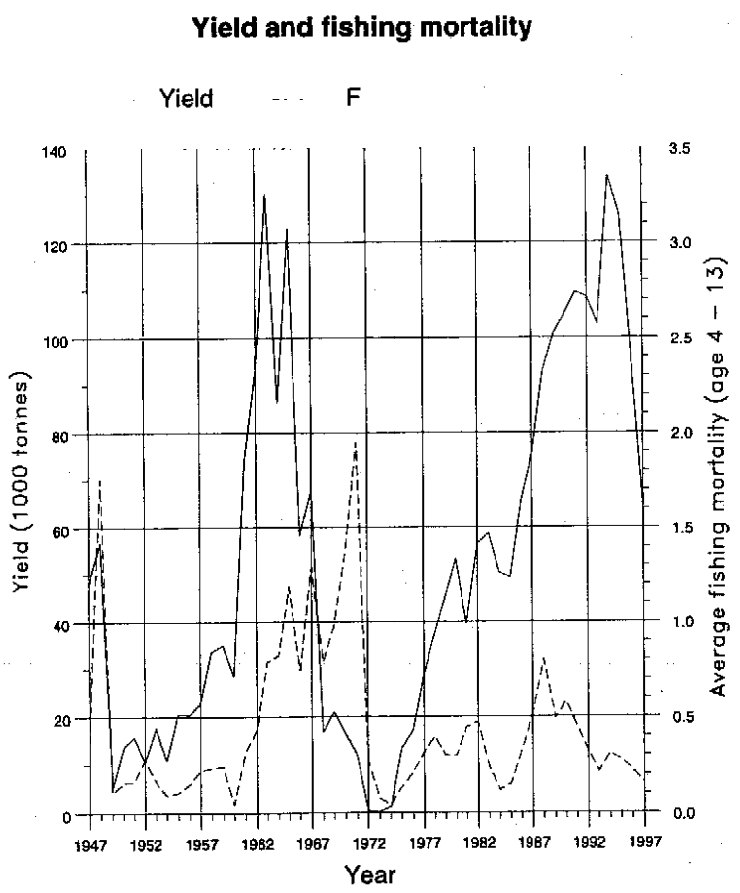
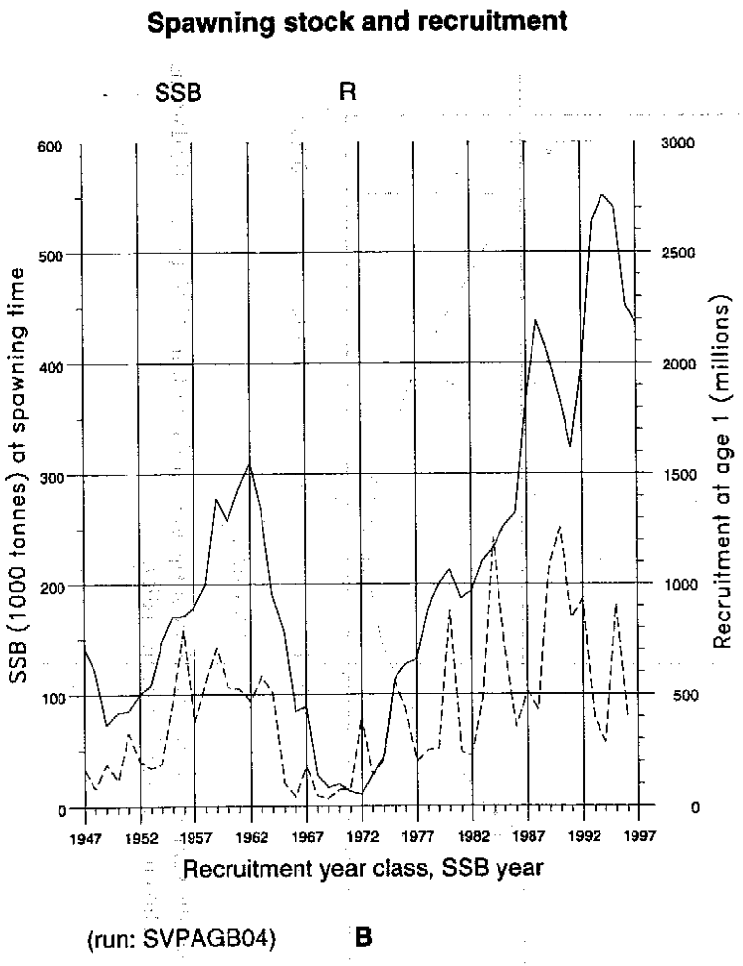


Figure 2.4.1 Icelandic summer spawners. Sum of squares used for fitting VPA to acoustic data, as a function of terminal fishing mortality.

Figure 2.4.2 Fish stock summary. Herring Icelandic Summer-spawning (Fishing Area Va). 5–5–1998.





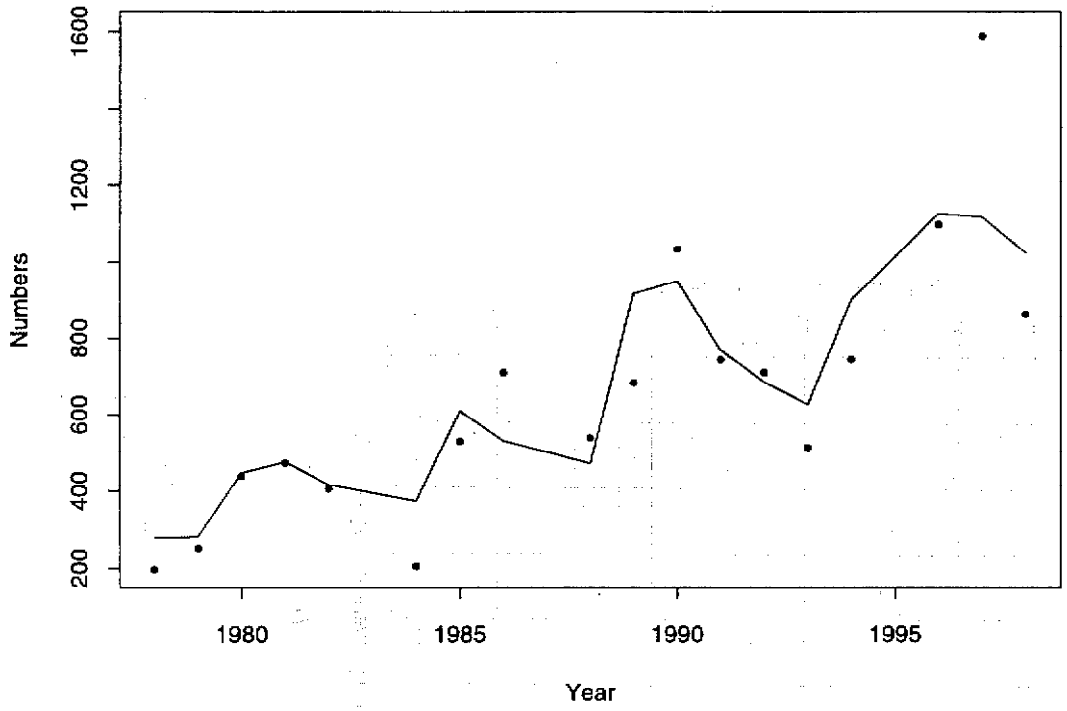


Figure 2.4.3 Icelandic summer spawners. Trends in acoustics (dots) and VPA stock numbers (curve). F=0.1535156.

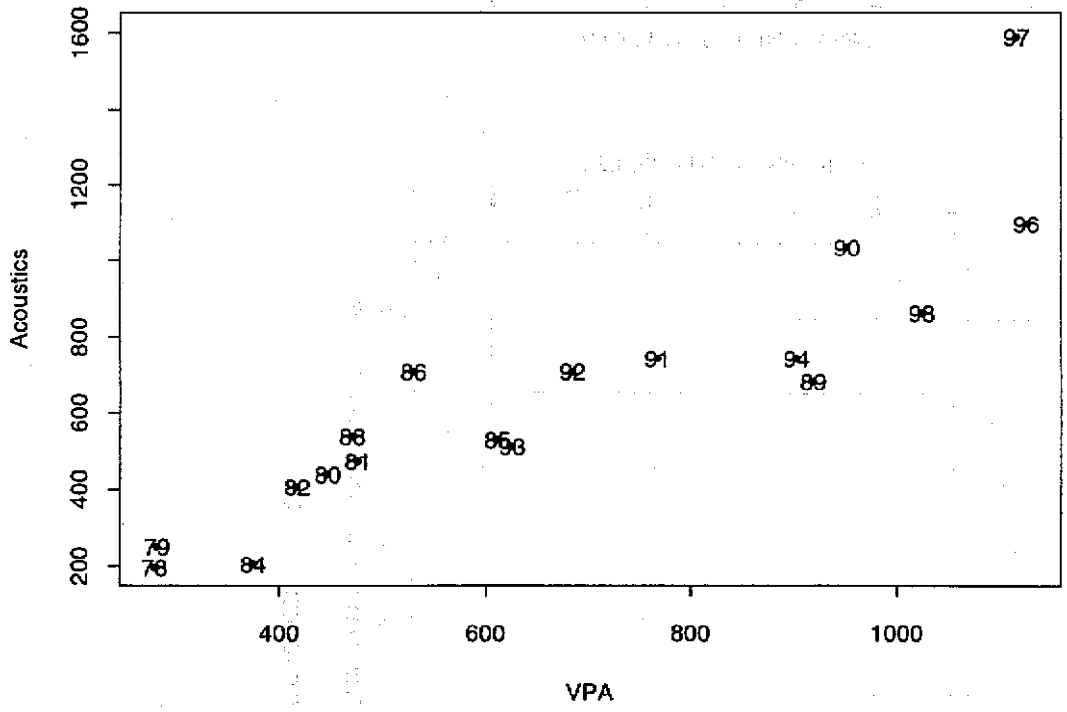


Figure 2.4.4 Icelandic summer spawners. Acoustic estimates vs VPA stock numbers (at the 1 January)

Figure 2.5.1 Fish stock summary. Herring Icelandic Summer-spawning (Fishing Area Va). 5–5–1998.

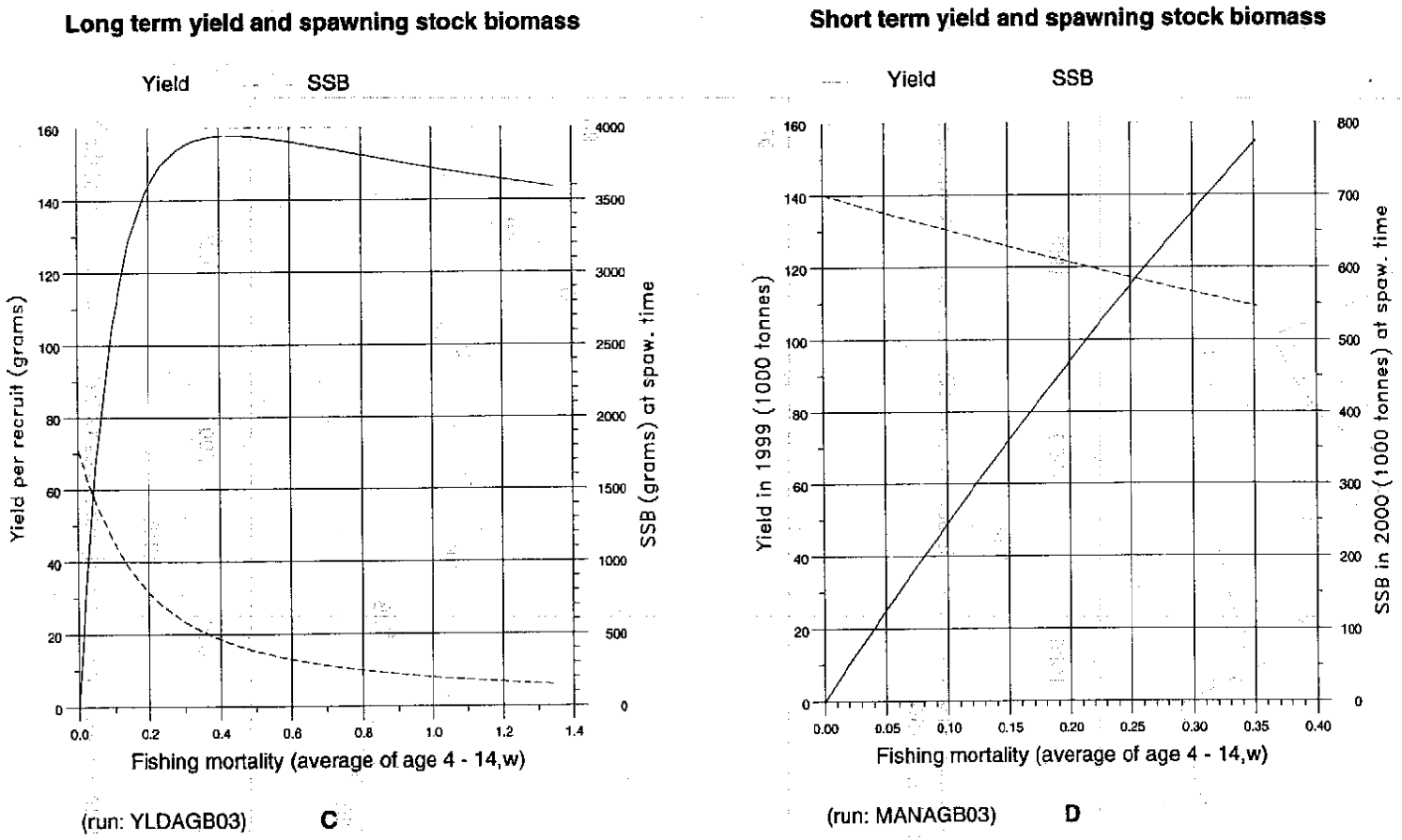


Figure 2.7.1 Herring Icelandic Summer-spawning (Fishing Area Va). 5–5–1998.

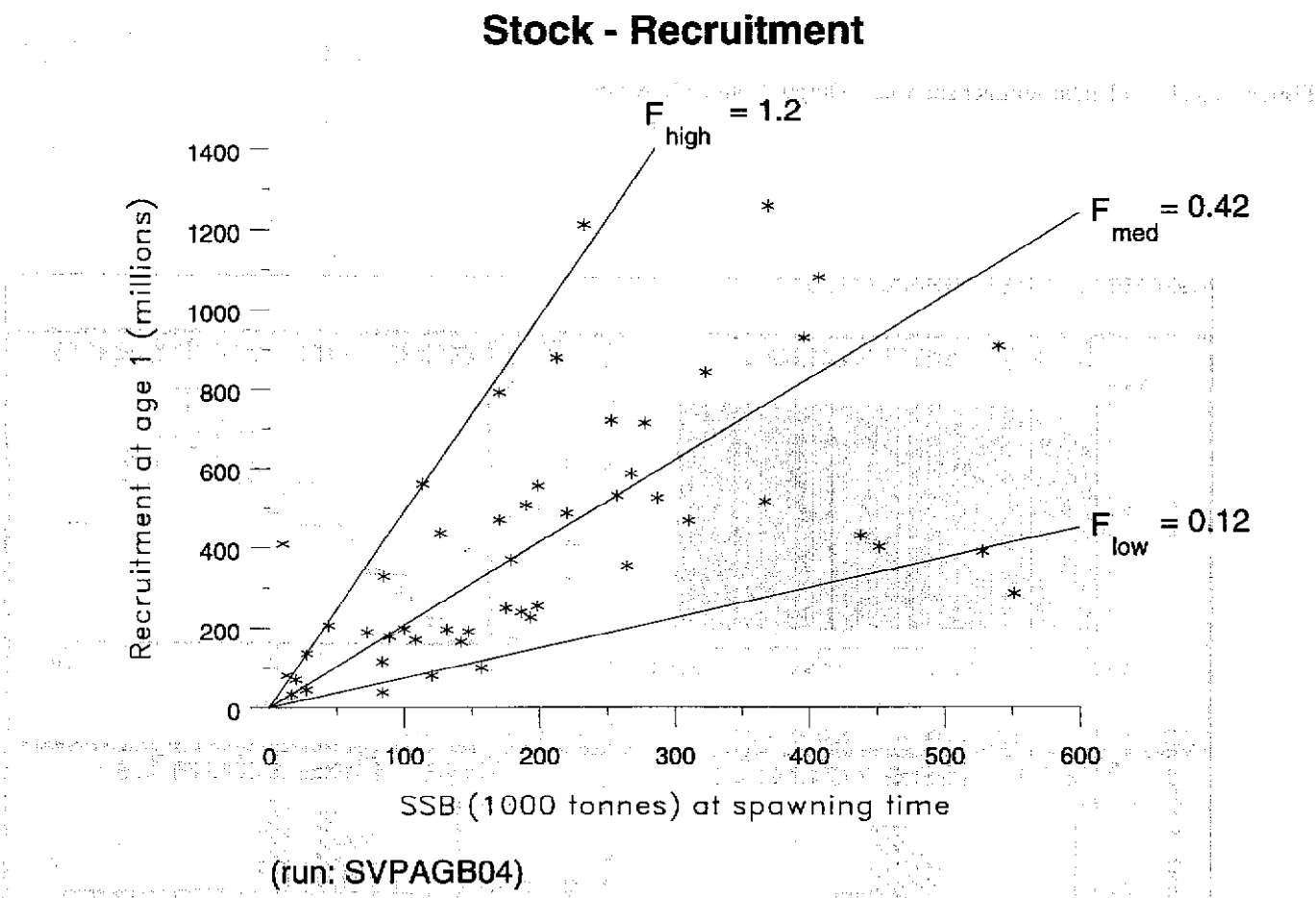


Figure 2.10.1 Icelandic summer spawners. Output from an ICA run.

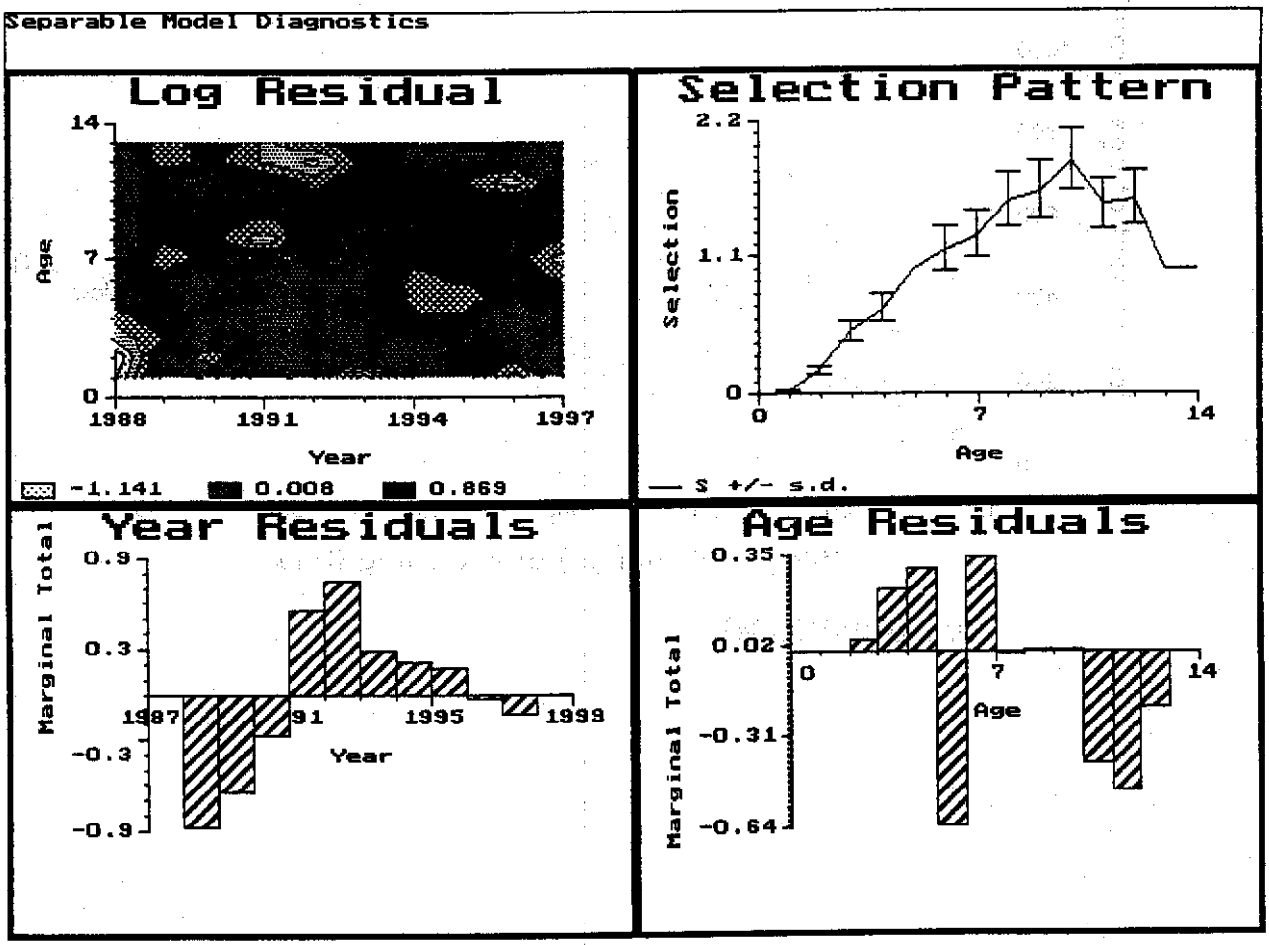
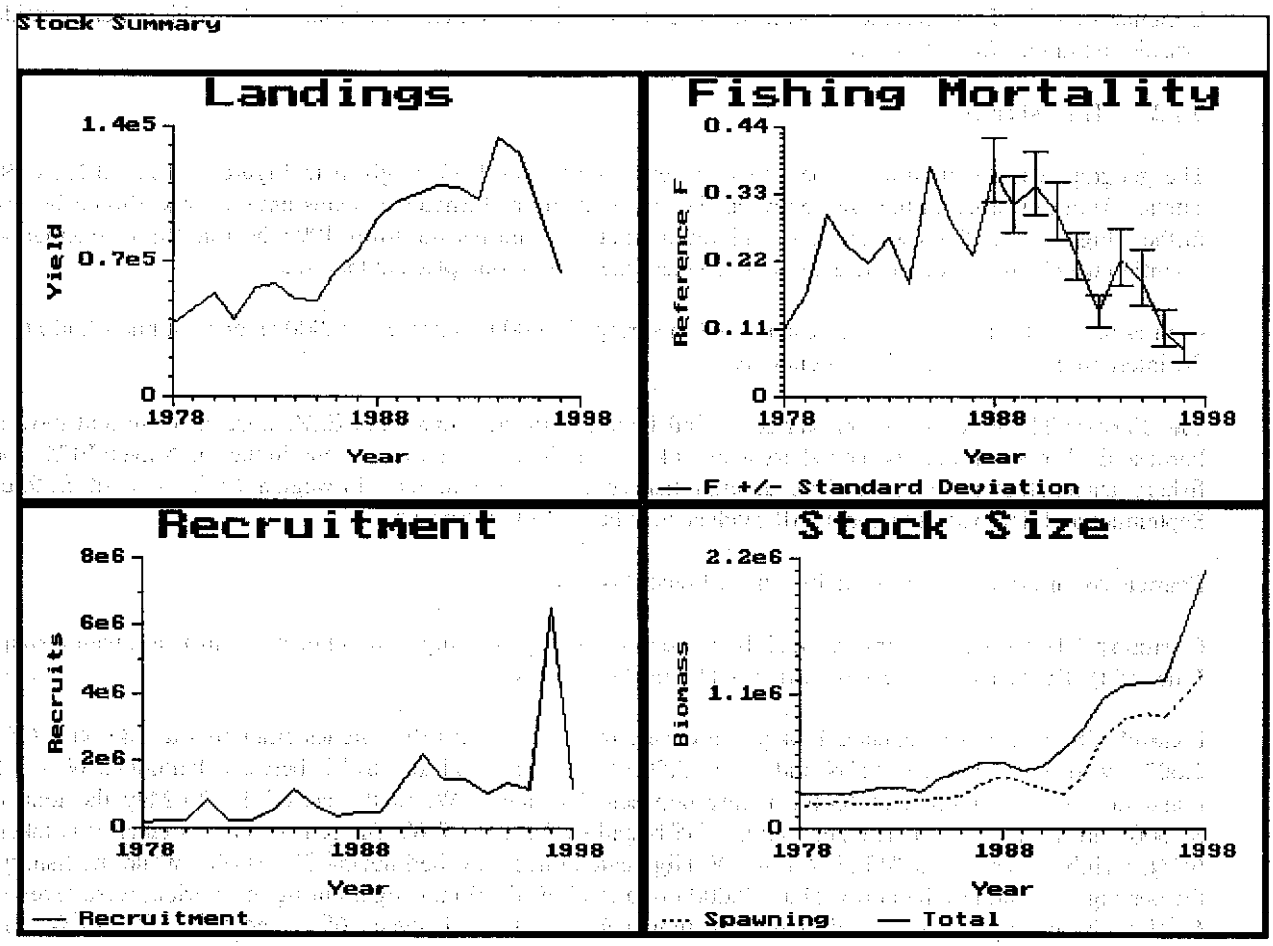


Figure 2.10.1 (continued) Icelandic summer spawners. Output from an ICA run.



3 NORWEGIAN SPRING-SPAWNING HERRING

3.1 The Fisheries

3.1.1 Management agreements for 1997

At a meeting in Oslo in December 1996 the main participants in the fishery for Norwegian spring-spawning herring reached an agreement to limit their total catch to 1.5 million tonnes in 1997, 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 which have joined the agreement. At a meeting in March 1997 in the North East Atlantic Fisheries Commission (NEAFC) agreement was made on a total TAC, and on an allocation, for the fishing areas outside national jurisdiction in the Norwegian Sea.

3.1.2 The fisheries

The geographical distribution of the fishery in each quarter of 1997 is given in Figures 3.1.2.1–3.1.2.4. Reports of catches from this stock in the area between Faroes, Scotland and Shetland seems unusual, and should be investigated further. Figure 3.1.2.5 shows the main migration routes in the period April 1997–March 1998, together with dates (months) which are placed in the general area where the fishery took place at that time.

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 mid February in the Norwegian EEZ, west of Møre and moved into 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 and first part of October. All catches were taken with purse seine.

France: No information was available on the French fishery.

Germany: The German fishery was mainly carried out in May and July (3,000 t each month), and with a small catch in June (55 t). The German fishery is carried out by mid-water trawl.

Iceland: The fishery was opened 1 May and during the first 10 days the catches amounted to 48,000 t. Of this some 2,000 t were taken between 65°N and 66°N, 2,500 t between 66°N and 67°N, between latitude 2°W and 5°W. The remainder was taken south of 65°N, mainly between 2°W and 4°W. In the period 11–20 May the total catch was 62,000 t, most of it (54,000 t) taken between 65°N and 67°N, 2°W–5°W. The remainder was taken was taken south of 65°N, mainly in the area 64°45'N, 4°W–5°W. High catch rates prevailed during 21–20 May while the fishery followed the herring migration to the north. Thus 50,000 t of a total of 65,000 t, caught during this period, were taken in the area 67°N–68°N, mainly between 2°W–5°W. The remainder was taken between 65°N and 66°N, 2°W–5°W. In late June catches were taken in the southern part of the area which consisted of smaller herring which arrived there at that time. During the period 1–10 June catch rates remained fairly high. The total catch in this period was about 22,000 t, most of it was taken in the area 64°30'N–66°N between 2°W and 0°30'W and consisted of relatively small, younger herring. Only insignificant catches were taken north of 66°N in this period. In the period 11–20 June the Icelandic herring catch was only 1,300 t, and taken in the area 65°N, 3°W. During the period 21-30 June a few Icelandic purse seiners tried to fish the large herring which by then were located north of 69°N, in the eastern part of the Jan Mayen EEZ and in international waters. Few fishable concentrations were located and the catch was only 3,500 t. In autumn the Icelandic vessels caught approximately 8,000 t in the Norwegian EEZ.

Ireland: The main part of the Irish fishery took part in April-May in the international waters in the Norwegian Sea. The Irish fishery is carried out by mid-water trawl.

Netherlands: The Dutch fishery took part in May–June in international waters. The fishery is carried out by large vessels using mid-water trawls.

Norway: By far the larger part of the Norwegian fisheries occurs in Norwegian coastal waters where the herring occurs in easily available concentrations in the period September until March. The fishery is mainly a purse seine fishery carried out by many size categories of vessels. In 1997 approximately 330,000 t were caught in the winter season, the fisheries were in winter 1997 hampered with long spells of bad weather. Only about 13,000 t were caught in the summer season. The main fishery took part in autumn on the return of the herring to the wintering area where 520,000 t were caught.

Russia: In 1997 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 Halten Banks (approximately 65°N), and some days later further south in the area of Buagrunnen and Langrunnen Banks (approximately 62°N–63°N). The fishery was finished westwards of Buagrunnen and Langrunnen Banks in the beginning of April. In February–April the catch was 40,000 t, 49,000 t and 250 t respectively. In May–June a fishery was carried out in the Faroese EEZ where 3,100 t were caught. In the international area in the Norwegian Sea the Russian catches in June-September where 15,600 t, and at the end of August started a fishery along the area of the western slope of Malangen Bank (approximately 70°N–71°N) within the Norwegian EEZ. This fishery terminated in October. The Russian fishery is carried out by vessels using mid-water trawls, and practically the whole catch is used for human consumption.

Sweden: No information was available on the Swedish fishery.

UK (Scotland): The UK fishery is mainly carried out in the international area in spring but some catches are also taken in the Norwegian EEZ in autumn. The fisheries are conducted by mid-water trawl and purse seine.

3.1.3 Management agreements for 1998

At a meeting in Oslo in October 1997 the main participants in the fishery for Norwegian spring-spawning herring agreed to limit their catches to 1.302 million tonnes in 1998, and on the allocation of this TAC. Further, NEAFC at its annual meeting in November 1997 decided to prolong to 1998 the agreement regarding fishing on Norwegian spring-spawning herring outside waters of national jurisdiction in the Norwegian Sea.

3.2 Catch Statistics

The total annual catches of Norwegian spring-spawning herring for the period 1972–1997 (1997 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 1997 to obtain the total international catch-at-age and weight-at-age was done using the computer programme described by Patterson (WD, 1998). 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. Minor changes in the 1996 catch data have been accounted for, and the 1994 catch data have been revised (numbers only, not weight) using the same method for calculating Norwegian catch in numbers as in 1995–1997.

Some countries provided age distributions with a younger plus-group than used by the Working Group (Netherlands: 9+, Scotland: 10+, Denmark: 12+). These catches were distributed on older age groups according to the age distribution found from the acoustic survey in the Norwegian Sea in 1997 (Table 3.3.3.1). It was noted that the age distributions of older fish in the Russian catches in quarter 3 and 4 and in the Irish catches are quite different from the other age distributions of older fish (not dominated by the 1983 year class). However, these age distributions were included as reported.

In order to standardise the reporting of catch data in future, the Working Group will work by correspondence to decide the areas and time periods for which the data should be reported.

As reporting of catches by some countries was by fishery and not by quarter, some allocations of various fisheries to various quarters were made. The Norwegian winter, pre-spawning and spawning fishery was allocated to the first quarter, while the Norwegian summer and autumn fishery was allocated to the third and fourth quarter, respectively. The Russian spring, summer and autumn fisheries were allocated to the first, third and fourth quarters, respectively. The Icelandic fishery was allocated to quarters by calendar month, except that the fishery in September–October was allocated to the fourth quarter. The German fishery in May–July was all allocated to the second quarter. Catches by Faroes, Scotland, Denmark and Netherlands were all allocated to quarter based on calendar month, while catches from Ireland, Sweden and France all were assumed to be taken in the second quarter.

In addition to the number of samples described in Table 3.2.5, the majority of the Norwegian catches (4,477 samples representing 594,240 tonnes or 69% of the total Norwegian catch) that 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 17.02–23.03 1998 (Working Document by A. Slotte and A. Dommasnes). The abundance estimate is given in Table 3.3.1.1. In 1998 the herring spawned over a wide area along the Norwegian coast, from 58°N to approximately 69°30'N.

3.3.2 Wintering areas

The Wintering Area was surveyed acoustically in November–December 1997 and in January 1998 (Working Document by K. Foote *et al.*). 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 mapped on a ICES co-ordinated multinational survey in May 1997 (ICES 1997). The abundance estimate from this survey is given in Table 3.3.3.1.

3.3.4 Nursery area

The nursery area of the Norwegian spring-spawning herring are 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.

The results from the joint Norwegian/Russian acoustic survey in the Barents Sea in May/June are given in Table 3.3.4.1. In later years, the Norwegian research vessels have not been granted access to the Russian Exclusive Economic Zone (EEZ) and have, consequently, not been able to cover the entire distribution area of the young herring. The data on the 1996 year class from the Norwegian estimate is obviously too low since only the distribution area within the Norwegian EEZ was covered (Working Document by I. Røttingen).

823 million individuals from the Varangerfjord in Northern Norway are included in the Russian estimate in 1997 (Table 3.3.4.1). However, this estimate was based on pelagic recordings thought, but not verified by trawling, to be young herring. Trawl stations in that area some weeks after the survey showed that these recordings consisted of 1 year old haddock. Thus the Varangerfjord estimate should be subtracted from the total Russian estimate, giving an estimate of 2.6 billion 1 year old herring in the Barents Sea in May/June 1997. Further, the Russian estimate of 2.5 billion 3 year old herring in May/June 1997 is difficult to explain. This estimate far exceeds any other earlier estimate of this year class (Table 3.3.4.1). Immigration into the Barents Sea of 3 year herring is highly improbable and for the time being, this estimate is therefore not taken into account.

Thus the following combined estimates (billion individuals) for the immature herring in the Barents Sea were agreed upon by the Working Group:

Age/ Year:	1997
1	2.6
2	0.04
3	0.4
4	0.35
5	0.05

A Russian survey carried out in March/April 1998 (WD by A. Krysov) resulted in estimates of 12.7 billion age 1 fish (1997 year class) and 2.4 billion age 2 fish (1996 year class). It is planned to repeat this survey next year, and it may eventually support the estimation of the young herring in the Barents Sea.

Table 3.3.4.1 includes information on juvenile herring back to 1984 (1983 year class). However, using this information in the extensive review of appropriate modelling and relevant input data made by the Working Group last year (ICES 1997) gave an extremely high variance. The reason for this may be the introduction of the Simrad EK-500 echo sounder and the BEI integrator as standard sampling equipment of the herring surveys at the beginning of the 1990s. This digital equipment greatly improved the possibility to split the integrator values into different species categories and to separate herring schools from sea bottom recordings, as well as improving amplifications and other forms for signal processing. There are indications that the previous system (Simrad EK-400, analogue signal processing) could under certain conditions suffer saturation and threshold problems which could result in underestimates of stock abundance. Indications of this can for example be seen by comparing acoustic estimates of young herring in the Barents Sea. The 1983 and 1992 year classes are estimated from the VPA (Table 3.5.7.6A) to be of approximate equal strength (24 and 32 billion as 3 year old). In the following extract from Table 3.3.4.1 the juvenile estimates from these year classes can be compared:

Survey Equipment:	Analogue EK-400	Digital EK-500/BEI
Age/Year class:	**1983**	**1992**
1	21.4	102.7
2	19.9	59.2

The distribution areas of these year classes were similar. There is therefore reason to believe that the results from the survey carried out with analogue equipment to a large extent are underestimates of the stock size (Table 3.3.4.1 before 1990) and can therefore not be considered directly comparable to the rest of the series.

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 1998

The larval survey 1998 started off Vesterålen the 9th of April (Figure 3.3.5.1). The sampling equipment was Gulf-III during daytime (0600–2200 hours) and dipnets during night-time (2200–0600 hours). At every third station nutrient composition, chlorophyll content and standing stock of zooplankton were measured. A high number of herring larvae was found from the start of the survey. More than 100 larvae per square meter sea surface were found on the banks outside Vesterålen and at the Røstbank. These larvae were in the later yolksac stages. Further south there was an area with somewhat fewer larvae, but between 62°N–66°N very high concentrations of large larvae were found. More than 100 larvae per square meter sea surface were found in the whole area and three areas with more than 1000 were found at the Haltenbank, Sklinnabank and outside Møre. More than 50% of these larvae were in stage 2a, when the yolksac has been resorbed and the dorsal fin has started to develop. At this stage they had started to grow and were beyond the most critical stage for starvation. Many of the herring larvae were observed with copepod nauplii in their guts. South of Statt fewer larvae were found than last year, however, more than 100 larvae per square meter sea surface were found in a relatively large area from Karmøy to Lista these larvae were newly hatched and in the earliest yolksac stages. The larval index for 1998 (Table 3.3.5.1) is the second highest since we started these investigations. Only the index from 1997 was higher. A very high mean standard length (12 mm) of the larvae was found in 1998. This is an indication of good growth in the larval population. However, the larval surveys have not so far been a reliable indicator of year class strength.

3.4 Tagging Experiments

The Norwegian tagging experiment on herring, initiated in 1975, has continued. 31,193 herring were tagged in April 1997, and 39,494 in March–April 1998. A considerable effort has also been made to find and correct errors in the material from previous years. As a result of this, some discrepancies have come up in the tagging data previously used by the Working Group. Although the discrepancies do not seem to affect the estimate of M, they should be thoroughly checked, and changes in the historical database should be documented as far as possible. For the present Working Group, data from 1996 and earlier years are the same as those used in last year's assessment.

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.

Recoveries are made from tag detectors installed at fish processing factories. For stock assessment purposes, tags are used only from factories where detector efficiency has been tested and found to be 100%, and where it is known that the detectors have been working as intended. Two factories filled these criteria in 1997, and a total of 95 million herring (23,443 t) were screened at these factories. All tagged herring which were recovered were measured, weighed, and aged. 12 tags from the 1983 year class were recovered in 1997.

The number of released and recovered fish of the 1983 and older year classes as used by the Working Group is given in Table 3.4.1. Tagged fish that were recovered the year they were tagged or the following year are not used for stock assessment. The use of the data in the assessment is described in Section 3.5.4.2.

3.5 Stock Assessment and VPA

3.5.1 Models for stock assessment

The assessment model applied in 1997 was essentially unchanged this year. The year classes that are not recruited to the fishery are treated separately and the same software as used in 1997 was also used this year (ICES 1997/Assess:14, ICES 1997/DD:8). It is assumed that the survey observations are proportional to the stock, and that for each survey there is a different proportionality factor, which is constant across ages and years. The model consists of three parts: A VPA, a Poisson model for the probability density distribution of tag returns and a probability density distribution for the survey observations, of which three different types were tried: 1) lognormal distribution, 2) gamma distribution with the variance calculated from the deviations between the modelled stock and the survey observations and 3) gamma distribution with the variance as an extra parameter to be estimated. A common variance for all surveys is assumed.

In the assessment made this year the international survey in the Norwegian Sea was added as a fourth survey series in the tuning procedure.

Following the assessment of last year a Bayesian assessment was carried out also this year, where also M was admitted to be uncertain. The results were consistent with those of the previous year in that there was an increasing probability for M towards lower values and - correspondingly - the mean spawning stock was lower than in the conventional estimate.

3.5.2 Input data

The year and age range, natural mortality and handling of missing values in the catch-at-age matrix was discussed in some detail in last year's report. This year it was decided to maintain the choices made last year.

Age-structured information on catches, and biological information from 1950 to 1997 were available for use and were included. Historical information from 1936 onwards is being re-evaluated at the IMR, Bergen and it is expected eventually to include these years in the time series. It was decided not to replace the missing observations in the catch-at-age matrix with values predicted by fitting a log-transformed separable model (Shepherd and Nicholson, 1991).

The analysis was run for ages 0 to 15 with a 16+ group. It was decided to calculate historic populations in the plus-group 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 conventional fashion. For VPA calculations the fishing mortality at the last true age was chosen to be calculated as the population-weighted mean fishing mortality from ages 8 to 13, on the basis that historical selection patterns have been approximately flat over this age-range. Following the advice given by ACFM

at its November 1995 meeting, it was decided to use $F_{5\text{-}14}$ weighted by the population number (hereafter denoted as $F_{5\text{-}14,w}$) as the reference F for this stock.

M was set 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 was set to 0.1.

The catch at age, weight at age in the catch and stock and maturity ogive for the period 1950–1997 are given in Tables 3.5.2.1–3.5.2.4.

3.5.3 Choice of survey and tagging data

The following acoustic survey information on the abundance of the adult stock was available:

- Surveys on the spawning stock in February-March, ages 5 to 15 and years 1988 to 1998. (1992, 1993 and 1997 missing due to bad weather conditions).
- Surveys on the wintering area in December, ages 4 to 14 and years 1992 to 1997.
- Surveys on the wintering area in January, ages 5 to 15 and years 1991 to 1998 (1997 missing).
- Survey on the adult stock in the Norwegian Sea, ages 4 to 14 and years 1996 to 1997.

The survey data file used in the assessment is given in Table 3.5.3.1.

It was decided to include information on releases and recaptures of fish of the 1983 and older cohorts in the assessment model, assuming all of these to be from the 1983 year class. The tagging data file used in the assessment is given in Table 3.5.3.2.

3.5.4 Treatment of acoustic surveys and tagging data in the assessment model

3.5.4.1 Survey structural relationships

As in the previous assessment of this stock, a simple age-independent proportionality relationship was assumed for the estimates of stock abundance $U_{a,y,i}$ from the *i*th survey in year *y* at age *a* on the adult stock. Denoting the constant of proportionality for the ith survey as Q_i the structural relationship to the VPA population abundance N, natural mortality M and fishing mortality F is:

$$U_{a,y,i} = Q_i N_{a,y} \exp\left((-F_{a,y} - M_{a,y})t_i\right)$$

Where t_i represents the timing of each survey relative to 1 January in fractions of years. Values of t_i are 0.17 for the February-March survey, 0.92 for the December survey, 0.001 for the January survey and 0.38 for the international survey.

3.5.4.2 Tagging

A known number of tagged fish $K_{j,a,y}$ were released into the sea in each of j experiments and then assumed to suffer an initial tagging mortality S. The number of tagged fish in the sea T is estimated by:

$$T_{j,a,y} = K_{j,a,y} S$$

and in subsequent years as:

$$T_{j,a+1,y+1} = T_{j,a,y} \exp\left(-F_{a,y} - M_{a,y}\right)$$

Recaptures of tagged fish ($G_{j,a,y}$) are then modelled as rare Poisson events whose expectation ($H_{j,a,y}$) is given by the catch equation and the number of tagged fish in the sea. Expected recaptures of tagged fish of age a in year y given that m_y fish are screened out of a catch of $C_{a,y}$ untagged individuals is approximately:

$$H_{j,a,y} = \left(\frac{m_y}{\sum_a C_{a,y}} \right) T_{j,a,y} \frac{F_{a,y}}{F_{a,y} + M_{a,y}} \left(1 - \exp\left(-F_{a,y} - M_{a,y}\right)\right)$$

3.5.5 Stock assessment

An extensive review of appropriate modelling choices and suitable input data was conducted in the previous assessment of this stock (ICES CM 1997/Assess:14) and the Working Group did not attempt to repeat the entire review procedure. Instead, the assessment model previously identified as the most appropriate choice was fitted again with the new survey data (Tables 3.3.1.1, 3.3.2.1, 3.3.2.2 and 3.3.3.1), new tagging information (Table 3.4.1) and new catch-at-age, weight at age and maturity ogive information for 1997 (Table 3.5.2.1–3.5.2.4). The new survey and tagging data input files are given in Tables 3.5.3.1 and 3.5.3.2. The sensitivity of the updated assessment to some plausible alternative modelling choices was then tested.

A summary of the more important model choices tested is given in Table 3.5.5.1.

Run 1 was made using the 1997 Working Group's assessment model with new data. Runs 2 and 3 were made with an assumption of either normal or lognormal observation errors for the surveys. Examination of the residual patterns for the three runs indicated that none of the three error models tested appeared to describe the distribution of data well, and no reliable choice could be made on this basis. Comparison of the runs showed that:

(a) Adding new data in the 1997 WG assessment model led to a revision in stock size from 5.5 to 13.8 Million t in 1996.
(b) The estimate of variance increased from 703,000 to 5,294,000.
(c) The marked upward revision in the estimate of stock size was not robust to alternative choices about error models.

The Working Group examined an alternative choice for the estimation of the parameters of the Gamma distribution. In the 1997 Working Group a moment-based variance estimator in an iterative procedure was used although other alternatives had been suggested. One such alternative was to estimate the variance directly as a parameter in the nonlinear search. This was implemented and the resulting model fit listed as Run 4 in Table 3.5.5.1. Results from this model fit were:

(a) More closely consistent with results obtained assuming other distributions.
(b) The survey variance estimate decreased from 5,294,000 to 620,000, suggesting that the fit in Run 1 had not found the maximum in the likelihood function.
(c) Stock size estimates were more closely consistent with those obtained previously.

Residual plots from this fit are shown in Figure 3.5.5.1.

The Working Group concluded that the iterative, moment-based variance estimation procedure is inappropriate and should not be used.

The Working Group examined the sensitivity of the assessment model to the inclusion or otherwise of acoustic survey data obtained in the February and March surveys prior to 1991, which arguably may not be consistent with estimates obtained subsequently with improved equipment. The values also have low residuals in the preceding model fit (Figure 3.5.5.1). The model was fitted again excluding these data (Run 5), resulting in a further decrease in survey variance from 620,000 to 607,000. Residual plots are given in Figure 3.5.5.2.

Some additional runs were made to assess the effect of removing weak year-classes from the assessment, and to assess alterations to selection pattern, but no obvious improvements in the consistency of the assessments were obtained. Due to time constraints within the meeting, and due to the fact that the software used to fit the model has not been developed for rapid implementation, a more detailed exploration of alternative model choices was not possible. The Working Group recommends therefore that for future assessments the catch-at-age and survey data should be compiled and circulated some weeks in advance of the Working Group meeting.

After the analyses described above, the Working Group resolved to base its best estimates of stock size on the model fit in Run 5 for the following reasons:

(1) Exclusion of acoustic survey data before 1991 is supported both by low residuals in the model fits and also by prior knowledge about equipment performance (Section 3.3.4).

(2) Although the data do not appear to be well described by the gamma distribution, no improvement would be obtained by assuming a normal distribution, and only a marginal and possibly illusory improvement would be gained by assuming a lognormal distribution. For consistency therefore the Working Group retains the use of the gamma distribution assumption. Uncertainty in error-model choice is included in the Bayesian assessment calculation (Section 3.7).
(3) Reasons for other model choices have been documented in ICES CM 1997/Assess:14.

For comparative purposes, results from Run 4 and corresponding short-term deterministic projections are also given in detail.

Defining the following variables,

a,y,i,j - subscripts for age, year, survey and tagging experiment
H - Expected number of recaptures of tagged fish
G - Reported number of recaptures of tagged fish
U - Survey abundance index
α- Gamma function shape parameter
β- Gamma function scale parameter
Q - survey 'catchability' (Scaling between VPA abundance estimate and survey abundance estimate)
Γ - Gamma function
F - Fishing Mortality
M - Natural Mortality
N - Population abundance on 1st January
t - fraction of mortality incurred before the survey

the likelihood function used in the Working Group's 'final' assessment calculation is:

$$\sum_{j,a,y} G_{j,a,y} \ln\left(H_{j,a,y}\right) - H_{j,a,y} - \ln\left(G_{j,a,y}!\right) +$$

$$\sum_{i,a,y} -U_{i,a,y}/\beta_{i,a,y} + (\alpha_{i,a,y}-1)\ln\left(U_{i,a,y}/\beta_{i,a,y}\right) - \ln\left(\beta_{i,a,y}\Gamma\left(\alpha_{i,a,y}\right)\right)$$

where the scale parameter estimate is:

$$\beta_{i,a,y} = \sigma^2 / \left(Q_i N_{a,y} \exp\left(\left(-F_{a,y} - M_{a,y}\right)t_i\right)\right)$$

and shape parameter estimate is:

$$\alpha_{i,a,y} = \left(Q_i N_{a,y} \exp\left(\left(-F_{a,y} - M_{a,y}\right)t_i\right)\right)^2 / \sigma^2$$

with the gamma function:

$$\Gamma(\alpha) = \int_0^{\infty} \exp(-u)\, u^{\alpha-1}\, du$$

and the parameters estimated are:

Population abundance N at age 15 at 1 January 1998,
Population abundance N at age 6 at 1 January 1998,
Catchabilities Q_i for each of the four surveys on the adult stock,
Tagging survival S,
Variance σ^2.

A constraint is imposed such that $F_{15-16}=F_{7-13,\ 1997} = F_{14,\ 1997}$, and a linear interpolation is made for F at age between F=0 at age =-1 and $F_{5,1997}$ and for F at age 6 between $F_{5,1997}$ and $F_{7,1997}$.

Parameter estimates and corresponding estimates of coefficients of variation from a simple parametric bootstrap calculation are given in Table 3.5.5.2. Matrices of fishing mortality, population abundance and corresponding stock size estimates are given in Tables 3.5.7.1A to 3.5.7.6A for Run 5 and also in Tables 3.5.7.1B to 3.5.7.6B for Run 4.

3.5.6 Assessment of the 1993 and younger year classes

Two sets of recruitment forecasts were made, corresponding to the results of the final VPA (run 5) and the comparative assessment (run 4) respectively. The RCT3 program was used for predicting the abundance of the year classes which were not determined by the assessment model given above, i.e. the 1993–1997 year classes.

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 Tables 3.5.6.1A (Run 5) and 3.5.6.1B (Run 4) and the results of the analysis are given in Table 3.5.6.2A (Run 5) and Table 3.5.6.2B (Run 4). The year class strength of the 1993–1997 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	1998 WG Run 5	1998 WG Run 4	1997 WG
1993	12.326	14.296	13.685
1994	2.481	2.632	0.688
1995	0.396	0.399	0.667
1996	3.724	4.249	3.103
1997	2.771	3.190	-

It may not be appropriate to compare the estimates of age 1 and 2 from the acoustic survey in the Barents Sea in May/June in 1990 and earlier years to those for 1991 and later years, as discussed in Section 3.3.4.

Given the highly variable recruitment in this stock, the Working Group considered that using these estimates would be preferable to using the assumption of a mean value for forthcoming recruitment.

3.5.7 The final VPA

The final VPA was run using the values of terminal F from the Working Group's best estimate using the assessment method presented in Section 3.5.4 (run 5) for the 1992 and older year classes. The fishing mortalities for the 1993–1995 year classes were adjusted so that the abundance at age 3 of those year classes are the same as those predicted by RCT3. The fishing mortalities and stock numbers are given in Tables 3.5.7.1A–3.5.7.2A, while the stock biomass at age and spawning stock biomass at age are given in Tables 3.5.7.3A–3.5.7.4A. A summary of landings, fishing mortality, stock biomass, spawning stock biomass and recruitment is given in Tables 3.5.7.5A and 3.5.7.6A, for recruitment at age 0 and 3 respectively, and Figure 3.5.7.1A. Plots of recruitment at age 0 and age 3 vs. spawning stock biomass are given in Figure 3.5.7.2A.

Corresponding information for run 4 is given in Tables 3.5.7.1B–3.5.7.6B and Figures 3.5.7.1B and 3.5.7.2B for comparative purposes.

3.5.8 Yield-per-recruit analysis

The yield per recruit analysis using the fishing pattern and stock parameters from 1998 from the management option table based on run 5 gave estimates of $F_{0.1}$=0.19 (based on ages 0-16+), while F_{max} was not defined. Yield per recruit vs. F is plotted in Figure 3.5.8.1.

3.6 Short-Term Prediction

3.6.1 Input data to the short-term prediction

These data are given in Table 3.6.1.1A for the final assessment (Run 5) and in Table 3.6.1.1B for comparative purposes (Run 4). The number at age at January 1, 1998, was taken from the final VPA for the year classes 1995 and older. For the 1996 and 1997 year classes, values corresponding to the RCT3 estimate of year class strength at age 3 were used. The weight at age and the maturity ogive in the stock in 1998 was set equal to the weight at age and maturity ogive for the corresponding age groups obtained from biological samples taken during the December 1997 survey. The 1998 values of those parameters were also used for later years. The weight at age in the catch and the fishing pattern in 1998 and later years were set equal to the 1997 values. The natural mortality was set to the same values as used in the assessment, i.e. 0.15 on ages 3 and older. The weight at age in the stock and in the catch has been decreasing in the later years, and the Working Group assessed whether this reduction would prevail. However, a long-term study (WD by Holst *et al.*) indicates that the condition of the adult herring covaries with the ocean climate in the feeding area (Norwegian Sea). As the prospects for a more favourable ocean temperature regime in the feeding areas are positive (Section 7.2.1), the Working Group decided to use maturity at age and weight at age in the stock data for 1998 and the weight at age in the catch data for 1997 in the short-term prediction.

3.6.2 Results of the short-term prediction

Assuming that the internationally agreed TAC of 1,302,000 t in 1998 is taken, this will cause the fishing mortality ($F_{5-14,u}$) to decrease from 0.23 in 1997 to 0.17 in 1998. The effects of different levels of $F_{5-14,u}$ on the catch in 1999 and on the stock and SSB in 2000 are presented in Table 3.6.2.1A (Run 5) and Table 3.6.2.1B (Run 4). Unweighted fishing mortalities are considered in the following discussions.

The assessment shows that the spawning stock biomass decreased from 10.1 million tonnes in 1997 to 9.8 million tonnes in 1998, and will decrease further to 8.8 million tonnes in 1999. From 1999 to 2000, the spawning stock biomass will decrease for all values of F. With a *status quo* TAC in 1999, the $F_{5-14,u}$ will decrease from 0.17 in 1998 to 0.15 in 1999. The fishing mortality in 1998 of 0.17 is close to the value of 0.16 obtained in last year's assessment.

3.7 Bayesian Stock Assessment and Estimation of Uncertainty

3.7.1 Method and assumptions

A Bayesian approach to the estimation of uncertainty in some key parameters of management interest was used. This methodology is as used by the Working Group previously (ICES CM 1997/Assess:14). The method allows the Working Group to incorporate opinions held about the stock which are based on biological observations but which are difficult to quantify. It allows incorporation of such qualitative observations into the assessment procedure in a formal fashion, although a quantification of a large part of the uncertainty, due to choice of survey data and selection pattern model, remains intractable. The methodology used was described previously but is repeated here for convenience.

Conventional Bayesian analysis relies on an evaluation of the posterior probability $\mathbf{P(\Theta|X)}$ of a certain set of assumptions Θ, given prior belief $\mathbf{P(\Theta)}$ about those assumptions, a set of new information $\mathbf{X}$ and a likelihood function allowing the evaluation of $\mathbf{P(X|\Theta)}$. The conditional probability can be expressed as:

$$\mathbf{P(\Theta|X) = P(X|\Theta)\ P(\Theta) / \int P(X|\Theta)\ P(\Theta)\ d\Theta}$$

Conventionally the Θ is a vector of input parameters to a model **M**, which is assumed to be correct and upon which the likelihood function is predicated. It is also possible to treat the entire model structure **M** as an additional unknown, and to integrate both over uncertainty in model parameters and over uncertainty in the model structure (in this case each Θ has a meaning which is specific to each **M**). The evaluation of posterior probabilities proceeds analogously:

$$\mathbf{P(\Theta,M|X) = P(X|\Theta,M)\ P(\Theta|M)\ P(M) / \int P(X|\Theta,M)\ P(\Theta,M)\ P(M)\ d\Theta\ dM}$$

This approach allows the evaluation of a posterior probability distribution for any quantity of management interest (e.g. catch forecast, outcome of a harvest control regime, etc.) that can be calculated from any Θ and **M**. Such a distribution can be constructed for any reasonable range of alternative model components in **M**, so long as for each model component a likelihood term $\mathbf{P(X|\Theta,M)}$ can be calculated.

In the present case, this has allowed the Working Group to make a calculation of uncertainty that includes uncertainty in the choice of appropriate error model and in the choice of appropriate stock-recruitment function. Gamma, lognormal

and normal errors were admitted as alternative error models for the acoustic surveys with equal prior probability. With this approach it is not necessary to make a subjective choice of appropriate stock recruitment-function, as alternatives thought to be plausible can be admitted. In this case, the Working Group admitted two recruitment models as acceptable structural models with equal prior probability, being either the Beverton-Holt model or a Ricker model. For both models, all the year-classes since 1992 were included in the calculation

In summary, uncertainty was admitted on the following parameters as below:

Cohort abundance at age 15 in 1998:	**Uniform prior chosen to be unrestrictive**
Cohort abundance at age 6 in 1998	**Uniform prior chosen to be unrestricitive**
Log catchabilities ln(q) for each acoustic survey	**Uniform prior chosen to be unrestrictive, except for the international survey where ln(q) was constrained within +/- 2.5 of the maximum-likelihood estimate.(*)**
Additional mortality due to *Ichthyophonus*	**Uniform prior 0 to 0.1 consistent with previous assessment (year-classes 1987 and older, during 1991-1994)**
Acoustic survey variance σ^2	**Prior probability proportional to 1/ σ^2 (see Jeffreys, 1961), range chosen to be unrestrictive**
Initial survival of tagged fish St	**Uniform prior in range 0.2-1.0, consistent with survival of tagged fish held in capture**
Error Models for Surveys	**Equal prior probability assigned to normal, lognormal and gamma models**
Recruitment Models	**Equal prior probability assigned to Beverton-Holt model, and Ricker model (all year classes to 1992)**

Some additional choices made were:

Selection Pattern Model	**As 'Run 5'**
Input data	**As 'Run 5'**

(*) - This choice was made because this survey has only been completed for two years.

There are two differences from the prior distributions used previously. Firstly, the parameter for natural mortality of juvenile fish was replaced with a simple multiplier consistent with the assumptions in the maximum-likelihood assessment, because there are no survey observations on the younger age-groups which can be used to derive a contribution to the likelihood function from the data, other than the stock-recruitment function. Hence the assumption was made that $M_{0\text{-}2} = 6.M_{3\text{-}16}$. Secondly, only two stock-recruit models were specified as alternative choices, being either Ricker or Beverton-Holt, and the option to fit a stock-recruit model excluding the strongest year-classes only was not included.

A Markov Chain Monte Carlo approach was again used (Gilks *et al.* 1996) to generate multivariate samples from posterior probability distributions. A hybrid adaptive rejection sampling algorithm similar to that described by Gilks (1996) was used, except that Gilks' secant upper envelope function was replaced with a series of rectangular approximations. Although computationally less efficient, this algorithm is more robust to structural bound-constraints (such as the upper bound of 100% tagging survival that the assessment model requires). Choice of burn-in period and the interval between which samples were assumed to be uncorrelated was set to 1000 iterations and 100 iterations respectively, following previous calculations of minimum values of 600 and 76 respectively using the GIBBSIT algorithm of Raftery and Lewis (1996) on a similar assessment model (Patterson, WD 1997).

The Working Group has still not developed a fully internally-consistent model of stock dynamics and forecasting, and it was again necessary to treat recruitment forecasting externally using RCT3 and then use estimates so derived to fix the

recruiting year classes (ages 1 to 5 in 1998) in the stochastic calculations to the same abundance (relative to the abundance at age 6) that they have in the deterministic calculation.

The calculations of uncertainty made here are considered to be underestimates. Although uncertainty in natural mortality has been included and an integration is made over the parameter space, uncertainty introduced due to model choice (alternative selection patterns) and outlier deletion has not been modelled explicitly.

3.7.2 Uncertainty in stock assessment expressed as posterior distributions

Posterior distributions calculated by the method described above for the parameters estimated directly in the assessment procedure (cohort abundance, natural mortality rates, etc.), for the 'nuisance' parameters (catchability, survey variance) and for estimates of stock size and fishing mortality are given in Figures 3.7.2.1 and 3.7.2.2. These indicate likely stock abundance centred around 6 million t in 1997 with a range from 3 to 12 Million t. These estimates are rather lower than the maximum-likelihood estimate of 10 Mt. The coefficient of variation of the spawning stock size estimate is calculated to be 64%.

The perception of natural mortality, which was admitted uncertain in the range 0.1 to 0.25, indicates that lower values are more likely and the probability reaches a maximum on the bound M=0.1. Lower values of *Ichthyophonus*-induced mortality (less than 0.04) also appear more likely. The posterior estimate of appropriate error model differs from the choice made in the conventional procedure, and indicates the normal error distribution to have a higher posterior probability. These estimates are consistent with those found in the previous estimates derived using this method.

3.8 Precautionary Approach to Fisheries Management

The report of the Study Group on the Precautionary Approach to Fisheries Management (ICES 1998/ACFM:10, Ref. D) was considered. The Working Group agreed that the following values for the precautionary and limit reference points should apply to the stock of Norwegian spring-spawning herring:

B_{lim}=2.5 million t (as indicated by ICES 1998).

Even at the B_{lim} level this will be the largest herring stock in the North Atlantic area. If there is no change in the migration pattern, the entire adult stock will be easily accessible in concentrated schools in fjord areas throughout a large part of the year making it very difficult for a management agency to carry out a total ban in the fishery. In the rebuilding period (1970–1990) the fishing mortality was restricted to F=0.05 at spawning stock levels below 2.5 million t. This restriction was accepted by the management agencies, and in retrospect this can be considered a successful regulatory measure (WD by I. Røttingen). The Working Group therefore suggests that a fishing mortality of 0.05 at spawning stock levels below 2.5 million t should be accepted as a precautionary regulatory measure for stock rebuilding.

F_{pa} was set to 0.15 as indicated by ICES 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.

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 will decline in the years to come (Table 3.6.2.1A). 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 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. And in the ACFM May 1997 report (ICES 1997) it is stated in the Advice for Management for Norwegian spring-spawning herring: "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 in the event of the stock biomass declining towards MBAL."

The proposed harvest control rule is illustrated in Figure 3.9.1 and compared to harvest control rules with other values of B_{pa} and the catch ceiling in Section 3.10.

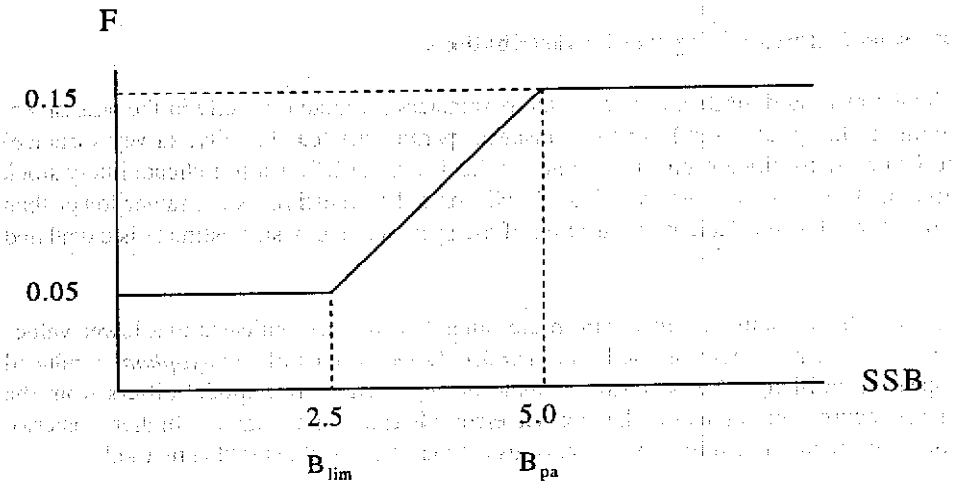


Figure 3.9.1 Illustration of the harvest control rule described in Section 3.8.

3.10 Medium-Term Projections

Two different approaches to medium-term projections were applied. First, a simple model implemented on an Excel spreadsheet was run, similar to the approach used at last year's meeting of this Working Group. Second, distributions from the Bayesian approach (Section 3.7) were used for projective runs.

3.10.1 Simple spreadsheet forecasts

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 5. (Table 3.6.1.1A).

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 log scale for ages 4 and older in 1998, 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 abundance of 4-year old and older fish was assumed to be fully correlated and independent of younger ages. It was found that this particular assumption made little difference compared to an assumption of full independence across all ages from age 4 and older.

The projections started at January 1 1998 and the allocated catch for 1998 was implemented using an F of 0.17. 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.

Based on the discussion in Sections 3.8 and 3.9, the Working Group decided to investigate what effect the introduction of some measures which includes reduction in F when the stock declines to B_{pa} has on the probability for the spawning stock to decline below B_{lim}.

In last year's report, harvest control rules of the form F =constant with a catch ceiling were investigated. This year, the following harvest control rules were tested:

1) F=0.15 for SSB> B_{pa}, linear reduction of F to 0.05 at SSB=2.5 million tonnes, F=0.05 below 2.5 million tonnes. In addition, a catch ceiling of 1.5 million tonnes was applied. This rules was tested out for values of B_{pa}=2.5, 4.0 and 5.0 million tonnes.

1000 simulations were performed for each harvest control rule. For various harvest control rule parameters, the average yield for the 10-year period 1999–2008 as a function of harvest control rule parameters is given in Table 3.10.1.1, while the probability of SSB to falling 2.5 million tonnes in this period is given in Table 3.10.1.2.

Table 3.10.1.1 Medium-term simulation output. Average catch, 1999-2008, for different parameters in harvest control rule.

		Bpa level in control rule		
	Ybar(99-08)	2.5	4.0	5.0
	1	0.73	0.71	0.69
Maximum catch	1.25	0.77	0.75	0.73
	1.5	0.80	0.78	0.76

Table 3.10.1.2 Medium-term simulation output. Probability of spawning stock biomass falling below 2.5 million tonnes during the period 1999- 2009, for different parameters in harvest control rule.

		Bpa level in control rule		
	P(SSB < 2.5 by 2009)	2.5	4.0	5.0
	1	0.33	0.22	0.19
Maximum catch	1.25	0.38	0.27	0.21
	1.5	0.38	0.27	0.21

From these tables, the following conclusions can be drawn:

1. Continued fishing using the present harvest control rule, gives a high probability of the stock falling below B_{lim} in the medium-term (10 years).
2. The probability of SSB falling below 2.5 million tonnes in the coming 10-year period is almost halved when a reduction in F at SSB levels below B_{pa}=5.0 million tonnes is applied.
3. The mean catch in the medium-term period is below 1.0 million tonnes.

Figures 3.10.1.1 and 3.10.1.2 show the yield and SSB for harvest control rules with B_{pa} =5.0 and 2.5 million tonnes, respectively. The catch ceiling is set to 1.5 million tonnes in both cases. 5, 25, 50, 75 and 95 percentiles are given to illustrate the uncertainty in the prognosis.

3.10.2 Bayesian medium-term projections and short-term risk calculation

Medium-term projections under some simple harvest control assumptions have been calculated according to the methodology described in ICES CM 1997 and also in more detail by Patterson (1997).

As noted previously, admitting uncertainty in natural mortality requires a redefinition of the measure of exploitation of the stock, as fishing mortality rates are strongly dependent on natural mortality. The parameterisation used was to redefine exploitation rate as E=F/Z. Hence, for comparison with the conventional assessment (M assumed fixed = 0.15) calculations based on exploitation rate constraints have been made. Where reference is made in the conventional assessment and forecasting to an F_{pa} of 0.15, for example, this has been interpreted as F_{pa} = F=M.

The perception of stock size based on the Bayesian assessment is again rather different from that calculated in the conventional assessment. The exploitation rate, as defined above, is rather high, being in the range 1.86 to 4.0 (25% and 75% confidence limits) in the Bayesian calculation compared with 1.73 in the maximum-likelihood assessment. This occurs because VPA calculations estimate values of F predicated on assumed values of M. When assumptions about M are relaxed in the Bayesian assessment, perceptions of F alter correspondingly.

Three medium-term calculations have been initiated from the Bayesian assessment. These are intended to illustrate the likely development of the stock under recent exploitation levels, and to illustrate the likely development of the stock if each of two harvest control rules were applied.

The assumptions and starting parameters used in these runs are summarised below:

1. Population abundance in 1998, natural mortality: Draws from Bayes posterior distribution used (Section 3.7).

2. Stock-recruit modelling: Draws of Ricker or Beverton-Holt models and parameter estimates from Bayes posterior distribution (Section 3.7).
3. Selection pattern: Conditional on population abundance estimates in 1998. This selection pattern was assumed to hold for 1998–2002.
4. Weights at age in stock, maturity ogive and weights at age in the catch: Estimates used for 1997 also assumed to hold for the years 1998–2002.

Although it was considered desirable to develop a fully internally-consistent model of stock dynamics and forecasting, this goal was not entirely attained due to the perceived need to use the 'RCT3' recruitment prediction procedure for year classes 1993 to 1997 separately from the assessment procedure. The solution used was to fix the recruiting year classes (ages 1 to 5 in 1998) in the stochastic calculations to the same abundance (relative to the abundance at age 6) that they have in the deterministic calculation.

Estimates of future population dynamics of the stock under an assumption of $F_{1998\text{-}2002} = F_{1997}$ are given in Figure 3.10.2.1. This projection indicates a further small increase in catches until 1999, with a decline in catches thereafter. Stock size is projected to decline progressively until the stock dynamics become overwhelmed by uncertainty in future recruitment.

The first harvest control rule modelled is based on that implicitly used by management at present:

Catch = Lower value of:
Catch for F=M (corresponds to F=0.15);
and
Catch of 1.5 million tonnes.

The outcome of applying this rule is given in Figure 3.10.2.2. According to this calculation, recent levels of F are well in excess of M and applying the harvest rule would entail an abrupt reduction in fishing mortality and also in catches, to about 600,000 t in 1998, but remaining approximately stable thereafter. Under this regime the projected stock size appears approximately stable also.

A third alternative was modelled, in which an additional constraint was imposed:

If Spawning stock size < 2.5 Mt
then
Catch = Catch for F = 1/3 M (corresponds to F=0.05)

The outcome is shown in Figure 3.10.2.3. This is closely similar to the previous simulation, indicating that at least in the short term there is small probability of the stock size being under 2.5Mt and the reduced-F regime being invoked.

Percentiles of the distribution of catches for each medium-term simulation are also given in Table 3.10.2.1.

In the short term, these simulations indicate that catches above around 1.55 million t in 1998 or above 1.65 million t in 1999 would exceed F status-quo catches with probabilities above 50%. Catches above 500,000 t in 1998 and above about 750,000 t in 1999 would exceed the catch corresponding to the harvest control rule with probability above 50%. Corresponding percentiles for a wide range of catch options are given in Table 3.10.2.2. As noted above, these percentiles do not necessarily correspond to the predictions based on the maximum-likelihood estimates.

3.11 Management Considerations

The Working Group stresses that the assessment of this stock is not considered reliable. There are still only a few years of survey observations on recruiting year classes, and little historic information on which to base estimates of survey catchability. Essentially, this resource consists of a few recruiting year classes and there is little historic information which allows comparative year-class strength to be evaluated without making assumptions about natural mortality. On this account, the assessment calculation is believed to be strongly dependent on the assumed structure of the assessment, particularly the assumption of a uniform catchability on all ages in the surveys and on the assumed value of natural mortality in the assessment. The apparent plausibility of alternative assumptions about error distributions and appropriate data sets also contribute to the uncertainty in the assessment. The Bayesian calculation may present a more consistent perception of the stock dynamics under these factors, but even the estimate of a coefficient of variation of 64% in the stock size estimate is probably an underestimate.

In the light of the above, it 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 under which the catch taken 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 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 7). 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 1998, but the assessment is imprecise and the assessment procedure is sensitive to details of model structure. However, the long term development of this stock is known. The spawning stock is supported by two strong year classes (1991 and 1992) having reached a maximum stock size in 1997. The spawning stock is projected to decline due to the recruitment of weak year classes to the spawning stock. Both short-term and medium-term predictions show considerable reductions in spawning stock size from year 2000 due to a succession of weak recruiting year classes. Thus the present declining trend in the TAC recommendations, which are in accordance with the adopted harvest control rule, from ACFM (1.5 million t in 1997, 1.2 million t in 1998), should continue in 1999.

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

Information on the migration pattern up to autumn 1997 was provided to the ACFM November 1997, and formed the basis for the answer to the request from NEAFC.

3.12.1 Wintering areas 1997/1998

The spawning stock this year wintered in the Vestfjorden area as it has done since 1987/1988. However, with the recruitment of the strong 1991 and 1992 year classes, the centre of the biomass of the wintering stock have moved from the inner part of the fjord system (Ofotfjorden and Tysfjorden) out to the main areas of Vestfjorden (WD by Foote *et al.*). This shift in distribution can be seen from Figure 3.12.1. Further, this winter a minor part of the population wintered in Kvæfjorden/Gullesfjorden just north of Vestfjorden.

3.12.2 Spawning season 1998

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). The distribution of herring larvae (Figure 3.3.5.1) gives a perception of the distribution of the spawning areas.

3.12.3 Feeding areas in 1998

Information on the emigration from the spawning areas and the distribution in the feeding areas in the Norwegian Sea in spring/summer 1998 will be mapped on an ICES co-ordinated survey in May 1998. 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 1998/99 wintering areas.

3.13 Reductions in Fecundity and Occurrence of Atresia

In a study (WD by Holst *et al.*) of fecundity in the Norwegian spring spawning herring, a considerable decrease in the gonad weights was detected in recent years (Figure 3.13.1). Further, atresia (resorbing eggs) was common when length specific weights (condition) of herring (Figure 3.13.2) are low as currently shown. This seems to play a relatively important role in determining the fecundity of herring. The results indicate a considerable decrease in the fecundity in the stock in recent years.

3.14 Discards

The fishery for Norwegian spring-spawning herring is a single stock purse seine and pelagic trawl fishery. Discards are not generally considered a major problem in this fishery. The nursery areas (mainly Barents Sea) are separated from the feeding, wintering and spawning areas (Norwegian coast, Norwegian Sea) of the fishable adult stock.

However, discards (and other forms for additional mortality in the fishery)may occur under following circumstances:

1) A major part of the fishery is for human consumption. In this fishery the prices are size-graded with higher prices for the larger fish. Discarding may occur in order to increase the number of larger fish in the catch.
2) Breaking of gear is sometimes reported while fishing on high concentrations of herring.

There are no estimates of additional mortality due to the above instances.

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

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 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[1]	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

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

Table 3.2.3

Record No	Country	Quarter	Area	Sampled Catch	Official Catch	WG Catch	No. of samples	No. fish aged	No. fish measured	CN 0	CN 1	CN 2	CN 3	CN 4	CN 5	CN 6	CN 7	CN 8	CN 9	CN 10	CN 11	CN 12	CN 13	CN 14	CN 15	CN 16
Norwegian	0	16	1997																							
1	Scotland	2	IIa	22999	23200	22999	37	2087	9506	0	0	0	52	484	15995	36691	17597	7798	1674	332	1240	1787	258	10643	0	0
2	Scotland	3	IIa	0	433	433	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	Scotland	4	IIa	0	1717	1717	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	Faroes	1	Vb	0	0	122	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	Faroes	2	Vb	0	0	16282	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	Faroes	3	Vb	0	0	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	Faroes	4	Vb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	Faroes	1	IIa	0	0	4345	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	Faroes	2	IIa	0	0	20003	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	Faroes	3	IIa	0	0	14991	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	Faroes	4	IIa	0	0	4209	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	Iceland	2	IIa	203284	212075	212089	10	817	912	0	0	0	0	2052	93385	378672	151879	72861	8210	1026	0	28734	0	101595	0	0
13	Iceland	3	Va	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	Iceland	4	IIa	0	7965	7965	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	Denmark	2	IIa	30851	32020	30851	19	790	1103	0	0	0	0	1300	14020	35240	20860	7900	4480	8840	12490	1793	259	10676	0	0
16	Denmark	3	IIa	0	9908	9908	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	Denmark	4	IIa	0	3533	3533	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	Norway	1	IIa	329558	277833	329558	77	7153	7153	0	0	415	21108	39002	502748	511074	160441	78293	24926	2221	2668	16869	0	82064	0	0
19	Norway	3	IIa	13399	13103	13399	31	1732	1732	0	0	0	902	2637	15342	19565	3626	3009	1134	1329	1457	1750	47	7708	0	0
20	Norway	4	IIa	518006	517209	518006	39	3632	3632	0	0	19844	81325	182798	772246	577030	243443	87637	6371	0	309	12443	0	80678	0	0
21	Russia	1	IIa	89250	86952	89250	11	662	20432	0	0	0	4578	4548	165935	154889	50886	16856	4247	0	0	3177	4046	22470	0	0
22	Russia	3	IIa	18500	18500	18500	21	1904	20907	0	0	0	1298	2486	24429	26724	5312	2989	690	260	2111	3508	3506	140	0	0
23	Russia	4	IIa	61150	61150	61150	8	512	14241	0	0	0	15148	15598	68670	54842	23989	7573	2285	657	3391	4252	9866	1617	302	0
24	Germany	2	IIa	0	7490	6190	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	Ireland	2	IIa	11179	0	11179	1	625	1173	0	0	0	0	113	4385	12249	8965	6843	711	1529	2810	4308	652	163	0	0
26	Netherland	2	IIa	8694	17866	8694	16	400	400	0	0	184	0	2903	10712	8101	2706	1608	385	166	622	897	130	5341	0	0
27	France	2	IIa	0	1500	1500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	Sweden	2	IIa	0	19499	19499	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	Norway	1	IVa	0	51725	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	Norway	3	Vb	0	266	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
-1						1426507																				

Table 3.2.4

Record No	Country	Quarter	Area	Sampled Catch	Official Catch	WG Catch	No. of samples	No. fish aged	No. fish measured	CW 0	CW 1	CW 2	CW 3	CW 4	CW 5	CW 6	CW 7	CW 8	CW 9	CW 10	CW 11	CW 12	CW 13	CW 14	CW 15	CW 16
Norwegian	0	16	1997																							
1	Scotland	2	IIa	22999	23200	22999	37	2087	9506	0.000	0.000	0.000	0.167	0.204	0.205	0.224	0.259	0.283	0.303	0.302	0.299	0.322	0.311	0.328	0.000	0.000
2	Scotland	3	IIa	0	433	433	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
3	Scotland	4	IIa	0	1717	1717	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
4	Faroes	1	Vb	0	0	122	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	Faroes	2	Vb	0	0	16282	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	Faroes	3	Vb	0	0	35	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	Faroes	4	Vb	0	0	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	Faroes	1	IIa	0	0	4345	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	Faroes	2	IIa	0	0	20003	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	Faroes	3	IIa	0	0	14991	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	Faroes	4	IIa	0	0	4209	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	Iceland	2	IIa	203284	212075	212089	10	817	912	0.000	0.000	0.000	0.000	0.147	0.188	0.212	0.256	0.279	0.310	0.320	0.000	0.322	0.000	0.335	0.000	0.000
13	Iceland	3	Va	0	0	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
14	Iceland	4	IIa	0	7965	7965	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15	Denmark	2	IIa	30851	32020	30851	19	790	1103	0.000	0.000	0.000	0.000	0.201	0.191	0.218	0.260	0.279	0.325	0.332	0.335	0.322	0.311	0.326	0.000	0.000
16	Denmark	3	IIa	0	9908	9908	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17	Denmark	4	IIa	0	3533	3533	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
18	Norway	1	IIa	329558	277833	329558	77	7153	7153	0.000	0.000	0.051	0.127	0.137	0.177	0.226	0.277	0.314	0.333	0.330	0.364	0.366	0.000	0.388	0.000	0.000
19	Norway	3	IIa	13399	13103	13399	31	1732	1732	0.000	0.000	0.000	0.114	0.139	0.185	0.212	0.248	0.273	0.288	0.290	0.298	0.324	0.311	0.324	0.000	0.000
20	Norway	4	IIa	518006	517209	518006	39	3632	3632	0.000	0.000	0.089	0.180	0.194	0.233	0.257	0.295	0.329	0.371	0.000	0.415	0.351	0.000	0.376	0.000	0.000
21	Russia	1	IIa	89250	86952	89250	11	662	20432	0.000	0.000	0.000	0.130	0.131	0.167	0.203	0.253	0.276	0.309	0.000	0.000	0.337	0.324	0.345	0.000	0.000
22	Russia	3	IIa	18500	18500	18500	21	1904	20907	0.000	0.000	0.000	0.195	0.179	0.218	0.242	0.279	0.316	0.349	0.358	0.351	0.353	0.354	0.400	0.000	0.000
23	Russia	4	IIa	61150	61150	61150	8	512	14241	0.000	0.000	0.000	0.163	0.208	0.263	0.292	0.348	0.387	0.406	0.470	0.455	0.436	0.454	0.477	0.510	0.000
24	Germany	2	IIa	0	7490	6190	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	Ireland	2	IIa	11179	0	11179	1	625	1173	0.000	0.000	0.000	0.000	0.192	0.190	0.218	0.254	0.281	0.311	0.331	0.337	0.346	0.356	0.384	0.000	0.000
26	Netherland	2	IIa	8694	17856	8694	16	400	400	0.000	0.000	0.165	0.000	0.191	0.215	0.249	0.290	0.321	0.317	0.302	0.299	0.322	0.311	0.328	0.000	0.000
27	France	2	IIa	0	1500	1500	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	Sweden	2	IIa	0	19499	19499	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	Norway	1	IVa	0	51725	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30	Norway	3	Vb	0	296	0	0	0	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-1						1426507																				

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	30851.00	45461.00	19	1103	790	100.40
France	0.00	1500.00	0	0	0	0.00
Germany	0.00	7490.00	0	0	0	0.00
Iceland	203284.00	220040.00	10	912	817	100.05
Ireland	11179.00	0.00	1	1173	625	100.05
Netherlands	8694.00	17866.00	16	400	400	99.44
Norway	860963.00	808145.00	147	12517	12517	100.00
Russia	168900.00	166602.00	40	55580	3078	100.00
Scotland	22999.00	25350.00	37	9506	2087	102.24
Sweden	0.00	19499.00	0	0	0	0.00
Total IIa	1306870.00	1311953.00	270	81191	20314	100.05

Sum of Offical Catches : 1311953.00
Unallocated Catch : 98015.00
Working Group Catch : 1409968.00

AREA : IVa

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Norway	0.00	51725.00	0	0	0	0.00
Total IVa	0.00	51725.00	0	0	0	0.00

Sum of Offical Catches : 51725.00
Unallocated Catch : -51725.00
Working Group Catch : 0.00

AREA : Va

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %

Sum of Offical Catches : 0.00
Unallocated Catch : 100.00
Working Group Catch : 100.00

AREA : Vb

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Norway	0.00	296.00	0	0	0	0.00
Total Vb	0.00	296.00	0	0	0	0.00

Sum of Offical Catches : 296.00
Unallocated Catch : 16143.00
Working Group Catch : 16439.00

Table 3.2.5 (continued)

PERIOD : 1

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Norway	329558.00	329558.00	77	7153	7153	100.05
Russia	89250.00	86952.00	11	20432	662	100.00
Period Total	418808.00	416510.00	88	27585	7815	100.01

Sum of Offical Catches :	416510.00
Unallocated Catch :	6765.00
Working Group Catch :	423275.00

PERIOD : 2

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Denmark	30851.00	32020.00	19	1103	790	100.40
France	0.00	1500.00	0	0	0	0.00
Germany	0.00	7490.00	0	0	0	0.00
Iceland	203284.00	212075.00	10	912	817	100.05
Ireland	11179.00	0.00	1	1173	625	100.05
Netherlands	8694.00	17866.00	16	400	400	99.44
Scotland	22999.00	23200.00	37	9506	2087	102.24
Sweden	0.00	19499.00	0	0	0	0.00
Period Total	277007.00	313650.00	83	13094	4719	100.25

Sum of Offical Catches :	313650.00
Unallocated Catch :	35636.00
Working Group Catch :	349286.00

PERIOD : 3

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Denmark	0.00	9908.00	0	0	0	0.00
Norway	13399.00	13399.00	31	1732	1732	100.09
Russia	18500.00	18500.00	21	20907	1904	100.02
Scotland	0.00	433.00	0	0	0	0.00
Period Total	31899.00	42240.00	52	22639	3636	100.01

Sum of Offical Catches :	42240.00
Unallocated Catch :	15126.00
Working Group Catch :	57366.00

PERIOD : 4

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Denmark	0.00	3533.00	0	0	0	0.00
Iceland	0.00	7965.00	0	0	0	0.00
Norway	518006.00	517209.00	39	3632	3632	100.00
Russia	61150.00	61150.00	8	14241	512	100.00
Scotland	0.00	1717.00	0	0	0	0.00
Period Total	579156.00	591574.00	47	17873	4144	100.00

Sum of Offical Catches :	591574.00
Unallocated Catch :	5006.00
Working Group Catch :	596580.00

Table 3.2.5 (continued)

Total over all Areas and Periods

Country	Sampled Catch	Official Catch	No. of samples	No. measured	No. aged	SOP %
Denmark	30851.00	45461.00	19	1103	790	100.40
France	0.00	1500.00	0	0	0	0.00
Germany	0.00	7490.00	0	0	0	0.00
Iceland	203284.00	220040.00	10	912	817	100.05
Ireland	11179.00	0.00	1	1173	625	100.05
Netherlands	8694.00	17866.00	16	400	400	99.44
Norway	860963.00	860166.00	147	12517	12517	100.00
Russia	168900.00	166602.00	40	55580	3078	100.00
Scotland	22999.00	25350.00	37	9506	2087	102.24
Sweden	0.00	19499.00	0	0	0	0.00
Total for Stock	1306870.00	1363974.00	270	81191	20314	100.05

Sum of Offical Catches : 1363974.00
Unallocated Catch : 62533.00
Working Group Catch : 1426507.00

DETAILS OF DATA FILLING-IN

Filling-in for record : (13) Iceland 3 Va
Using Only
>> (12) Iceland 2 IIa

Filling-in for record : (14) Iceland 4 IIa
Using Only
>> (20) Norway 4 IIa

Filling-in for record : (10) Faroes 3 IIa
Using Only
>> (20) Norway 4 IIa

Filling-in for record : (11) Faroes 4 IIa
Using Only
>> (20) Norway 4 IIa

Filling-in for record : (8) Faroes 1 IIa
Using Only
>> (18) Norway 1 IIa

Filling-in for record : (9) Faroes 2 IIa
Using Only
>> (12) Iceland 2 IIa

Filling-in for record : (4) Faroes 1 Vb
Using Only
>> (12) Iceland 2 IIa

Filling-in for record : (5) Faroes 2 Vb
Using Only
>> (12) Iceland 2 IIa

Filling-in for record : (6) Faroes 3 Vb
Using Only
>> (12) Iceland 2 IIa

Filling-in for record : (7) Faroes 4 Vb
Using Only
>> (12) Iceland 2 IIa

Filling-in for record : (2) Scotland 3 IIa
Using Only
>> (19) Norway 3 IIa

Filling-in for record : (3) Scotland 4 IIa
Using Only
>> (20) Norway 4 IIa

Filling-in for record : (16) Denmark 3 IIa
Using Only
>> (19) Norway 3 IIa

Filling-in for record : (17) Denmark 4 IIa

Table 3.2.5 (continued)

```
Using Only
  >>  ( 20)  Norway                    4 IIa

  Filling-in for record : ( 24)   Germany              2 IIa
Mean Weighted by Number of Samples of:
  >>  ( 25)  Ireland                   2 IIa
  >>  ( 15)  Denmark                   2 IIa
  >>  (  1)  Scotland                  2 IIa
  >>  ( 26)  Netherlands               2 IIa

  Filling-in for record : ( 27)   France               2 IIa
Mean Weighted by Number of Samples of:
  >>  ( 25)  Ireland                   2 IIa
  >>  ( 15)  Denmark                   2 IIa
  >>  (  1)  Scotland                  2 IIa
  >>  ( 26)  Netherlands               2 IIa

  Filling-in for record : ( 28)   Sweden               2 IIa
Mean Weighted by Number of Samples of:
  >>  ( 25)  Ireland                   2 IIa
  >>  ( 15)  Denmark                   2 IIa
  >>  (  1)  Scotland                  2 IIa
  >>  ( 26)  Netherlands               2 IIa
```

Catch Numbers at Age by Area

Ages	IIa	IVa	Va	Vb	Total
0	0.00	0.00	0.00	0.00	0.00
1	0.00	0.00	0.00	0.00	0.00
2	21816.36	0.00	0.00	0.00	21816.36
3	130444.69	0.00	0.00	0.00	130444.69
4	270781.84	0.00	1.01	165.94	270948.75
5	1788182.75	0.00	45.94	7551.78	1795780.50
6	1962815.25	0.00	186.28	30622.13	1993623.63
7	748857.06	0.00	74.71	12282.02	761213.75
8	320558.16	0.00	35.84	5892.06	326486.03
9	60197.20	0.00	4.04	663.92	60865.16
10	19935.04	0.00	0.50	82.97	20018.51
11	32404.90	0.00	0.00	0.00	32404.90
12	88181.72	0.00	14.13	2323.64	90519.48
13	19119.64	0.00	0.00	0.00	19119.64
14	362068.09	0.00	49.98	8215.70	370333.78
15	302.00	0.00	0.00	0.00	302.00
16	0.00	0.00	0.00	0.00	0.00

Mean Weight at Age by Area (Kg)

Ages	IIa	IVa	Va	Vb	Total
0	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.0894	0.0000	0.0000	0.0000	0.0894
3	0.1669	0.0000	0.0000	0.0000	0.1669
4	0.1840	0.0000	0.1465	0.1465	0.1840
5	0.2073	0.0000	0.1881	0.1881	0.2072
6	0.2324	0.0000	0.2117	0.2117	0.2321
7	0.2774	0.0000	0.2556	0.2556	0.2770
8	0.3055	0.0000	0.2788	0.2788	0.3050
9	0.3307	0.0000	0.3101	0.3101	0.3305
10	0.3276	0.0000	0.3200	0.3200	0.3276
11	0.3435	0.0000	0.0000	0.0000	0.3435
12	0.3436	0.0000	0.3224	0.3224	0.3430
13	0.3970	0.0000	0.0000	0.0000	0.3970
14	0.3571	0.0000	0.3354	0.3354	0.3566
15	0.5099	0.0000	0.0000	0.0000	0.5099
16	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	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Age											
2		101	183	44			16		407		
3	255	5	187	59			128	1792	231		
4	146	373	0	54			676	7621	7638		381
5	6805	103	345	12			1375	3807	11243		1905
6	202	5402	112	354			476	2151	2586		10640
7		182	4489	122			63	322	957		6708
8			146	4148			13	20	471		1280
9				102			140	1	0		434
10							35	124	0		130
11							1820	63	165		39
12								2573	0		0
13+									2024		175
14											0
15+											804
Total	7408	6166	5462	4895	-	-	4742	18474	25756	-	22496

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	1992	1993	1994	1995	1996	1997
Age						
1		72		380		9
2	36	1518	16	183	1465	73
3	1247	2389	3708	5133	3008	661
4	1317	3287	4124	5274	13180	1480
5	173	1267	2593	1839	5637	6110
6	16	13	1096	1040	994	4458
7	208	13	34	308	552	1843
8	139	158	25	19	92	743
9	3742	26	196	13	0	66
10	69	4435	29	111	7	0
11			3239	39	41	0
12				907	15	126
13+					393	0
14+						842
Total	6947	13178	15209	15246	25384	16411

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

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
3	4114	1169
4	22461	3599
5	13244	18867
6	4916	13546
7	2045	2473
8	424	1771
9	14	178
10	7	77
11	155	288
12	0	415
13+	3134	60
		2472
Total	50504	44915

Table 3.3.4.1 Norwegian spring-spawning herring. Acoustic estimates (billion individuals) of immature herring in the Barents Sea.

Year	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996 Norway	1996 Russia
Age														
1	21.4						4.4	24.3	32.6	102.7	6.6	0.5	0.0	0.2
2		19.9						5.2	14.0	25.8	59.2	7.7	0.2	0.3
3			3.0						5.7	1.5	18.0	8.0	0.9	2.7
4											1.7	1.1	0.3	0.9
5														0.05

Year	1997 Norway	1997 Russia
Age		
1	0.6	3.4
2	0.01	0.07
3	0.4	2.5
4	0.4	0.3
5	0.05	0.05

Table 3.3.4.2 Norwegian spring spawners. Acoustic abundance (TS = 20 logL - 71.9) of 0-group herring in Norwegian coastal waters in 1975–1997 (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	5244	6065

Table 3.3.4.3 Norwegian spring-spawning herring. Abundance indicies for 0-group herring in the Barents Sea, 1973–1997.

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

Table 3.3.5.1 The indices for herring larvae for the period 1981–1998 ($n10^{-12}$).

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

Table 3.4.1 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
1987		33 067									
1988		38 152									
1989	0,011739	20 620	11								
1990	0,006216	24 585	4	9							
1991	0,004525	12 558	1	7	5						
1992	0,001704	15 262	4	0	2	2					
1993	0,008660	15 839	5	13	6	12	9				
1994	0,008950	5 364	2	10	6	8	4	11			
1995	0,009128	859	6	10	5	15	6	9	7		
1996	0,004051		3	2	6	10	2	1	4	3	
1997	0,003862		0	3	1	3	2	3	0	0	0

Table 3.5.2.1

1

Run title : Herring Spring-spawn (run: SEPBJA06/S06)

At 3-May-98 17:24:08

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

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

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

YEAR,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,
AGE										
0,	966699,	1789628,	1288431,	620750,	369320,	480700,	361300,	230300,	392650,	42680,
1,	279810,	198530,	1358079,	1607560,	408110,	211920,	272830,	378090,	66280,	987710,
2,	66640,	32550,	39250,	288480,	104130,	204530,	22030,	285360,	167800,	7040,
3,	1750,	1510,	12170,	3120,	184380,	76040,	11460,	8990,	204870,	139230,
4,	1790,	2680,	1820,	810,	800,	83580,	39900,	25620,	2690,	325400,
5,	11090,	2590,	2810,	410,	310,	530,	204580,	57110,	46660,	2660,
6,	8930,	14660,	2440,	1500,	720,	180,	1370,	219970,	130600,	42130,
7,	19440,	11480,	9620,	1940,	2020,	360,	150,	1950,	288450,	113200,
8,	97350,	24070,	7330,	6160,	1190,	1830,	300,	1490,	3790,	172080,
9,	7070,	110380,	20390,	4920,	5910,	930,	2490,	740,	1430,	890,
10,	12300,	8860,	116300,	13610,	5260,	10770,	2930,	1910,	1740,	570,
11,	20090,	12430,	8520,	72810,	11780,	9250,	9560,	4000,	2620,	350,
12,	9870,	19800,	12970,	4970,	81350,	17410,	8240,	10050,	1100,	850,
13,	7740,	8850,	15350,	4500,	4420,	92370,	15300,	10780,	6910,	890,
14,	7090,	7740,	5670,	6300,	5470,	7960,	77280,	13870,	7210,	1750,
15,	6940,	8520,	4720,	2170,	6560,	6040,	4580,	70400,	9670,	1430,
+gp,	18620,	15070,	12170,	3840,	8670,	12490,	29100,	17910,	46000,	9010,
0 TOTALNUM,	1543221,	2269350,	2918041,	2643849,	1200320,	1216889,	1063400,	1338540,	1380469,	1847871,
TONSLAND,	986600,	1111100,	1101800,	830100,	848600,	984500,	1281800,	1547700,	1955000,	1677200,
SOPCOF %,	100,	100,	100,	100,	100,	100,	100,	100,	100,	100,

1

Run title : Herring Spring-spawn (run: SEPBJA06/S06)

At 3-May-98 17:24:08

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

YEAR,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,
AGE										
0,	178360,	56120,	11930,	3050,	34710,	2930,	6590,	3060,	2010,	4300,
1,	43700,	50710,	52940,	4290,	4100,	350,	780,	360,	240,	620,
2,	38830,	14190,	3320,	8510,	2040,	170,	390,	180,	120,	310,
3,	9910,	18820,	630,	182,	3538,	239,	10,	327,	2325,	2210,
4,	188050,	80,	1860,	102,	348,	2520,	24,	13,	544,	2360,
5,	138740,	880,	60,	124,	358,	65,	2450,	91,	0,	34,
6,	1420,	470,	330,	36,	248,	151,	26,	3067,	0,	0,
7,	9400,	70,	330,	111,	69,	28,	20,	1,	1309,	42,
8,	13410,	1170,	100,	113,	149,	18,	0,	0,	0,	1077,
9,	34510,	3360,	1340,	36,	20,	0,	0,	0,	0,	0,
10,	200,	3600,	2620,	441,	0,	0,	0,	0,	0,	0,
11,	110,	30,	2810,	691,	49,	0,	0,	0,	0,	0,
12,	80,	20,	30,	545,	59,	0,	0,	0,	0,	0,
13,	250,	20,	10,	0,	59,	0,	0,	0,	0,	0,
14,	260,	20,	20,	2,	0,	18,	0,	0,	0,	0,
15,	180,	40,	10,	12,	0,	0,	0,	0,	0,	0,
+gp,	1520,	200,	190,	0,	0,	0,	0,	0,	0,	0,
0 TOTALNUM,	658930,	149800,	78530,	18245,	45748,	6489,	10291,	7099,	6548,	10953,
TONSLAND,	712200,	67800,	62300,	21100,	13161,	7017,	7619,	13713,	10436,	22706,
SOPCOF %,	100,	100,	100,	100,	99,	100,	101,	100,	100,	100,

Table 3.5.2.1 (continued)

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

YEAR,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,
AGE										
0,	2010,	3260,	690,	830,	2260,	12700,	3386,	2857,	1381,	1385,
1,	240,	380,	80,	110,	110,	468,	170,	1315,	138,	633,
2,	120,	190,	40,	1190,	20,	167,	249,	20722,	309,	3577,
3,	302,	635,	641,	417,	1382,	318,	448,	2150,	53979,	1978,
4,	1216,	187,	581,	459,	789,	2119,	539,	1550,	1759,	50139,
5,	2032,	687,	228,	860,	451,	952,	6154,	1650,	1450,	1867,
6,	87,	1122,	817,	220,	626,	618,	1820,	13000,	1550,	350,
7,	0,	33,	1584,	451,	196,	682,	1264,	5900,	10500,	706,
8,	62,	0,	44,	828,	507,	129,	1561,	5500,	7500,	2800,
9,	503,	0,	1,	35,	605,	460,	722,	6300,	4200,	1200,
10,	0,	253,	0,	10,	12,	733,	1634,	1000,	7700,	950,
11,	0,	0,	269,	11,	4,	14,	648,	3100,	1947,	450,
12,	0,	0,	0,	96,	4,	4,	0,	5000,	6600,	783,
13,	0,	0,	0,	0,	12,	14,	0,	0,	8000,	650,
14,	0,	0,	0,	0,	0,	86,	0,	0,	0,	700,
15,	0,	0,	0,	0,	0,	0,	165,	0,	0,	45,
+gp,	0,	0,	0,	0,	0,	0,	0,	264,	247,	0,
0 TOTALNUM,	6572,	6747,	4974,	5518,	6978,	19466,	18759,	70309,	107260,	68213,
TONSLAND,	19824,	12864,	18577,	13736,	16655,	23054,	53532,	169872,	225256,	127306,
SOPCOF %,	100,	100,	100,	100,	100,	100,	100,	100,	100,	100,

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

YEAR,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,
AGE										
0,	1549,	712,	102,	10,	163,	657,	43,	0,	0,	0,
1,	279,	193,	40,	337,	15,	13,	2,	0,	0,	0,
2,	911,	2520,	1554,	333,	134,	724,	810,	113,	3014,	2182,
3,	6292,	289,	1863,	844,	1259,	2841,	3250,	5759,	3436,	13045,
4,	2506,	362,	266,	278,	3310,	10687,	11009,	34646,	71362,	27095,
5,	55037,	565,	1188,	141,	498,	8727,	36392,	62281,	157100,	179578,
6,	945,	32429,	1085,	1470,	119,	862,	16480,	63784,	94058,	199362,
7,	368,	347,	22628,	887,	1198,	365,	1558,	23109,	40628,	76121,
8,	596,	80,	129,	21885,	575,	2960,	814,	1551,	10341,	32649,
9,	1458,	68,	152,	250,	22568,	1863,	3733,	1585,	568,	6087,
10,	887,	330,	204,	46,	248,	41011,	3566,	6975,	737,	2002,
11,	282,	138,	241,	9,	64,	0,	64541,	8374,	6609,	3240,
12,	336,	68,	65,	69,	25,	0,	283,	91188,	1757,	9052,
13,	268,	32,	18,	10,	124,	0,	46,	407,	83655,	1912,
14,	156,	26,	59,	26,	0,	0,	10,	25,	0,	37033,
15,	54,	0,	17,	53,	0,	0,	207,	0,	0,	30,
+gp,	0,	0,	31,	1,	0,	0,	0,	45,	0,	0,
0 TOTALNUM,	71925,	38158,	29641,	26648,	30300,	70711,	142742,	299842,	473266,	589388,
TONSLAND,	135301,	103830,	86411,	84683,	104448,	232457,	479228,	905501,	1220283,	1426507,
SOPCOF %,	100,	100,	100,	100,	100,	100,	102,	100,	101,	100,

1

Table 3.5.2.2

Run title : Herring Spring-spawn (run: SEPBJA06/S06)

At 3-May-98 17:24:08

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

Table 2 Catch weights at age (kg) YEAR,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,
AGE										
0,	.0090,	.0090,	.0060,	.0060,	.0090,	.0080,	.0090,	.0090,	.0080,	.0090,
1,	.0300,	.0300,	.0110,	.0100,	.0230,	.0260,	.0240,	.0160,	.0170,	.0150,
2,	.0700,	.0710,	.0740,	.0450,	.0550,	.0470,	.0590,	.0480,	.0400,	.0360,
3,	.1330,	.1350,	.1190,	.0870,	.0850,	.0980,	.1390,	.0890,	.0630,	.0660,
4,	.2270,	.2310,	.1880,	.1590,	.1480,	.1710,	.2190,	.2170,	.2460,	.0930,
5,	.2550,	.2590,	.2770,	.2760,	.2880,	.2750,	.2390,	.2340,	.2600,	.3050,
6,	.2830,	.2870,	.3370,	.3220,	.3330,	.2680,	.2980,	.2620,	.2650,	.3050,
7,	.3050,	.3100,	.3180,	.3720,	.3600,	.3230,	.2950,	.3310,	.3010,	.3100,
8,	.3210,	.3270,	.3630,	.3630,	.3520,	.3290,	.3390,	.3600,	.4100,	.3330,
9,	.3380,	.3440,	.3790,	.3930,	.3500,	.3360,	.3500,	.3670,	.4250,	.3590,
10,	.3550,	.3600,	.3600,	.4070,	.3740,	.3410,	.3580,	.3860,	.4560,	.4130,
11,	.3660,	.3720,	.4200,	.3970,	.3840,	.3580,	.3510,	.3950,	.4600,	.4460,
12,	.3770,	.3830,	.4110,	.4220,	.3740,	.3850,	.3670,	.3930,	.4670,	.4010,
13,	.3860,	.3920,	.4390,	.4470,	.3940,	.3530,	.3750,	.4040,	.4460,	.4080,
14,	.3900,	.3970,	.4500,	.4650,	.3990,	.3810,	.3720,	.4010,	.4590,	.4390,
15,	.3990,	.4060,	.4440,	.4520,	.4110,	.3860,	.4270,	.4290,	.4650,	.4270,
+gp,	.4040,	.4110,	.4480,	.4520,	.4160,	.3860,	.4340,	.4370,	.4740,	.4310,
0 SOPCOFAC,	.9985,	1.0004,	1.0014,	1.0017,	.9997,	1.0003,	.9995,	.9995,	1.0001,	1.0005,
1										

Run title : Herring Spring-spawn (run: SEPBJA06/S06)

At 3-May-98 17:24:08

Table 2 Catch weights at age (kg) YEAR,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,
AGE										
0,	.0100,	.0090,	.0080,	.0110,	.0110,	.0060,	.0060,	.0090,	.0070,	.0110,
1,	.0270,	.0210,	.0580,	.0530,	.0290,	.0530,	.0550,	.0790,	.0620,	.0910,
2,	.0490,	.0470,	.0850,	.1210,	.0620,	.1060,	.1170,	.1690,	.1320,	.1930,
3,	.0750,	.0720,	.1050,	.1770,	.1030,	.1610,	.1680,	.2410,	.1890,	.3160,
4,	.1080,	.1050,	.1710,	.2160,	.1540,	.2130,	.2220,	.3180,	.2500,	.3500,
5,	.1580,	.1520,	.2560,	.2500,	.2150,	.2390,	.2490,	.3580,	.2800,	.3980,
6,	.3750,	.2960,	.2160,	.2770,	.2580,	.2550,	.2650,	.3810,	.2980,	.4390,
7,	.3830,	.3760,	.2770,	.3050,	.2950,	.2770,	.2880,	.4130,	.3230,	.4950,
8,	.3640,	.3290,	.2980,	.3330,	.3220,	.2870,	.2990,	.4290,	.3360,	.5110,
9,	.3820,	.3290,	.3040,	.3530,	.3410,	.3240,	.3370,	.4840,	.3790,	.5580,
10,	.4410,	.3410,	.3050,	.3660,	.3540,	.3380,	.3520,	.5060,	.3960,	.5830,
11,	.4100,	.3630,	.3090,	.3770,	.3650,	.2570,	.2670,	.3840,	.3000,	.5370,
12,	.4420,	.3850,	.3570,	.3880,	.3760,	.2570,	.3240,	.4660,	.3640,	.5370,
13,	.5170,	.3770,	.3480,	.3990,	.3870,	.2570,	.3240,	.4660,	.3640,	.5370,
14,	.4910,	.4510,	.3570,	.4190,	.4060,	.2570,	.3240,	.4660,	.3640,	.5370,
15,	.4640,	.4230,	.3670,	.4440,	.4300,	.2570,	.3240,	.4660,	.3640,	.5370,
+gp,	.4870,	.4290,	.3760,	.4440,	.4300,	.2570,	.3240,	.4660,	.3640,	.5370,
0 SOPCOFAC,	.9991,	1.0036,	1.0030,	1.0001,	.9935,	1.0011,	1.0051,	1.0002,	1.0004,	.9991,

Table 3.5.2.2 (continued)

```
        Table  2    Catch weights at age (kg)
        YEAR,        1978,    1979,    1980,    1981,    1982,    1983,    1984,    1985,    1986,    1987,

        AGE
          0,         .0120,   .0100,   .0120,   .0100,   .0100,   .0110,   .0090,   .0090,   .0070,   .0100,
          1,         .1000,   .0880,   .1010,   .0820,   .0870,   .0900,   .0470,   .0220,   .0770,   .0750,
          2,         .2100,   .1810,   .2020,   .1630,   .1590,   .1650,   .1450,   .0220,   .0970,   .0910,
          3,         .2740,   .2930,   .2660,   .1960,   .2560,   .2170,   .2180,   .2140,   .0550,   .1240,
          4,         .4240,   .3590,   .3990,   .2910,   .3120,   .2650,   .2620,   .2770,   .2490,   .1730,
          5,         .4540,   .4160,   .4490,   .3410,   .3780,   .3370,   .3250,   .2950,   .2940,   .2530,
          6,         .4950,   .4360,   .4600,   .3680,   .4150,   .3780,   .3460,   .3380,   .3120,   .2320,
          7,         .5240,   .4820,   .4850,   .3800,   .4350,   .4100,   .3810,   .3600,   .3520,   .3120,
          8,         .5960,   .4820,   .4720,   .3970,   .4490,   .4260,   .4000,   .3810,   .3740,   .3280,
          9,         .6130,   .5390,   .6180,   .4360,   .4480,   .4350,   .4130,   .3970,   .3980,   .3490,
         10,         .6500,   .5530,   .6450,   .4500,   .5060,   .4440,   .4050,   .4090,   .4020,   .3530,
         11,         .5900,   .5180,   .6080,   .4920,   .4930,   .4680,   .4260,   .4170,   .4010,   .3700,
         12,         .5900,   .5180,   .5940,   .4810,   .4990,   .4610,   .4150,   .4350,   .4100,   .3850,
         13,         .5900,   .5180,   .5940,   .4810,   .4990,   .4610,   .4150,   .4350,   .4100,   .3850,
         14,         .5900,   .5180,   .5940,   .4810,   .4990,   .4610,   .4150,   .4350,   .4100,   .3850,
         15,         .5900,   .5180,   .5940,   .4810,   .4990,   .4610,   .4150,   .4350,   .4100,   .3850,
        +gp,         .5900,   .5180,   .5940,   .4810,   .4990,   .4610,   .4150,   .4350,   .4100,   .3850,
0       SOPCOFAC,    .9998,   1.0016,  .9999,   1.0007,  1.0001,  .9981,   .9999,   .9997,   1.0010,  .9979,


        Table  2    Catch weights at age (kg)
        YEAR,        1988,    1989,    1990,    1991,    1992,    1993,    1994,    1995,    1996,    1997,

        AGE
          0,         .0080,   .0100,   .0070,   .0070,   .0070,   .0070,   .0070,   .0070,   .0070,   .0070,
          1,         .0620,   .0600,   .0780,   .0150,   .0750,   .0300,   .0630,   .0630,   .0630,   .0630,
          2,         .0750,   .2040,   .1020,   .1040,   .1030,   .1060,   .1020,   .1020,   .1360,   .0890,
          3,         .1240,   .1880,   .2300,   .2080,   .1910,   .1530,   .1940,   .1530,   .1360,   .1670,
          4,         .1540,   .2640,   .2390,   .2500,   .2330,   .2430,   .2390,   .1920,   .1680,   .1840,
          5,         .1940,   .2600,   .2660,   .2880,   .3040,   .2820,   .2800,   .2340,   .2060,   .2070,
          6,         .2410,   .2820,   .3050,   .3120,   .3370,   .3200,   .3170,   .2830,   .2620,   .2320,
          7,         .2650,   .3060,   .3080,   .3160,   .3650,   .3300,   .3280,   .3280,   .3090,   .2770,
          8,         .3040,   .3090,   .3760,   .3300,   .3610,   .3650,   .3560,   .3490,   .3370,   .3050,
          9,         .3050,   .3910,   .4070,   .3440,   .3710,   .3730,   .3720,   .3560,   .3660,   .3310,
         10,         .3170,   .4220,   .4120,   .3720,   .4030,   .3790,   .3900,   .3740,   .3600,   .3280,
         11,         .3080,   .3640,   .4240,   .3540,   .3650,   .3800,   .3790,   .3660,   .3610,   .3440,
         12,         .3340,   .4290,   .4280,   .3980,   .3940,   .3850,   .3990,   .3930,   .3670,   .3430,
         13,         .3340,   .4290,   .4280,   .3980,   .4040,   .3900,   .4030,   .3870,   .3790,   .3970,
         14,         .3340,   .4290,   .4280,   .3980,   .4060,   .3950,   .4050,   .4000,   .3790,   .3570,
         15,         .3340,   .4290,   .4280,   .3980,   .4080,   .4000,   .4070,   .4000,   .3790,   .5100,
        +gp,         .3340,   .4290,   .4280,   .3980,   .4100,   .4050,   .4050,   .4000,   .3790,   .5100,
0       SOPCOFAC,    .9998,   1.0007,  .9992,   1.0015,  1.0024,  .9981,   1.0192,  1.0000,  1.0075,  .9996,
1
```

Table 3.5.2.3

Run title : Herring Spring-spawn (run: SEPBJA06/S06)

At 3-May-98 17:24:08

Table 3 Stock weights at age (kg)

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

Table 3 Stock weights at age (kg)

YEAR,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,
AGE										
0,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,
1,	.0080,	.0080,	.0080,	.0080,	.0080,	.0080,	.0080,	.0080,	.0080,	.0080,
2,	.0470,	.0470,	.0470,	.0470,	.0470,	.0470,	.0470,	.0470,	.0470,	.0470,
3,	.1000,	.1000,	.1000,	.1000,	.1000,	.1000,	.1000,	.1000,	.1000,	.1000,
4,	.2040,	.2040,	.2040,	.2320,	.2190,	.1850,	.1940,	.1860,	.1850,	.1800,
5,	.2420,	.2520,	.2700,	.2500,	.2910,	.2530,	.2130,	.1990,	.2190,	.2280,
6,	.2920,	.2600,	.2910,	.2920,	.3000,	.2940,	.2640,	.2360,	.2220,	.2690,
7,	.2950,	.2900,	.2930,	.3020,	.3160,	.3120,	.3170,	.2600,	.2490,	.2700,
8,	.2930,	.3000,	.3210,	.3040,	.3240,	.3290,	.3630,	.3630,	.3060,	.2940,
9,	.3050,	.3050,	.3180,	.3230,	.3260,	.3270,	.3530,	.3500,	.3540,	.3240,
10,	.3150,	.3150,	.3200,	.3220,	.3350,	.3340,	.3490,	.3700,	.3770,	.4200,
11,	.3300,	.3250,	.3440,	.3210,	.3380,	.3410,	.3540,	.3600,	.3910,	.4300,
12,	.3400,	.3300,	.3490,	.3440,	.3340,	.3490,	.3570,	.3780,	.3790,	.3660,
13,	.3450,	.3400,	.3700,	.3570,	.3470,	.3410,	.3590,	.3870,	.3780,	.3680,
14,	.3520,	.3450,	.3790,	.3630,	.3540,	.3580,	.3650,	.3900,	.3610,	.4330,
15,	.3600,	.3550,	.3750,	.3650,	.3580,	.3750,	.4020,	.3940,	.3830,	.4140,
+gp,	.3650,	.3600,	.3800,	.3700,	.3580,	.3750,	.4020,	.3940,	.3830,	.4140,

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Run title : Herring Spring-spawn (run: SEPBJA06/S06)

At 3-May-98 17:24:08

Table 3 Stock weights at age (kg)

YEAR,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,
AGE										
0,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,
1,	.0080,	.0080,	.0080,	.0150,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,
2,	.0470,	.0470,	.0470,	.0800,	.0700,	.0850,	.0850,	.0850,	.0850,	.0850,
3,	.1000,	.1000,	.1000,	.1000,	.1500,	.1700,	.1700,	.1810,	.1810,	.1810,
4,	.1150,	.1150,	.2090,	.1900,	.1500,	.2590,	.2590,	.2590,	.2590,	.2590,
5,	.2060,	.1450,	.2720,	.2250,	.1400,	.3420,	.3420,	.3420,	.3420,	.3430,
6,	.2660,	.2700,	.2300,	.2500,	.2100,	.3840,	.3840,	.3840,	.3840,	.3840,
7,	.2750,	.3000,	.2950,	.2750,	.2400,	.4090,	.4090,	.4090,	.4090,	.4090,
8,	.2740,	.3060,	.3170,	.2900,	.2700,	.4040,	.4440,	.4440,	.4440,	.4440,
9,	.2850,	.3080,	.3230,	.3100,	.3000,	.4610,	.4610,	.4610,	.4610,	.4610,
10,	.3500,	.3180,	.3250,	.3250,	.3250,	.5200,	.5200,	.5200,	.5200,	.5200,
11,	.3250,	.3400,	.3290,	.3350,	.3350,	.5340,	.5430,	.5430,	.5430,	.5430,
12,	.3630,	.3680,	.3800,	.3450,	.3450,	.5000,	.4820,	.4820,	.4820,	.4820,
13,	.4080,	.3600,	.3700,	.3550,	.3550,	.5000,	.4820,	.4820,	.4820,	.4820,
14,	.3880,	.3930,	.3800,	.3650,	.3650,	.5000,	.4820,	.4820,	.4820,	.4820,
15,	.3780,	.3970,	.3910,	.3900,	.3900,	.5000,	.4820,	.4820,	.4820,	.4820,
+gp,	.3780,	.3970,	.3910,	.3900,	.3900,	.5000,	.4820,	.4820,	.4820,	.4820,

Table 3.5.2.3 (continued)

Table 3 Stock weights at age (kg)

YEAR,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,
AGE										
0,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,
1,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,	.0100,
2,	.0850,	.0850,	.0850,	.0850,	.0850,	.0850,	.0850,	.0230,	.0850,	.0550,
3,	.1800,	.1780,	.1750,	.1700,	.1700,	.1550,	.1400,	.1480,	.0540,	.0900,
4,	.2940,	.2320,	.2830,	.2240,	.2040,	.2490,	.2040,	.2340,	.2060,	.1430,
5,	.3260,	.3590,	.3470,	.3360,	.3030,	.3040,	.2950,	.2650,	.2650,	.2410,
6,	.3710,	.3850,	.4020,	.3780,	.3550,	.3680,	.3380,	.3120,	.2890,	.2790,
7,	.4090,	.4200,	.4210,	.3870,	.3830,	.4040,	.3760,	.3460,	.3390,	.2990,
8,	.4610,	.4440,	.4650,	.4080,	.3950,	.4240,	.3950,	.3700,	.3680,	.3160,
9,	.4760,	.5050,	.4650,	.3970,	.4130,	.4370,	.4070,	.3950,	.3910,	.3420,
10,	.5200,	.5200,	.5200,	.5200,	.4530,	.4360,	.4130,	.3970,	.3820,	.3430,
11,	.5430,	.5510,	.5340,	.5430,	.4680,	.4930,	.4220,	.4280,	.3880,	.3620,
12,	.5000,	.5000,	.5000,	.5120,	.5060,	.4950,	.4370,	.4280,	.3950,	.3760,
13,	.5000,	.5000,	.5000,	.5120,	.5060,	.4950,	.4370,	.4280,	.3950,	.3760,
14,	.5000,	.5000,	.5000,	.5120,	.5060,	.4950,	.4370,	.4280,	.3950,	.3760,
15,	.5000,	.5000,	.5000,	.5120,	.5060,	.4950,	.4370,	.4280,	.3950,	.3760,
+gp,	.5000,	.5000,	.5000,	.5120,	.5060,	.4950,	.4370,	.4280,	.3950,	.3760,

Table 3 Stock weights at age (kg)

YEAR,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,
AGE										
0,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,	.0010,
1,	.0150,	.0150,	.0080,	.0110,	.0070,	.0080,	.0100,	.0180,	.0180,	.0180,
2,	.0500,	.1000,	.0480,	.0370,	.0300,	.0250,	.0250,	.0250,	.0250,	.0250,
3,	.0980,	.1540,	.2190,	.1470,	.1280,	.0810,	.0750,	.0660,	.0760,	.0960,
4,	.1350,	.1750,	.1980,	.2100,	.2240,	.2010,	.1510,	.1380,	.1180,	.1180,
5,	.1970,	.2090,	.2580,	.2440,	.2960,	.2650,	.2540,	.2300,	.1880,	.1740,
6,	.2770,	.2520,	.2880,	.3000,	.3270,	.3230,	.3180,	.2960,	.2610,	.2290,
7,	.3150,	.3050,	.3090,	.3240,	.3550,	.3540,	.3710,	.3460,	.3160,	.2860,
8,	.3390,	.3670,	.4280,	.3360,	.3450,	.3580,	.3470,	.3880,	.3460,	.3230,
9,	.3430,	.3770,	.3700,	.3430,	.3670,	.3810,	.4120,	.3630,	.3740,	.3700,
10,	.3590,	.3590,	.4030,	.3820,	.3410,	.3690,	.3820,	.4090,	.3900,	.3780,
11,	.3650,	.3950,	.3870,	.3660,	.3610,	.3960,	.4070,	.4140,	.3900,	.3860,
12,	.3760,	.3960,	.4400,	.4250,	.4300,	.3930,	.4100,	.4220,	.3840,	.3600,
13,	.3760,	.3960,	.4400,	.4250,	.4700,	.3740,	.4100,	.4100,	.3980,	.3930,
14,	.3760,	.3960,	.4400,	.4250,	.4700,	.4030,	.4100,	.4100,	.3980,	.3910,
15,	.3760,	.3960,	.4400,	.4250,	.4700,	.4000,	.4100,	.4050,	.3980,	.3910,
+gp,	.3760,	.3960,	.4400,	.4250,	.4500,	.4000,	.4100,	.4470,	.3980,	.3910,

Table 3.5.2.4

Run title : Herring Spring-spawn (run: SEPBJA06/S06)

At 3-May-98 17:24:08

Table 5 Proportion mature at age

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

Table 5 Proportion mature at age

YEAR,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,
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,	.0800,	.0400,	.0000,	.0400,	.0200,	.0000,	.0100,	.0000,
4,	.2200,	.2200,	.2200,	.3500,	.1100,	.0300,	.0600,	.3400,	.1500,	.0100,
5,	.3700,	.3700,	.3700,	.6800,	.6700,	.3200,	.2800,	.3500,	1.0000,	.2300,
6,	.8500,	.8500,	.8500,	.9400,	1.0000,	.9000,	.3200,	.7600,	.9600,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
10,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
11,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
12,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
13,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
14,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
15,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

1

Run title : Herring Spring-spawn (run: SEPBJA06/S06)

At 3-May-98 17:24:08

Table 5 Proportion mature at age

YEAR,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,
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,	.1000,	.1000,	.1000,	.1000,	.0000,
3,	.0000,	.6200,	.0600,	.1000,	.0000,	.5000,	.5000,	.5000,	.5000,	.7300,
4,	.0000,	.8900,	.1300,	.2500,	.1000,	.9000,	.9000,	1.0000,	.9000,	.8900,
5,	.0100,	.9500,	.3100,	.6000,	.2500,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
6,	.7600,	1.0000,	.1700,	.9000,	.6000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	1.0000,	1.0000,	.9000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
10,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
11,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
12,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
13,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
14,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
15,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

Table 3.5.2.4 (continued)

Table 5 Proportion mature at age YEAR,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,
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,	.1300,	.1000,	.2500,	.3000,	.1000,	.1000,	.1000,	.1000,	.1000,	.1000,
4,	.9000,	.6200,	.5000,	.5000,	.4800,	.5000,	.5000,	.5000,	.2000,	.3000,
5,	1.0000,	.9500,	.9700,	.9000,	.7000,	.6900,	.9000,	.9000,	.9000,	.9000,
6,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	.7100,	.9500,	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,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,
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,	.1000,	.4000,	.1000,	.1000,	.0100,	.0100,	.0000,	.0000,	.0000,
4,	.3000,	.3000,	.8000,	.7000,	.2000,	.3000,	.3000,	.0100,	.0100,	.3000,
5,	.9000,	.9000,	.9000,	1.0000,	.8000,	.8000,	.8000,	.8000,	.4500,	.9000,
6,	1.0000,	1.0000,	.9000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
7,	1.0000,	1.0000,	.9000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
8,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
9,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
10,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
11,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
12,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
13,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
14,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
15,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,
+gp,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,	1.0000,

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Table 3.5.3.1 Survey data used in the assessment.

```
Norwegian Spring-Spawning Herring
     104
Feb-March Acoustic Survey
1988    1998
1          1      0.1667    0.1667
3            15
1    -255  -146    6805   202     -1     -1     -1     -1     -1   -1     -1    -1   -1
1      -5  -373    -103  5402   -182     -1     -1     -1     -1   -1     -1    -1   -1
1    -187  -1      -345  -112   4489   -146     -1     -1     -1   -1     -1    -1   -1
1     -59  -54      -12  -354   -122   4148   -102     -1     -1   -1     -1    -1   -1
1      -1   -1       -1    -1     -1     -1     -1     -1     -1   -1     -1    -1   -1
1      -1   -1       -1    -1     -1     -1     -1     -1     -1   -1     -1    -1   -1
1     -128  -676   1375   476    -63    -13   -140    -35   1820   -1     -1    -1   -1
1     -1792 -7621 3807   2151   322    -20     -1   -124    -63 2573     -1    -1   -1
1    -231 -7638 -11243  2586    957    471     -1     -1    -165   -1   2024   -1   -1
1      -1  -1     -1      -1      -1     -1     -1     -1     -1     -1    -1    -1   -1
1     -1  -381  -1905  10640  6708    1280   434    -130   -39     -1     -175    -1 804
December Acoustic Survey
1992    1997
1          1      0.917    0.917
4            14
1     1317     -173    -16    -208   -139   3742     -69    -1   -1    -1    -1
1     3287     1267    -13    -13    -158    -26    4435    -1    -1    -1    -1
1     4124     2593   1096    -34    -25    -196     -29   3239   -1    -1     -1
1     5274     1839   1040     308    -19    -13     -111   -39   907    -1     -1
1     -13180   5637   994    552   92    -1     -7     -41    -15     393    -1
1      -1480    6109   4458    1843    742   -66     -1    -1   -125   -1   842
January Acoustic Survey
1991    1998
1          1      0.001    0.001
3            15
1      -220 -70    -20      -180     -150     5500     -440    -1     -1      -1    -1     -1   -1
1      -410 -820   -260      -60     -510     -120    4690     -30    -1      -1    -1     -1   -1
1       -61 -1905 2048      -256      -27     -269     -182   5691    -128     -1    -1     -1   -1
1       -642 -3431 4847     1503     -102      -29     -161    -131   3679     -1    -1     -1   -1
1       -47  -3781 4013     2445    1215      -42      -24     -267    -29   4326    -1     -1   -1
1      -315 -10442 -13557    4312    1271     290      -22     -25    -200     -58   1146   -1   -1
1      -1       -1     -1        -1      -1      -1       -1      -1     -1      -1    -1    -1    -1
1       -267   -1938 -4162     9647    6974    1518      743     -16    -4       -1   -181   -7    314
International Acoustic Survey
1996     1997
1           1            0.33      0.42
4          14
1       22461     13244    4916   2045    424   -14    -7   -155   -1   3134   -1
1        3599     18867   13546   2473   1771 178   -77   -288   -415   -60 2472
```

Table 3.5.3.2 Tagging data used in the assessment of Norwegian Spring-Spawning Herring.

No of Experiments	First Year
9	1987

Experiment	Start Year	Releases	Age
1	1987	33067	4
2	1988	38152	5
3	1989	20620	6
4	1990	24585	7
5	1991	12558	8
6	1992	15262	9
7	1993	15839	10
8	1994	5364	11
9	1995	859	12

Years of Recaptures	First Year
9	1989

Screened	Year	Age	1	2	3	4	5	6	7	8	9
11739	1989	6	11	-1	-1	-1	-1	-1	-1	-1	-1
6216	1990	7	4	9	-1	-1	-1	-1	-1	-1	-1
4525	1991	8	1	7	5	-1	-1	-1	-1	-1	-1
1704	1992	9	4	0	2	2	-1	-1	-1	-1	-1
8660	1993	10	5	13	6	12	9	-1	-1	-1	-1
8950	1994	11	2	10	6	8	4	11	-1	-1	-1
9128	1995	12	6	10	5	15	6	9	7	-1	-1
4051	1996	13	3	2	6	10	2	1	4	3	-1
3862	1997	14	0	3	1	3	2	3	0	0	0

Table 3.5.5.1 Norwegian Spring-Spawning Herring. Summary of the main results of the exploratory modelling procedure.

Run No.	Model	Survey Data	SSB (Million tonnes)		Survey Variance
			1996	**1997**	(. 10^ 3)
	1997 WG Assessment		5.48	9.13	703
1	1997 WG Model	As 97 WG+All New Surveys	13.75	19.47	5294
2	As 1 except normal error distribution assumed	As 97 WG+All New Surveys	5.95	10.91	886
3	As 1 except lognormal error distribution assumed	As 97 WG+All New Surveys	6.92	12.78	919
4	As 1, except variance estimated as parameter	As 97 WG+All New Surveys	6.71	12.34	620
5	As 1, except variance estimated as parameter	Surveys before 1991 omitted	5.56	9.95	607

Table 3.5.5.2 Norwegian Spring-Spawning Herring. Summary of parameter estimates from the model fitting procedure, and estimates of standard deviations of parameter estimates from a simple parametric bootstrap procedure (conditional on the maximum-likelihood estimates).

Parameter	Estimate	Coefficient of variation (%)
Population abundance age 6 in 1998 (Thousands)	18294412	13
Population abundance age 14 in 1998 (Thousands)	59337	18
Initial Tagging Mortality	0.496	7
Catchability for Feb/March Surveys	0.530	11
Catchability for December Surveys	0.270	14
Catchability for January Surveys	0.593	12
Catchability for International Surveys	0.762	13
Variance	607541	30
SSB in 1997 (Million tonnes)	9.95	13

Table 3.5.6.1 a Run 5

```
NORWEGIAN SPRING-SPAWNING HERRING recruits as 3-year-olds
6,25,2
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     99   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  24449    177      21400    19900 -11 -11 -11
1984   1039     34 -11 -11 146 -11 -11
1985   2383     23 -11 -11      373    -11 -11
1986    603   0.25  -11 -11    1 -11 -11
1987    393   0.25  -11 -11       54    -11  70
1988   1839      3        -11      -11      -11    -11 820
1989   5768     58       4400     5200      -11     1247     1905
1990  10754     31      24300    14000      676     2389     3431
1991  27613    119      32600    25800     7621     3708     3781
1992  32196    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      -11      -11      -11
1996    -11     65       2600      -11      -11      -11      -11
1997    -11     39        -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 3.5.6.1 b Run 4

```
NORWEGIAN SPRING-SPAWNING HERRING recruits as 3-year-olds
6,25,2
1973    848 5    -11 -11 -11 -11 -11
1974    563 1    -11 -11 -11 -11 -11
1975    193   0.25  -11 -11 -11 -11 -11
1976    685   0.25  -11 -11 -11 -11 -11
1977    333 1    -11 -11 -11 -11 -11
1978    409 2    -11 -11 -11 -11 -11
1979    823 9    -11 -11 -11 -11 -11
1980    100   0.25  -11 -11 -11 -11 -11
1981     71   0.25  -11 -11 -11 -11 -11
1982    154   0.25  -11 -11 -11 -11 -11
1983  26675    177      21400    19900 -11 -11 -11
1984   1138     34 -11 -11 146 -11 -11
1985   2785     23 -11 -11      373    -11 -11
1986    727   0.25  -11 -11    1 -11 -11
1987    459   0.25  -11 -11       54    -11  70
1988   2012      3        -11      -11      -11    -11 820
1989   6565     58       4400     5200      -11     1247     1905
1990  12918     31      24300    14000      676     2389     3431
1991  33649    119      32600    25800     7621     3708     3781
1992  39164    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      -11      -11      -11
1996    -11     65       2600      -11      -11      -11      -11
1997    -11     39        -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 3.5.6.2 a

Analysis by RCT3 ver3.1 of data from file :

w:\acfm\wgnpbw\98\her_noss\t3561a.txt

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

Data for 6 surveys over 25 years : 1973 - 1997

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

	I----------Regression----------I				I----------Prediction---------I			
Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
BS 0-g	.04	5.80	1.44	.682	20	75.00	9.11	1.665	.023
BS 1-g	.74	2.28	.49	.765	5	8.79	8.76	.794	.100
BS 2-g	.87	1.13	.33	.879	5	8.95	8.95	.517	.237
Spawn Dec 3 Jan 4	1.35	-1.08	.20	.961	4	8.01	9.76	.318	.624
					VPA Mean =		7.63	2.010	.016

Yearclass = 1994

	I----------Regression----------I				I----------Prediction---------I			
Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
BS 0-g	.04	5.85	1.44	.681	20	28.00	7.08	1.670	.041
BS 1-g	.73	2.32	.48	.771	5	6.22	6.87	1.318	.066
BS 2-g	.87	1.17	.32	.882	5	5.53	5.97	1.153	.087
Spawn	.71	4.11	1.04	.800	7	5.95	8.32	1.347	.064
Dec 3	1.35	-1.09	.20	.961	4	6.50	7.71	.502	.458
Jan 4	1.01	1.21	.50	.933	6	7.57	8.89	.674	.255
					VPA Mean =		7.75	2.001	.029

Yearclass = 1995

	I----------Regression----------I				I----------Prediction---------I			
Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights

Table 3.5.6.2 a (continued)

BS 0-g	.04	5.92	1.43	.682	20	16.00	6.61	1.703	.262
BS 1-g	.73	2.37	.48	.777	5	4.62	5.72	1.753	.247
BS 2-g	.86	1.21	.32	.885	5	3.71	4.42	1.595	.298
Spawn									
Dec 3									
Jan 4									
						VPA Mean =	7.88	1.981	.193

Yearclass = 1996

	I----------Regression----------I				I----------Prediction---------I				
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
BS 0-g	.04	6.01	1.41	.686	20	65.00	8.78	1.694	.215
BS 1-g	.72	2.42	.48	.784	5	7.86	8.08	.995	.623
BS 2-g									
Spawn									
Dec 3									
Jan 4									
						VPA Mean =	8.02	1.951	.162

Yearclass = 1997

	I----------Regression----------I				I----------Prediction---------I				
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
BS 0-g	.04	6.12	1.37	.693	20	39.00	7.75	1.679	.564
BS 1-g									
BS 2-g									
Spawn									
Dec 3									
Jan 4									
						VPA Mean =	8.16	1.911	.436

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1993	12326	9.42	.25	.24	.88		
1994	2481	7.82	.34	.34	1.00		
1995	396	5.98	.87	.72	.68		
1996	3724	8.22	.79	.21	.07		
1997	2771	7.93	1.26	.21	.03		

Table 3.5.6.2 b

Analysis by RCT3 ver3.1 of data from file :

w:\acfm\wgnpbw\98\her_noss\t3561b.txt

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

Data for 6 surveys over 25 years : 1973 - 1997

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

	I----------Regression----------I				I----------Prediction---------I			
Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
BS 0-g	.05	5.85	1.52	.670	20	75.00	9.28	1.754	.019
BS 1-g	.74	2.42	.45	.795	5	8.79	8.92	.743	.108
BS 2-g	.88	1.20	.30	.899	5	8.95	9.10	.477	.262
Spawn Dec 3 Jan 4	1.40	-1.27	.20	.964	4	8.01	9.94	.316	.597
					VPA Mean =		7.75	2.061	.014

Yearclass = 1994

	I----------Regression----------I				I----------Prediction---------I			
Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
BS 0-g	.05	5.91	1.52	.669	20	28.00	7.18	1.757	.038
BS 1-g	.74	2.45	.46	.799	5	6.22	7.02	1.240	.076
BS 2-g	.88	1.22	.30	.901	5	5.53	6.08	1.071	.102
Spawn	.72	4.21	1.07	.792	7	5.95	8.49	1.395	.060
Dec 3	1.40	-1.27	.20	.964	4	6.50	7.82	.499	.471
Jan 4	1.03	1.22	.54	.926	6	7.57	9.05	.723	.224
					VPA Mean =		7.88	2.048	.028

Yearclass = 1995

	I----------Regression----------I				I----------Prediction---------I			
Survey/ Series	Slope	Inter-cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights

Table 3.5.6.2 b (continued)

BS 0-g	.04	5.99	1.51	.671	20	16.00	6.70	1.787	.229
BS 1-g	.73	2.48	.46	.803	5	4.62	5.85	1.659	.266
BS 2-g	.88	1.25	.30	.902	5	3.71	4.50	1.494	.327
Spawn									
Dec 3									
Jan 4									
					VPA Mean =		8.01	2.026	.178

Yearclass = 1996

	I----------Regression----------I				I----------Prediction---------I				
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
BS 0-g	.04	6.09	1.48	.675	20	65.00	8.94	1.773	.189
BS 1-g	.73	2.51	.46	.808	5	7.86	8.23	.948	.661
BS 2-g									
Spawn									
Dec 3									
Jan 4									
					VPA Mean =		8.16	1.992	.150

Yearclass = 1997

	I----------Regression----------I				I----------Prediction---------I				
Survey/ Series	Slope	Inter- cept	Std Error	Rsquare	No. Pts	Index Value	Predicted Value	Std Error	WAP Weights
BS 0-g	.04	6.21	1.43	.684	20	39.00	7.88	1.751	.553
BS 1-g									
BS 2-g									
Spawn									
Dec 3									
Jan 4									
					VPA Mean =		8.30	1.948	.447

Year Class	Weighted Average Prediction	Log WAP	Int Std Error	Ext Std Error	Var Ratio	VPA	Log VPA
1993	14296	9.57	.24	.24	.98		
1994	2632	7.88	.34	.35	1.04		
1995	399	5.99	.85	.72	.72		
1996	4249	8.35	.77	.20	.07		
1997	3190	8.07	1.30	.21	.03		

Table 3.5.7.1 a

Run title : Herring Spring-spawn (run: SEPBJA06/S06)

At 3-May-98 17:24:08

Traditional vpa using file input for terminal F

Table 8 Fishing mortality (F) at age YEAR,	1950,	1951,	1952,	1953,	1954,	1955,	1956,	1957,
AGE								
0,	.0104,	.0174,	.2455,	.1082,	.4996,	.3874,	.3408,	.3741,
1,	.1217,	.0390,	.2699,	.2894,	.4172,	.5567,	.5949,	.8901,
2,	.0658,	.0661,	.0160,	.0505,	.1521,	.0987,	.5132,	.2514,
3,	.0278,	.0013,	.0118,	.0171,	.0424,	.0320,	.0426,	.0462,
4,	.0508,	.0465,	.0141,	.0165,	.0396,	.0537,	.1079,	.1763,
5,	.0410,	.0581,	.0908,	.0279,	.0612,	.0692,	.0756,	.0844,
6,	.0709,	.0441,	.0565,	.0674,	.0799,	.0605,	.1097,	.0687,
7,	.0884,	.0839,	.0673,	.0415,	.1184,	.0808,	.0723,	.1105,
8,	.0446,	.1085,	.0779,	.0449,	.0800,	.0854,	.1111,	.0587,
9,	.0346,	.0527,	.0873,	.0810,	.1009,	.0666,	.1049,	.0891,
10,	.0375,	.0390,	.0668,	.1173,	.1477,	.1271,	.1307,	.0930,
11,	.0369,	.0427,	.0490,	.0645,	.1846,	.1325,	.1759,	.1163,
12,	.0379,	.0556,	.0544,	.0641,	.1175,	.1098,	.1647,	.1469,
13,	.0667,	.0602,	.0682,	.0584,	.0886,	.1012,	.1147,	.1210,
14,	.0781,	.0787,	.0545,	.0789,	.1039,	.0949,	.1424,	.1208,
15,	.0459,	.0697,	.0726,	.0782,	.1304,	.1044,	.1295,	.1000,
+gp,	.0459,	.0697,	.0726,	.0782,	.1304,	.1044,	.1295,	.1000,
0 FBAR 5-14,	.0537,	.0623,	.0673,	.0646,	.1083,	.0928,	.1202,	.1009,

Table 8 Fishing mortality (F) at age YEAR,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,
AGE										
0,	.6958,	.0689,	.1068,	.1360,	.3679,	.0451,	.0621,	.5500,	.1392,	.1961,
1,	.9181,	.7079,	.1421,	.4130,	.2658,	.9250,	.0665,	.1786,	.7192,	1.7622,
2,	1.2040,	.5811,	.6955,	.0835,	.0871,	.4621,	.5117,	.1927,	.2389,	.3323,
3,	.0414,	.1058,	.7587,	.1583,	.1028,	.1240,	.0612,	.6737,	.3137,	.5034,
4,	.0431,	.0781,	.1698,	.0927,	.0525,	.0588,	.0840,	.1789,	.4085,	1.1192,
5,	.0689,	.0769,	.1041,	.0497,	.0442,	.0424,	.1886,	.1573,	.5321,	.8593,
6,	.0612,	.1160,	.0916,	.0705,	.1097,	.0310,	.1391,	.2997,	.5982,	1.3102,
7,	.0728,	.0990,	.0985,	.0928,	.1213,	.0698,	.0309,	.2829,	.7536,	1.6834,
8,	.0689,	.1150,	.0804,	.0802,	.0718,	.1458,	.0725,	.4469,	1.3073,	1.4826,
9,	.0714,	.0987,	.1278,	.0675,	.0976,	.0700,	.2847,	.2423,	.9790,	1.3296,
10,	.1105,	.1140,	.1357,	.1117,	.0907,	.2443,	.3074,	.3472,	1.3436,	1.4501,
11,	.1330,	.1475,	.1449,	.1118,	.1256,	.2153,	.3356,	.8375,	1.0666,	1.0905,
12,	.1742,	.1777,	.2138,	.1117,	.1666,	.2626,	.2856,	.6639,	.5451,	1.2609,
13,	.1249,	.2207,	.1926,	.1012,	.1302,	.2729,	.3657,	.6932,	1.3723,	1.1286,
14,	.0736,	.1679,	.2032,	.1069,	.1628,	.3429,	.3633,	.6227,	1.4701,	1.9718,
15,	.0820,	.1127,	.1387,	.1057,	.1466,	.2569,	.3195,	.6204,	1.1880,	1.4777,
+gp,	.0820,	.1127,	.1387,	.1057,	.1466,	.2569,	.3195,	.6204,	1.1880,	1.4777,
0 FBAR 5-14,	.0960,	.1334,	.1393,	.0904,	.1121,	.1697,	.2374,	.4594,	.9968,	1.3567,
1										

Run title : Herring Spring-spawn (run: SEPBJA06/S06)

At 3-May-98 17:24:08

Traditional vpa using file input for terminal F

Table 8 Fishing mortality (F) at age YEAR,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,
AGE										
0,	.7997,	.0921,	.3347,	.2441,	.7939,	.0035,	.0118,	.0159,	.0030,	.0130,
1,	.7439,	1.6597,	.2501,	.4295,	1.7489,	.0323,	.0023,	.0016,	.0031,	.0023,
2,	.6937,	1.7486,	1.2205,	.1204,	.9309,	.7288,	.0937,	.0013,	.0013,	.0099,
3,	3.2066,	2.0406,	.5307,	.2855,	.0983,	.4069,	.1233,	.1561,	.0300,	.0432,
4,	4.5599,	.2604,	1.4842,	.1420,	1.2886,	.0893,	.0609,	.2243,	.3938,	.0365,
5,	4.7169,	.7590,	.2998,	.3119,	.9580,	.8549,	.1115,	.3212,	.0022,	.0354,
6,	1.8048,	.6023,	.6842,	.2794,	1.8087,	1.5117,	.9647,	.1880,	.0005,	.0026,
7,	1.2122,	.3507,	1.1085,	.4857,	1.2502,	1.1070,	.7745,	.0378,	.1083,	.2687,
8,	.9377,	.4226,	1.1726,	1.6241,	2.9485,	1.3528,	.0086,	.0141,	.0090,	.1158,
9,	1.5725,	.6055,	1.1825,	2.5237,	1.7609,	.0147,	.0192,	.0101,	.0083,	.0106,
10,	1.2945,	.6310,	1.3751,	1.9509,	.0388,	.0293,	.0174,	.0228,	.0119,	.0097,
11,	1.3198,	.6261,	1.5563,	2.2735,	1.5547,	.0471,	.0351,	.0205,	.0271,	.0140,
12,	.7483,	.8732,	3.9033,	1.8355,	2.0462,	.0090,	.0576,	.0424,	.0244,	.0325,
13,	1.9490,	.3927,	1.6255,	.2170,	1.1128,	.0136,	.0105,	.0714,	.0516,	.0291,
14,	1.2342,	.8365,	.8120,	2.7742,	.3302,	1.2425,	.0160,	.0124,	.0899,	.0636,
15,	1.3620,	.5776,	1.4061,	2.0280,	2.1062,	.6032,	.0165,	.0190,	.0146,	.1157,
+gp,	1.3620,	.5776,	1.4061,	2.0280,	2.1062,	.6032,	.0165,	.0190,	.0146,	.1157,
0 FBAR 5-14,	1.6790,	.6100,	1.3720,	1.4276,	1.3809,	.6183,	.2015,	.0741,	.0333,	.0582,

Table 3.5.7.1 a (continued)

Table 8 Fishing mortality (F) at age

YEAR,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,
AGE										
0,	.0050,	.0041,	.0070,	.0116,	.0148,	.0005,	.0033,	.0012,	.0023,	.0034,
1,	.0018,	.0023,	.0002,	.0028,	.0038,	.0076,	.0000,	.0032,	.0001,	.0026,
2,	.0011,	.0035,	.0006,	.0090,	.0012,	.0144,	.0101,	.0052,	.0018,	.0092,
3,	.0171,	.0103,	.0210,	.0110,	.0186,	.0352,	.0701,	.1654,	.0241,	.0207,
4,	.0286,	.0124,	.0110,	.0178,	.0247,	.0340,	.0729,	.3436,	.1875,	.0266,
5,	.0379,	.0192,	.0179,	.0193,	.0207,	.0357,	.1241,	.3125,	.5875,	.2929,
6,	.1147,	.0251,	.0272,	.0205,	.0166,	.0339,	.0841,	.3902,	.5098,	.2553,
7,	.0030,	.0544,	.0426,	.0179,	.0216,	.0214,	.0853,	.3991,	.5921,	.4340,
8,	.7485,	.0035,	.0920,	.0268,	.0238,	.0169,	.0592,	.5933,	1.2624,	.2893,
9,	.0690,	.0021,	.0333,	.0916,	.0233,	.0257,	.1171,	.3355,	1.2486,	.6434,
10,	.0124,	.0427,	.0025,	.6964,	.0399,	.0338,	.1136,	.2228,	.8269,	1.0630,
11,	.0114,	.0146,	.0553,	.3917,	.5462,	.0575,	.0359,	.3073,	.8219,	.0923,
12,	.0165,	.0134,	.0173,	.0240,	.1999,	2.2586,	.0005,	.3953,	2.0562,	.9048,
13,	.0391,	.0195,	.0158,	.0204,	.0035,	3.2774,	.2937,	.0006,	2.1502,	1.5336,
14,	.0349,	.0475,	.0231,	.0187,	.0243,	.0298,	.2407,	.5035,	.0007,	1.4985,
15,	.0793,	.0422,	.0581,	.0276,	.0221,	.0290,	.0698,	.3792,	1.3962,	.4168,
+gp,	.0793,	.0422,	.0581,	.0276,	.0221,	.0290,	.0698,	.3792,	1.3962,	.4168,
0 FBAR 5-14,	.1088,	.0242,	.0327,	.1327,	.0920,	.5791,	.1154,	.3460,	1.0056,	.7007,

Table 8 Fishing mortality (F) at age

YEAR,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	FBAR 95-97
AGE											
0,	.0009,	.0001,	.0000,	.0000,	.0000,	.0001,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0017,	.0003,	.0000,	.0001,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0093,	.0387,	.0052,	.0004,	.0001,	.0002,	.0002,	.0001,	.0074,	.0330,	.0135,
3,	.0288,	.0052,	.0524,	.0050,	.0024,	.0028,	.0013,	.0019,	.0030,	.0580,	.0210,
4,	.0313,	.0020,	.0056,	.0094,	.0229,	.0235,	.0129,	.0158,	.0282,	.0280,	.0240,
5,	.0350,	.0084,	.0075,	.0034,	.0198,	.0735,	.0987,	.0893,	.0878,	.0872,	.0881,
6,	.2236,	.0247,	.0189,	.0109,	.0034,	.0410,	.1828,	.2369,	.1788,	.1452,	.1870,
7,	.4372,	.1131,	.0205,	.0183,	.0104,	.0122,	.0919,	.3945,	.2204,	.2034,	.2728,
8,	.7579,	.1497,	.0531,	.0235,	.0140,	.0305,	.0322,	.1180,	.2900,	.2616,	.2232,
9,	.2271,	.1638,	.4384,	.1310,	.0289,	.0545,	.0464,	.0770,	.0548,	.2616,	.1311,
10,	1.4616,	.0695,	.9521,	.2163,	.1762,	.0640,	.1330,	.1088,	.0442,	.2616,	.1382,
11,	1.0588,	.9170,	.0632,	.0832,	.4904,	.0001,	.1286,	.4885,	.1353,	.2616,	.2951,
12,	.0875,	.7529,	1.6748,	.0219,	.3359,	.0012,	.3500,	.2548,	.1674,	.2616,	.2279,
13,	.8807,	.0102,	.4237,	1.6292,	.0471,	.0019,	.9446,	1.1849,	.3694,	.2616,	.6053,
14,	4.7156,	.1734,	.0220,	1.9526,	.0483,	.0000,	.2359,	4.0283,	.0007,	.2616,	1.4302,
15,	.3809,	.0897,	.1527,	.0238,	.0286,	.0592,	.1152,	.0000,	.3033,	.2616,	.1883,
+gp,	.3809,	.0897,	.1527,	.0238,	.0286,	.0592,	.1152,	.0000,	.3033,	.2616,	
0 FBAR 5-14,	.9885,	.2383,	.3674,	.4090,	.1175,	.0279,	.2244,	.6981,	.1549,	.2267,	

Table 3.5.7.2 a

Run title : Herring Spring-spawn (run: SEPBJA06/S06)

At 3-May-98 17:24:09

Traditional vpa using file 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,
AGE								
0,	7473777,	1439081,	938987,	835771,	397029,	237538,	274748,	236506,
1,	262360,	3007109,	575015,	298670,	304949,	97946,	65556,	79447,
2,	142213,	94446,	1175823,	178474,	90917,	81693,	22821,	14702,
3,	108549,	54137,	35944,	470460,	68991,	31748,	30092,	5554,
4,	40164,	90870,	46535,	30573,	398070,	56914,	26464,	24821,
5,	49701,	32858,	74657,	39493,	25883,	329324,	46426,	20449,
6,	85983,	41059,	26684,	58682,	33057,	20954,	264513,	37050,
7,	79939,	68941,	33817,	21705,	47215,	26267,	16977,	204018,
8,	19629,	62984,	54564,	27213,	17923,	36100,	20853,	13593,
9,	28021,	16159,	48639,	43443,	22395,	14240,	28529,	16061,
10,	32024,	23297,	13194,	38365,	34483,	17426,	11467,	22109,
11,	25811,	26549,	19286,	10622,	29366,	25606,	13209,	8660,
12,	56296,	21411,	21896,	15805,	8571,	21015,	19304,	9535,
13,	61433,	46653,	17432,	17848,	12759,	6559,	16207,	14092,
14,	9510,	49465,	37807,	14014,	14491,	10051,	5102,	12438,
15,	25681,	7571,	39353,	30813,	11147,	11241,	7867,	3809,
+gp,	56954,	48729,	47306,	73622,	59465,	51756,	42143,	27994,
0 TOTAL,	8558046,	5131320,	3206936,	2205573,	1576712,	1076379,	912275,	750838,

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

YEAR,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,
AGE										
0,	278105,	4053428,	1913386,	732827,	177125,	1646403,	905561,	79326,	453493,	35822,
1,	66148,	56387,	1538203,	699104,	260052,	49847,	639834,	345996,	18608,	160413,
2,	13263,	10738,	11294,	542520,	188063,	81052,	8036,	243395,	117663,	3686,
3,	4649,	1618,	2442,	2291,	202892,	70081,	20760,	1959,	81610,	37672,
4,	4564,	3839,	1253,	984,	1683,	157563,	53282,	16807,	859,	51327,
5,	17911,	3763,	3056,	910,	772,	1374,	127875,	42166,	12097,	492,
6,	16177,	14389,	2999,	2370,	745,	636,	1134,	91146,	31010,	6115,
7,	29773,	13096,	11028,	2355,	1901,	575,	531,	849,	58137,	14675,
8,	157224,	23826,	10209,	8601,	1847,	1450,	461,	443,	551,	23551,
9,	11033,	126309,	18279,	8109,	6833,	1480,	1078,	369,	244,	128,
10,	12645,	8842,	98497,	13846,	6524,	5334,	1188,	698,	249,	79,
11,	17340,	9745,	6790,	74015,	10658,	5128,	3596,	752,	425,	56,
12,	6636,	13066,	7238,	5056,	56967,	8091,	3559,	2213,	280,	126,
13,	7086,	4798,	9415,	5031,	3892,	41507,	5355,	2302,	980,	140,
14,	10747,	5382,	3312,	6684,	3913,	2941,	27193,	3198,	991,	214,
15,	9488,	8593,	3917,	2326,	5170,	2862,	1796,	16275,	1476,	196,
+gp,	25456,	15200,	10099,	4117,	6832,	5919,	11413,	4140,	7024,	1235,
0 TOTAL,	688244,	4373015,	3651415,	2111146,	935869,	2082240,	1812650,	852034,	785697,	335927,
1										

Run title : Herring Spring-spawn (run: SEPBJA06/S06)

At 3-May-98 17:24:09

Traditional vpa using file input for terminal F

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

YEAR,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,
AGE										
0,	46386,	96073,	6207,	2098,	9073,	127017,	85007,	29426,	100218,	50393,
1,	11970,	8476,	35623,	1806,	668,	1668,	51461,	34155,	11775,	40622,
2,	11196,	2313,	655,	11279,	478,	47,	656,	20874,	13864,	4773,
3,	1075,	2275,	164,	79,	4065,	77,	9,	243,	8476,	5629,
4,	19600,	37,	254,	83,	51,	3172,	44,	7,	179,	7080,
5,	14426,	177,	25,	50,	62,	12,	2497,	36,	5,	104,
6,	179,	111,	71,	16,	31,	20,	4,	1922,	22,	4,
7,	1420,	25,	52,	31,	10,	4,	4,	1,	1371,	19,
8,	2346,	364,	15,	15,	16,	3,	1,	2,	1,	1059,
9,	4602,	791,	205,	4,	3,	1,	1,	1,	1,	1,
10,	29,	822,	371,	54,	0,	0,	1,	0,	1,	1,
11,	16,	7,	376,	81,	7,	0,	0,	1,	0,	1,
12,	16,	4,	3,	68,	7,	1,	0,	0,	0,	0,
13,	31,	7,	1,	0,	9,	1,	1,	0,	0,	0,
14,	39,	4,	4,	0,	0,	3,	1,	1,	0,	0,
15,	26,	10,	1,	1,	0,	0,	1,	1,	1,	0,
+gp,	216,	49,	27,	0,	0,	0,	1,	1,	1,	0,
0 TOTAL,	113573,	111543,	44057,	15664,	14482,	132026,	139688,	86670,	135916,	109687,

Table 3.5.7.2 a (continued)

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

YEAR,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,
AGE										
0,	61332,	121681,	14923,	10919,	23298,	3658902,	155829,	358332,	90946,	61098,
1,	20224,	24812,	49271,	6025,	4388,	9333,	1486816,	63147,	145511,	36891,
2,	16477,	8208,	10064,	20027,	2443,	1777,	3766,	604484,	25593,	59152,
3,	1921,	6692,	3325,	4089,	8069,	992,	712,	1516,	244488,	10386,
4,	4641,	1626,	5701,	2803,	3481,	6817,	824,	572,	1106,	205431,
5,	5875,	3881,	1382,	4853,	2370,	2923,	5671,	660,	349,	789,
6,	86,	4868,	3277,	1168,	4097,	1998,	2428,	4312,	415,	167,
7,	4,	66,	4086,	2745,	985,	3469,	1662,	1921,	2512,	215,
8,	13,	3,	54,	3370,	2321,	830,	2922,	1314,	1109,	1196,
9,	812,	5,	3,	42,	2824,	1951,	702,	2371,	625,	270,
10,	1,	652,	4,	2,	33,	2375,	1636,	538,	1459,	154,
11,	1,	1,	538,	4,	1,	28,	1976,	1257,	370,	549,
12,	1,	1,	1,	438,	2,	0,	22,	1641,	796,	140,
13,	0,	1,	1,	1,	368,	2,	0,	19,	951,	88,
14,	0,	0,	0,	1,	0,	316,	0,	0,	17,	95,
15,	0,	0,	0,	0,	0,	0,	264,	0,	0,	14,
+gp,	0,	0,	0,	0,	0,	0,	0,	90,	35,	0,
0 TOTAL,	111387,	172497,	92631,	56488,	54682,	3691709,	1665232,	1042171,	516281,	376636,

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

YEAR,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	GMST 50-95	AMST 50-95
AGE													
0,	275405,	858721,	1600436,	4109446,	4791380,	1831909,	373433,	61511,	0,	0,	0,	215893,	893920,
1,	24755,	111876,	349086,	650682,	1670774,	1948019,	744758,	151024,	25008,	0,	0,	79826,	352654,
2,	14960,	10048,	45473,	141925,	264527,	679285,	792006,	302796,	61727,	10168,	0,	24283,	132390,
3,	33829,	6026,	3930,	18392,	57682,	107540,	276132,	321955,	123101,	24911,	4000,	7708,	51113,
4,	8756,	19927,	5160,	3210,	15752,	49531,	92298,	237368,	276576,	105635,	20233,	5066,	37002,
5,	172170,	7304,	17117,	4417,	2737,	13251,	41641,	78421,	201094,	231439,	88411,	3243,	26357,
6,	507,	143089,	6235,	14623,	3788,	2310,	10597,	32472,	61731,	158538,	182575,	2128,	21164,
7,	111,	349,	120153,	5266,	12450,	3250,	1908,	7597,	22054,	44434,	118010,	1406,	17467,
8,	120,	62,	268,	101320,	4450,	10605,	2763,	1498,	4408,	15227,	31207,	934,	13458,
9,	771,	48,	46,	219,	85179,	3777,	8853,	2303,	1146,	2839,	10090,	590,	11038,
10,	122,	529,	35,	25,	165,	71223,	3078,	7274,	1835,	934,	1881,	386,	9366,
11,	46,	24,	425,	12,	18,	119,	57504,	2319,	5615,	1511,	619,	239,	7680,
12,	431,	14,	8,	343,	9,	9,	103,	43522,	1225,	4222,	1001,	151,	7057,
13,	49,	340,	6,	1,	289,	6,	8,	62,	29035,	892,	2797,	79,	5994,
14,	16,	17,	290,	3,	0,	237,	5,	3,	16,	17272,	591,	47,	4750,
15,	18,	0,	13,	244,	0,	0,	204,	3,	0,	14,	11445,	30,	4139,
+gp,	0,	0,	24,	5,	0,	0,	0,	0,	0,	0,	9,		
0 TOTAL,	522066,	1158373,	2148703,	5050128,	6909200,	4721075,	2405290,	1250929,	814571,	618035,	472968,		
1													

Table 3.5.7.3 a

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

YEAR,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,
AGE										
0,	2781,	40534,	19134,	7328,	1771,	16464,	9056,	793,	4535,	358,
1,	5292,	4511,	123056,	55928,	20804,	3988,	51187,	27680,	1489,	12833,
2,	6234,	5047,	5308,	254985,	88390,	38094,	3777,	114396,	55302,	1732,
3,	4649,	1618,	2442,	2291,	202893,	70081,	20760,	1959,	81610,	37672,
4,	9311,	7832,	2555,	2283,	3685,	291492,	103368,	31261,	1590,	92389,
5,	43345,	9482,	8252,	2275,	2247,	3477,	272374,	83911,	26492,	1121,
6,	47236,	37412,	8726,	6922,	2235,	1869,	2993,	215104,	68842,	16450,
7,	87831,	37980,	32312,	7112,	6008,	1793,	1682,	2208,	144762,	39622,
8,	460666,	71477,	32772,	26148,	5986,	4769,	1675,	1607,	1685,	69240,
9,	33651,	385241,	58128,	26191,	22275,	4839,	3807,	1292,	863,	416,
10,	39832,	27851,	315189,	44585,	21854,	17816,	4145,	2583,	940,	331,
11,	57222,	31672,	23357,	237590,	36024,	17486,	12729,	2706,	1660,	241,
12,	22561,	43117,	25260,	17392,	190268,	28236,	12704,	8363,	1061,	460,
13,	24445,	16315,	34834,	17959,	13504,	141539,	19225,	8908,	3706,	514,
14,	37829,	18569,	12553,	24262,	13853,	10527,	99255,	12471,	3576,	926,
15,	34156,	30507,	14688,	8492,	18507,	10734,	7221,	64122,	5655,	811,
+gp,	92914,	54720,	38375,	15233,	24460,	22196,	45881,	16313,	26901,	5113,
0 TOTALBIO,	1009955,	823883,	756941,	756976,	674765,	685401,	671837,	595676,	430668,	280231,

1

Run title : Herring Spring-spawn (run: SEPBJA06/S06)

At 3-May-98 17:24:09

Traditional vpa using file input for terminal F

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

YEAR,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,
AGE										
0,	464,	961,	62,	21,	91,	1270,	850,	294,	1002,	504,
1,	958,	678,	2850,	271,	67,	167,	5146,	3416,	1178,	4062,
2,	5262,	1087,	308,	9023,	334,	40,	558,	17743,	11785,	4057,
3,	1075,	2275,	164,	79,	6098,	130,	16,	440,	15341,	10189,
4,	22540,	43,	532,	157,	76,	8215,	114,	18,	463,	18337,
5,	29718,	256,	68,	112,	87,	41,	8538,	122,	17,	356,
6,	477,	300,	164,	40,	66,	78,	17,	7380,	85,	16,
7,	3905,	76,	154,	85,	25,	18,	16,	6,	5606,	78,
8,	6428,	1113,	49,	43,	44,	10,	6,	7,	5,	4700,
9,	13116,	2435,	663,	13,	8,	3,	3,	5,	6,	5,
10,	102,	2614,	1207,	176,	1,	2,	3,	2,	5,	6,
11,	52,	23,	1238,	271,	22,	1,	2,	3,	2,	4,
12,	59,	13,	12,	236,	25,	6,	1,	1,	2,	2,
13,	125,	24,	5,	0,	33,	4,	5,	1,	1,	2,
14,	151,	15,	15,	1,	0,	13,	3,	4,	1,	1,
15,	97,	39,	5,	6,	0,	0,	3,	3,	4,	0,
+gp,	818,	193,	104,	0,	0,	0,	3,	3,	4,	0,
0 TOTALBIO,	85347,	12145,	7599,	10532,	6977,	10000,	15283,	29448,	35506,	42320,

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

YEAR,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,
AGE										
0,	613,	1217,	149,	109,	233,	36589,	1558,	3583,	909,	611,
1,	2022,	2481,	4927,	602,	439,	933,	148682,	6315,	14551,	3689,
2,	14006,	6976,	8555,	17023,	2076,	1511,	3201,	139031,	21754,	32533,
3,	3458,	11911,	5819,	6952,	13717,	1537,	397,	2243,	132023,	9348,
4,	13643,	3772,	16133,	6278,	7102,	16975,	1681,	1337,	2278,	293766,
5,	19153,	13934,	4795,	16306,	7180,	8886,	16730,	1748,	925,	1901,
6,	320,	18744,	13174,	4416,	14545,	7352,	8206,	13453,	1200,	466,
7,	15,	278,	17204,	10623,	3773,	14013,	6250,	6647,	8516,	642,
8,	58,	14,	251,	13752,	9167,	3519,	11543,	4861,	4082,	3779,
9,	3863,	26,	12,	168,	11664,	8524,	2858,	9364,	2443,	924,
10,	5,	3390,	23,	11,	151,	10354,	6758,	2135,	5573,	529,
11,	5,	4,	2871,	20,	4,	136,	8339,	5380,	1437,	1988,
12,	3,	4,	3,	2242,	11,	2,	98,	7023,	3143,	527,
13,	1,	3,	3,	3,	1862,	8,	0,	82,	3757,	329,
14,	2,	1,	2,	3,	2,	1562,	0,	0,	65,	359,
15,	1,	1,	1,	2,	2,	2,	1152,	0,	0,	54,
+gp,	1,	1,	1,	2,	2,	2,	1,	383,	137,	0,
0 TOTALBIO,	57169,	62758,	73925,	78513,	71933,	111905,	218055,	203586,	202794,	351445,

Table 3.5.7.3 a (continued)

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

YEAR,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,
AGE										
0,	2754,	8587,	16004,	41094,	47914,	18319,	3734,	615,	0,	0,
1,	3713,	16781,	27927,	71575,	116954,	155842,	74476,	27328,	4502,	0,
2,	7480,	10048,	21827,	52512,	79358,	169822,	198001,	75699,	15432,	2542,
3,	23352,	9280,	8607,	27037,	73833,	87108,	207099,	212491,	93556,	23914,
4,	11821,	34872,	10217,	6741,	35285,	99557,	139369,	327568,	326360,	124650,
5,	339175,	15266,	44163,	10776,	8102,	35116,	105769,	180368,	378056,	402704,
6,	1403,	360585,	17955,	43869,	12388,	7461,	33700,	96117,	161119,	363052,
7,	350,	1064,	371274,	17060,	44198,	11503,	7079,	26287,	69692,	127082,
8,	406,	227,	1147,	340436,	15352,	37965,	9588,	5813,	15250,	49183,
9,	2644,	182,	170,	750,	312608,	14390,	36476,	8359,	4286,	10503,
10,	439,	1898,	142,	97,	563,	262814,	11759,	29752,	7157,	3529,
11,	167,	96,	1643,	43,	64,	472,	234043,	9602,	21900,	5834,
12,	1621,	54,	37,	1458,	40,	37,	421,	183663,	4704,	15198,
13,	183,	1346,	24,	6,	1358,	21,	33,	255,	115558,	3505,
14,	61,	69,	1274,	13,	1,	956,	20,	11,	65,	67534,
15,	69,	0,	55,	1036,	2,	1,	837,	14,	0,	55,
+gp,	0,	0,	105,	19,	2,	1,	0,	0,	0,	0,
0 TOTALBIO,	395640,	460357,	522572,	614524,	748020,	901383,	1062402,	1183942,	1217637,	1199283,
1										

Table 3.5.7.4 a

Run title : Herring Spring-spawn (run: SEPBJA06/S06)

At 3-May-98 17:24:09

Traditional vpa using file 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,
AGE								
0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	0,	0,	0,	0,	0,	0,	0,	0,
2,	0,	0,	0,	0,	0,	0,	0,	0,
3,	0,	0,	0,	0,	0,	2494,	2361,	0,
4,	8031,	18177,	9339,	6134,	79681,	23924,	11632,	0,
5,	33645,	22205,	50288,	26770,	17486,	253914,	38628,	22772,
6,	128680,	61613,	39992,	87852,	49427,	45344,	545490,	55461,
7,	193189,	166684,	81898,	52701,	113762,	70586,	45660,	520781,
8,	55828,	177994,	154669,	77394,	50794,	102256,	58914,	38607,
9,	83900,	48295,	144870,	129476,	66612,	42502,	84822,	47828,
10,	99002,	72012,	40669,	117662,	105437,	53392,	35120,	67972,
11,	82332,	84637,	61443,	33790,	92300,	80900,	41552,	27405,
12,	182320,	69217,	70794,	51053,	27539,	67573,	61728,	30545,
13,	204396,	155319,	57988,	59433,	42359,	21748,	53666,	46630,
14,	32070,	166797,	127792,	47256,	48739,	33836,	17095,	41766,
15,	91162,	26810,	139320,	109026,	39238,	39670,	27695,	13447,
+gp,	203850,	173996,	168866,	262658,	211045,	184166,	149580,	99655,
0 TOTSPBIO,	1398402,	1243755,	1147929,	1061204,	944418,	1022305,	1173942,	1012868,

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

YEAR,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,
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,	365,	126,	178,	89,	0,	2727,	407,	0,	779,	0,
4,	2009,	1684,	544,	780,	397,	8564,	6059,	10285,	226,	814,
5,	15690,	3429,	2977,	1516,	1476,	1091,	73726,	28480,	24745,	233,
6,	39312,	30965,	7240,	6364,	2178,	1652,	931,	156291,	61324,	14215,
7,	85895,	37046,	31519,	6942,	5847,	1754,	1652,	2114,	132254,	32985,
8,	450689,	69608,	32026,	25553,	5854,	4630,	1638,	1514,	1457,	58810,
9,	32914,	375778,	56536,	25627,	21730,	4734,	3645,	1243,	771,	358,
10,	38808,	27125,	306310,	43433,	21334,	17127,	3959,	2458,	810,	282,
11,	55625,	30744,	22679,	231450,	35044,	16859,	12126,	2452,	1470,	213,
12,	21841,	41726,	24357,	16943,	184339,	27095,	12162,	7710,	990,	400,
13,	23782,	15721,	33661,	17514,	13131,	135678,	18259,	8188,	3183,	453,
14,	36993,	17988,	12117,	23647,	13427,	10021,	94288,	11543,	3041,	749,
15,	33373,	29716,	14270,	8277,	17967,	10306,	6890,	59368,	4947,	690,
+gp,	90784,	53301,	37283,	14848,	23745,	21311,	43776,	15103,	23532,	4345,
0 TOTSPBIO,	928080,	734958,	581697,	422984,	346470,	263549,	279516,	306748,	259528,	114547,

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Run title : Herring Spring-spawn (run: SEPBJA06/S06)

At 3-May-98 17:24:09

Traditional vpa using file input for terminal F

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

YEAR,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,
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,	3,	51,	1621,	1077,	0,
3,	0,	1133,	9,	8,	0,	62,	8,	213,	7534,	7296,
4,	0,	37,	59,	38,	7,	7218,	100,	18,	395,	16018,
5,	183,	222,	20,	64,	19,	37,	8318,	116,	16,	350,
6,	298,	278,	26,	34,	32,	66,	15,	7135,	84,	16,
7,	3408,	72,	136,	80,	19,	16,	14,	6,	5463,	75,
8,	5766,	1051,	43,	36,	32,	9,	5,	7,	5,	4577,
9,	11041,	2258,	580,	10,	6,	3,	3,	5,	6,	5,
10,	88,	2418,	1036,	143,	1,	2,	3,	2,	5,	6,
11,	45,	22,	1044,	212,	19,	1,	2,	3,	2,	4,
12,	54,	12,	8,	193,	20,	6,	1,	1,	2,	2,
13,	101,	23,	4,	0,	29,	4,	5,	1,	1,	2,
14,	131,	13,	13,	1,	0,	12,	3,	4,	1,	1,
15,	83,	36,	5,	5,	0,	0,	3,	3,	4,	0,
+gp,	703,	180,	89,	0,	0,	0,	3,	3,	4,	0,
0 TOTSPBIO,	21901,	7754,	3072,	823,	185,	7440,	8534,	9130,	14598,	28351,

Table 3.5.7.4 a (continued)

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

YEAR,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,
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,	442,	1172,	1430,	2052,	1349,	151,	98,	217,	12975,	919,
4,	12061,	2301,	7938,	3087,	3350,	8333,	822,	637,	440,	86587,
5,	18796,	13015,	4574,	14429,	4941,	6019,	14650,	1502,	773,	1637,
6,	312,	18418,	12943,	4342,	14305,	5125,	7615,	12745,	1124,	447,
7,	14,	273,	16876,	10446,	3709,	13775,	6105,	6292,	7907,	606,
8,	53,	13,	245,	13511,	9009,	3460,	11304,	4513,	3545,	3617,
9,	3779,	25,	12,	164,	11464,	8375,	2783,	8920,	2124,	854,
10,	4,	3325,	22,	10,	148,	10166,	6582,	2056,	5054,	469,
11,	5,	4,	2813,	19,	4,	133,	8186,	5140,	1304,	1941,
12,	3,	4,	3,	2203,	11,	2,	96,	6650,	2521,	474,
13,	1,	3,	3,	3,	1833,	5,	0,	81,	2985,	278,
14,	2,	1,	2,	3,	2,	1534,	0,	0,	64,	304,
15,	1,	1,	1,	2,	2,	2,	1127,	0,	0,	51,
+gp,	1,	1,	1,	2,	2,	2,	1,	364,	118,	0,
0 TOTSPBIO,	35475,	38558,	46863,	50274,	50131,	57082,	59369,	49117,	40933,	98183,

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

YEAR,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,
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,	2294,	914,	3374,	2662,	7272,	858,	2040,	0,	0,	0,
4,	3483,	10304,	8047,	4644,	6936,	29353,	41135,	3222,	3206,	36735,
5,	299662,	13524,	39126,	10612,	6373,	27472,	82536,	140883,	166128,	353939,
6,	1352,	354340,	15889,	43169,	12199,	7319,	32597,	92470,	155908,	352490,
7,	331,	1036,	328498,	16776,	43494,	11318,	6910,	24894,	67157,	122670,
8,	371,	220,	1124,	334579,	15103,	37286,	9415,	5659,	14594,	47200,
9,	2546,	176,	160,	730,	307063,	14098,	35766,	8171,	4199,	10080,
10,	373,	1857,	127,	94,	545,	257251,	11430,	28992,	7020,	3387,
11,	148,	87,	1608,	42,	60,	465,	227612,	9009,	21284,	5599,
12,	1583,	50,	31,	1433,	38,	36,	400,	176377,	4557,	14585,
13,	166,	1325,	23,	5,	1331,	21,	29,	223,	109709,	3363,
14,	38,	67,	1253,	11,	1,	942,	19,	7,	64,	64811,
15,	65,	0,	54,	1019,	2,	1,	815,	13,	0,	53,
+gp,	0,	0,	102,	19,	2,	1,	0,	0,	0,	0,
0 TOTSPBIO,	312411,	383899,	399415,	415794,	400418,	386421,	450707,	489919,	553826,	1014912,

1

Table 3.5.7.5 a

Run title : Herring Spring-spawn (run: SEPBJA06/S06)

At 3-May-98 17:24:09

Table 16 Summary (without SOP correction)

Traditional vpa using file input for terminal F

	RECRUITS, Age 0	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 5-14,
1950,	747377536,	19619082,	13984028,	933000,	.0667,	.0537,
1951,	143907984,	19055266,	12437552,	1278400,	.1028,	.0623,
1952,	93898768,	20595604,	11479294,	1254800,	.1093,	.0673,
1953,	83577048,	18573720,	10612048,	1090600,	.1028,	.0646,
1954,	39702932,	19292220,	9444186,	1644500,	.1741,	.1083,
1955,	23753766,	16616774,	10223046,	1359800,	.1330,	.0928,
1956,	27474766,	14604080,	11739434,	1659400,	.1414,	.1202,
1957,	23650586,	11550192,	10128688,	1319500,	.1303,	.1009,
1958,	27810500,	10099550,	9280808,	986600,	.1063,	.0960,
1959,	405342656,	8238827,	7349572,	1111100,	.1512,	.1334,
1960,	191338576,	7569418,	5816970,	1101800,	.1894,	.1393,
1961,	73282680,	7569753,	4229841,	830100,	.1962,	.0904,
1962,	17712450,	6747648,	3464701,	848600,	.2449,	.1121,
1963,	164640160,	6854007,	2635488,	984500,	.3736,	.1697,
1964,	90556048,	6718368,	2795161,	1281800,	.4586,	.2374,
1965,	7932618,	5956768,	3067481,	1547700,	.5046,	.4594,
1966,	45349296,	4306681,	2595278,	1955000,	.7533,	.9968,
1967,	3582231,	2802311,	1145467,	1677200,	1.4642,	1.3567,
1968,	4638558,	853466,	219013,	712200,	3.2519,	1.6790,
1969,	9607282,	121451,	77541,	67800,	.8744,	.6100,
1970,	620670,	75989,	30719,	62300,	2.0281,	1.3720,
1971,	209800,	105320,	8232,	21100,	2.5633,	1.4276,
1972,	907340,	69766,	1854,	13161,	7.0983,	1.3809,
1973,	12701702,	100001,	74399,	7017,	.0943,	.6183,
1974,	8500674,	152833,	85340,	7619,	.0893,	.2015,
1975,	2942581,	294480,	91376,	13713,	.1501,	.0741,
1976,	10021786,	355062,	145979,	10436,	.0715,	.0333,
1977,	5039345,	423195,	283510,	22706,	.0801,	.0582,
1978,	6133165,	571686,	354751,	19824,	.0559,	.1088,
1979,	12168084,	627579,	385580,	12864,	.0334,	.0242,
1980,	1492295,	739250,	468635,	18577,	.0396,	.0327,
1981,	1091881,	785134,	502736,	13736,	.0273,	.1327,
1982,	2329761,	719332,	501305,	16655,	.0332,	.0920,
1983,	365890368,	1119049,	570816,	23054,	.0404,	.5791,
1984,	15582862,	2180546,	593685,	53532,	.0902,	.1154,
1985,	35833148,	2035859,	491170,	169872,	.3459,	.3460,
1986,	9094620,	2027938,	409329,	225256,	.5503,	1.0056,
1987,	6109821,	3514455,	981828,	127306,	.1297,	.7007,
1988,	27540440,	3956402,	3124109,	135301,	.0433,	.9885,
1989,	85872112,	4603566,	3838995,	103830,	.0270,	.2383,
1990,	160043536,	5225721,	3994153,	86411,	.0216,	.3674,
1991,	410944512,	6145245,	4157938,	84683,	.0204,	.4090,
1992,	479138208,	7480200,	4004181,	104448,	.0261,	.1175,
1993,	183190784,	9013826,	3864209,	232457,	.0602,	.0279,
1994,	37343300,	10624036,	4507063,	479228,	.1063,	.2244,
1995,	6151075,	11839416,	4899194,	905501,	.1848,	.6981,
1996,	0,	12176370,	5538258,	1220283,	.2203,	.1549,
1997,	0,	11992842,	10149124,	1426507,	.1406,	.2267,
Arith. Mean	85667304,	6389590,	3891334,	609620,	.4979,	.3855,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		
1						

Table 3.5.7.6 a Summary (without SOP correction)
Traditional vpa using file input for terminal F

	RECRUITS Age 3	TOT BIO	SP BIO	LANDINGS	Y/SSB	FBAR 5-14	FW 5-14
1950	10854940	17993416	13984028	933000	0.0667	0.0537	0.0584
1951	5413743	16061772	12437552	1278400	0.1028	0.0623	0.0697
1952	3594422	14515330	11479294	1254800	0.1093	0.0673	0.0728
1953	47046016	17412376	10612048	1090600	0.1028	0.0646	0.0663
1954	6899113	18581252	9444186	1644500	0.1741	0.1083	0.1124
1955	3174837	16130704	10223046	1359800	0.133	0.0928	0.0783
1956	3009160	14416902	11739434	1659400	0.1414	0.1202	0.1099
1957	555352	11393882	10128688	1319500	0.1303	0.1009	0.1026
1958	464887	9956482	9280808	986600	0.1063	0.096	0.0787
1959	161775	7737907	7349572	1111100	0.1512	0.1334	0.1129
1960	244166	6094433	5816970	1101800	0.1894	0.1393	0.1359
1961	229051	4387340	4229841	830100	0.1962	0.0904	0.1046
1962	20289262	5637997	3464701	848600	0.2449	0.1121	0.1458
1963	7008124	6268545	2635488	984500	0.3736	0.1697	0.2525
1964	2076012	6078176	2795161	1281800	0.4586	0.2374	0.2271
1965	195852	4528080	3067481	1547700	0.5046	0.4594	0.2803
1966	8160987	3693428	2595278	1955000	0.7533	0.9968	0.7002
1967	3767196	2653076	1145467	1677200	1.4642	1.3567	1.5170
1968	107482	786631	219013	712200	3.2519	1.679	3.4498
1969	227478	94191	77541	67800	0.8744	0.61	0.5948
1970	16366	43789	30719	62300	2.0281	1.372	1.3236
1971	7864	12173	8232	21100	2.5633	1.4276	1.5201
1972	406544	64846	1854	13161	7.0983	1.3809	1.4874
1973	7657	85230	74365	7017	0.0944	0.6183	1.1640
1974	927	87291	84834	7619	0.0898	0.2015	0.1138
1975	24302	79950	75162	13713	0.1824	0.0741	0.1899
1976	847581	215419	135210	10436	0.0772	0.0333	0.1059
1977	562941	336966	283510	22706	0.0801	0.0582	0.1105
1978	192131	405271	354751	19824	0.0559	0.1088	0.0439
1979	669182	520835	385580	12864	0.0334	0.0242	0.0241
1980	332522	602940	468635	18577	0.0396	0.0327	0.0345
1981	408937	607787	502736	13736	0.0273	0.1327	0.0217
1982	806911	691851	501305	16655	0.0332	0.092	0.0202
1983	99189	728718	570816	23054	0.0404	0.5791	0.0294
1984	71228	646138	593685	53532	0.0902	0.1154	0.0918
1985	151566	546565	491170	169872	0.3459	0.346	0.3838
1986	24448766	1655796	409329	225256	0.5503	1.0056	1.0783
1987	1038613	3146120	981828	127306	0.1297	0.7007	0.4109
1988	2382889	3816930	3124109	135301	0.0433	0.9885	0.0392
1989	602605	4249404	3838995	103830	0.027	0.2383	0.0246
1990	393010	4568136	3994153	86411	0.0216	0.3674	0.0196
1991	1839230	4493426	4157938	84683	0.0204	0.409	0.0214
1992	5768203	5037938	4004181	104448	0.0261	0.1175	0.0254
1993	10754034	5574007	3864209	232457	0.0602	0.0279	0.0591
1994	27613230	7861920	4507063	479228	0.1063	0.2244	0.1152
1995	32195544	10802992	4899194	905501	0.1848	0.6981	0.1775
1996	12310062	11977038	5538258	1220283	0.2203	0.1549	0.1422
1997	2491056	11967424	10149124	1426507	0.1406	0.2267	0.1330
Arith. Mean	5206728	5526017	3890761	609620	0.4987	0.3855	
0 Units	(Thousanc	(Tonnes	(Tonnes	(Tonnes)			

Table 3.5.7.1 b

Run title : Herring Spring-spawn (run: SEPBJA11/S11)

At 4-May-98 21:34:06

Traditional vpa using file input for terminal F

Table 8 Fishing mortality (F) at age YEAR,	1950,	1951,	1952,	1953,	1954,	1955,	1956,	1957,
AGE								
0,	.0104,	.0174,	.2455,	.1082,	.4996,	.3874,	.3408,	.3741,
1,	.1217,	.0390,	.2699,	.2894,	.4172,	.5567,	.5949,	.8901,
2,	.0658,	.0661,	.0160,	.0505,	.1521,	.0987,	.5132,	.2514,
3,	.0278,	.0013,	.0118,	.0171,	.0424,	.0320,	.0426,	.0462,
4,	.0508,	.0465,	.0141,	.0165,	.0396,	.0537,	.1079,	.1763,
5,	.0410,	.0581,	.0908,	.0279,	.0612,	.0692,	.0756,	.0844,
6,	.0709,	.0441,	.0565,	.0674,	.0799,	.0605,	.1097,	.0687,
7,	.0884,	.0839,	.0673,	.0415,	.1184,	.0808,	.0723,	.1105,
8,	.0446,	.1085,	.0779,	.0449,	.0800,	.0854,	.1111,	.0587,
9,	.0346,	.0527,	.0873,	.0810,	.1009,	.0666,	.1049,	.0891,
10,	.0375,	.0390,	.0668,	.1173,	.1477,	.1271,	.1307,	.0930,
11,	.0369,	.0427,	.0490,	.0645,	.1846,	.1325,	.1759,	.1163,
12,	.0379,	.0556,	.0544,	.0641,	.1175,	.1098,	.1647,	.1469,
13,	.0667,	.0602,	.0682,	.0584,	.0886,	.1012,	.1147,	.1210,
14,	.0781,	.0787,	.0545,	.0789,	.1039,	.0949,	.1424,	.1208,
15,	.0459,	.0697,	.0726,	.0782,	.1304,	.1044,	.1295,	.1000,
+gp,	.0459,	.0697,	.0726,	.0782,	.1304,	.1044,	.1295,	.1000,
0 FBAR 5-14,	.0537,	.0623,	.0673,	.0646,	.1083,	.0928,	.1202,	.1009,

Table 8 Fishing mortality (F) at age YEAR,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,
AGE										
0,	.6958,	.0689,	.1068,	.1360,	.3679,	.0451,	.0621,	.5500,	.1392,	.1961,
1,	.9181,	.7079,	.1421,	.4130,	.2658,	.9250,	.0665,	.1786,	.7192,	1.7622,
2,	1.2040,	.5811,	.6955,	.0835,	.0871,	.4621,	.5117,	.1927,	.2389,	.3323,
3,	.0414,	.1058,	.7587,	.1583,	.1028,	.1240,	.0612,	.6737,	.3137,	.5034,
4,	.0431,	.0781,	.1698,	.0927,	.0525,	.0588,	.0840,	.1789,	.4085,	1.1192,
5,	.0689,	.0769,	.1041,	.0497,	.0442,	.0424,	.1886,	.1573,	.5321,	.8593,
6,	.0612,	.1160,	.0916,	.0705,	.1097,	.0310,	.1391,	.2997,	.5982,	1.3102,
7,	.0728,	.0990,	.0985,	.0928,	.1213,	.0698,	.0309,	.2829,	.7536,	1.6834,
8,	.0689,	.1150,	.0804,	.0802,	.0718,	.1458,	.0725,	.4469,	1.3073,	1.4826,
9,	.0714,	.0987,	.1278,	.0675,	.0976,	.0700,	.2847,	.2423,	.9790,	1.3296,
10,	.1105,	.1140,	.1357,	.1117,	.0907,	.2443,	.3074,	.3472,	1.3436,	1.4501,
11,	.1330,	.1475,	.1449,	.1118,	.1256,	.2153,	.3356,	.8375,	1.0666,	1.0905,
12,	.1742,	.1777,	.2138,	.1117,	.1666,	.2626,	.2856,	.6639,	.5451,	1.2609,
13,	.1249,	.2207,	.1926,	.1012,	.1302,	.2729,	.3657,	.6932,	1.3723,	1.1286,
14,	.0736,	.1679,	.2032,	.1069,	.1628,	.3429,	.3633,	.6227,	1.4701,	1.9718,
15,	.0820,	.1127,	.1387,	.1057,	.1466,	.2569,	.3195,	.6204,	1.1880,	1.4777,
+gp,	.0820,	.1127,	.1387,	.1057,	.1466,	.2569,	.3195,	.6204,	1.1880,	1.4777,
0 FBAR 5-14,	.0960,	.1334,	.1393,	.0904,	.1121,	.1697,	.2374,	.4594,	.9968,	1.3567,

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Run title : Herring Spring-spawn (run: SEPBJA11/S11)

At 4-May-98 21:34:06

Traditional vpa using file input for terminal F

Table 8 Fishing mortality (F) at age YEAR,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,
AGE										
0,	.7997,	.0919,	.3347,	.2441,	.7866,	.0035,	.0118,	.0158,	.0030,	.0130,
1,	.7439,	1.6597,	.2493,	.4295,	1.7489,	.0318,	.0023,	.0016,	.0031,	.0023,
2,	.6937,	1.7485,	1.2204,	.1199,	.9309,	.7287,	.0923,	.0013,	.0013,	.0099,
3,	3.2063,	2.0406,	.5307,	.2855,	.0978,	.4069,	.1232,	.1535,	.0299,	.0432,
4,	4.5599,	.2603,	1.4841,	.1420,	1.2885,	.0889,	.0609,	.2243,	.3851,	.0365,
5,	4.7169,	.7590,	.2997,	.3119,	.9579,	.8547,	.1110,	.3211,	.0822,	.0345,
6,	1.8047,	.6022,	.6840,	.2792,	1.8081,	1.5113,	.9641,	.1869,	.0005,	.0026,
7,	1.2122,	.3507,	1.1084,	.4855,	1.2485,	1.1056,	.7738,	.0378,	.1076,	.2687,
8,	.9377,	.4226,	1.1723,	1.6232,	2.9414,	1.3458,	.0086,	.0141,	.0090,	.1149,
9,	1.5725,	.6055,	1.1824,	2.5188,	1.7556,	.0146,	.0190,	.0101,	.0083,	.0106,
10,	1.2944,	.6310,	1.3750,	1.9503,	.0386,	.0291,	.0172,	.0226,	.0118,	.0097,
11,	1.3198,	.6261,	1.5562,	2.2731,	1.5523,	.0468,	.0349,	.0204,	.0269,	.0139,
12,	.7483,	.8732,	3.9006,	1.8351,	2.0429,	.0090,	.0573,	.0421,	.0242,	.0322,
13,	1.9490,	.3927,	1.6254,	.2163,	1.1118,	.0136,	.0105,	.0709,	.0513,	.0289,
14,	1.2342,	.8364,	.8119,	2.7735,	.3288,	1.2390,	.0160,	.0123,	.0893,	.0631,
15,	1.3620,	.5776,	1.4061,	2.0274,	2.1018,	.5993,	.0164,	.0189,	.0145,	.1148,
+gp,	1.3620,	.5776,	1.4061,	2.0274,	2.1018,	.5993,	.0164,	.0189,	.0145,	.1148,
0 FBAR 5-14,	1.6790,	.6099,	1.3716,	1.4267,	1.3786,	.6169,	.2012,	.0738,	.0331,	.0579,

Table 3.5.7.1 b (continued)

Table 8 Fishing mortality (F) at age YEAR,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,
AGE										
0,	.0050,	.0040,	.0070,	.0116,	.0146,	.0005,	.0030,	.0010,	.0019,	.0030,
1,	.0018,	.0023,	.0002,	.0028,	.0038,	.0075,	.0000,	.0029,	.0001,	.0022,
2,	.0011,	.0035,	.0006,	.0089,	.0012,	.0144,	.0099,	.0048,	.0017,	.0079,
3,	.0170,	.0100,	.0210,	.0110,	.0182,	.0350,	.0701,	.1629,	.0220,	.0189,
4,	.0286,	.0124,	.0108,	.0178,	.0247,	.0334,	.0726,	.3436,	.1841,	.0243,
5,	.0379,	.0192,	.0179,	.0188,	.0207,	.0357,	.1214,	.3109,	.5874,	.2863,
6,	.1114,	.0251,	.0272,	.0204,	.0162,	.0339,	.0841,	.3794,	.5059,	.2552,
7,	.0030,	.0527,	.0426,	.0179,	.0216,	.0209,	.0853,	.3991,	.5656,	.4288,
8,	.7484,	.0035,	.0888,	.0268,	.0238,	.0169,	.0577,	.5933,	1.2622,	.2698,
9,	.0684,	.0021,	.0332,	.0882,	.0233,	.0257,	.1167,	.3253,	1.2482,	.6432,
10,	.0124,	.0423,	.0025,	.6963,	.0383,	.0337,	.1136,	.2219,	.7829,	1.0619,
11,	.0114,	.0146,	.0548,	.3916,	.5461,	.0551,	.0359,	.3072,	.8163,	.0849,
12,	.0164,	.0134,	.0172,	.0237,	.1999,	2.2557,	.0005,	.3948,	2.0560,	.8905,
13,	.0387,	.0194,	.0158,	.0204,	.0035,	3.2708,	.2926,	.0005,	2.1381,	1.5327,
14,	.0346,	.0469,	.0231,	.0187,	.0242,	.0295,	.2388,	.5007,	.0006,	1.4536,
15,	.0786,	.0418,	.0574,	.0275,	.0221,	.0289,	.0691,	.3752,	1.3757,	.3951,
+gp,	.0786,	.0418,	.0574,	.0275,	.0221,	.0289,	.0691,	.3752,	1.3757,	.3951,
0 FBAR 5-14,	.1083,	.0239,	.0323,	.1323,	.0918,	.5778,	.1147,	.3433,	.9963,	.6907,

Table 8 Fishing mortality (F) at age YEAR,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	FBAR 95-97
AGE											
0,	.0008,	.0001,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
1,	.0015,	.0002,	.0000,	.0001,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,	.0000,
2,	.0077,	.0332,	.0047,	.0003,	.0001,	.0001,	.0001,	.0000,	.0068,	.0330,	.0133,
3,	.0246,	.0043,	.0447,	.0045,	.0021,	.0024,	.0010,	.0016,	.0026,	.0532,	.0191,
4,	.0285,	.0017,	.0046,	.0080,	.0209,	.0206,	.0107,	.0130,	.0231,	.0242,	.0201,
5,	.0319,	.0076,	.0064,	.0029,	.0168,	.0668,	.0859,	.0736,	.0712,	.0707,	.0718,
6,	.2170,	.0224,	.0172,	.0093,	.0028,	.0346,	.1641,	.2014,	.1437,	.1152,	.1535,
7,	.4370,	.1093,	.0186,	.0166,	.0088,	.0100,	.0767,	.3424,	.1806,	.1570,	.2267,
8,	.7415,	.1496,	.0512,	.0213,	.0127,	.0258,	.0265,	.0967,	.2390,	.2042,	.1800,
9,	.2077,	.1583,	.4381,	.1257,	.0261,	.0492,	.0391,	.0627,	.0442,	.2042,	.1037,
10,	1.4602,	.0627,	.8972,	.2161,	.1679,	.0575,	.1187,	.0904,	.0356,	.2042,	.1101,
11,	1.0556,	.9143,	.0566,	.0756,	.4898,	.0001,	.1144,	.4196,	.1099,	.2042,	.2446,
12,	.0798,	.7475,	1.6568,	.0195,	.2990,	.0012,	.3288,	.2215,	.1365,	.2042,	.1874,
13,	.8478,	.0093,	.4184,	1.5457,	.0419,	.0016,	.9419,	1.0382,	.3065,	.2042,	.5163,
14,	4.6339,	.1630,	.0200,	1.8679,	.0433,	.0000,	.2026,	3.8622,	.0005,	.2042,	1.3556,
15,	.3550,	.0822,	.1420,	.0215,	.0258,	.0528,	.1015,	.0000,	.2495,	.2042,	.1512,
+gp,	.3550,	.0822,	.1420,	.0215,	.0258,	.0528,	.1015,	.0000,	.2495,	.2042,	
0 FBAR 5-14,	.9712,	.2344,	.3580,	.3901,	.1109,	.0247,	.2099,	.6409,	.1268,	.1772,	
1											

Table 3.5.7.2 b

Run title : Herring Spring-spawn (run: SEPBJA11/S11)

At 4-May-98 21:34:07

Traditional vpa using file 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,
AGE								
0,	7473777,	1439081,	938987,	835771,	397029,	237538,	274748,	236506,
1,	262360,	3007109,	575015,	298670,	304949,	97946,	65556,	79447,
2,	142213,	94446,	1175823,	178474,	90917,	81693,	22821,	14702,
3,	108549,	54137,	35944,	470460,	68991,	31748,	30092,	5554,
4,	40164,	90870,	46535,	30573,	398070,	56914,	26464,	24821,
5,	49701,	32858,	74657,	39493,	25883,	329324,	46426,	20449,
6,	85983,	41059,	26684,	58682,	33057,	20954,	264513,	37050,
7,	79939,	68941,	33817,	21705,	47215,	26267,	16977,	204018,
8,	19629,	62984,	54564,	27213,	17923,	36100,	20853,	13593,
9,	28021,	16159,	48639,	43443,	22395,	14240,	28529,	16061,
10,	32024,	23297,	13194,	38365,	34483,	17426,	11467,	22109,
11,	25811,	26549,	19286,	10622,	29366,	25606,	13209,	8660,
12,	56296,	21411,	21896,	15805,	8571,	21015,	19304,	9535,
13,	61433,	46653,	17432,	17848,	12759,	6559,	16207,	14092,
14,	9510,	49465,	37807,	14014,	14491,	10051,	5102,	12438,
15,	25681,	7571,	39353,	30813,	11147,	11241,	7867,	3809,
+gp,	56954,	48729,	47306,	73622,	59465,	51756,	42143,	27994,
0 TOTAL,	8558046,	5131320,	3206936,	2205573,	1576712,	1076379,	912277,	750838,

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

YEAR,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,
AGE										
0,	278105,	4053428,	1913386,	732827,	177125,	1646403,	905561,	79326,	453493,	35822,
1,	66148,	56387,	1538203,	699104,	260052,	49847,	639834,	345996,	18608,	160413,
2,	13263,	10738,	11294,	542521,	188063,	81052,	8036,	243395,	117663,	3686,
3,	4649,	1618,	2442,	2291,	202892,	70081,	20760,	1959,	81610,	37672,
4,	4564,	3839,	1253,	984,	1683,	157563,	53282,	16807,	859,	51327,
5,	17911,	3763,	3056,	910,	772,	1374,	127875,	42166,	12097,	492,
6,	16177,	14389,	2999,	2370,	745,	636,	1134,	91146,	31010,	6115,
7,	29773,	13096,	11028,	2355,	1901,	575,	531,	849,	58137,	14675,
8,	157224,	23826,	10209,	8601,	1847,	1450,	461,	443,	551,	23551,
9,	11033,	126309,	18279,	8109,	6833,	1480,	1078,	369,	244,	128,
10,	12645,	8842,	98497,	13846,	6524,	5334,	1188,	698,	249,	79,
11,	17340,	9745,	6790,	74015,	10658,	5128,	3596,	752,	425,	56,
12,	6636,	13066,	7238,	5056,	56967,	8091,	3559,	2213,	280,	126,
13,	7086,	4798,	9415,	5031,	3892,	41507,	5355,	2302,	980,	140,
14,	10747,	5382,	3312,	6684,	3913,	2941,	27193,	3198,	991,	214,
15,	9488,	8593,	3917,	2326,	5170,	2862,	1796,	16275,	1476,	196,
+gp,	25456,	15200,	10099,	4117,	6832,	5919,	11413,	4140,	7024,	1235,
0 TOTAL,	688244,	4373015,	3651415,	2111146,	935869,	2082240,	1812653,	852034,	785697,	335927,

1

Run title : Herring Spring-spawn (run: SEPBJA11/S11)

At 4-May-98 21:34:07

Traditional vpa using file input for terminal F

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

YEAR,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,
AGE										
0,	46386,	96322,	6207,	2098,	9133,	127127,	85008,	29508,	102503,	50397,
1,	11970,	8476,	35725,	1806,	668,	1691,	51505,	34156,	11808,	41551,
2,	11196,	2313,	655,	11320,	478,	47,	666,	20892,	13865,	4786,
3,	1075,	2275,	164,	79,	4082,	77,	9,	247,	8483,	5630,
4,	19600,	37,	254,	83,	51,	3186,	44,	7,	182,	7086,
5,	14426,	177,	25,	50,	62,	12,	2509,	36,	5,	107,
6,	179,	111,	71,	16,	31,	20,	4,	1933,	22,	4,
7,	1420,	25,	52,	31,	10,	4,	4,	1,	1380,	19,
8,	2346,	364,	15,	15,	16,	3,	1,	2,	1,	1066,
9,	4602,	791,	205,	4,	3,	1,	1,	1,	1,	1,
10,	29,	822,	371,	54,	0,	0,	1,	0,	1,	1,
11,	16,	7,	376,	81,	7,	0,	0,	1,	0,	1,
12,	16,	4,	3,	68,	7,	1,	0,	0,	0,	0,
13,	31,	7,	1,	0,	9,	1,	1,	0,	0,	0,
14,	39,	4,	4,	0,	0,	3,	1,	1,	0,	0,
15,	26,	10,	1,	1,	0,	0,	1,	1,	1,	0,
+gp,	216,	49,	27,	0,	0,	0,	1,	1,	1,	0,
0 TOTAL,	113574,	111792,	44158,	15705,	14558,	132173,	139756,	86786,	138255,	110651,

Table 3.5.7.2 b (continued)

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

YEAR,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,
AGE										
0,	61334,	124047,	14980,	10920,	23617,	3990129,	170558,	418186,	109384,	70905,
1,	20225,	24813,	50233,	6048,	4388,	9463,	1621483,	69135,	169846,	44387,
2,	16855,	8208,	10065,	20418,	2452,	1777,	3818,	659236,	28027,	69046,
3,	1927,	6845,	3325,	4090,	8228,	996,	712,	1537,	266748,	11376,
4,	4641,	1630,	5833,	2803,	3481,	6954,	828,	572,	1124,	224590,
5,	5880,	3882,	1386,	4967,	2370,	2923,	5789,	662,	349,	805,
6,	89,	4873,	3277,	1172,	4195,	1998,	2428,	4413,	418,	167,
7,	4,	68,	4090,	2745,	988,	3553,	1662,	1921,	2599,	217,
8,	13,	3,	56,	3374,	2321,	832,	2995,	1314,	1109,	1271,
9,	818,	5,	3,	44,	2827,	1951,	705,	2433,	625,	270,
10,	1,	658,	4,	2,	35,	2377,	1636,	540,	1513,	154,
11,	1,	1,	543,	4,	1,	29,	1978,	1257,	372,	595,
12,	1,	1,	1,	442,	2,	0,	23,	1643,	796,	142,
13,	0,	1,	1,	1,	372,	2,	0,	20,	953,	88,
14,	0,	0,	0,	1,	0,	319,	0,	0,	17,	97,
15,	0,	0,	0,	0,	0,	0,	266,	0,	0,	15,
+gp,	0,	0,	0,	0,	0,	0,	0,	90,	35,	0,
0 TOTAL,	111789,	175035,	93798,	57030,	55280,	4023304,	1814885,	1162960,	583915,	424124,

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

YEAR,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,	1998,	GMST 50-95	AMST 50-95
AGE													
0,	301134,	977303,	1922484,	5007493,	5828215,	2114773,	405941,	61511,	0,	0,	0,	224311,	962533,
1,	28743,	122337,	397298,	781618,	2035896,	2369563,	859762,	165041,	25008,	0,	0,	82956,	380550,
2,	18008,	11669,	49727,	161527,	317762,	827732,	963393,	349553,	67101,	10168,	0,	25191,	143615,
3,	27851,	7265,	4589,	20121,	65651,	129184,	336486,	391636,	142111,	27095,	4000,	7973,	55264,
4,	9608,	23389,	6226,	3777,	17241,	56390,	110926,	289315,	336551,	121997,	22113,	5221,	39270,
5,	188661,	8038,	20097,	5334,	3225,	14532,	47545,	94455,	245805,	283059,	102494,	3330,	27337,
6,	520,	157283,	6866,	17188,	4578,	2730,	11700,	37553,	75531,	197018,	227001,	2179,	21707,
7,	111,	360,	132370,	5809,	14658,	3930,	2270,	8546,	26425,	56308,	151123,	1437,	17840,
8,	122,	62,	278,	111835,	4918,	12505,	3348,	1809,	5223,	18987,	41423,	953,	13761,
9,	835,	50,	46,	227,	94229,	4179,	10488,	2807,	1414,	3540,	13324,	601,	11293,
10,	122,	584,	37,	25,	173,	79013,	3425,	8682,	2269,	1164,	2484,	392,	9577,
11,	46,	24,	472,	13,	18,	126,	64208,	2618,	6827,	1885,	817,	243,	7835,
12,	470,	14,	8,	384,	10,	9,	108,	49291,	1481,	5264,	1322,	153,	7185,
13,	50,	374,	6,	1,	324,	7,	8,	67,	33997,	1112,	3694,	80,	5996,
14,	16,	18,	319,	3,	0,	267,	6,	3,	20,	21537,	780,	48,	4752,
15,	19,	0,	13,	269,	0,	0,	230,	4,	0,	18,	15113,	31,	4140,
+gp,	0,	0,	26,	5,	0,	0,	0,	0,	0,	0,	12,		
0 TOTAL,	576318,	1308769,	2540861,	6115634,	8386901,	5614944,	2819846,	1462889,	969760,	749151,	585701,		
1													

Table 3.5.7.3 b

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

YEAR,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,
AGE										
0,	2781,	40534,	19134,	7328,	1771,	16464,	9056,	793,	4535,	358,
1,	5292,	4511,	123056,	55928,	20804,	3988,	51187,	27680,	1489,	12833,
2,	6234,	5047,	5308,	254985,	88390,	38094,	3777,	114396,	55302,	1732,
3,	4649,	1618,	2442,	2291,	202893,	70081,	20760,	1959,	81610,	37672,
4,	9311,	7832,	2555,	2283,	3685,	291492,	103368,	31261,	1590,	92389,
5,	43345,	9482,	8252,	2275,	2247,	3477,	272374,	83911,	26492,	1121,
6,	47236,	37412,	8726,	6922,	2235,	1869,	2993,	215104,	68842,	16450,
7,	87831,	37980,	32312,	7112,	6008,	1793,	1682,	2208,	144762,	39622,
8,	460666,	71477,	32772,	26148,	5986,	4769,	1675,	1607,	1685,	69240,
9,	33651,	385241,	58128,	26191,	22275,	4839,	3807,	1292,	863,	416,
10,	39832,	27851,	315189,	44585,	21854,	17816,	4145,	2583,	940,	331,
11,	57222,	31672,	23357,	237590,	36024,	17486,	12729,	2706,	1660,	241,
12,	22561,	43117,	25260,	17392,	190268,	28236,	12704,	8363,	1061,	460,
13,	24445,	16315,	34834,	17959,	13504,	141539,	19225,	8908,	3706,	514,
14,	37829,	18569,	12553,	24262,	13853,	10527,	99255,	12471,	3576,	926,
15,	34156,	30507,	14688,	8492,	18507,	10734,	7221,	64122,	5655,	811,
+gp,	92914,	54720,	38375,	15233,	24460,	22196,	45881,	16313,	26901,	5113,
0 TOTALBIO,	1009955,	823883,	756943,	756976,	674765,	685401,	671837,	595676,	430668,	280231,

1

Run title : Herring Spring-spawn (run: SEPBJA11/S11)

At 4-May-98 21:34:07
Traditional vpa using file input for terminal F

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

YEAR,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,
AGE										
0,	464,	963,	62,	21,	91,	1271,	850,	295,	1025,	504,
1,	958,	678,	2858,	271,	67,	169,	5151,	3416,	1181,	4155,
2,	5262,	1087,	308,	9056,	334,	40,	566,	17759,	11785,	4068,
3,	1075,	2275,	164,	79,	6123,	130,	16,	447,	15355,	10189,
4,	22540,	43,	532,	157,	76,	8252,	114,	18,	472,	18353,
5,	29718,	256,	68,	112,	87,	41,	8580,	122,	17,	366,
6,	477,	300,	164,	40,	66,	78,	17,	7421,	85,	16,
7,	3905,	76,	154,	85,	25,	18,	16,	6,	5643,	78,
8,	6428,	1113,	49,	43,	44,	10,	6,	7,	5,	4735,
9,	13116,	2435,	663,	13,	8,	3,	3,	5,	6,	5,
10,	102,	2614,	1207,	176,	1,	2,	3,	3,	5,	6,
11,	52,	23,	1238,	271,	22,	1,	2,	3,	2,	4,
12,	59,	13,	12,	236,	25,	6,	1,	1,	2,	2,
13,	125,	24,	5,	0,	33,	4,	5,	1,	1,	2,
14,	151,	15,	15,	1,	0,	13,	3,	4,	1,	1,
15,	97,	39,	5,	6,	0,	0,	3,	3,	4,	0,
+gp,	818,	193,	104,	0,	0,	0,	3,	3,	4,	0,
0 TOTALBIO,	85347,	12148,	7607,	10565,	7002,	10041,	15338,	29512,	35592,	42485,

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

YEAR,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,
AGE										
0,	613,	1240,	150,	109,	236,	39901,	1706,	4182,	1094,	709,
1,	2023,	2481,	5023,	605,	439,	946,	162148,	6914,	16985,	4439,
2,	14327,	6977,	8555,	17356,	2084,	1511,	3246,	151624,	23823,	37975,
3,	3468,	12185,	5820,	6952,	13988,	1543,	997,	2275,	144044,	10238,
4,	13643,	3783,	16508,	6279,	7102,	17315,	1688,	1338,	2316,	321164,
5,	19170,	13935,	4810,	16688,	7181,	8887,	17078,	1755,	925,	1940,
6,	329,	18762,	13174,	4430,	14893,	7353,	8206,	13769,	1207,	466,
7,	15,	287,	17221,	10623,	3785,	14353,	6251,	6647,	8811,	648,
8,	58,	14,	259,	13766,	9168,	3530,	11829,	4861,	4083,	4015,
9,	3895,	26,	12,	174,	11677,	8524,	2867,	9610,	2443,	924,
10,	5,	3420,	23,	11,	157,	10366,	6758,	2142,	5778,	529,
11,	5,	4,	2898,	20,	4,	141,	8349,	5381,	1443,	2154,
12,	3,	4,	3,	2264,	11,	2,	102,	7031,	3143,	532,
13,	1,	3,	3,	3,	1881,	8,	0,	86,	3764,	330,
14,	2,	1,	2,	3,	2,	1578,	0,	0,	68,	363,
15,	1,	1,	1,	2,	2,	2,	1164,	0,	0,	56,
+gp,	1,	1,	1,	2,	2,	2,	1,	387,	138,	0,
0 TOTALBIO,	57559,	63124,	74463,	79287,	72612,	115963,	232390,	218002,	220065,	386484,

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

YEAR,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,
AGE										
0,	3011,	9773,	19225,	50075,	58282,	21148,	4059,	615,	0,	0,
1,	4311,	18350,	31784,	85978,	142513,	189565,	85976,	29707,	4502,	0,
2,	9004,	11669,	23869,	59765,	95329,	206933,	240848,	87388,	16775,	2542,
3,	27294,	11188,	10050,	29579,	84034,	104639,	252365,	258480,	108004,	26011,
4,	12971,	40931,	12328,	7932,	38619,	113344,	167499,	399255,	397129,	143957,
5,	371662,	16799,	51851,	13016,	9547,	38511,	120764,	217246,	462113,	492523,
6,	1441,	396353,	19773,	51564,	14971,	8818,	37206,	111156,	197136,	451172,
7,	351,	1099,	409022,	18820,	52035,	13911,	8421,	29569,	83503,	161040,
8,	412,	227,	1190,	375765,	16965,	44768,	11619,	7020,	18071,	61328,
9,	2864,	188,	170,	780,	345821,	15923,	43214,	10188,	5287,	13097,
10,	439,	2096,	148,	97,	589,	291557,	13082,	35509,	8848,	4401,
11,	168,	97,	1827,	47,	64,	498,	261328,	10836,	26625,	7274,
12,	1769,	54,	37,	1632,	44,	37,	443,	208009,	5686,	18951,
13,	188,	1481,	25,	6,	1523,	24,	33,	275,	135307,	4370,
14,	61,	73,	1403,	14,	1,	1078,	23,	11,	81,	84209,
15,	73,	1,	59,	1143,	2,	1,	944,	16,	0,	69,
+gp,	0,	1,	112,	21,	2,	1,	0,	0,	0,	0,
0 TOTALBIO,	436020,	510379,	582873,	696234,	860340,	1050752,	1247823,	1405279,	1469067,	1470943,

1

Table 3.5.7.4 b

Run title : Herring Spring-spawn (run: SEPBJA11/S11)

At 4-May-98 21:34:07

Traditional vpa using file 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,
AGE								
0,	0,	0,	0,	0,	0,	0,	0,	0,
1,	0,	0,	0,	0,	0,	0,	0,	0,
2,	0,	0,	0,	0,	0,	0,	0,	0,
3,	0,	0,	0,	0,	0,	2494,	2361,	0,
4,	8031,	18177,	9339,	6134,	79681,	23924,	11632,	0,
5,	33645,	22205,	50288,	26770,	17486,	253914,	38628,	22772,
6,	128680,	61613,	39992,	87852,	49427,	45344,	545490,	55461,
7,	193189,	166684,	81898,	52701,	113762,	70586,	45660,	520781,
8,	55828,	177994,	154669,	77394,	50794,	102256,	58914,	38607,
9,	83900,	48295,	144870,	129476,	66612,	42502,	84822,	47828,
10,	99002,	72012,	40669,	117662,	105437,	53392,	35120,	67972,
11,	82332,	84637,	61443,	33790,	92300,	80900,	41552,	27405,
12,	182320,	69217,	70794,	51053,	27539,	67573,	61728,	30545,
13,	204396,	155319,	57988,	59433,	42359,	21748,	53666,	46630,
14,	32070,	166797,	127792,	47256,	48739,	33836,	17095,	41766,
15,	91162,	26810,	139320,	109026,	39238,	39670,	27695,	13447,
+gp,	203850,	173996,	168866,	262658,	211045,	184166,	149580,	99655,
0 TOTSPBIO,	1398402,	1243755,	1147929,	1061204,	944418,	1022305,	1173942,	1012868,

Table 13 Spawning stock biomass at age (spawning time) Tonnes*10**-1										
YEAR,	1958,	1959,	1960,	1961,	1962,	1963,	1964,	1965,	1966,	1967,
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,	365,	126,	178,	89,	0,	2727,	407,	0,	779,	0,
4,	2009,	1684,	544,	780,	397,	8564,	6059,	10285,	226,	914,
5,	15690,	3429,	2977,	1516,	1476,	1091,	73726,	28480,	24745,	233,
6,	39312,	30965,	7240,	6364,	2178,	1652,	931,	156291,	61324,	14215,
7,	85895,	37046,	31519,	6942,	5847,	1754,	1652,	2114,	132254,	32985,
8,	450689,	69608,	32026,	25553,	5854,	4630,	1638,	1514,	1457,	58810,
9,	32914,	375778,	56536,	25627,	21730,	4734,	3645,	1243,	771,	358,
10,	38808,	27125,	306310,	43433,	21334,	17127,	3959,	2458,	810,	282,
11,	55625,	30744,	22679,	231450,	35044,	16859,	12126,	2452,	1470,	213,
12,	21841,	41726,	24357,	16943,	184339,	27095,	12162,	7710,	990,	400,
13,	23782,	15721,	33661,	17514,	13131,	135678,	18259,	8188,	3183,	453,
14,	36993,	17988,	12117,	23647,	13427,	10021,	94288,	11543,	3041,	749,
15,	33373,	29716,	14270,	8277,	17967,	10306,	6890,	59368,	4947,	690,
+gp,	90784,	53301,	37283,	14848,	23745,	21311,	43776,	15103,	23532,	4345,
0 TOTSPBIO,	928080,	734958,	581697,	422984,	346470,	263549,	279516,	306748,	259528,	114547,
1										

Run title : Herring Spring-spawn (run: SEPBJA11/S11)

At 4-May-98 21:34:07

Traditional vpa using file input for terminal F

Table 13 Spawning stock biomass at age (spawning time) Tonnes*10**-1										
YEAR,	1968,	1969,	1970,	1971,	1972,	1973,	1974,	1975,	1976,	1977,
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,	3,	51,	1623,	1077,	0,
3,	0,	1133,	9,	8,	0,	62,	8,	217,	7540,	7296,
4,	0,	37,	59,	38,	7,	7251,	100,	18,	403,	16032,
5,	183,	222,	20,	64,	19,	37,	8359,	116,	16,	359,
6,	298,	278,	26,	34,	32,	66,	15,	7175,	84,	16,
7,	3408,	72,	136,	80,	19,	16,	14,	6,	5500,	75,
8,	5766,	1051,	43,	36,	32,	9,	5,	7,	5,	4611,
9,	11041,	2258,	580,	10,	6,	3,	3,	5,	6,	5,
10,	88,	2418,	1036,	143,	1,	2,	3,	2,	5,	6,
11,	45,	22,	1044,	212,	19,	1,	2,	3,	2,	4,
12,	54,	12,	8,	193,	20,	6,	1,	1,	2,	2,
13,	101,	23,	4,	0,	29,	4,	5,	1,	1,	2,
14,	131,	13,	13,	1,	0,	12,	3,	4,	1,	1,
15,	83,	36,	5,	5,	0,	0,	3,	3,	4,	0,
+gp,	703,	180,	89,	0,	0,	0,	3,	3,	4,	0,
0 TOTSPBIO,	21901,	7754,	3072,	823,	186,	7473,	8576,	9183,	14649,	28410,

Table 3.5.7.4 b (continued)

	Table 13	Spawning stock biomass at age (spawning time)					Tonnes*10**-1				
	YEAR,	1978,	1979,	1980,	1981,	1982,	1983,	1984,	1985,	1986,	1987,
	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,	443,	1199,	1430,	2052,	1375,	152,	98,	220,	14159,	1007,
	4,	12062,	2307,	8122,	3087,	3350,	8500,	826,	637,	448,	94684,
	5,	18814,	13016,	4588,	14768,	4942,	6019,	14958,	1509,	773,	1671,
	6,	321,	18436,	12943,	4355,	14647,	5125,	7615,	13059,	1131,	447,
	7,	14,	281,	16892,	10447,	3721,	14110,	6106,	6292,	8202,	612,
	8,	53,	13,	253,	13525,	9010,	3471,	11586,	4513,	3545,	3850,
	9,	3811,	25,	12,	170,	11476,	8376,	2792,	9164,	2124,	854,
	10,	4,	3355,	22,	10,	154,	10177,	6582,	2064,	5263,	469,
	11,	5,	4,	2839,	19,	4,	139,	8195,	5140,	1310,	2104,
	12,	3,	4,	3,	2225,	11,	2,	101,	6658,	2521,	480,
	13,	1,	3,	3,	3,	1852,	5,	0,	85,	2994,	279,
	14,	2,	1,	2,	3,	2,	1550,	0,	0,	67,	310,
	15,	1,	1,	1,	2,	2,	2,	1139,	0,	0,	53,
	+gp,	1,	1,	1,	2,	2,	2,	1,	367,	119,	0,
0	TOTSPBIO,	35535,	38648,	47113,	50668,	50548,	57630,	59998,	49708,	42657,	106819,

	Table 13	Spawning stock biomass at age (spawning time)					Tonnes*10**-1				
	YEAR,	1988,	1989,	1990,	1991,	1992,	1993,	1994,	1995,	1996,	1997,
	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,	2682,	1102,	3943,	2913,	8277,	1031,	2486,	0,	0,	0,
	4,	3822,	12094,	9711,	5466,	7593,	33428,	49448,	3928,	3903,	42441,
	5,	328466,	14882,	45942,	12819,	7511,	30148,	94359,	169954,	203401,	433595,
	6,	1389,	389576,	17501,	50749,	14744,	8656,	36055,	107318,	191430,	439364,
	7,	331,	1071,	361966,	18510,	51215,	13690,	8232,	28148,	80788,	156171,
	8,	377,	220,	1167,	369383,	16692,	43987,	11416,	6849,	17381,	59194,
	9,	2763,	182,	160,	759,	339784,	15609,	42404,	9973,	5186,	12641,
	10,	374,	2052,	133,	94,	570,	285570,	12735,	34666,	8686,	4248,
	11,	149,	87,	1789,	46,	60,	490,	254510,	10236,	25942,	7021,
	12,	1729,	50,	31,	1604,	42,	36,	423,	200423,	5526,	18292,
	13,	170,	1457,	23,	5,	1494,	24,	29,	244,	129269,	4218,
	14,	38,	71,	1379,	11,	1,	1062,	22,	7,	80,	81279,
	15,	70,	1,	58,	1124,	2,	1,	920,	16,	0,	66,
	+gp,	0,	1,	109,	21,	2,	1,	0,	0,	0,	0,
0	TOTSPBIO,	342360,	422846,	443912,	463503,	447986,	433733,	513040,	571764,	671591,	1258529,
1											

Table 3.5.7.5 b

Run title : Herring Spring-spawn (run: SEPBJA11/S11)

At 4-May-98 21:34:07

Table 16 Summary (without SOP correction)

Traditional vpa using file input for terminal F

	RECRUITS, Age 0	TOTALBIO,	TOTSPBIO,	LANDINGS,	YIELD/SSB,	FBAR 5-14,
1950,	747377536,	19619082,	13984028,	933000,	.0667,	.0537,
1951,	143908016,	19055266,	12437552,	1278400,	.1028,	.0623,
1952,	93898768,	20595604,	11479294,	1254800,	.1093,	.0673,
1953,	83577048,	18573720,	10612048,	1090600,	.1028,	.0646,
1954,	39702936,	19292220,	9444186,	1644500,	.1741,	.1083,
1955,	23753766,	16616774,	10223046,	1359800,	.1330,	.0928,
1956,	27474774,	14604080,	11739434,	1659400,	.1414,	.1202,
1957,	23650592,	11550192,	10128688,	1319500,	.1303,	.1009,
1958,	27810502,	10099550,	9280808,	986600,	.1063,	.0960,
1959,	405342656,	8238827,	7349572,	1111100,	.1512,	.1334,
1960,	191338624,	7569419,	5816970,	1101800,	.1894,	.1393,
1961,	73282728,	7569754,	4229841,	830100,	.1962,	.0904,
1962,	17712458,	6747648,	3464701,	848600,	.2449,	.1121,
1963,	164640192,	6854008,	2635488,	984500,	.3736,	.1697,
1964,	90556080,	6718369,	2795162,	1281800,	.4586,	.2374,
1965,	7932643,	5956769,	3067482,	1547700,	.5046,	.4594,
1966,	45349308,	4306682,	2595279,	1955000,	.7533,	.9968,
1967,	3582239,	2802312,	1145468,	1677200,	1.4642,	1.3567,
1968,	4638563,	853468,	219014,	712200,	3.2518,	1.6790,
1969,	9632174,	121477,	77542,	67800,	.8744,	.6099,
1970,	620674,	76071,	30720,	62300,	2.0280,	1.3716,
1971,	209801,	105648,	8233,	21100,	2.5628,	1.4267,
1972,	913344,	70023,	1855,	13161,	7.0933,	1.3786,
1973,	12712656,	100407,	74729,	7017,	.0939,	.6169,
1974,	8500842,	153381,	85764,	7619,	.0888,	.2012,
1975,	2950760,	295121,	91827,	13713,	.1493,	.0738,
1976,	10250332,	355919,	146491,	10436,	.0712,	.0331,
1977,	5039751,	424853,	284096,	22706,	.0799,	.0579,
1978,	6133390,	575592,	355349,	19824,	.0558,	.1083,
1979,	12404686,	631241,	386483,	12864,	.0333,	.0239,
1980,	1498003,	744633,	471131,	18577,	.0394,	.0323,
1981,	1091973,	792873,	506680,	13736,	.0271,	.1323,
1982,	2361710,	726123,	505484,	16655,	.0329,	.0918,
1983,	399013280,	1159625,	576296,	23054,	.0400,	.5778,
1984,	17055794,	2323903,	599978,	53532,	.0892,	.1147,
1985,	41818656,	2180024,	497085,	169872,	.3417,	.3433,
1986,	10938424,	2200649,	426568,	225256,	.5281,	.9963,
1987,	7090520,	3864837,	1068190,	127306,	.1192,	.6907,
1988,	30113434,	4360202,	3423600,	135301,	.0395,	.9712,
1989,	97730240,	5103788,	4228462,	103830,	.0246,	.2344,
1990,	192248544,	5828734,	4439124,	86411,	.0195,	.3580,
1991,	500749632,	6962343,	4635026,	84683,	.0183,	.3901,
1992,	582821184,	8603398,	4479862,	104448,	.0233,	.1109,
1993,	211477280,	10507534,	4337329,	232457,	.0536,	.0247,
1994,	40594080,	12478244,	5130399,	479228,	.0934,	.2099,
1995,	6151075,	14052810,	5717633,	905501,	.1584,	.6409,
1996,	0,	14690678,	6715901,	1220283,	.1817,	.1268,
1997,	0,	14709434,	12585290,	1426507,	.1133,	.1772,
Arith. Mean	92242752,	6704653,	4052816,	609620,	.4943,	.3805,
0 Units,	(Thousands),	(Tonnes),	(Tonnes),	(Tonnes),		
1						

Table 3.5.7.6 b Summary (without SOP correction)
Traditional vpa using file input for terminal F

	RECRUITS Age 3	TOT BIO	SP BIO	LANDINGS	Y/SSB	FBAR 5-14	FW 5-14
1950	10854940	17993416	13984028	933000	0.0667	0.0537	0.0584
1951	5413743	16061772	12437552	1278400	0.1028	0.0623	0.0697
1952	3594422	14515330	11479294	1254800	0.1093	0.0673	0.0728
1953	47046016	17412376	10612048	1090600	0.1028	0.0646	0.0663
1954	6899113	18581252	9444186	1644500	0.1741	0.1083	0.1124
1955	3174837	16130704	10223046	1359800	0.133	0.0928	0.0783
1956	3009160	14416902	11739434	1659400	0.1414	0.1202	0.1099
1957	555352	11393882	10128688	1319500	0.1303	0.1009	0.1026
1958	464887	9956482	9280808	986600	0.1063	0.0960	0.0787
1959	161776	7737907	7349572	1111100	0.1512	0.1334	0.1129
1960	244166	6094433	5816970	1101800	0.1894	0.1393	0.1359
1961	229051	4387340	4229841	830100	0.1962	0.0904	0.1046
1962	20289264	5637997	3464701	848600	0.2449	0.1121	0.1458
1963	7008125	6268546	2635488	984500	0.3736	0.1697	0.2525
1964	2076014	6078177	2795162	1281800	0.4586	0.2374	0.2271
1965	195853	4528081	3067482	1547700	0.5046	0.4594	0.2803
1966	8160988	3693429	2595279	1955000	0.7533	0.9968	0.7002
1967	3767198	2653077	1145468	1677200	1.4642	1.3567	1.5170
1968	107483	786633	219014	712200	3.2518	1.6790	3.4498
1969	227479	94193	77542	67800	0.8744	0.6099	0.5948
1970	16366	43790	30720	62300	2.028	1.3716	1.3234
1971	7864	12174	8233	21100	2.5628	1.4267	1.5193
1972	408207	65097	1855	13161	7.0933	1.3786	1.4859
1973	7658	85602	74695	7017	0.0939	0.6169	1.1630
1974	927	87714	85251	7619	0.0894	0.2012	0.1133
1975	24689	80428	75599	13713	0.1814	0.0738	0.1888
1976	848317	216012	135721	10436	0.0769	0.0331	0.1053
1977	562952	337579	284096	22706	0.0799	0.0579	0.1095
1978	192681	405964	355349	19824	0.0558	0.1083	0.0438
1979	684542	524254	386483	12864	0.0333	0.0239	0.0241
1980	332550	607353	471131	18577	0.0394	0.0323	0.0345
1981	408952	612177	506680	13736	0.0271	0.1323	0.0215
1982	822812	698529	505484	16655	0.0329	0.0918	0.0201
1983	99573	736040	576296	23054	0.04	0.5778	0.0292
1984	71234	652905	599978	53532	0.0892	0.1147	0.0907
1985	153713	552827	497085	169872	0.3417	0.3433	0.3783
1986	26674806	1781633	426568	225256	0.5281	0.9963	1.0545
1987	1137602	3433608	1068190	127306	0.1192	0.6907	0.3937
1988	2785146	4196936	3423600	135301	0.0395	0.9712	0.0357
1989	726518	4705866	4228462	103830	0.0246	0.2344	0.0223
1990	458912	5079959	4439124	86411	0.0195	0.3580	0.0176
1991	2012149	5004165	4635026	84683	0.0183	0.3901	0.0192
1992	6565133	5642164	4479862	104448	0.0233	0.1109	0.0227
1993	12918390	6331076	4337329	232457	0.0536	0.0247	0.0527
1994	33648628	9169408	5130399	479228	0.0934	0.2099	0.1011
1995	39163604	12875704	5717633	905501	0.1584	0.6409	0.1490
1996	14211068	14477912	6715901	1220283	0.1817	0.1268	0.1150
1997	2709525	14684014	12585290	1426507	0.1133	0.1772	0.1059
Arith. Mean	5648634	5781726	4052243	609620	0.4951	0.3805	
0 Units	(Thousand	(Tonnes	(Tonnes	(Tonnes)			

Table 3.6.1.1 a

19:04 Wednesday, May 6, 1998

Herring Norwegian Spring-spawners

Prediction with management option table: Input data

Year: 1998								
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	400000.00	0.1500	0.0000	0.1000	0.1000	0.074	0.0580	0.167
4	2023300.0	0.1500	0.3000	0.1000	0.1000	0.147	0.0280	0.184
5	8841100.0	0.1500	0.9000	0.1000	0.1000	0.174	0.0872	0.207
6	18257500	0.1500	1.0000	0.1000	0.1000	0.217	0.1452	0.232
7	11801000	0.1500	1.0000	0.1000	0.1000	0.242	0.2034	0.277
8	3120700.0	0.1500	1.0000	0.1000	0.1000	0.278	0.2616	0.305
9	1009000.0	0.1500	1.0000	0.1000	0.1000	0.304	0.2616	0.331
10	188100.00	0.1500	1.0000	0.1000	0.1000	0.310	0.2616	0.328
11	61900.000	0.1500	1.0000	0.1000	0.1000	0.359	0.2616	0.344
12	100100.00	0.1500	1.0000	0.1000	0.1000	0.340	0.2616	0.343
13	279700.00	0.1500	1.0000	0.1000	0.1000	0.344	0.2616	0.397
14	59100.000	0.1500	1.0000	0.1000	0.1000	0.385	0.2616	0.357
15	1144500.0	0.1500	1.0000	0.1000	0.1000	0.363	0.2616	0.510
16+	900.000	0.1500	1.0000	0.1000	0.1000	0.375	0.2616	0.510
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 1999								
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	3724000.0	0.1500	0.0000	0.1000	0.1000	0.074	0.0580	0.167
4	.	0.1500	0.3000	0.1000	0.1000	0.147	0.0280	0.184
5	.	0.1500	0.9000	0.1000	0.1000	0.174	0.0872	0.207
6	.	0.1500	1.0000	0.1000	0.1000	0.217	0.1452	0.232
7	.	0.1500	1.0000	0.1000	0.1000	0.242	0.2034	0.277
8	.	0.1500	1.0000	0.1000	0.1000	0.278	0.2616	0.305
9	.	0.1500	1.0000	0.1000	0.1000	0.304	0.2616	0.331
10	.	0.1500	1.0000	0.1000	0.1000	0.310	0.2616	0.328
11	.	0.1500	1.0000	0.1000	0.1000	0.359	0.2616	0.344
12	.	0.1500	1.0000	0.1000	0.1000	0.340	0.2616	0.343
13	.	0.1500	1.0000	0.1000	0.1000	0.344	0.2616	0.397
14	.	0.1500	1.0000	0.1000	0.1000	0.385	0.2616	0.357
15	.	0.1500	1.0000	0.1000	0.1000	0.363	0.2616	0.510
16+	.	0.1500	1.0000	0.1000	0.1000	0.375	0.2616	0.510
Unit	Thousands	-	-	-	-	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
3	2771000.0	0.1500	0.0000	0.1000	0.1000	0.074	0.0580	0.167
4	.	0.1500	0.3000	0.1000	0.1000	0.147	0.0280	0.184
5	.	0.1500	0.9000	0.1000	0.1000	0.174	0.0872	0.207
6	.	0.1500	1.0000	0.1000	0.1000	0.217	0.1452	0.232
7	.	0.1500	1.0000	0.1000	0.1000	0.242	0.2034	0.277
8	.	0.1500	1.0000	0.1000	0.1000	0.278	0.2616	0.305
9	.	0.1500	1.0000	0.1000	0.1000	0.304	0.2616	0.331
10	.	0.1500	1.0000	0.1000	0.1000	0.310	0.2616	0.328
11	.	0.1500	1.0000	0.1000	0.1000	0.359	0.2616	0.344
12	.	0.1500	1.0000	0.1000	0.1000	0.340	0.2616	0.343
13	.	0.1500	1.0000	0.1000	0.1000	0.344	0.2616	0.397
14	.	0.1500	1.0000	0.1000	0.1000	0.385	0.2616	0.357
15	.	0.1500	1.0000	0.1000	0.1000	0.363	0.2616	0.510
16+	.	0.1500	1.0000	0.1000	0.1000	0.375	0.2616	0.510
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : MANBJA04
Date and time: 06MAY98:22:30

Table 3.6.1.1 b

The SAS System

19:04 Wednesday, May 6, 1998
Herring Norwegian Spring-spawners

Prediction with management option table: Input data

Year: 1998								
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	400000.00	0.1500	0.0000	0.1000	0.1000	0.074	0.0532	0.167
4	2211300.0	0.1500	0.3000	0.1000	0.1000	0.147	0.0242	0.184
5	10249400	0.1500	0.9000	0.1000	0.1000	0.174	0.0707	0.207
6	22700100	0.1500	1.0000	0.1000	0.1000	0.217	0.1152	0.232
7	15112300	0.1500	1.0000	0.1000	0.1000	0.242	0.1570	0.277
8	4142300.0	0.1500	1.0000	0.1000	0.1000	0.278	0.2042	0.305
9	1332400.0	0.1500	1.0000	0.1000	0.1000	0.304	0.2042	0.331
10	248400.00	0.1500	1.0000	0.1000	0.1000	0.310	0.2042	0.328
11	81700.000	0.1500	1.0000	0.1000	0.1000	0.359	0.2042	0.344
12	132200.00	0.1500	1.0000	0.1000	0.1000	0.340	0.2042	0.343
13	369400.00	0.1500	1.0000	0.1000	0.1000	0.344	0.2042	0.397
14	78000.000	0.1500	1.0000	0.1000	0.1000	0.385	0.2042	0.357
15	1511300.0	0.1500	1.0000	0.1000	0.1000	0.363	0.2042	0.510
16+	1200.000	0.1500	1.0000	0.1000	0.1000	0.375	0.2042	0.510
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Year: 1999								
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	4249000.0	0.1500	0.0000	0.1000	0.1000	0.074	0.0532	0.167
4	.	0.1500	0.3000	0.1000	0.1000	0.147	0.0242	0.184
5	.	0.1500	0.9000	0.1000	0.1000	0.174	0.0707	0.207
6	.	0.1500	1.0000	0.1000	0.1000	0.217	0.1152	0.232
7	.	0.1500	1.0000	0.1000	0.1000	0.242	0.1570	0.277
8	.	0.1500	1.0000	0.1000	0.1000	0.278	0.2042	0.305
9	.	0.1500	1.0000	0.1000	0.1000	0.304	0.2042	0.331
10	.	0.1500	1.0000	0.1000	0.1000	0.310	0.2042	0.328
11	.	0.1500	1.0000	0.1000	0.1000	0.359	0.2042	0.344
12	.	0.1500	1.0000	0.1000	0.1000	0.340	0.2042	0.343
13	.	0.1500	1.0000	0.1000	0.1000	0.344	0.2042	0.397
14	.	0.1500	1.0000	0.1000	0.1000	0.385	0.2042	0.357
15	.	0.1500	1.0000	0.1000	0.1000	0.363	0.2042	0.510
16+	.	0.1500	1.0000	0.1000	0.1000	0.375	0.2042	0.510
Unit	Thousands	-	-	-	-	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
3	3190000.0	0.1500	0.0000	0.1000	0.1000	0.074	0.0532	0.167
4	.	0.1500	0.3000	0.1000	0.1000	0.147	0.0242	0.184
5	.	0.1500	0.9000	0.1000	0.1000	0.174	0.0707	0.207
6	.	0.1500	1.0000	0.1000	0.1000	0.217	0.1152	0.232
7	.	0.1500	1.0000	0.1000	0.1000	0.242	0.1570	0.277
8	.	0.1500	1.0000	0.1000	0.1000	0.278	0.2042	0.305
9	.	0.1500	1.0000	0.1000	0.1000	0.304	0.2042	0.331
10	.	0.1500	1.0000	0.1000	0.1000	0.310	0.2042	0.328
11	.	0.1500	1.0000	0.1000	0.1000	0.359	0.2042	0.344
12	.	0.1500	1.0000	0.1000	0.1000	0.340	0.2042	0.343
13	.	0.1500	1.0000	0.1000	0.1000	0.344	0.2042	0.397
14	.	0.1500	1.0000	0.1000	0.1000	0.385	0.2042	0.357
15	.	0.1500	1.0000	0.1000	0.1000	0.363	0.2042	0.510
16+	.	0.1500	1.0000	0.1000	0.1000	0.375	0.2042	0.510
Unit	Thousands	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : MANBJA03
Date and time: 06MAY98:22:38

Table 3.6.2.1 a

19:04 Wednesday, May 6, 1998
Herring Norwegian Spring-spawners

Prediction with management option table

Year: 1998					Year: 1999					Year: 2000	
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
0.7477	0.1695	10506715	9836033	1302001	0.0000	0.0000	9380109	8906334	0	9407495	8735658
.	.	.	.	.	0.0500	0.0113	.	8896801	101925	9314253	8634256
.	.	.	.	.	0.1000	0.0227	.	8887279	202754	9222036	8534100
.	.	.	.	.	0.1500	0.0340	.	8877767	302499	9130832	8435175
.	.	.	.	.	0.2000	0.0453	.	8868266	401171	9040630	8337464
.	.	.	.	.	0.2500	0.0567	.	8858776	498784	8951418	8240952
.	.	.	.	.	0.3000	0.0680	.	8849296	595350	8863185	8145625
.	.	.	.	.	0.3500	0.0793	.	8839828	690879	8775919	8051467
.	.	.	.	.	0.4000	0.0907	.	8830369	785385	8689609	7958463
.	.	.	.	.	0.4500	0.1020	.	8820922	878879	8604245	7866598
.	.	.	.	.	0.5000	0.1134	.	8811485	971372	8519816	7775858
.	.	.	.	.	0.5500	0.1247	.	8802059	1062875	8436310	7686229
.	.	.	.	.	0.6000	0.1360	.	8792643	1153401	8353718	7597697
.	.	.	.	.	0.6500	0.1474	.	8783238	1242959	8272028	7510248
.	.	.	.	.	0.7000	0.1587	.	8773843	1331561	8191231	7423867
.	.	.	.	.	0.7500	0.1700	.	8764459	1419218	8111316	7338542
.	.	.	.	.	0.8000	0.1814	.	8755086	1505941	8032273	7254259
.	.	.	.	.	0.8500	0.1927	.	8745723	1591739	7954093	7171004
.	.	.	.	.	0.9000	0.2040	.	8736370	1676625	7876765	7088766
.	.	.	.	.	0.9500	0.2154	.	8727028	1760607	7800279	7007530
.	.	.	.	.	1.0000	0.2267	.	8717697	1843696	7724626	6927284
.	.	.	.	.	1.0500	0.2380	.	8708376	1925902	7649797	6848017
.	.	.	.	.	1.1000	0.2494	.	8699066	2007236	7575782	6769714
.	.	.	.	.	1.1500	0.2607	.	8689766	2087706	7502571	6692365
.	.	.	.	.	1.2000	0.2720	.	8680476	2167324	7430156	6615957
.	.	.	.	.	1.2500	0.2834	.	8671197	2246098	7358527	6540478
.	.	.	.	.	1.3000	0.2947	.	8661929	2324037	7287676	6465916
.	.	.	.	.	1.3500	0.3060	.	8652670	2401153	7217593	6392260
.	.	.	.	.	1.4000	0.3174	.	8643422	2477452	7148271	6319499
.	.	.	.	.	1.4500	0.3287	.	8634185	2552946	7079699	6247620
.	.	.	.	.	1.5000	0.3401	.	8624958	2627643	7011870	6176614
.	.	.	.	.	1.5500	0.3514	.	8615741	2701552	6944776	6106469
.	.	.	.	.	1.6000	0.3627	.	8606535	2774681	6878407	6037173
.	.	.	.	.	1.6500	0.3741	.	8597339	2847040	6812756	5968717
.	.	.	.	.	1.7000	0.3854	.	8588153	2918637	6747814	5901090
.	.	.	.	.	1.7500	0.3967	.	8578978	2989481	6683574	5834282
.	.	.	.	.	1.8000	0.4081	.	8569813	3059581	6620027	5768281
.	.	.	.	.	1.8500	0.4194	.	8560658	3128944	6557165	5703078
.	.	.	.	.	1.9000	0.4307	.	8551514	3197579	6494981	5638663
.	.	.	.	.	1.9500	0.4421	.	8542379	3265494	6433467	5575027
.	.	.	.	.	2.0000	0.4534	.	8533256	3332697	6372616	5512158
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANBJA04
Date and time : 06MAY98:22:30
Computation of ref. F: Simple mean, age 5 - 14
Basis for 1998 : TAC constraints

Table 3.6.2.1 b

19:04 Wednesday, May 6, 1998
Herring Norwegian Spring-spawners

Prediction with management option table

Year: 1998					Year: 1999					Year: 2000	
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
0.7396	0.1311	13135202	12383820	1302000	0.0000	0.0000	11970601	11417039	0	11931878	11146089
.	.	.	.	.	0.0500	0.0089	.	11407398	103230	11837602	11043653
.	.	.	.	.	0.1000	0.0177	.	11397765	205585	11744141	10942208
.	.	.	.	.	0.1500	0.0266	.	11388141	307075	11651489	10841744
.	.	.	.	.	0.2000	0.0354	.	11378526	407706	11559637	10742250
.	.	.	.	.	0.2500	0.0443	.	11368919	507486	11468579	10643717
.	.	.	.	.	0.3000	0.0532	.	11359320	606424	11378308	10546135
.	.	.	.	.	0.3500	0.0620	.	11349730	704526	11288816	10449495
.	.	.	.	.	0.4000	0.0709	.	11340148	801799	11200096	10353788
.	.	.	.	.	0.4500	0.0798	.	11330575	898252	11112142	10259004
.	.	.	.	.	0.5000	0.0886	.	11321010	993892	11024947	10165134
.	.	.	.	.	0.5500	0.0975	.	11311454	1088725	10938503	10072169
.	.	.	.	.	0.6000	0.1063	.	11301906	1182760	10852804	9980099
.	.	.	.	.	0.6500	0.1152	.	11292366	1276003	10767843	9888917
.	.	.	.	.	0.7000	0.1241	.	11282835	1368461	10683614	9798612
.	.	.	.	.	0.7500	0.1329	.	11273313	1460141	10600109	9709177
.	.	.	.	.	0.8000	0.1418	.	11263799	1551050	10517324	9620603
.	.	.	.	.	0.8500	0.1506	.	11254293	1641195	10435250	9532880
.	.	.	.	.	0.9000	0.1595	.	11244795	1730584	10353882	9446001
.	.	.	.	.	0.9500	0.1684	.	11235306	1819221	10273213	9359957
.	.	.	.	.	1.0000	0.1772	.	11225826	1907115	10193237	9274741
.	.	.	.	.	1.0500	0.1861	.	11216353	1994272	10113948	9190342
.	.	.	.	.	1.1000	0.1950	.	11206890	2080698	10035340	9106755
.	.	.	.	.	1.1500	0.2038	.	11197434	2166400	9957406	9023969
.	.	.	.	.	1.2000	0.2127	.	11187987	2251385	9880140	8941979
.	.	.	.	.	1.2500	0.2215	.	11178548	2335658	9803538	8860774
.	.	.	.	.	1.3000	0.2304	.	11169117	2419226	9727591	8780349
.	.	.	.	.	1.3500	0.2393	.	11159695	2502095	9652295	8700694
.	.	.	.	.	1.4000	0.2481	.	11150281	2584272	9577644	8621803
.	.	.	.	.	1.4500	0.2570	.	11140876	2665762	9503632	8543668
.	.	.	.	.	1.5000	0.2658	.	11131479	2746572	9430254	8466281
.	.	.	.	.	1.5500	0.2747	.	11122090	2826708	9357503	8389634
.	.	.	.	.	1.6000	0.2836	.	11112709	2906176	9285374	8313722
.	.	.	.	.	1.6500	0.2924	.	11103337	2984981	9213861	8238535
.	.	.	.	.	1.7000	0.3013	.	11093973	3063129	9142960	8164068
.	.	.	.	.	1.7500	0.3102	.	11084617	3140627	9072663	8090312
.	.	.	.	.	1.8000	0.3190	.	11075269	3217480	9002967	8017261
.	.	.	.	.	1.8500	0.3279	.	11065930	3293694	8933866	7944909
.	.	.	.	.	1.9000	0.3367	.	11056599	3369274	8865354	7873247
.	.	.	.	.	1.9500	0.3456	.	11047276	3444226	8797426	7802269
.	.	.	.	.	2.0000	0.3545	.	11037961	3518555	8730077	7731968
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANBJA03
Date and time : 06MAY98:22:38
Computation of ref. F: Simple mean, age 5 - 14
Basis for 1998 : TAC constraints

Table 3.10.2.1 Norwegian Spring-Spawning Herring. Stochastic medium-term catch predictions from Bayesian assessment detailed in Section 3.7.

1. Distributions of status-quo forecast catches (for F98 and later = F97) (in thousands of tonnes)

	Year				
Percentiles	**1998**	**1999**	**2000**	**2001**	**2002**
5	1059	857	631	429	310
25	1379	1322	1067	823	719
50	1536	1579	1347	1081	990
75	1667	1858	1707	1465	1462
95	1860	2305	2340	2114	2238
Expected	1510	1590	1407	1168	1143

2. Distributions of forecast catches conforming to a harvest control rule with:
   - Maximum catch limited to 1.5 Million t
   -Maximum fishing mortality limited to natural mortality (corresponding to F=0.15)

	Year				
Percentiles	**1998**	**1999**	**2000**	**2001**	**2002**
5	205	297	306	212	307
25	397	533	552	526	506
50	564	729	732	684	679
75	796	985	1002	938	986
95	1499	1500	1500	1500	1500
Expected	664	802	811	775	781

3. Distributions of forecast catches conforming to a harvest control rule with:
   - Maximum catch limited to 1.5 Million t
   -Maximum fishing mortality limited to natural mortality (corresponding to F=0.15)
   -Fishing mortality limited to 1/3 of natural mortality (corresponding to F=0.05) if SSB falls under 2.5 Million t

	Year				
Percentiles	**1998**	**1999**	**2000**	**2001**	**2002**
5	205	297	333	331	308
25	397	533	552	528	506
50	564	729	732	684	678
75	796	985	1002	938	986
95	1499	1500	1500	1500	1500
Expected	664	807	819	784	785

Table 3.10.2.2 Norwegian Spring-Spawning Herring. Estimated probability that catch options for 1998 and 1999 exceed the catches corresponding to either an F-status quo forecast catch or else a catch corresponding to a harvest control rule in which catch is limited to the lower of 1.5 Million t and the forecast catch corresponding to F=M (equivalent to F=0.15). Distributions from Bayesian assessment calculation.

1. Status-quo fishing mortality forecasts (for F98 and later = F97)

Catch (Thousand t)	Probability (%) that the catch exceeds the catch for F=F97	
	1998	**1999**
800	2	4
900	3	6
1000	4	9
1100	6	12
1200	11	17
1300	17	24
1400	27	31
1500	43	41
1600	60	52
1700	79	61
1800	90	71
1900	97	77
2000	99	82
2100		87
2200		91
2300		95
2400		97
2500		99

2. Harvest Control Rule Forecasts (For F=M (equiv. to F=0.15)) and Maximum catch = 1.5 Million t.

Catch (Thousand t)	Probability (%) that the catch exceeds the catch for harvest rule	
	1998	**1999**
200	5	5
300	13	5
400	26	12
500	50	21
600	56	33
700	69	46
800	76	59
900	80	70
1000	82	76
1100	84	79
1200	86	82
1300	86	84
1400	87	84
1500	89	86

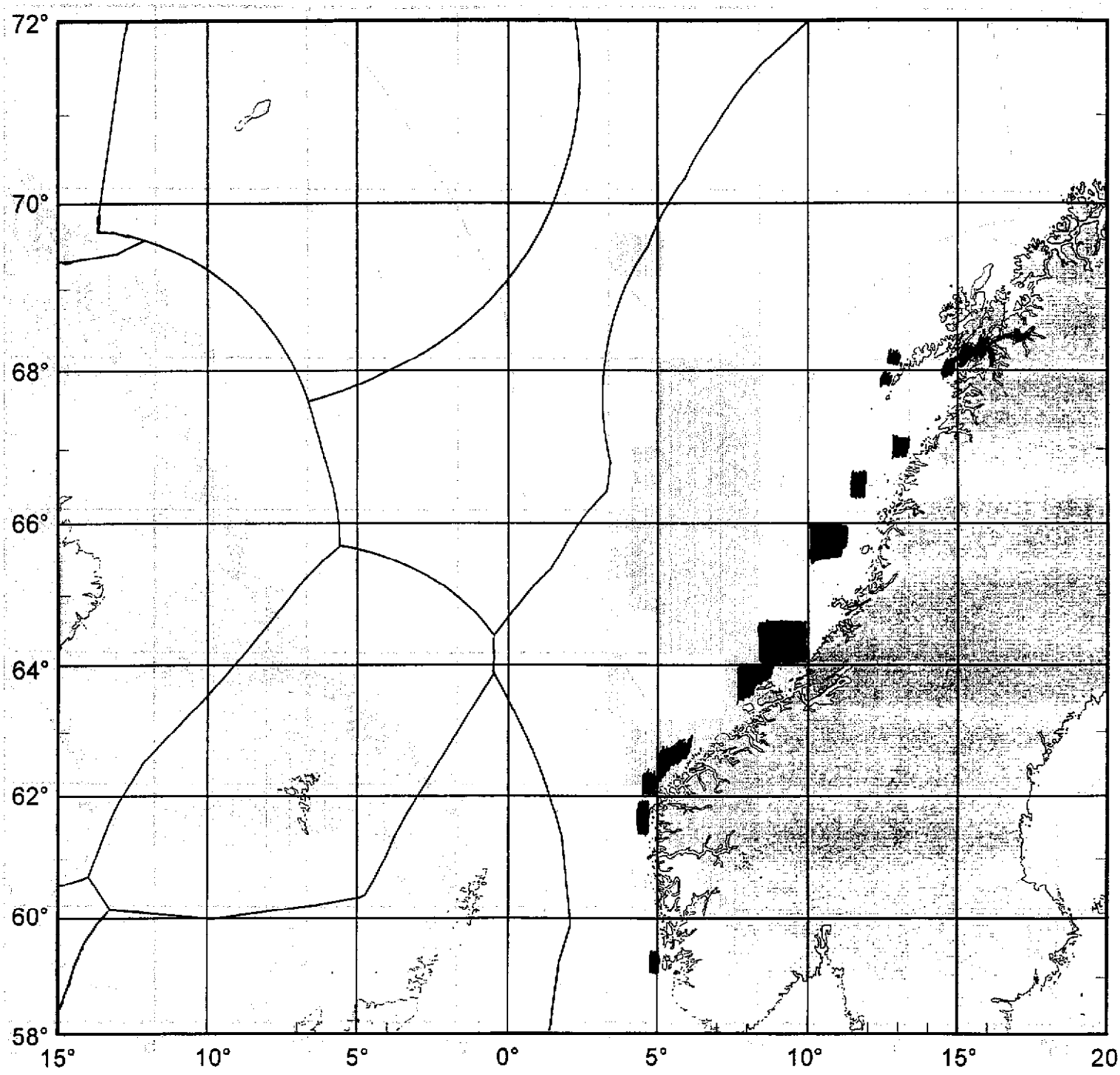


Figure 3.1.2.1 Norwegian spring spawning herring. Distribution of areas where catches have been reported in first quarter of 1997.

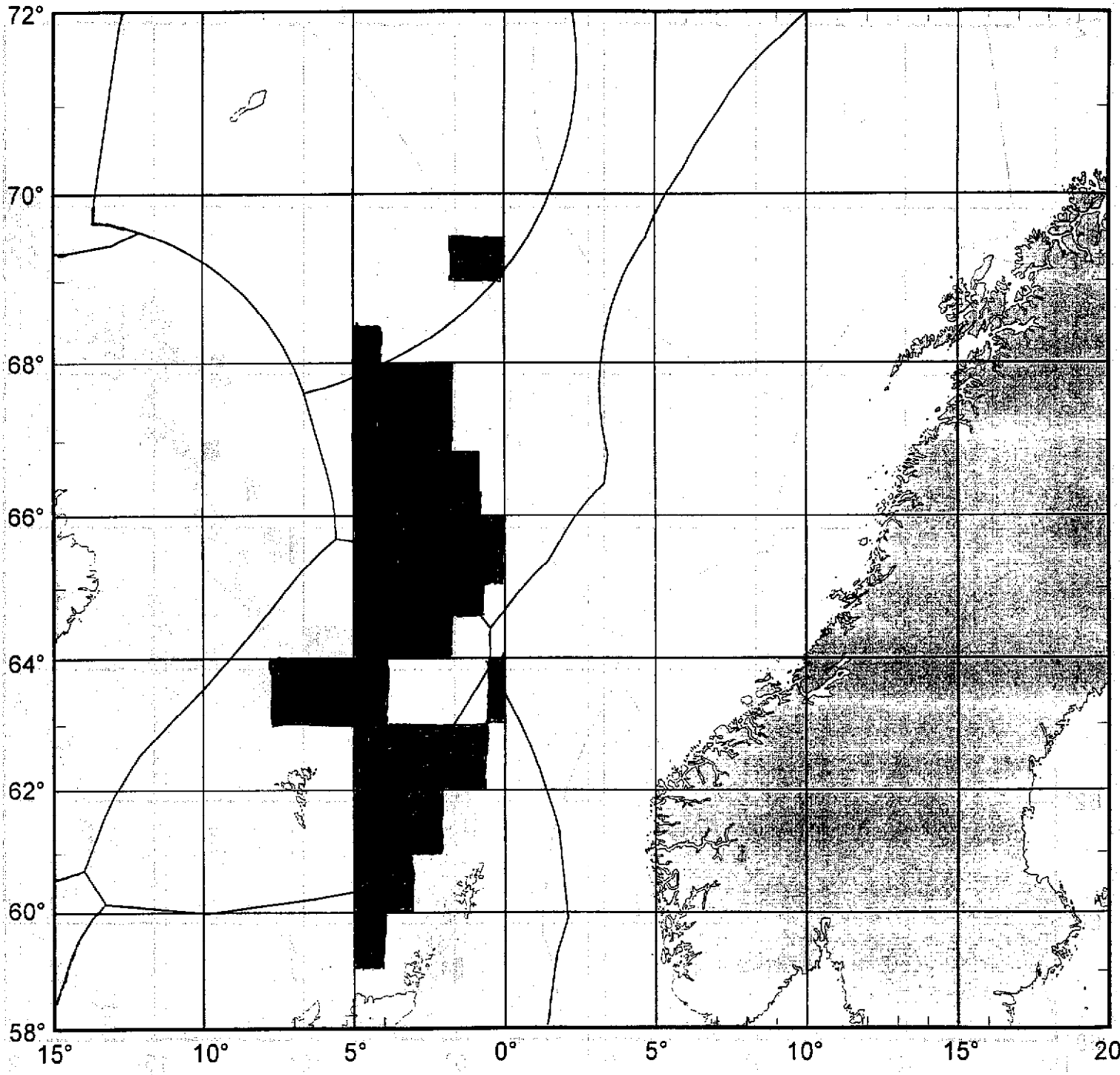


Figure 3.1.2.2 Norwegian spring spawning herring. Distribution of areas where catches have been reported in second quarter of 1997.

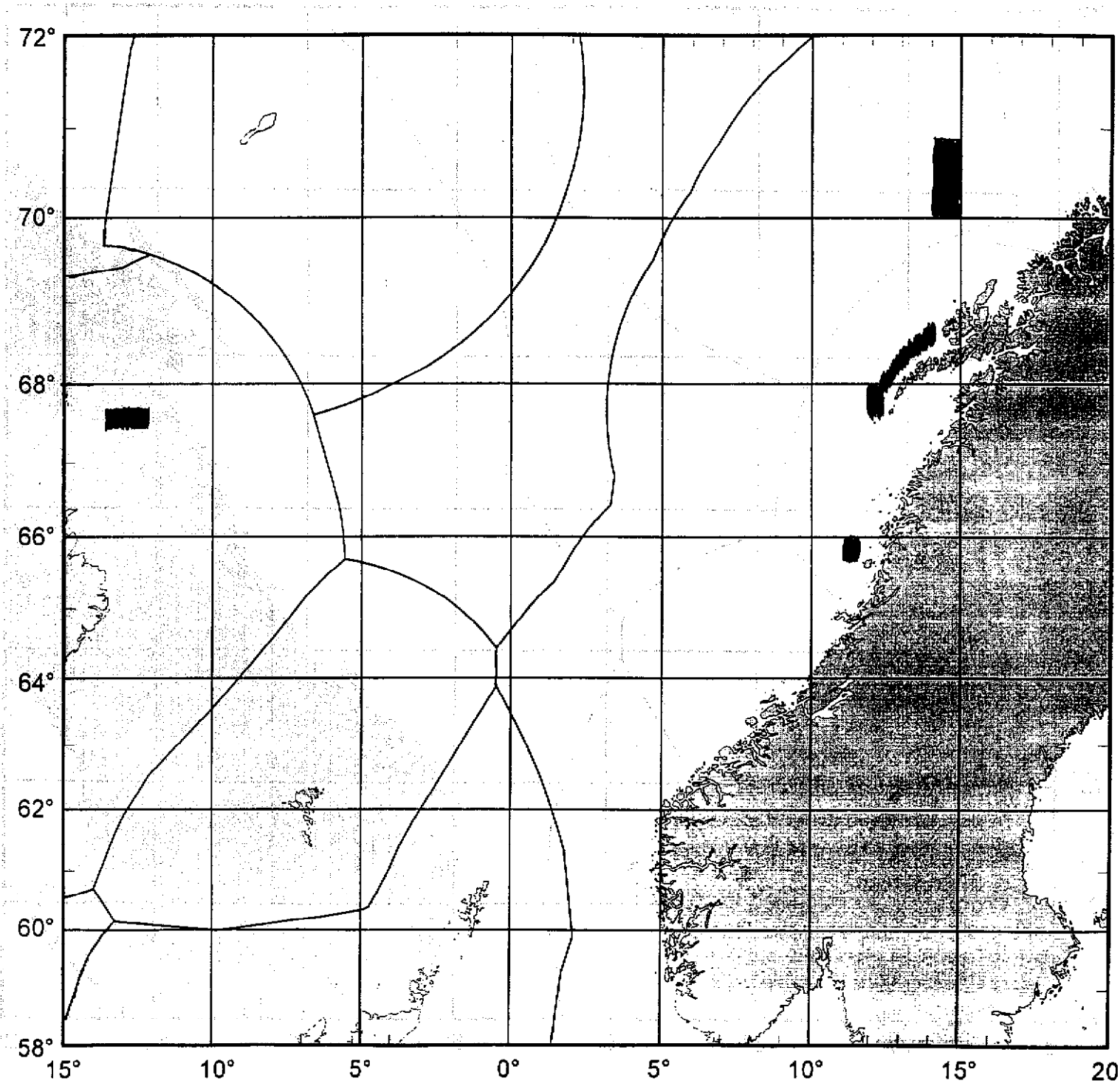


Figure 3.1.2.3 Norwegian spring spawning herring. Distribution of areas where catches have been reported in third quarter of 1997.

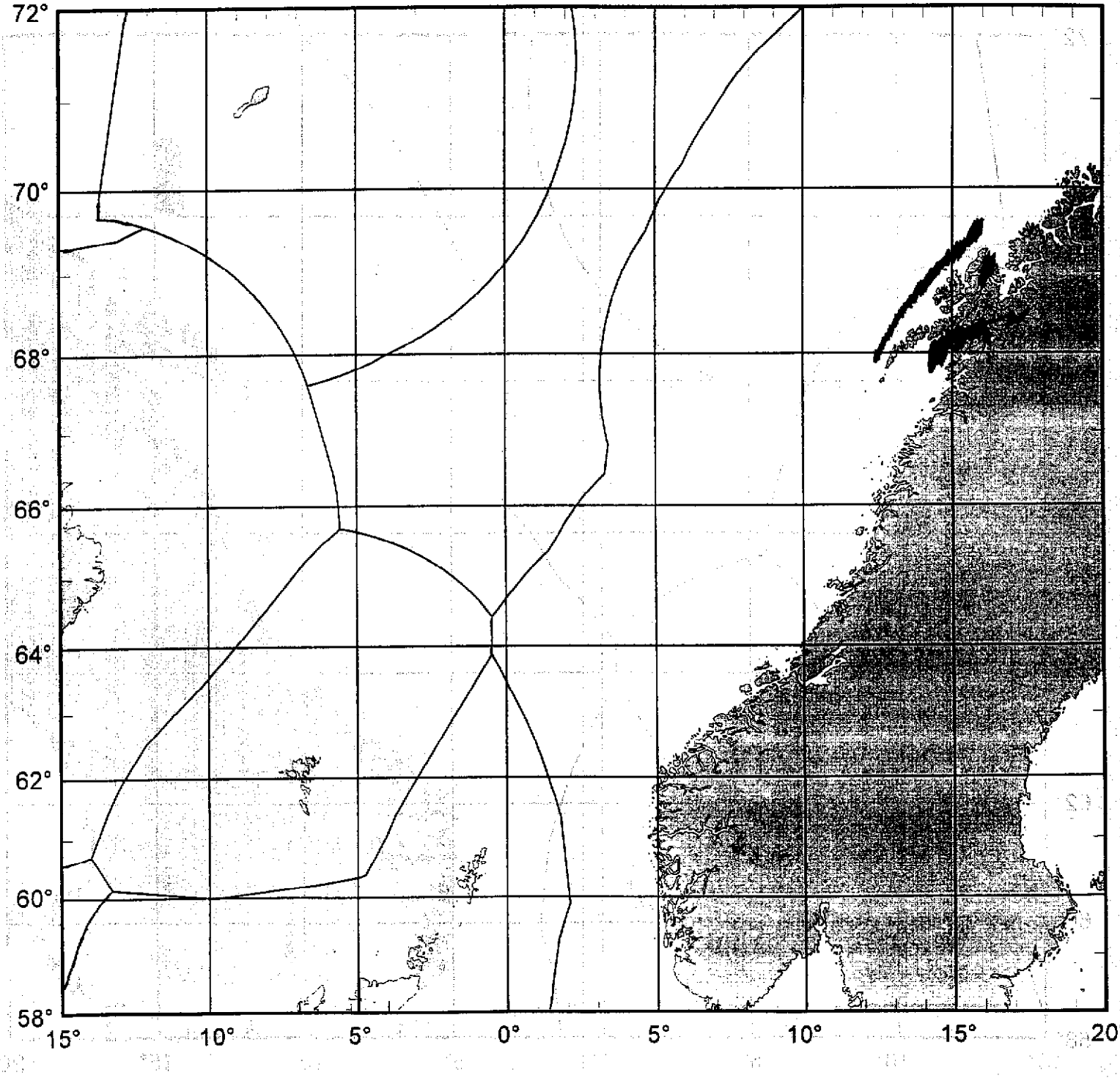


Figure 3.1.2.4 Norwegian spring spawning herring. Distribution of areas where catches have been reported in fourth quarter of 1997.

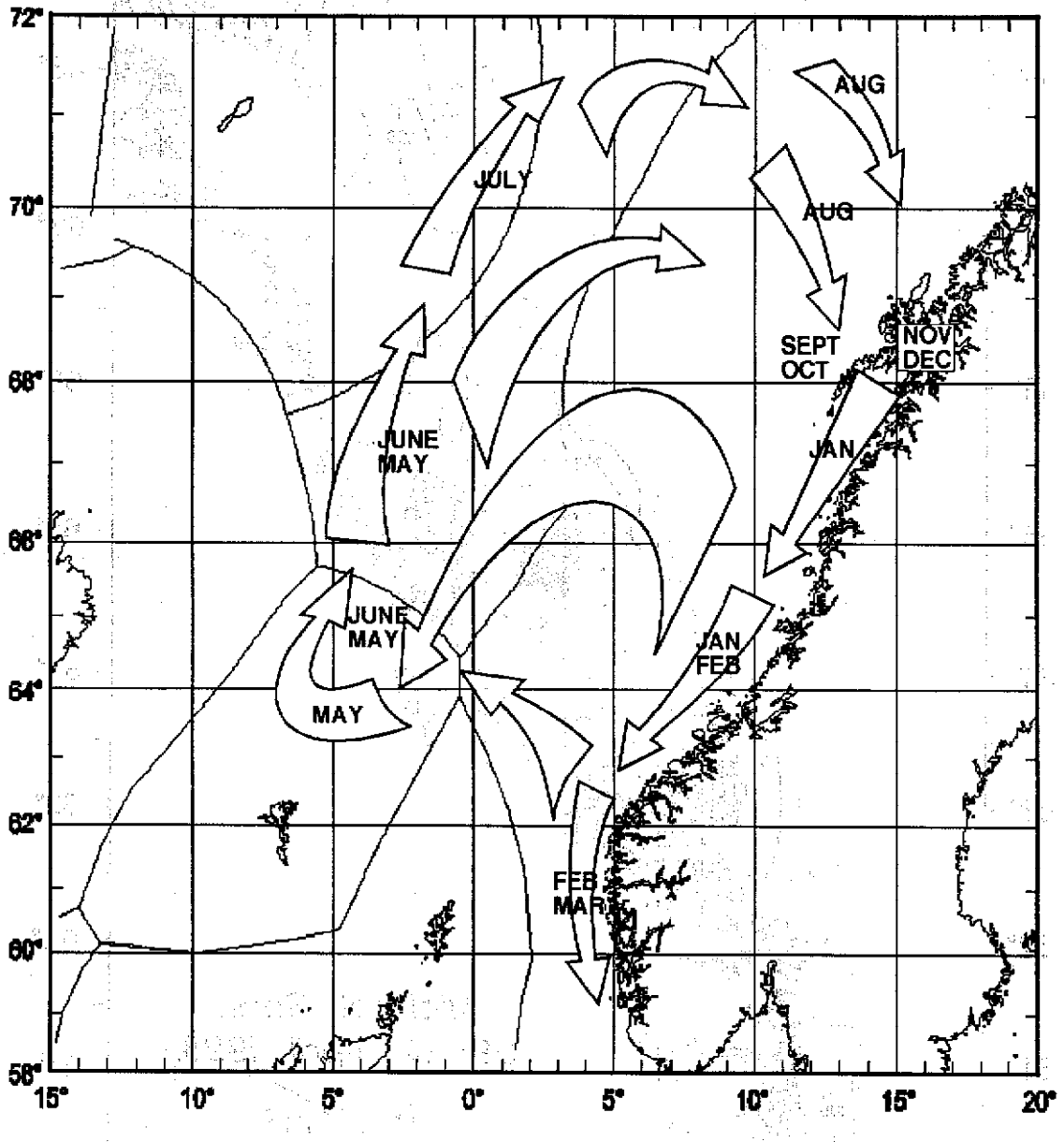


Figure 3.1.2.5 The migration pattern of Norwegian spring spawning herring (arrows) during April 1997 -March 1998. Dates indicate the time of year and the general area in which the fishery took place at the time.

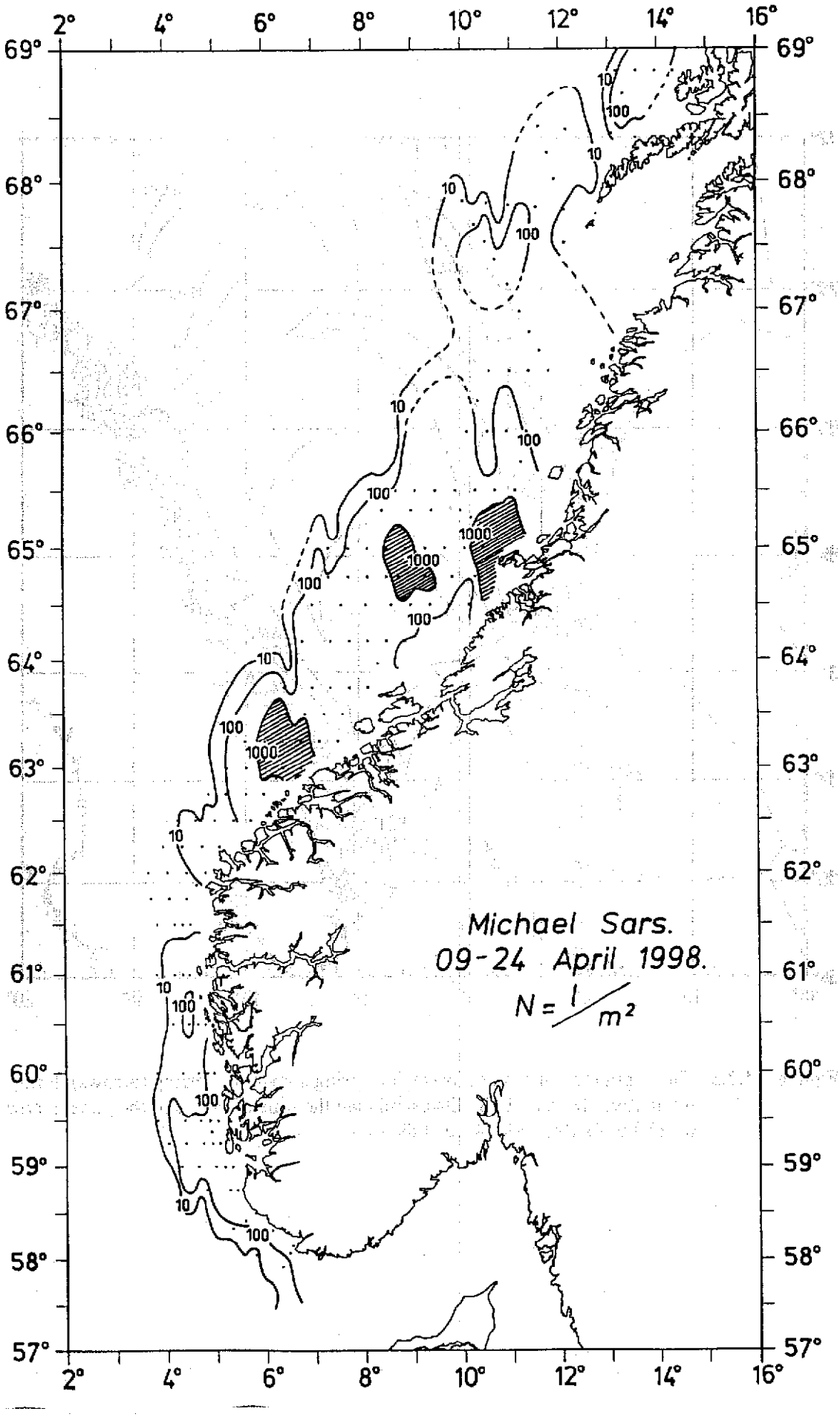


Figure 3.3.5.1 Norwegian spring spawning herring. Distribution of herring larvae in April 1998.

Figure 3.5.5.1 Norwegian Spring-Spawning Herring. Residual plots by year for an assessment model fit in which a Gamma error distribution is assumed, variance is estimated as a parameter in the nonlinear search Surveys before 1991 are included in the model fit. ('run 4', detailed in Table 3.5.5.1.)

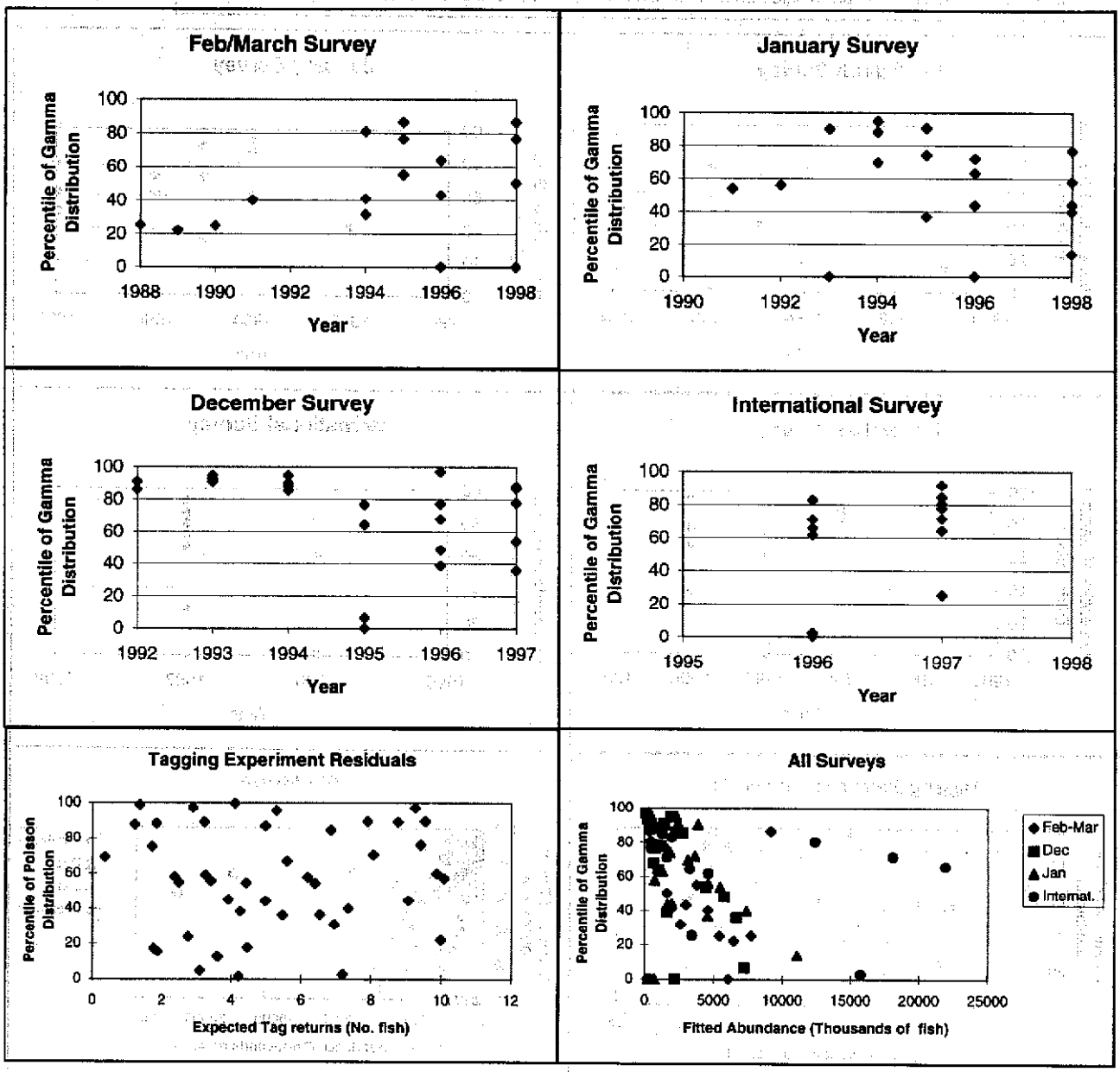


Figure 3.5.5.2 Norwegian Spring-Spawning Herring. Residual plots by year for an assessment model fit in which a Gamma error distribution is assumed, variance is estimated as a parameter in the nonlinear search and surveys before 1991 are omitted from the assessment ('run 5', detailed in Table 3.5.5.1.)

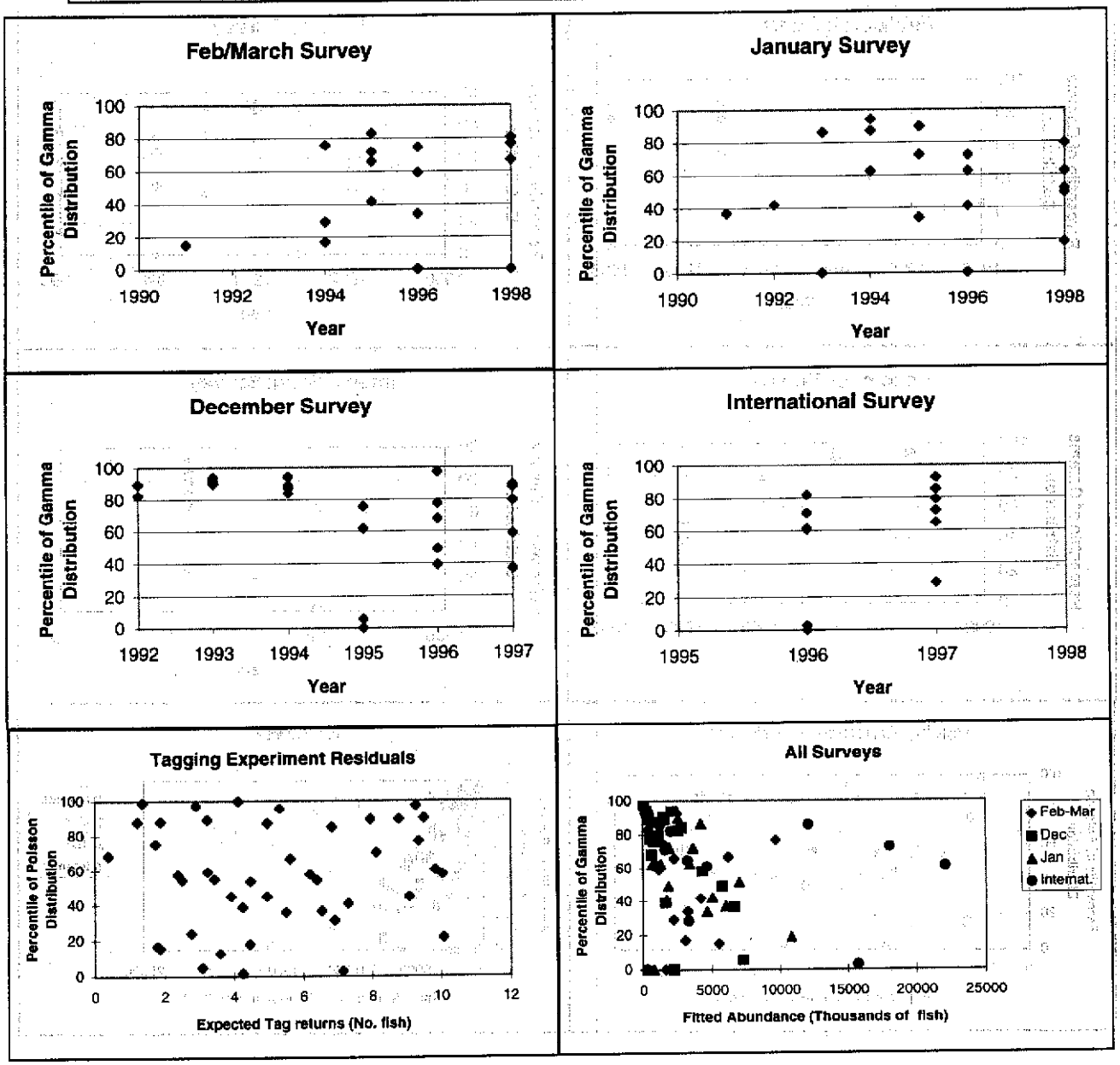
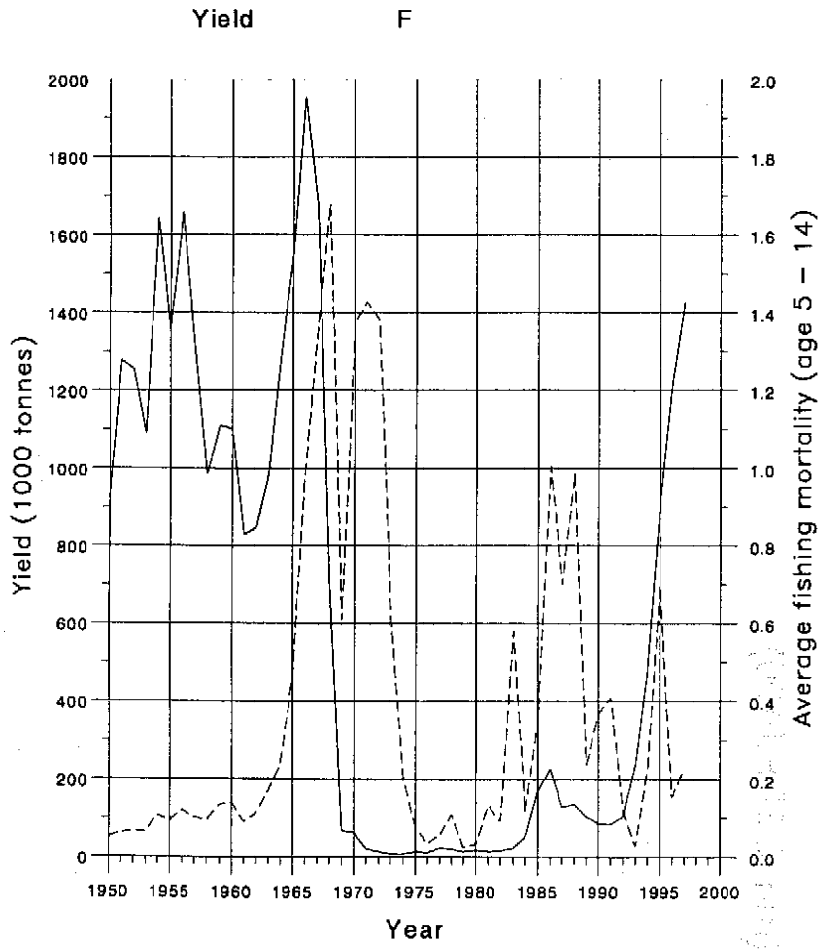


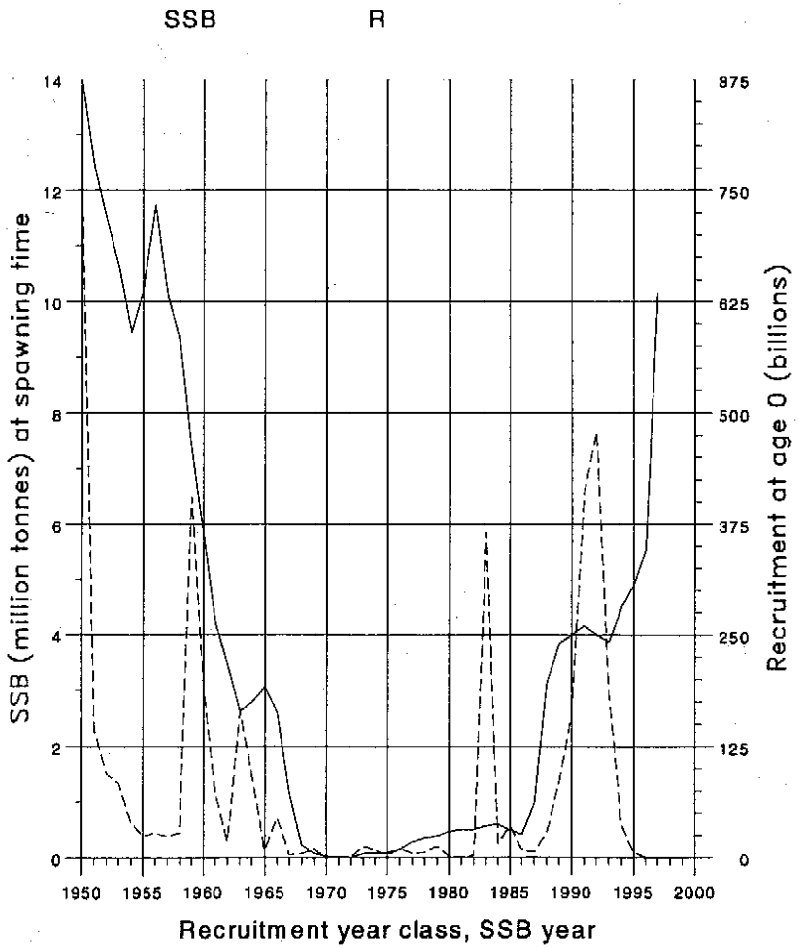
Figure 3.5.7.1 a

Yield and fishing mortality



(run: SEPBJA06)

Spawning stock and recruitment



(run: SEPBJA06)

Figure 3.5.7.2 a

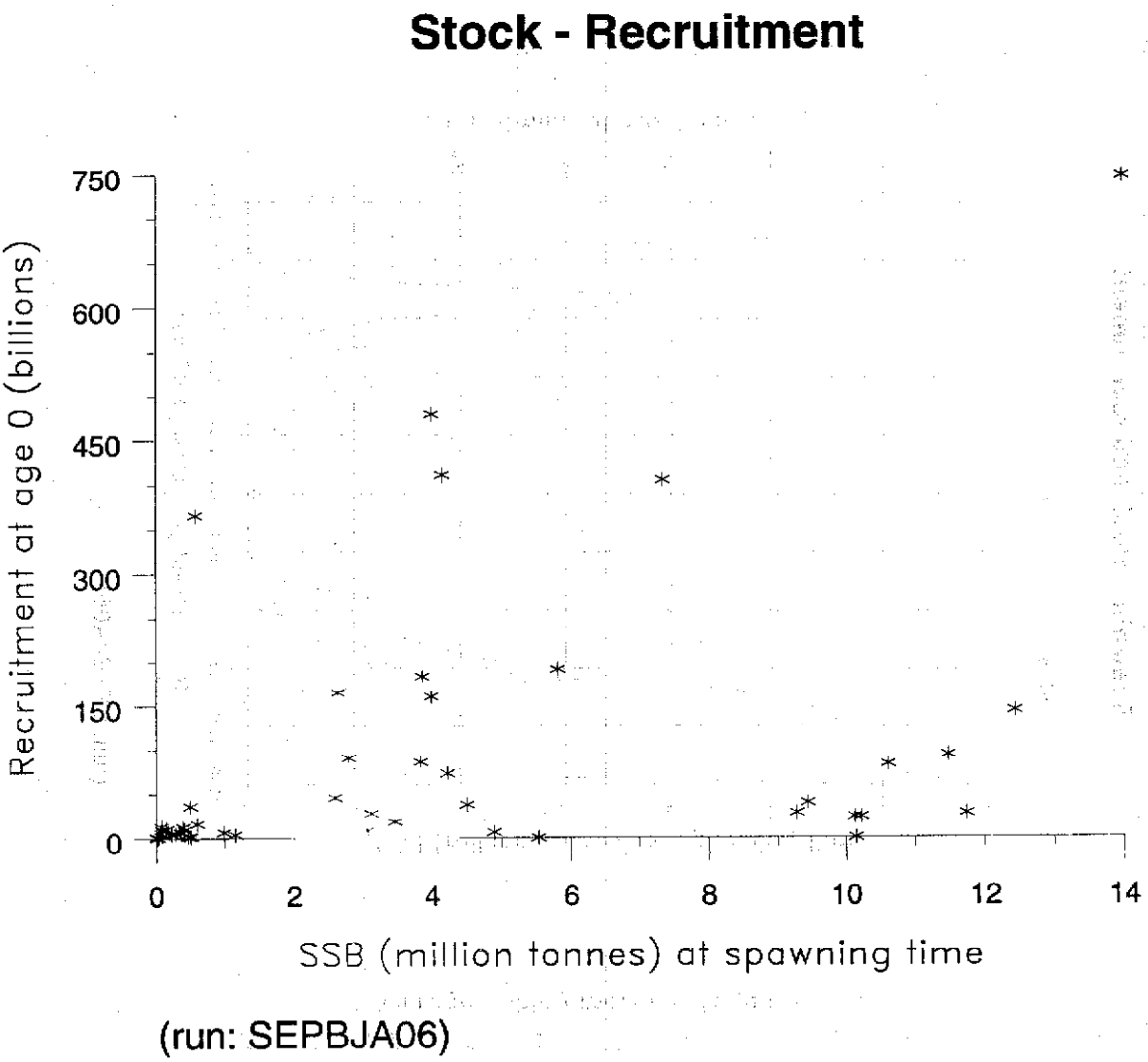


Figure 3.5.7.2 a (continued)

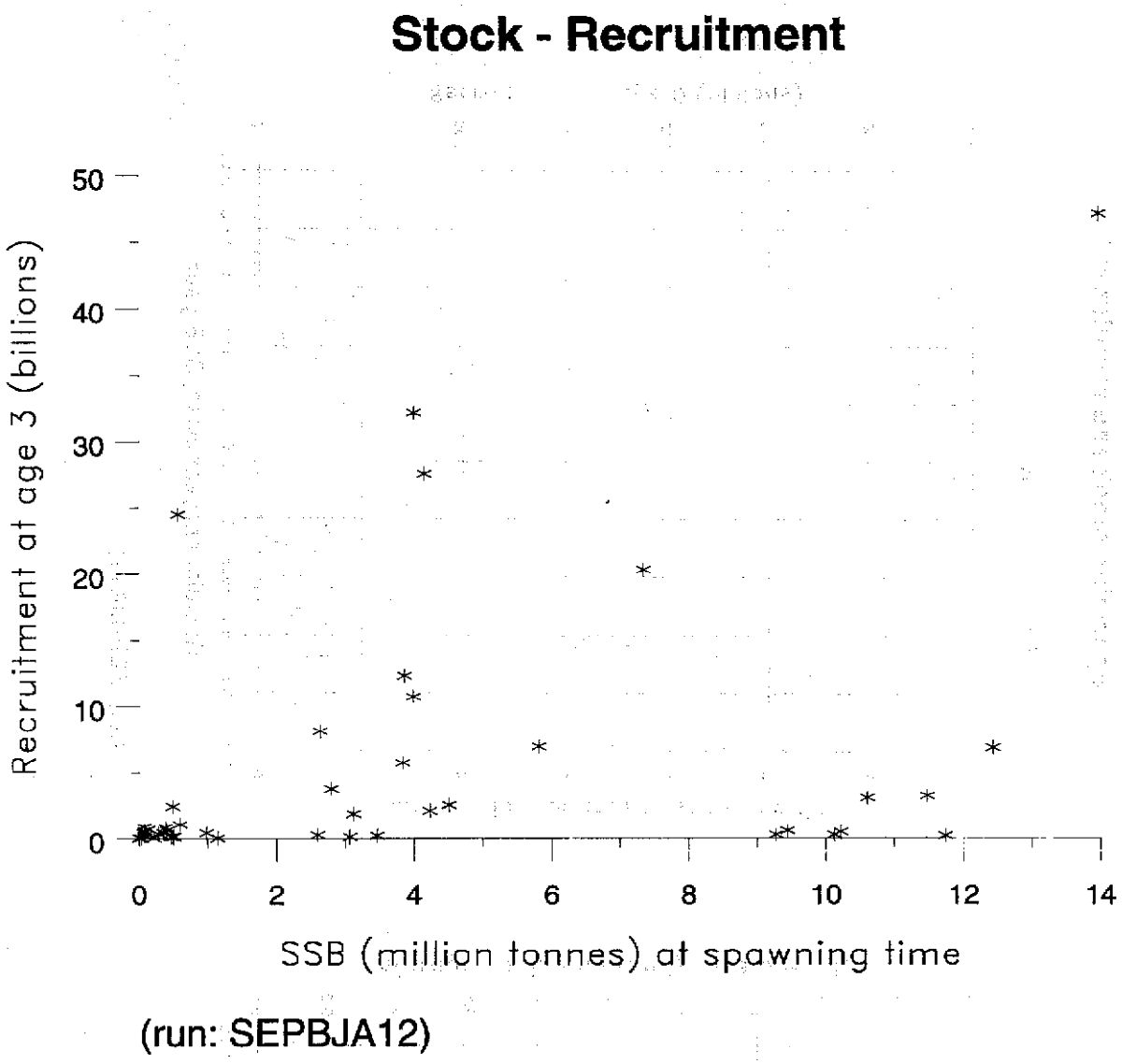
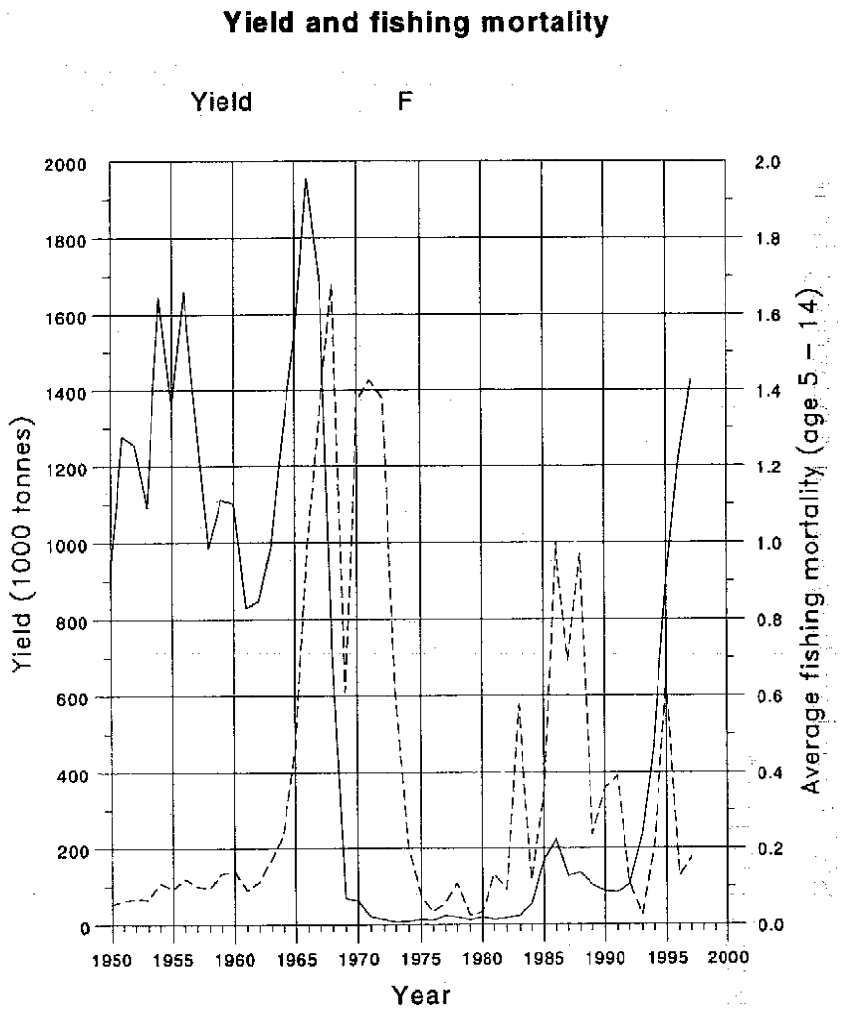
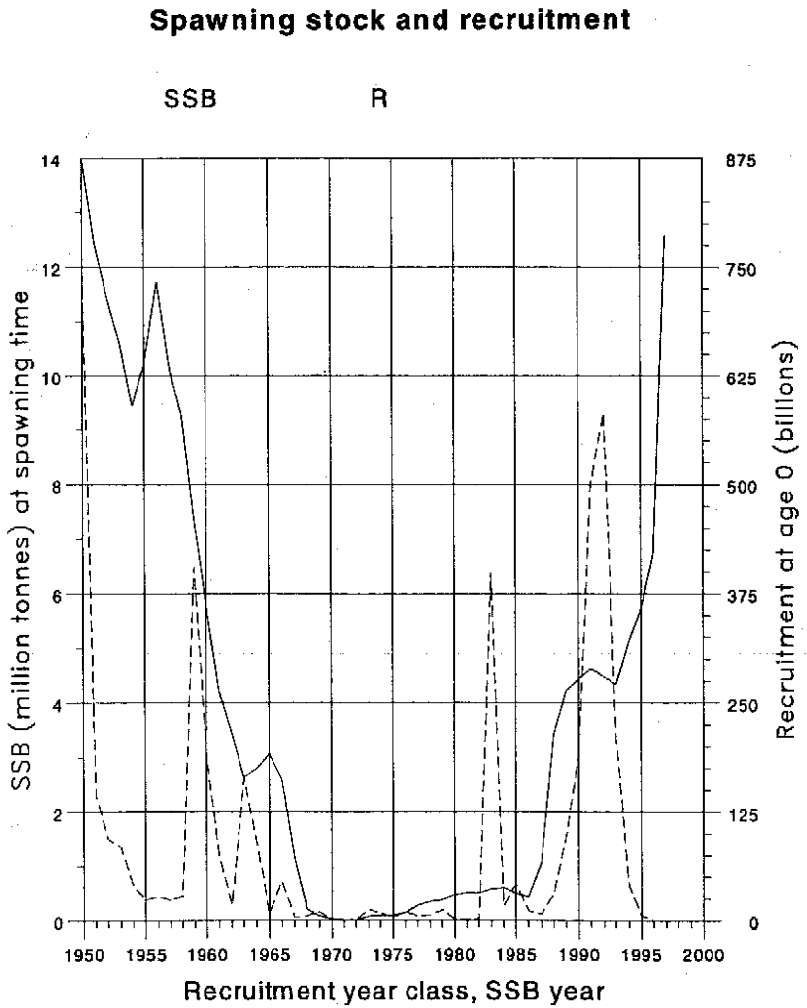


Figure 3.5.7.1 b



(run: SEPBJA11)



(run: SEPBJA11)

Figure 3.5.7.2 b

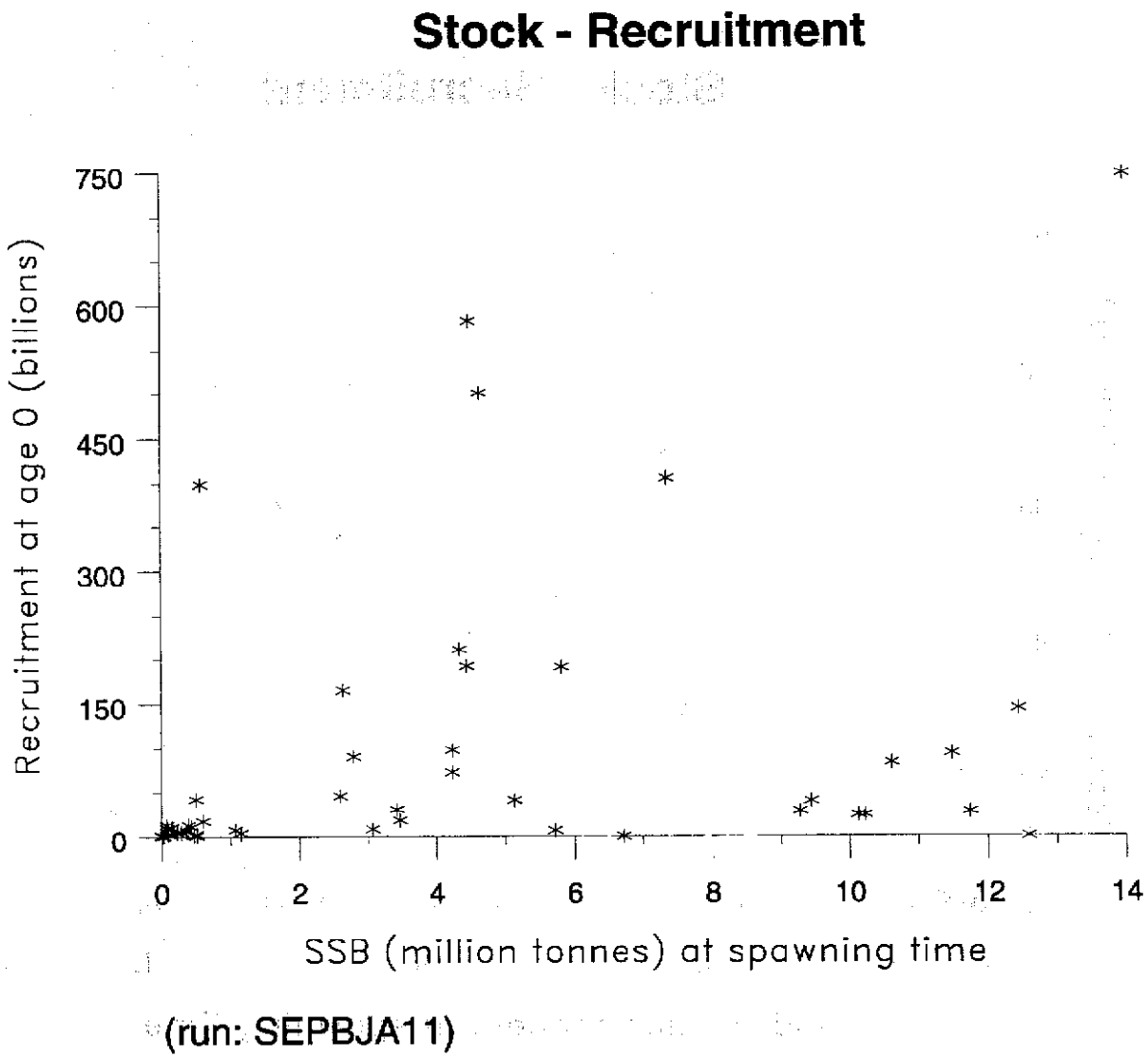


Figure 3.5.7.2 b (continued)

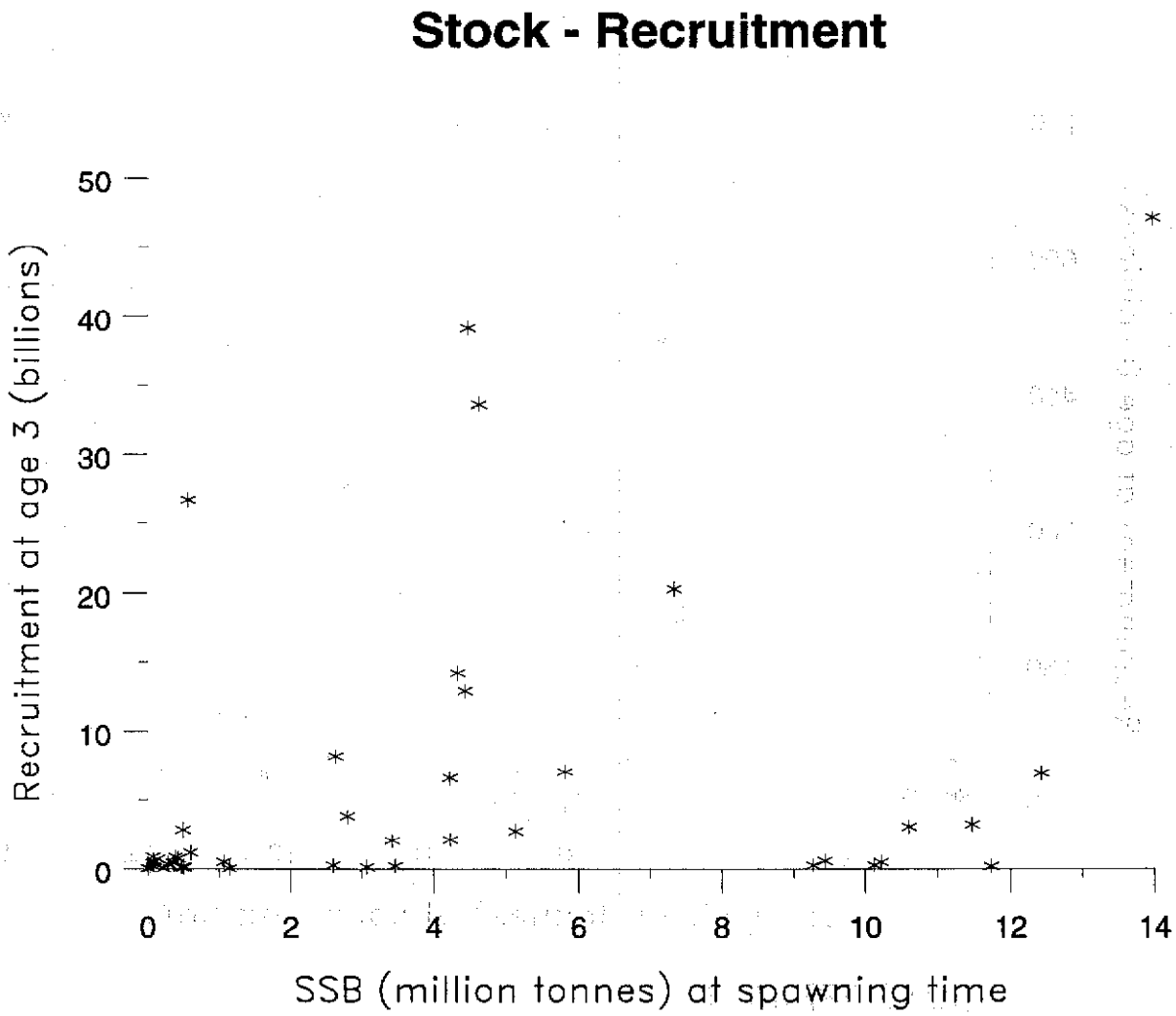
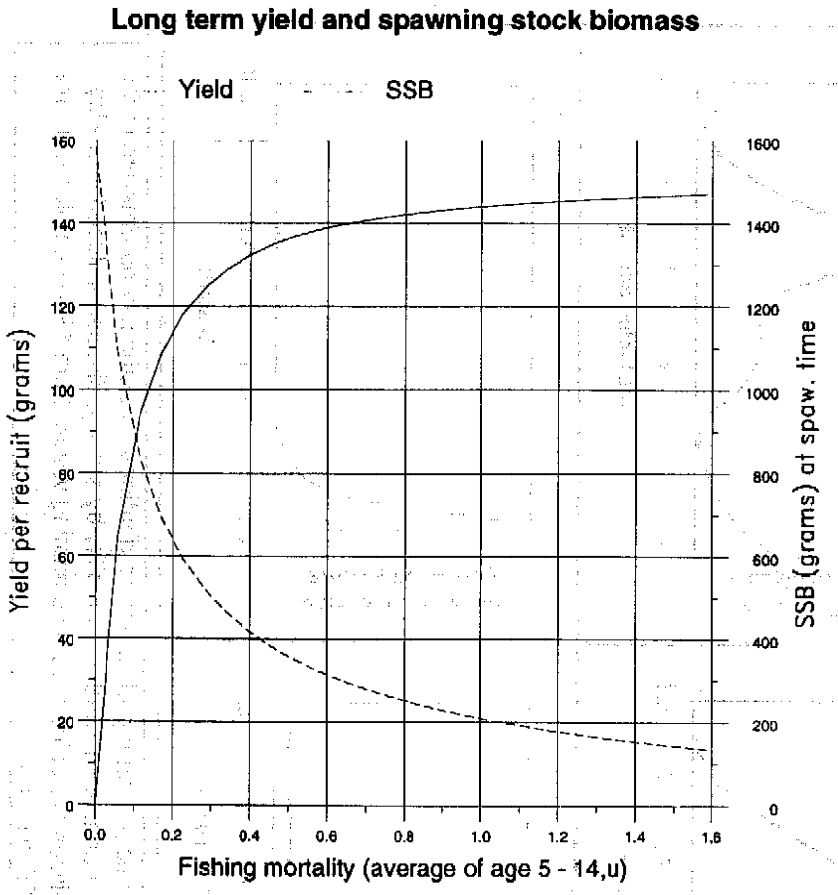
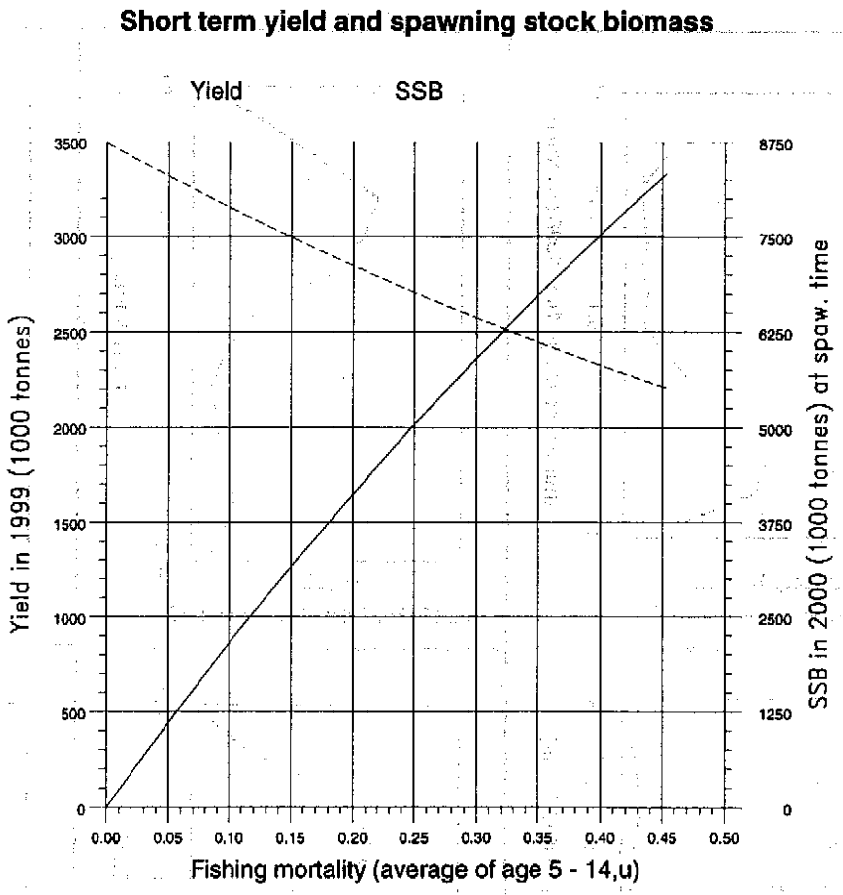


Figure 3.5.8.1



(run: YLDBJA02) **C**



(run: MANBJA04) **D**

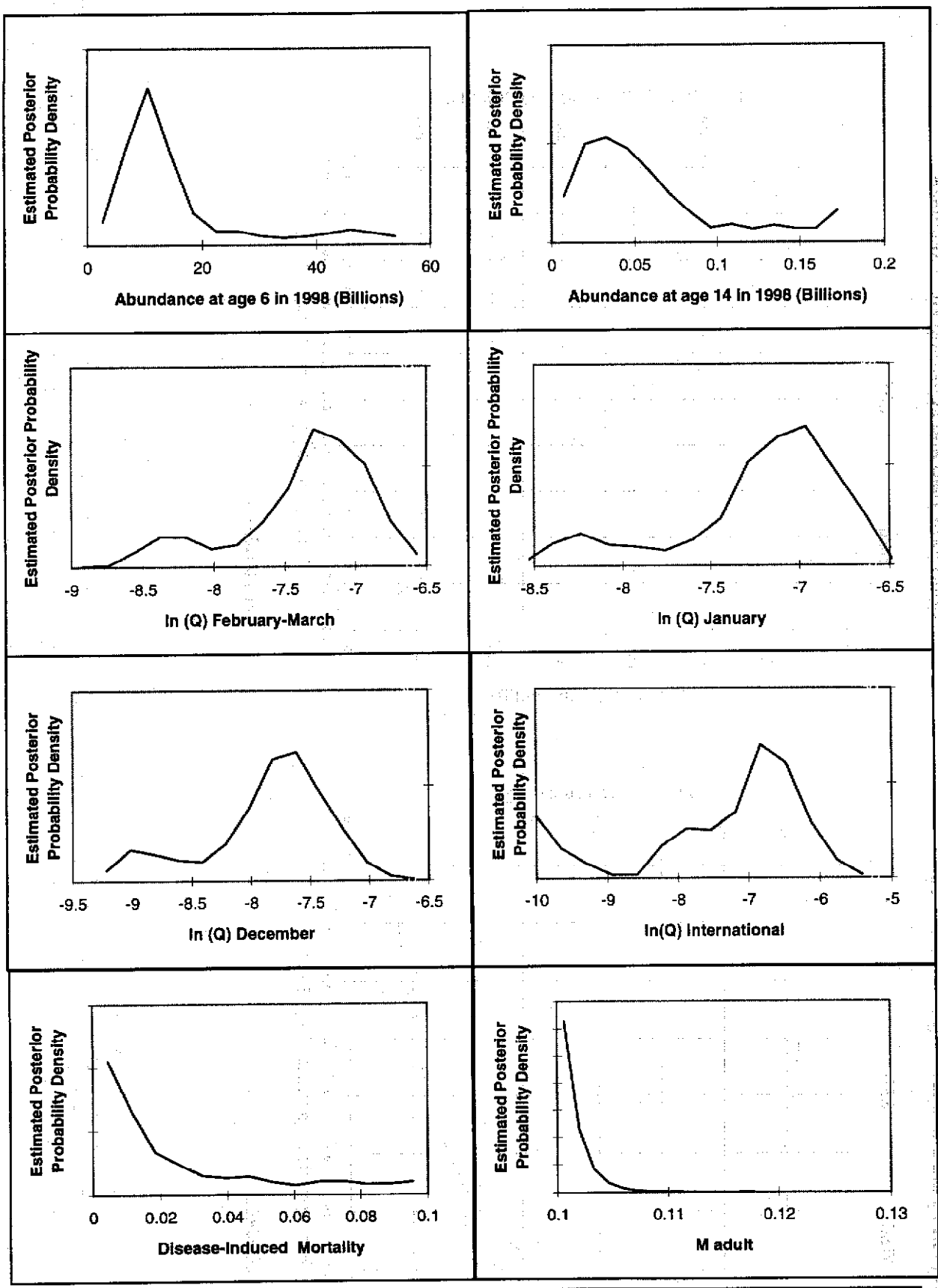


Figure 3.7.2.1. Estimated Bayes posterior probability distributions for some key parameters in the stock assessment: cohort abundances in 1998, catchability by survey, disease-induced mortality and natural mortality. Probabilities are calculated by summing values from 1300 samples from the thinned MCMC process into 15 intervals

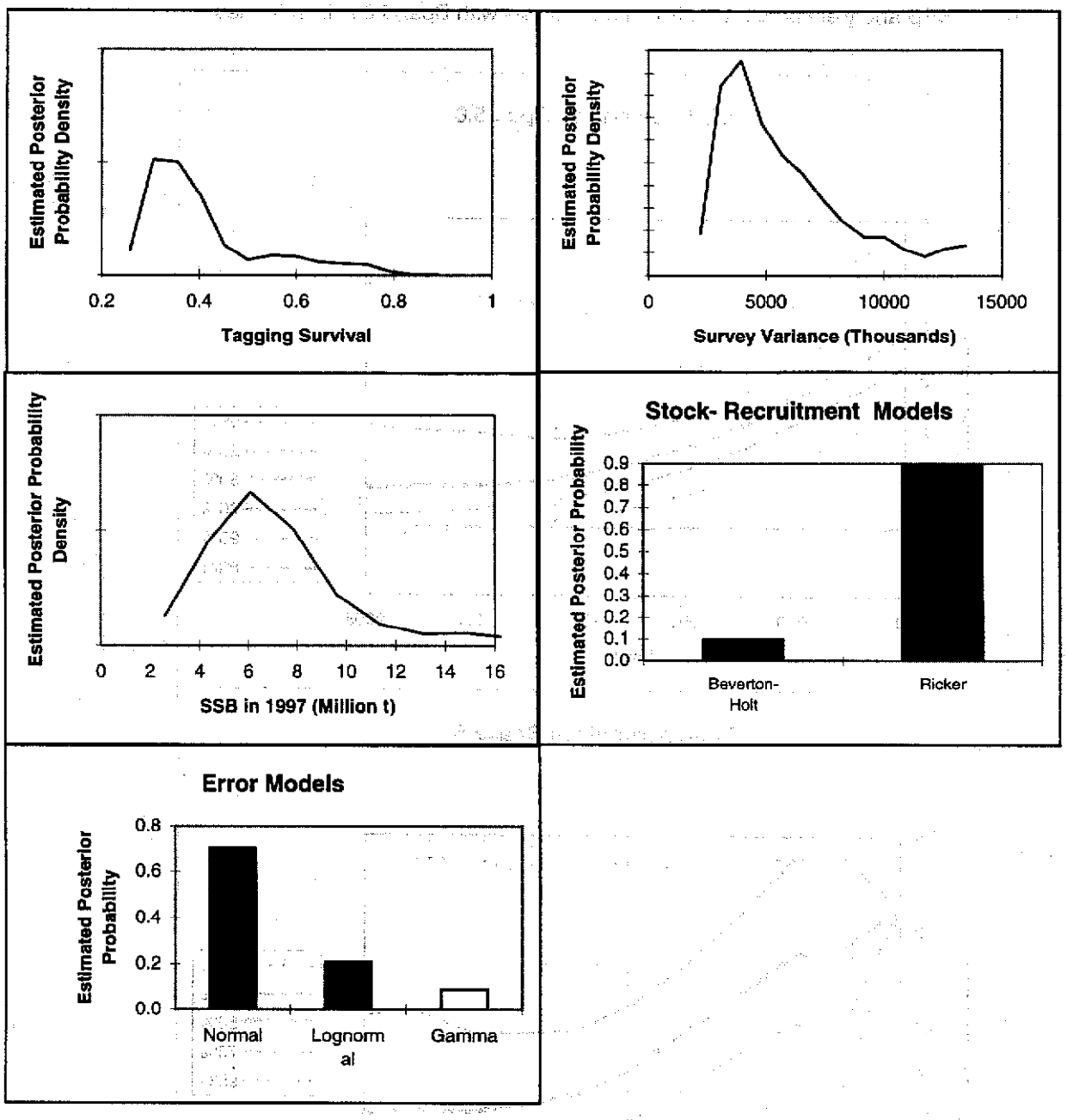


Figure 3.7.2.2. Estimated Bayes posterior probability distributions for further parameters in the stock assessment: appropriate error model, survey error variance, appropriate stock-recruit model, survival in tagging experiment, and spawning stock size in 1997.

Figure 3.10.1.1 SSB and yield percentiles from risk analysis with Bpa=5.0 million tonnes

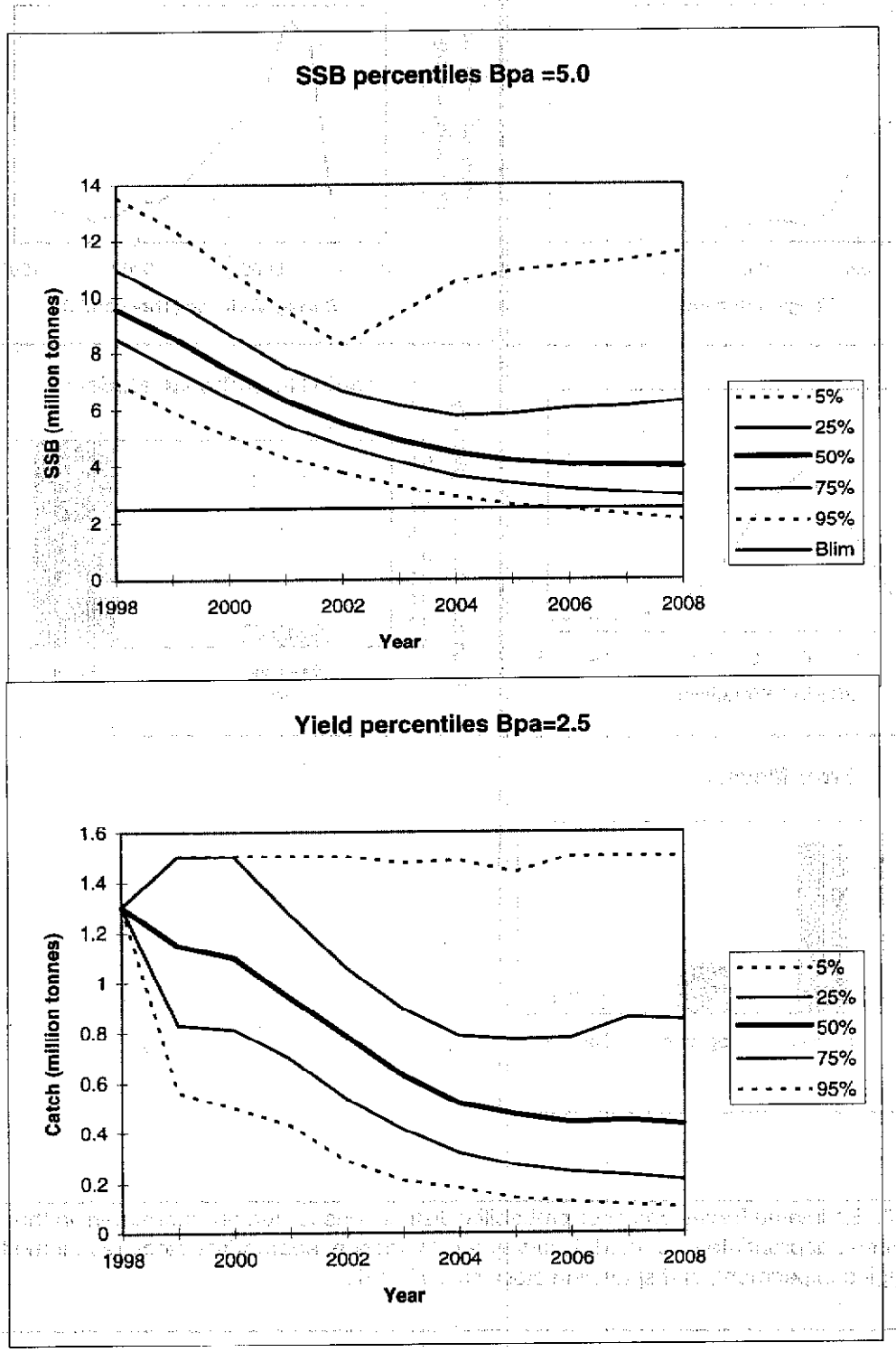
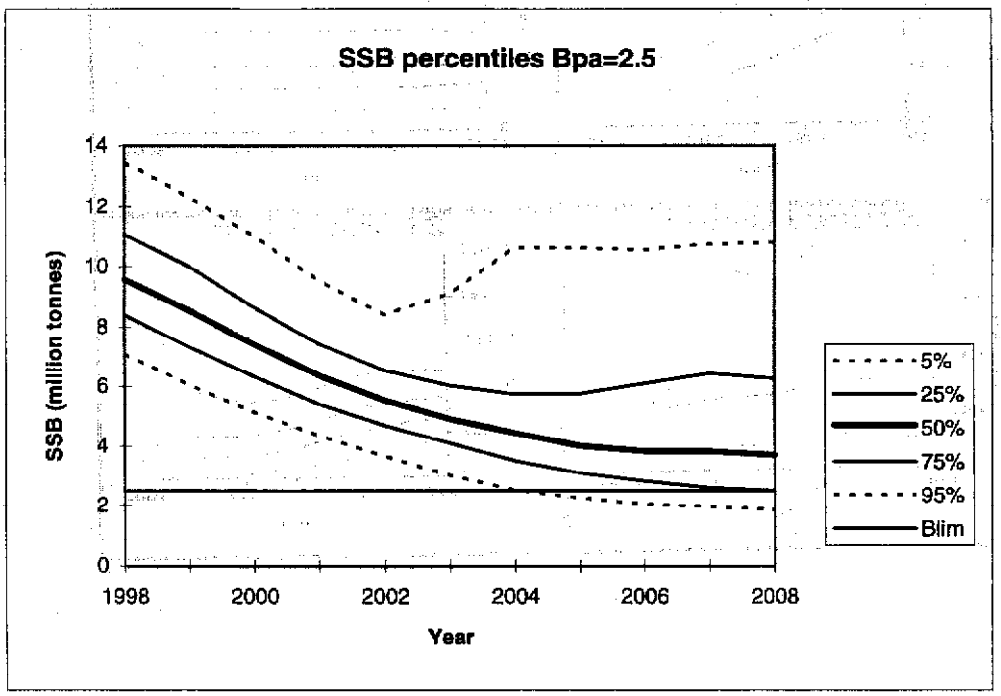
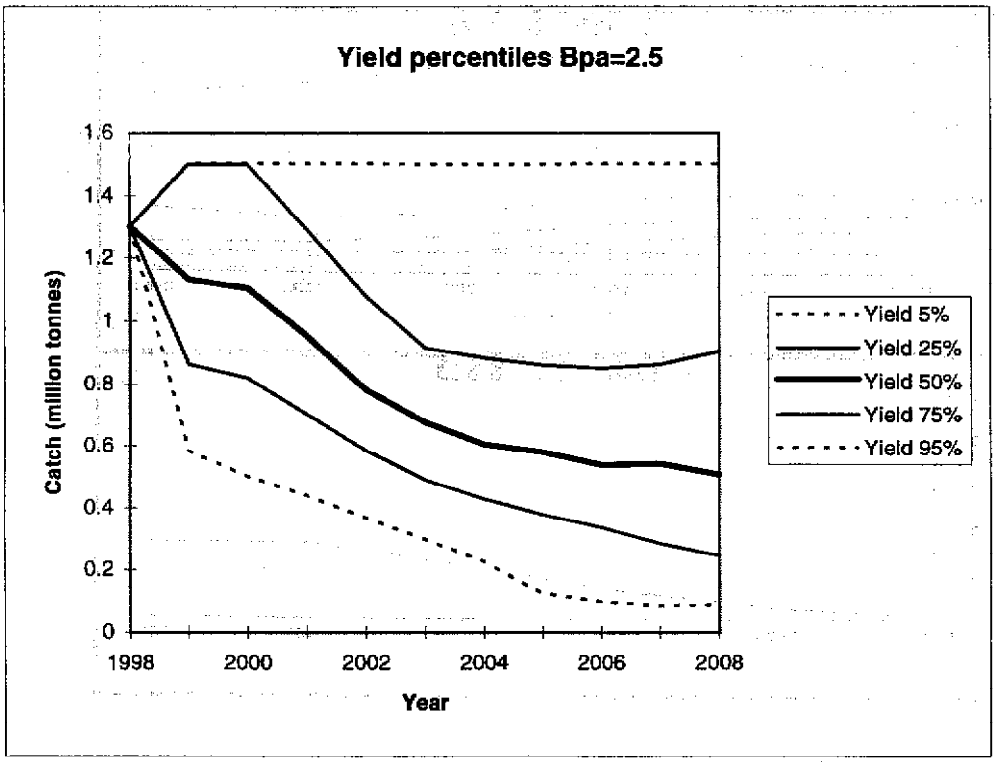
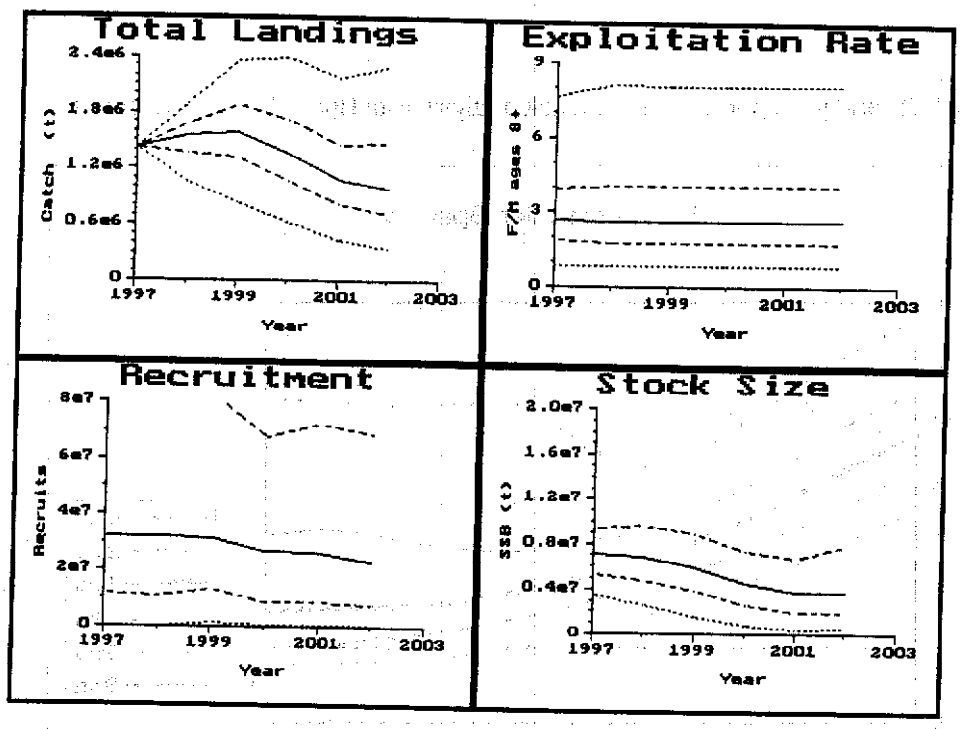


Figure 3.10.1.2 SSB and yield percentiles from risk analysis with Bpa = 2.5 million tonnes







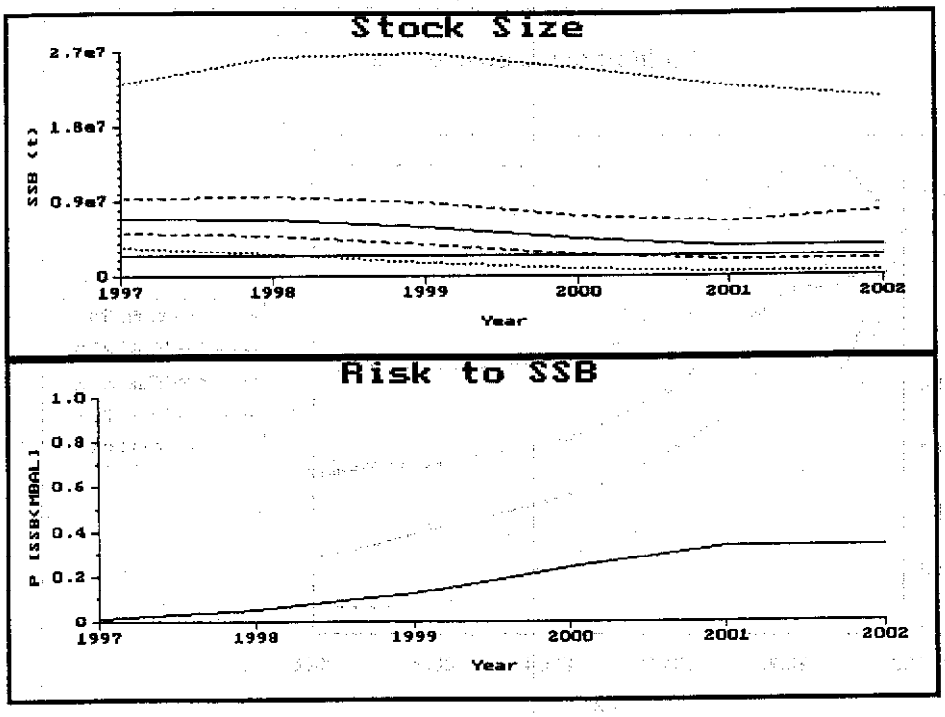


Figure 3.10.2.1. Norwegian Spring-Spawning Herring. Medium-term projections for exploitation rate F/M in 1998-2002 = F/M estimated in 1997. **Upper frame**, clockwise from top left: Total annual yield from the stock; exploitation rate F/M; recruitment at age 0; spawning stock size at spawning time. Full line, 50th percentiles. Dashed lines, 25th and 75th percentiles. Dotted lines, 5th and 95th percentiles. **Lower frame**, spawning stock size at spawning time compared with the reference level of 2.5 Million t, and the estimated probability that the stock will be less than 2.5 Million t at spawning time in each year.

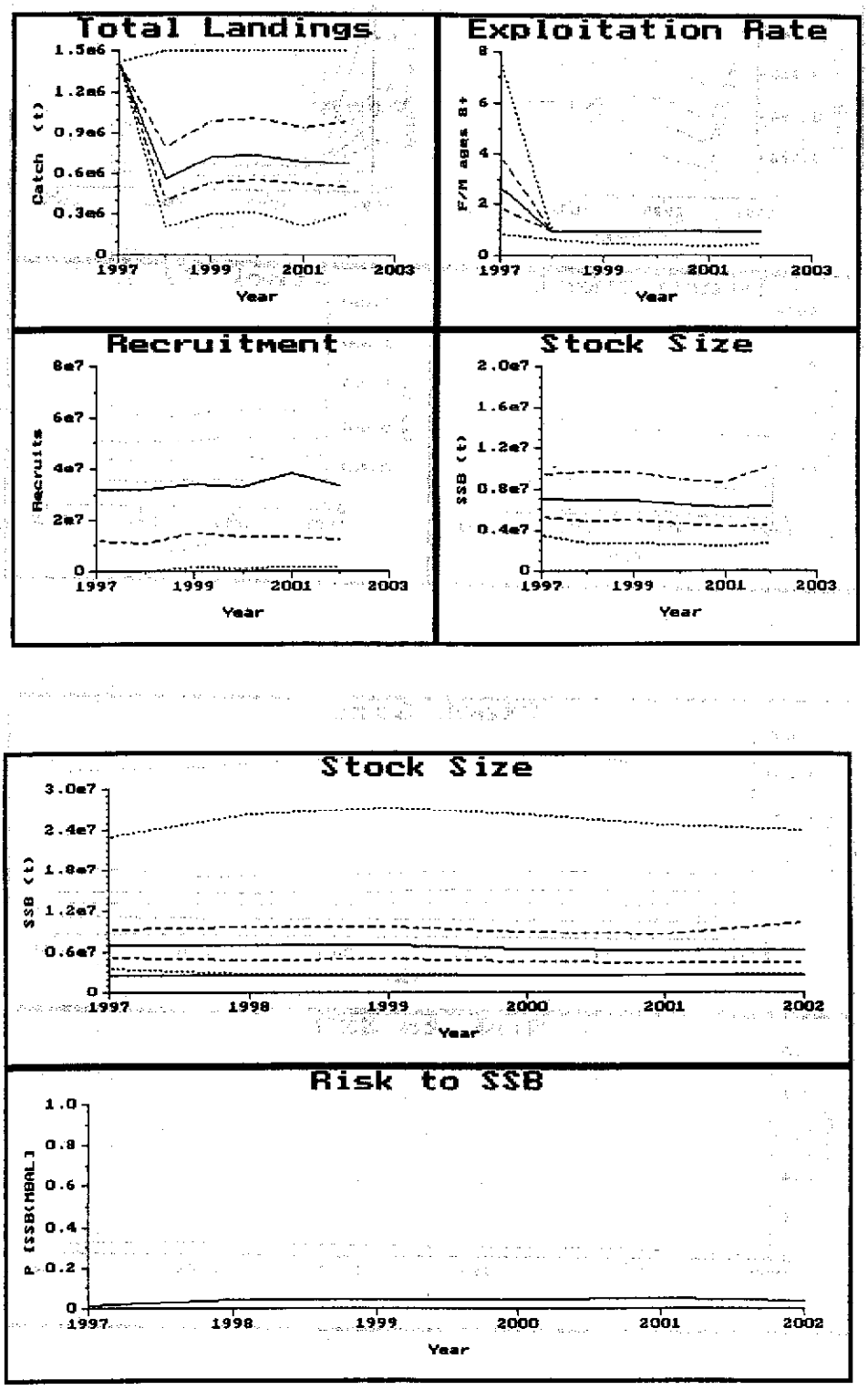


Figure 3.10.2.2. Norwegian Spring-Spawning Herring. Medium-term projections of stock dynamics under exploitation according to a harvest control rule in which catch is limited to the lower value of 1.5 Million t and the catch for F=M, from 1998 onwards. **Upper frame**, clockwise from top left: Total annual yield from the stock; exploitation rate F/M; recruitment at age 0; spawning stock size at spawning time. Full line, 50th percentiles. Dashed lines, 25th and 75th percentiles. Dotted lines, 5th and 95th percentiles. **Lower frame**, spawning stock size at spawning time compared with the reference level of 2.5 Million t, and the estimated probability that the stock will be less than 2.5 Million t at spawning time in each year.

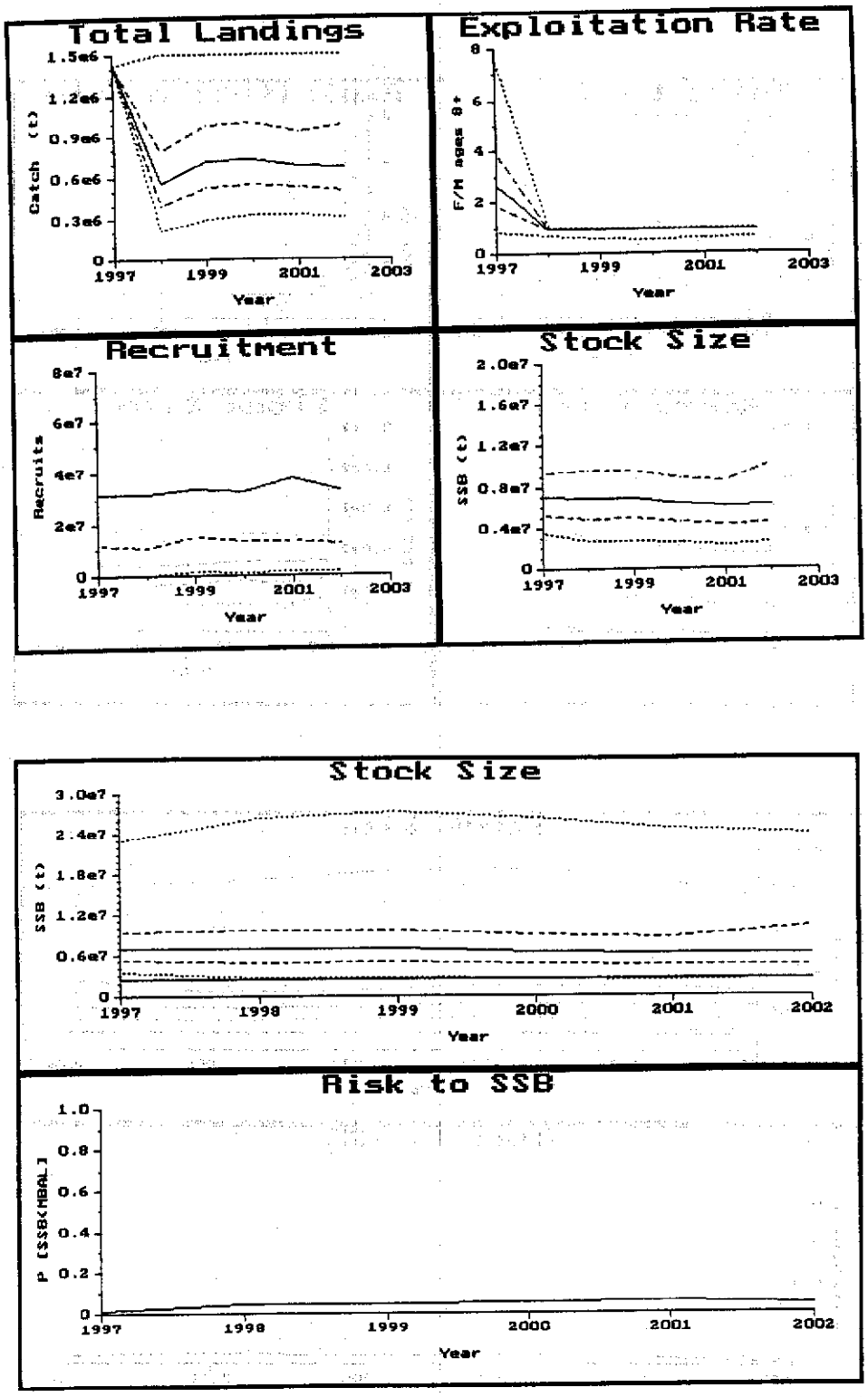


Figure 3.10.2.3. Norwegian Spring-Spawning Herring. Medium-term projections of stock dynamics under exploitation according to a harvest control rule in which catch is limited to the lower value of 1.5 Million t and the catch for F=M, from 1998 onwards, but if the estimated stock size falls below 2.5 Million t then a catch corresponding to F=1/3M is taken.
Upper frame, clockwise from top left: Total annual yield from the stock; exploitation rate F/M; recruitment at age 0; spawning stock size at spawning time. Full line, 50th percentiles. Dashed lines, 25th and 75th percentiles. Dotted lines, 5th and 95th percentiles. **Lower frame**, spawning stock size at spawning time compared with the reference level of 2.5 Million t, and the estimated probability that the stock will be less than 2.5 Million t at spawning time in each year.

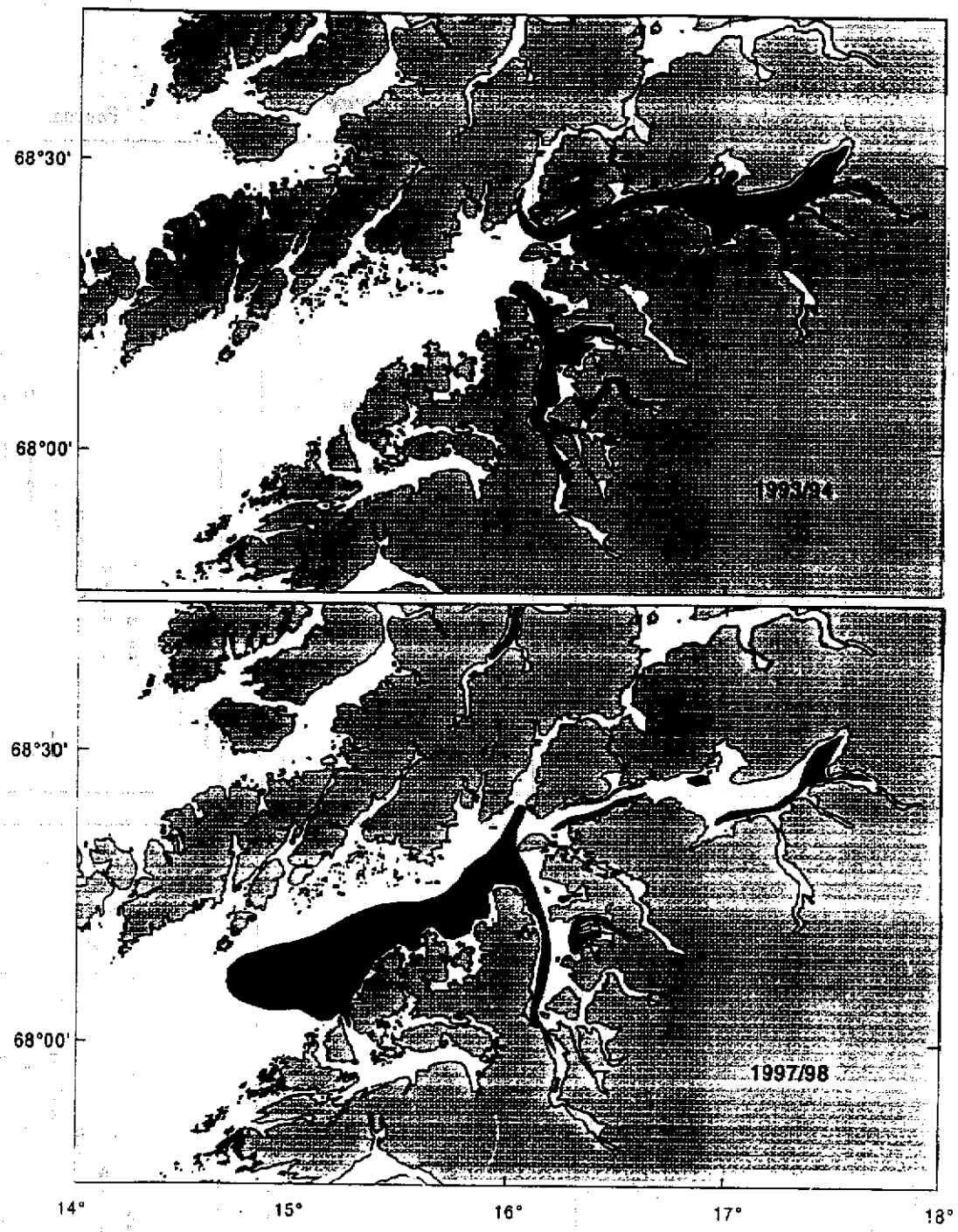


Figure 3.12.1 Norwegian spring spawning herring. General distribution of herring in the wintering areas, 1993/1994 (above) and 1997/1998 (below).

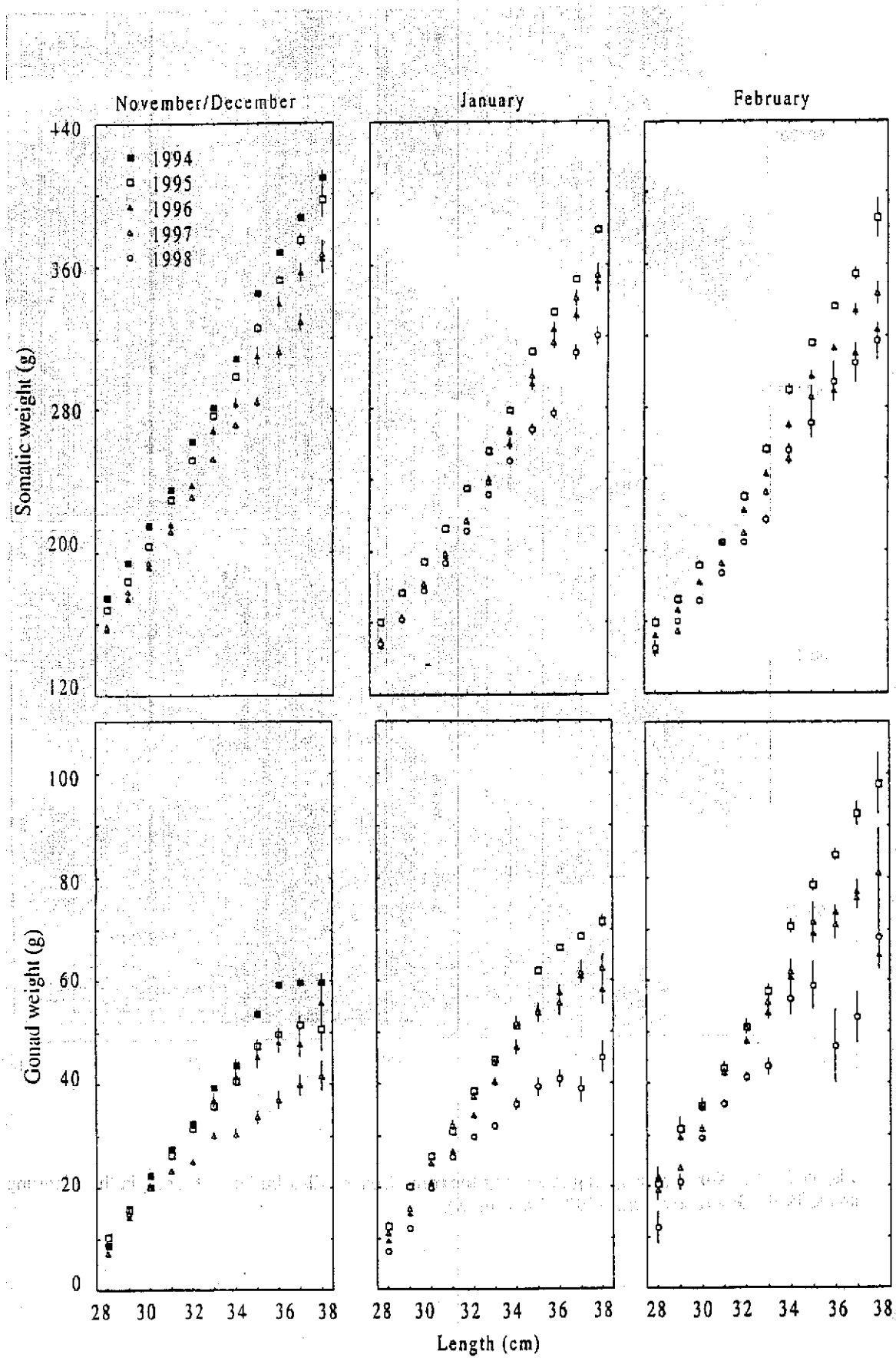


Figure 3.13.1 Norwegian spring spawning herring. Length specific somatic weight and length specific gonad weight 1994 - 1998.

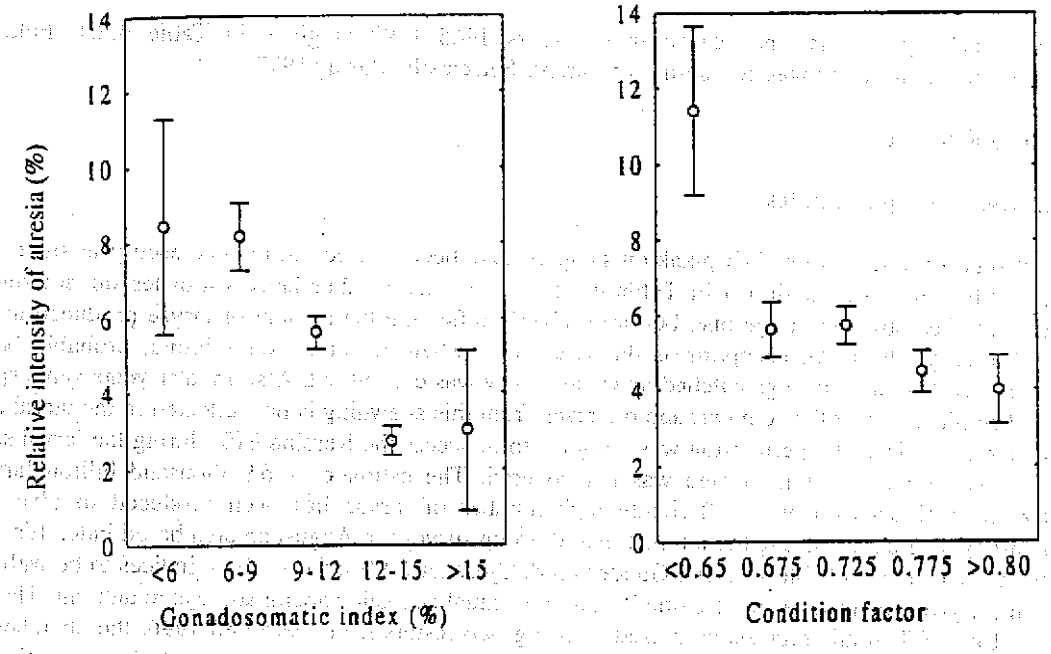


Figure 3.13.2 Norwegian spring spawning herring. Mean value and standard error of the relative intensity of atretic oocytes as function of interval of the gonadosomatic index and the condition factor of herring larger than 30.5 cm.

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. 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 the fishery was again closed. A minimum landing size of 11 cm has been in force for several years.

4.2 Catch Statistics

The international catch by country and season in the years 1965–1997 is given in Table 4.2.1. Following the recommendation from ACFM, there was no fishing for Barents Sea capelin during 1997.

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 & 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 later years some spawning is known to have taken place during the summer, and offspring from this spawning is not reflected in the larval abundance estimates in Table 4.3.1.1. In 1997, permission was not granted to access the Russian EEZ during the larval survey, and consequently the total larval distribution area was not covered. The estimate of 6.9 thousand billion larvae in the Norwegian EEZ in 1997 shows that a sufficiently high number of larvae has been produced to give rise to an intermediate or strong year class. 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 & 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 used with 0-group results from 1995 and 1996, the abundance of one-year-olds predicted is almost 10 times higher and 35% lower than one-year-olds measured during acoustic surveys in 1996 and 1997. However, as mentioned in the next Section, the acoustic survey in 1997 probably underestimated the 1-group for various reasons. Therefore, the estimated amount of 1-year-olds in the 1996 year class from the regression formula may be quite realistic. Based on this regression, the 0-group index obtained in 1997 of 522 would correspond to a year class strength of 342 billion one-year-olds in autumn 1998.

4.3.2 Acoustic stock size estimates in 1997

The 1997 acoustic survey was carried out jointly by one Russian and two Norwegian vessels in the period 12. September to 2. October. Restricted access to the Russian EEZ and only three vessels instead of four available to the survey probably caused an underestimation of stock size, in particular the one-year-olds (WD by Anon.). 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 900 thousand tonnes, and was dominated by the 1996 year class (one-year-olds) which constituted about 70% by numbers and 45% by weight. About 35% of the stock biomass consists of maturing fish, and the spawning stock is, therefore, well below the limit reference point of 500,000 tonnes.

4.3.3 Other surveys

During winter 1998, a Russian investigation was carried out on the prespawning concentrations of capelin, from 15 February to 12 April (WD by Ushakov and Prozorkevich). Results from this survey show that capelin older than those found during the autumn acoustic survey made up a significant proportion of these concentrations. The proportion of capelin five years old and older in the samples taken during these investigations, on capelin approaching the coast from the eastern part of the Barents Sea, was about 35%, while this component was not detected during the autumn survey. A possible explanation is that older capelin stayed in the eastern, poorly covered, areas during autumn. Another possibility is that these older individuals are from a "bottom dwelling component", scattered concentrations of capelin known to reside at near bottom depth, inaccessible to acoustic equipment. In any case, to include this component in the autumn survey demands that enough vessel time be allocated to the survey and that vessels are allowed to operate in the whole of the Barents Sea, ensuring that all pelagic occurrences of capelin will be detected and that enough bottom trawl hauls can be made to indicate whether the bottom dwelling capelin may make up a significant amount of the total stock.

4.4 Historical Stock Development

An overview of the development of the Barents Sea capelin stock in the period 1988–1997 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. However, for giving a crude overview of the development of the Barents Sea capelin stock the tables may be adequate.

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 1973–1997.

4.5 Stock-Recruitment Relationship and Effects from Herring

In a recent analysis of the stock-recruitment relationship (using data from table 4.4.10 Gjøsæter and Bogstad, in press) for capelin it was shown that a Beverton-Holt function $R = \frac{R_{max} SSB}{SSB + S_{1/2}}$ 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. The parameters of the Beverton-Holt function were: R_{max} = 789 billions one-year-olds and $S_{1/2}$ = 113 thousand tonnes. 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) and H_{1+} is the biomass (million tonnes) of one year and older herring in the Barents Sea (from the acoustic young herring surveys 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: $R = \frac{758 SSB}{SSB + 74 + 2797 H_{1+}}$. This model explains 87% of the variation. Figure 4.5.1 shows the model predictions versus the observed recruitment for all year classes in the period 1973 to 1996.

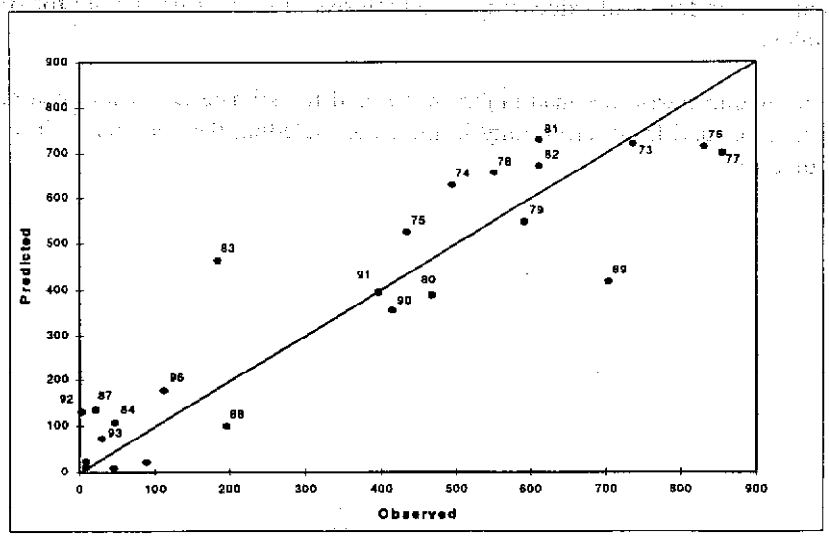


Figure 4.5.1 Predicted versus observed recruitment of Barents Sea capelin based on the Beverton-Holt function including a herring term, when all year classes from 1973 to 1996 are included.

4.6 Sampling

No fishing took place on the Barents Sea capelin in 1997, and consequently no samples from commercial vessels have been obtained. The sampling from scientific surveys is summarised below:

Investigation	No. of samples	Length measurements	Aged individuals
Acoustic survey 1997 (Norway)	90	6463	3405
Acoustic survey 1997 (Russia)	29	1698	285
Norwegian bottom trawl survey winter 1998	200	3854	522
Russian investigations winter 1998	4	399	399

4.7 Precautionary Approach to Fisheries Management

Since the assessment of the stock is directly based on the acoustic survey conducted annually in September-October, and the main fishing season is from January to March, 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 ACFM before its autumn 1998 meeting.

At present work is being undertaken to build harvesting strategies on a population dynamics model that incorporates the effect of herring on capelin recruitment and the effect of predation by cod on the size of the spawning stock (WD by S. Tjelmeland), which were not taken into account in the model used before the 1983–1986 collapse of the stock. In addition to these biological processes, the model will also account for several sources of uncertainty in the data. The model will be the basis for a revised management strategy including options for B_{lim} to be reviewed at the autumn ACFM meeting.

It should be noted that F-based reference points are not applicable to this stock since most of the capelin is assumed to die after spawning.

Since several instances of good recruitment for small values of the spawning stock have been observed in recent years, the size of the spawning stock that yields half the maximum recruitment in a Beverton-Holt formulation of the spawning-stock recruitment relation will always be estimated at a small value. This is shown by Gjøsæter and Bogstad (Gjøsæter and Bogstad, in press; ICES 1997/Assess:14) and the effect will be even more pronounced when mortality due to predation by cod influences the spawning stock. Consequently, the optimal spawning stock will also be estimated at a small value, in contrast to estimations made on data before the 1983–1986 collapse (ICES 1982/H:45). The Working Group therefore recommends that B_{lim} for this stock is defined as the optimal spawning stock, since the steepness of the spawning-stock recruitment relation for small values implies a high risk of recruitment failure for spawning stock values smaller than the optimal value.

The model will be used to reparameterise the maturation model and to estimate B_{lim} with uncertainty generated from variability in biological processes and from uncertainty in the data, including the uncertainty in the realised spawning stock caused by observation error.

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				

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

[1] Is probably 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 1997. Based on TS value 19.1 log L –74.0 dB, corresponding to $\sigma = 5.0 \cdot 10^{-7} \cdot L^{1.91}$.

Length (cm)	Age/Year class 1 1996	2 1995	3 1994	4 1993	5+ 1992	Sum (10^9)	Biomass (10^3 t)	Mean weight (g)
5.5 - 6.0	0.02					0.02	0	1.0
6.0 - 6.5	0.11					0.11	0	1.0
6.5 - 7.0	0.69					0.69	1	1.0
7.0 - 7.5	3.93					3.93	4	1.1
7.5 - 8.0	5.24					5.24	8	1.6
8.0 - 8.5	6.41	0.43				6.84	13	1.9
8.5 - 9.0	6.72	0.34				7.06	16	2.2
9.0 - 9.5	7.62	0.49				8.12	23	2.8
9.5 - 10.0	10.77	2.00				12.77	43	3.3
10.0 - 10.5	12.57	1.20				13.77	55	4.0
10.5 - 11.0	14.53	1.23				15.76	75	4.8
11.0 - 11.5	12.10	1.78				13.89	77	5.5
11.5 - 12.0	10.46	1.83				12.29	79	6.5
12.0 - 12.5	4.70	3.22	0.02			7.95	59	7.5
12.5 - 13.0	2.02	4.52	0.02			6.56	56	8.6
13.0 - 13.5	0.69	4.30	0.10			5.09	50	9.7
13.5 - 14.0	0.24	3.17	0.03			3.45	39	11.2
14.0 - 14.5	0.04	2.66	0.11			2.80	37	13.2
14.5 - 15.0	0.02	2.73	0.07			2.83	42	14.9
15.0 - 15.5	0.00	2.79	0.24	0.02		3.05	51	16.6
15.5 - 16.0	0.00	1.93	0.05			1.97	37	18.7
16.0 - 16.5	0.00	1.74	0.05			1.79	39	22.0
16.5 - 17.0	0.00	1.32	0.26	0.06		1.64	39	23.6
17.0 - 17.5	0.00	0.77	0.32			1.09	28	25.9
17.5 - 18.0	0.00	0.53	0.30	0.02		0.85	25	29.1
18.0 - 18.5	0.00	0.10	0.24			0.34	11	32.2
18.5 - 19.0	0.00	0.02	0.07			0.09	3	35.4
19.0 - 19.5	0.00	0.00	0.02			0.02	1	36.0
TSN (10^9)	98.88	39.10	1.91	0.09	0.00	139.97		
TSB (10^3 t)	415	448	44	2	0		909	
Mean length (cm)	10.14	13.34	16.50	16.68		11.12		
Mean weight (g)	4.2	11.5	22.9	26.2				6.5
SSN (10^9)	0.06	14.58	1.73	0.09		16.45		
SSB (10^3 t)	1	267	43	2	0		312	

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

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	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	22.0	194.6	707.7	415.0	396.2	3.1	29.5	8.3	88.9	111.8
2	30.0	18.2	179.4	601.0	224.2	73.0	5.1	9.4	12.5	44.2
3	0.3	3.5	16.4	36.8	163.1	25.3	6.4	1.6	2.2	2.2
4	0.0	0.0	0.1	1.4	1.6	3.7	0.3	0.4	0.1	0.1
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sum	52.2	216.3	903.7	1054.1	785.1	105.1	41.4	19.7	103.7	158.3
Biomass	189	503	2918	4750	3862	729	180	126	309	539

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	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
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	0.0	0.4	0.3	0.5	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	24.0	23.8	4.8	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	8.2	17.3	26.8	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	2.7	2.1	1.4	0.0	0.0	0.0	0.0
Sum	0.0	0.0	0.0	35.3	43.4	33.5	0.0	0.0	0.0	0.0
Landings	0	0	0	704	891	586	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	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	0.0	0.0	0.0	2.2	0.9	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	9.3	5.8	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	3.1	7.9	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.9	0.8	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Sum	0.0	0.0	0.0	15.5	15.3	0.0	0.0	0.0	0.0	0.0
Landings	0	0	0	226	232	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	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.02	0.03	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.10	0.06	0.00	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	1.20	0.85	0.00	0.00	0.00	0.00	0.00
5	0.00	0.00	0.00	N/A	N/A	0.00	0.00	0.00	0.00	0.00
Wavr (2-4)	0.00	0.00	0.00	0.02	0.05	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.

	1988		1989		1990		1991		1992	
Age	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}
1	0.023	0.068	0.014	0.042	0.005	0.016	0.015	0.046	0.059	0.178
2	0.023	0.068	0.014	0.042	0.005	0.016	0.015	0.045	0.059	0.176
3	0.073	0.219	0.158	0.474	0.005	0.016	0.051	0.154	0.109	0.326
4	0.433	1.298	0.117	0.350	0.005	0.016	0.051	0.154	0.071	0.212
5	0.433	1.298	0.117	0.350	0.005	0.016	0.051	0.154	0.071	0.212
Avr	0.197	0.590	0.084	0.251	0.005	0.016	0.037	0.111	0.074	0.221

Table 4.4.5 (Continued)

	1993		1994		1995		1996		1997	
Age	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}	M_{imm}	M_{mat}
1	0.157	0.471	0.201	0.602	0.073	0.219	0.041	0.122	0.062	0.185
2	0.157	0.471	0.201	0.602	0.073	0.219	0.041	0.122	0.062	0.185
3	0.190	0.571	0.201	0.602	0.019	0.058	0.041	0.122	0.062	0.185
4	0.214	0.642	0.282	0.847	0.044	0.133	0.050	0.149	0.014	0.041
5	0.214	0.642	0.282	0.847	0.044	0.133	0.050	0.149	0.014	0.041
Avr	0.186	0.559	0.221	0.700	0.052	0.152	0.043	0.133	0.042	0.127

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	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	25.7	214.7	734.0	462.4	600.1	9.2	120.3	13.8	118.2	172.0
2	27.4	19.6	181.4	689.5	382.0	293.7	1.4	10.8	5.7	72.5
3	1.2	26.8	17.0	174.8	548.4	162.3	33.3	1.9	6.5	10.2
4	0.0	0.2	1.6	16.0	25.7	88.9	9.8	2.4	1.4	1.8
5	0.0	0.0	0.0	0.1	0.3	0.5	1.3	0.1	0.3	0.1
Sum	54.4	261.3	934.0	1342.8	1556.6	554.6	166.0	28.9	132.2	256.6
Biomass	115	718	2011	7011	8297	4363	737	156	313	779

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

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	1.38	1.30	1.52	1.51	1.42	1.38	1.76	2.66	1.16	1.68
2	2.28	3.78	3.57	4.18	4.15	3.91	3.79	4.83	7.31	3.19
3	13.46	13.48	12.67	16.88	9.66	9.48	9.94	12.36	15.19	20.46
4	16.18	18.70	19.86	29.87	21.31	18.54	16.64	18.18	18.43	26.29
5	36.67	0.00	22.00	22.00	33.18	32.50	20.62	20.30	24.83	29.37
Avr	2.12	2.75	2.15	5.22	5.33	7.87	4.44	5.41	2.36	3.04

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

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
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	0.00	0.01	0.04	0.00
3	0.65	0.41	0.46	0.65	0.16	0.12	0.10	0.44	0.59	0.82
4	0.82	0.68	1.00	1.00	0.89	0.74	0.71	0.86	0.92	0.95
5	1.00	1.00	1.00	1.00	0.86	0.99	0.92	0.87	1.00	1.00
Avr	0.02	0.04	0.01	0.10	0.07	0.15	0.07	0.10	0.04	0.04

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

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	0	0	0	0	0	0	0	0	0	0
2	0	0	2	19	0	0	0	1	3	1
3	11	139	140	1421	915	129	34	15	71	175
4	0	2	37	142	80	329	60	38	24	49
5	0	0	0	0	0	0	11	1	7	2
Sum	11	141	179	1582	996	458	105	55	105	228

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

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

5.1 The Fishery

5.1.1 Regulation of the fishery

The fishery depends mostly 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 1997/1998 season

In accordance with a previously determined procedure, ACFM recommended that a preliminary TAC of 850,000 tonnes should not exceed 2/3 of the total TAC predicted for the season, i.e. 1,265,000 tonnes. This advice was accepted by all parties concerned.

The season opened on 1 July and the fishery began in deep waters near the shelf edge off the eastern north coast and northeast of Iceland. In general, catch rates remained high throughout July as the fishing area gradually shifted to the northwest. During the latter half of July, the fishery was conducted in both the Iceland and Greenland EEZs. The total catch in July 1998 amounted to about 475,000 tonnes.

Like in 1997, catch rates declined in August. At the same time, immature capelin began appearing in the catches and around mid-August large areas inside the Iceland EEZ were closed to the fishery. In late August catch rates had declined to very low levels. At that time, large concentrations of immatures also appeared in the Greenland EEZ, to the east and southeast of Scoresby Sound. Fishing then automatically ceased and was not resumed until October. The August catch amounted to 130,000 tonnes.

Catch rates were generally low in the period October-December, the catch consisting in part of immatures. The reason for this was that most of the mature stock was until December distributed in deep waters off the western north coast and the NW-peninsula of Iceland where the weather was too stormy for purse-seine fishing. A total of 160,000 tonnes of capelin was caught during October–December 1997.

The total catch in the 1997 summer and autumn season thus amounted to about 765,000 tonnes, of which almost 80% was taken in July and August.

Due to stormy weather and scattered condition of capelin, catch rates were extremely low in January and the first half of February 1998. The only adult capelin concentrations located were mixed with juveniles near the shelf edge east of Iceland. In order to protect the juveniles, the fishing area was closed on two occasions, for one week each time. The total catch amounted to only 20,000 tonnes during this period and was mostly taken with pelagic trawl.

In the third week of February, adult capelin appeared at the southern east coast of Iceland and at about the same time the main spawning migration was located at the shelf edge just south of 65°N. Most of these capelin soon entered the shallow water area southeast of Iceland and mixed with the fish already there.

There was an intense fishery off the south coast of Iceland in the last week of February and in March. Because prevailing westerly winds slowed the westward running coastal current, only relatively minor concentrations of capelin rounded the Reykjanes promontory to spawn off the west coast as usual.

In spite of a week-long strike by Icelandic fishermen in late March, the catch in the shallow waters off the south coast amounted to about 440,000 tonnes during the 4-week period in February–March. About 20,000 tonnes were taken in early April, bringing the total catch during the winter 1998 season to just over 480,000 tonnes.

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 1978–1997 and winter 1979–1998 seasons is given by age and years in Tables 5.2.2 and 5.2.3 respectively.

The distribution of the catch during the summer-autumn 1997 and winter 1998 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 1982–1997 are given in Table 5.3.1.2. The details of the estimate made in August/September 1997 (Working Document by Hjálmar Vilhjálmsson) are given in Table 5.3.1.3.

5.3.2 Stock abundance in autumn 1997

An acoustic survey was carried out in the period 1–25 November 1997 (Working Document by Hjálmar Vilhjálmsson and Sigurdur Thór Jónsson). The distribution of the stock was wide and continuous, reaching from 28°W, northwest of the NW-peninsula of Iceland, across the outer part of the northern shelf to 11°W off the northern and central east coast. The largest and most dense capelin concentrations were recorded near the shelf edge off the western north coast as well as east of the Langanes promontory on the northeast coast of Iceland.

The November 1997 survey was conducted under difficult conditions. There was stormy weather during most of the month off the western north coast of Iceland as well as between northwest Iceland and Greenland, where drift ice also prevented surveying part of the distribution area of the juvenile component. Since most of the adult stock was located off the western north coast of Iceland the November 1997 estimate of adult stock abundance is considered imprecise. Furthermore, the autumn 1997 survey clearly missed and thus underestimated the juvenile stock component. In view of previous experience in working under similar weather conditions, the adult stock was most likely underestimated as well.

According to the autumn 1997 survey, the immature stock component amounted to 66.4 and 30.8 * 10^9 fish, belonging to age groups 1 and 2 respectively. With the qualifications described in the previous paragraph, the estimated fishable/spawning stock abundance was 61.2 * 10^9 fish in late November 1997. The observed mean weight in the fishable stock was 15.1 g and the fishable/spawning stock biomass, therefore, about 925,000 t.

Details of this stock estimate are given in Tables 5.3.2.1, 5.3.2.2 and 5.3.2.3.

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 1978/79–1997/98 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 1979–1998.

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 1981–1997 (year classes 1978–1995) 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 1997/1998 season

The 1993 models for predicting the numbers of maturing capelin of ages 2 and 3 from the November 1996 acoustic assessment of the 1994 and 1995 year classes gave estimates of 83.8 and 30.9 billion maturing 2- and 3-group capelin on 1 August 1997.

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 15.7 and 21.6 g for age groups 2 and 3 respectively.

The fishable stock biomass, obtained by multiplying the stock in numbers by the predicted mean weight of maturing capelin in autumn, was projected forward to spawning time in March 1998 assuming a monthly $M = 0.035$ and a remaining spawning stock of 400,000 tonnes. This gave a predicted TAC of 1,250,000 tonnes spread evenly over

August 1997–March 1998 (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 total for the season, the Working Group recommended that a preliminary TAC for the 1997/98 capelin fishery be set at 850,000 t.

According to the autumn 1997 survey, the estimated fishable/spawning stock was 61.2 * 10^9 fish in late November 1997. At that time the observed mean weight in the fishable stock was 15.1 g and the stock biomass therefore about 925,000 t. With the usual prerequisite of a monthly natural mortality rate of 0.035, a remaining spawning stock of 400,000 t and an estimated weight increase of 2.8 g the above abundance estimate indicated a TAC of 570,000 t in the period December 1997–March 1998 if the catch were spread evenly over the period. Counting the catch taken in July–November 1997 (705,000 t), this corresponded to a total TAC of some 1,275,000 t for all of the 1997/98 season. Therefore, it was decided to set the TAC at 1,250,000 t, i.e. at the level originally predicted.

Average weights were higher in the catch during the winter 1998 season than the average weights calculated for the fishable stock from the November 1997 stock abundance estimate. The spawning stock remaining at the end of the 1998 winter fishery, calculated from the estimated stock in numbers in November 1997, monthly catch in numbers during December 1997–April 1998 and a monthly M=0.035, is 27.6 * 10^9 fish. Using the mean weight predicted in the usual manner from the November 1997 survey, it is estimated that 492,000 tonnes of capelin remained to spawn in February/April 1998.

5.5.3 Stock prognosis and assessment for the 1998/1999 season

Calculations of expected TAC for the 1998/1999 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 1998.

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 $y = 0.588x + 18.8$; $R^2 = 0.82$, $p < 0.05$. Similarly for the older stock component, where N_{2tot} is regressed on N_{3mat}, gives $y = 0.307x - 7.6$; $R^2 = 0.57$, $p < 0.05$. The two regression plots are shown in Figure 5.5.3.1.

The Working Group decided that the November 1997 estimate of the abundance of 1-group (year class 1996) was unrealistically low and inadequate for predictive purposes. The reasons for this are given in Section 5.3.2. However, an abundance estimate of the 1996 year class was obtained in August/September 1997 which the Working Group considers to be more realistic (cf. Section 5.3.1 and Table 5.3.1.3). The 1997 August/September estimate of 1-group capelin abundance was therefore projected forward to November 1997, for predicting the abundance of maturing capelin of the 1996 year class on 1 August 1998.

The predictive figures for the 1996 and 1995 year classes are given in Table 5.5.1.1 These gave an estimate of 94.4 and 30.8 billion mature fish, belonging to the 1996 and 1995 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 $R^2 = 0.74$ and 0.81 for age groups 2 and 3 respectively. These two regression plots are shown in Figure 5.5.3.2. Applying the appropriate regression equations, $y = -0.028x + 18.9$ for the younger component and $y = -0.064x + 28.6$ for the older one and using the predicted abundance of age groups 2 and 3 on 1 August 1998 combined, *i.e.* 125.2 * 10^9 fish, results in estimated mean weights of 15.4 and 20.6 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 1,420,000 t if spread evenly over the period August 1998–March 1999. This corresponds to a preliminary TAC of about 950,000 t. As in previous years, decisions on the final TAC for the 1998/99 season should be based on surveys carried out in October/November 1998 and/or January/February 1999.

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 usually begins 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 approximately 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 preliminary TAC is near the lower 95% confidence limit of the TAC prediction for the whole season (July–March). 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 >1,500,000 tonnes. In the former case, corresponding to B_{pa}, the fishery should not be opened until after the completion of a stock assessment survey in autumn/winter in that season. The latter case simply represents a scenario where predicted stock abundance is beyond the highest historic abundance on record.

5.7 Special Comments

The Working Group recommends that, if necessary, measures be taken through area closures to prevent fishing on concentrations of juvenile capelin which have only in part used their natural growth potential.

In recent years, by far the largest capelin have been caught in July and the first half of August. After that, the average size in the catches has declined drastically and not increased again until late autumn. An example of this development is shown in Figure 5.7.1. 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. Second, as the food supply diminishes in August the fishable stock becomes more scattered and mixed with juveniles. From then on, for a period of one and a half to two months, it has proven difficult to catch capelin except through repeated sieving of schools consisting of a mixture of adults and juveniles.

In order to minimize possible deaths caused by loss of scales of fish escaping through the seine net, the Working Group recommends that the 1998 summer/autumn season is opened around 20 June and that a closure of the fishery is considered from mid-August until the end of September.

An overview of stock developments during 1978–1997 is given in Table 5.7.1.

5.8 Sampling

Investigation	No. of samples	Length meas. individuals	Aged individuals
Fishery 1997	154	16086	5693
Survey 1997	121	8000	10060
Fishery 1998	52	5196	5196
Survey 1998	40	4000	4000

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	86/87	87/88	88/89	89/90	90/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98
Prelim. TAC	1100	500	900	900	600	0	500	900	950	800	1100	850
Rec. TAC	1290	1115	1065	-	250	740	900	1250	850	1390	1600	1265
Landings	1333	1116	1036	808	314	677	788	1179	842	930	1571	1245
Spawn. stock	420	400	445	115	330	475	460	460	420	830	422	492

Table 5.2.1 The international capelin catch 1964–1998 (thousand tonnes).

Year	Winter season					Summer and autumn season						
	Iceland	Nor-way	Faroes	Green-land	Season total	Iceland	Nor-way	Faroes	Green-land	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	1561.5
1998	457.0	-	14.7	9.6	481.3							

Table 5.2.2 The total international catch of capelin in the Iceland-East Greenland-Jan Mayen area by age groups in numbers (billions) and the total catch by numbers and weight (thousand tonnes) the autumn season (August-December) 1978–1997.

	Year									
Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1	-	0.6	4.9	0.6	-	0.6	0.5	0.8	+	+
2	21.4	29.4	17.2	27.9	-	7.2	9.8	25.6	10.0	27.7
3	12.2	6.1	5.4	2.0	-	0.8	7.8	15.4	23.3	6.7
4	-	-	-	+	-	-	0.1	0.2	0.5	+
Total number	33.6	36.1	27.5	30.5	-	8.6	18.2	42.0	33.8	34.4
Total weight	655.0	588.0	527.6	613.0	-	133.4	548.5	919.7	772.9	458.6

	Year									
Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	0.3	1.7	0.8	0.3	1.7	0.2	0.6	1.5	0.2	1.8
2	13.6	6.0	5.9	2.7	14.0	24.9	15.0	9.7	25.2	33.4
3	5.4	1.5	1.0	0.4	2.1	5.4	2.8	1.1	12.7	10.2
4	+	+	+	+	+	0.2	+	+	0.2	0.4
Total number	19.3	9.2	7.7	3.4	17.8	30.7	18.4	12.3	38.4	45.8
Total weight	371.4	121.0	111.2	56.0	298.1	611.6	324.1	205.7	773.7	763.6

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) 1979–1998.

	Year									
Age	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
2	1.0	1.3	1.7	-	-	2.1	0.4	0.1	+	+
3	20.8	17.6	7.1	0.8	-	18.1	9.1	9.8	6.9	23.4
4	4.8	3.5	1.9	0.1	-	3.4	5.4	6.9	15.5	7.2
5	0.1	-	-	-	-	-	-	0.2	-	0.3
Total number	26.7	22.4	10.7	0.9	-	23.6	14.5	17.0	22.4	30.9
Total weight	539.9	392.1	156.0	13.2	-	439.6	348.5	391.8	560.5	657.2

	Year									
Age	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
2	0.1	1.4	0.5	2.7	0.2	0.6	1.3	0.6	0.9	0.3
3	22.9	24.8	7.4	29.4	20.1	22.7	17.6	27.4	29.1	20.4
4	7.8	9.6	1.5	2.8	2.5	3.9	5.9	7.7	11.0	5.4
5	+	0.1	+	+	+	+	+	+	+	+
Total number	30.8	35.9	9.4	34.9	22.8	27.2	24.8	35.7	41.0	26.1
Total weight	665.1	686.8	202.4	621.1	489.6	567.1	539.8	723.6	797.6	481.3

Table 5.2.4 The total international catch in numbers (millions) of capelin in the Iceland-east Greenland-Jan Mayen area in the summer/autumn season of 1997 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	11	-	-	-	11	+
9.5	11	-	-	-	11	+
10	61	11	-	-	73	0.2
10.5	124	8	-	-	132	0.3
11	141	22	-	-	163	0.4
11.5	144	234	8	-	386	0.8
12	298	755	0	-	1054	2.3
12.5	293	2374	4	-	2671	5.8
13	311	4139	135	-	4584	10.0
13.5	199	5354	408	-	5960	13.0
14	93	5605	1186	-	6884	15.0
14.5	37	5090	1726	33	6886	15.0
15	-	4256	2203	39	6497	14.2
15.5	6	2746	1861	114	4727	10.3
16	6	1607	1468	68	3150	6.9
16.5	6	900	774	102	1782	3.9
17	-	265	221	53	539	1.2
17.5	-	40	115	11	166	0.4
18	-	6	53	1	60	0.1
18.5	33	5	45	-	83	0.2
Total number	1775	33416	10207	421	45819	
Percentage	3.9	72.9	22.3	0.9	100.0	100.0
Total weight	17.5	529.7	206.1	10.3	763.6	

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 1998 by age and length, and the catch in weight (thousand tonnes) by age groups.

Total length (cm)	Age	Age 3	Age 4	Age 5	Total	Percentage
10.5	4	4	-	-	8	+
11	8	0	-	-	8	+
11.5	4	4	-	-	8	+
12	-	50	-	-	50	0.2
12.5	23	137	4	-	164	0.6
13	122	508	6	-	636	2.4
13.5	54	1546	14	-	1614	6.2
14	59	2720	141	-	2921	11.2
14.5	6	2850	338	-	3193	12.2
15	15	3512	776	+	4303	16.5
15.5	-	3416	958	+	4374	16.8
16	-	2780	1026	-	3806	14.6
16.5	4	1648	939	+	2591	9.9
17	-	829	647	-	1476	5.7
17.5	6	230	422	-	658	2.5
18	-	86	167	-	253	1.0
18.5	-	8	23	-	31	0.1
19	-	8	4	-	12	+
Total number	305	20337	5463	+	26105	
Percentage	1.2	77.9	20.9	+	100.0	100.0
Total weight	0.4	363.0	117.9	+	481.3	

Table 5.3.1.1 Abundance indices of 0-group capelin 1970–1997 and their division by areas.

Area	Year													
	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
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	3
N-Iceland	2	12	52	46	57	46	10	19	29	25	19	6	5	18
East Iceland	-	+	7	17	7	3	15	3	+	1	+	-	+	1
Total	11	19	89	116	134	89	32	43	31	49	40	29	13	22
	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
NW-Irminger Sea	+	1	+	1	3	1	+	8	3	2	3	+	2	5
W-Iceland	2	8	16	6	22	13	7	2	11	21	12	6	17	14
N-Iceland	17	19	17	6	26	24	12	43	20	13	69	10	57	30
East Iceland	9	3	4	1	1	2	2	1	+	15	10	8	6	12
Total	28	31	37	14	52	40	21	54	34	51	94	24	82	61

Table 5.3.1.2 Estimated numbers, mean length and weight of age 1 capelin in during the August surveys of 1983–1997.

	Year														
	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Number (10^9)	155	286	31	71	101	147	111	36	50	87	33	85	189	138	142.7
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	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	2.8

Table 5.3.1.3 Acoustic assessment of abundance of capelin age groups 1-3, 13/8-5/9 1997.

Length (cm)	Age/year class			Spawning stock (10^9)	Total number (10^9)	Weight 10^3 t	Mean weight (g)
	Age 1 1996	Age 2 1995	Age 3 1994				
7	0.6	0.0	0.0		0.6	0.5	0.9
7.5	1.1	0.0	0.0		1.1	1.4	1.2
8	3.3	0.0	0.0		3.3	4.2	1.3
8.5	12.1	0.0	0.0		12.1	20.7	1.7
9	27.5	0.0	0.0		27.5	57.4	2.1
9.5	26.9	0.0	0.0		26.9	67.2	2.5
10	28.6	0.0	0.0		28.6	83.0	2.9
10.5	20.7	0.0	0.0		20.7	70.9	3.4
11	12.6	0.0	0.0		12.6	52.2	4.1
11.5	6.3	0.0	0.0		6.3	30.1	4.8
12	2.5	0.1	0.0		2.5	13.6	5.4
12.5	0.5	1.3	0.0		1.8	12.2	7.0
13	0.1	1.7	0.0		1.7	14.0	8.1
13.5	0.0	2.3	0.0		2.3	21.7	9.4
14	0.0	2.4	0.0	2.4	2.4	25.0	10.3
14.5	0.0	7.0	0.0	7.0	7.0	83.4	11.9
15	0.0	3.6	0.0	3.7	3.7	48.9	13.3
15.5	0.0	4.6	0.1	4.7	4.7	67.8	14.4
16	0.0	3.5	0.0	3.5	3.5	59.6	17.1
16.5	0.0	2.7	0.4	3.0	3.0	57.6	19.0
17	0.0	0.4	0.0	0.4	0.4	6.8	18.2
17.5	0.0	1.1	0.0	1.1	1.1	25.8	23.4
18	0.0	0.0	0.0	0.0	0.0	0.4	28.8
Number (10^9)	142.7	30.6	0.5	25.8	173.9	824.7	
Weight (10^3t)	405.1	410.6	9.2	375.4	824.7		
Mean length (cm)	9.3	14.4	15.6	14.8	10.2		
Mean weight (g)	2.8	13.4	17.8	14.5	4.7		

Table 5.3.2.1 Acoustic assessment of total abundance of capelin age groups 1-3, 1/11-25/11 1997.

	Age/Year class			Number	Total		Mean
	1	2	3	mature	number	Weight	weight
Length (cm)	1996	1995	1994	(10^9)	(10^9)	(10^3 t)	(g)
6.5	0.0	0.0	0.0	0.0	0.0	0.0	0.8
7	0.8	0.0	0.0	0.0	0.8	0.8	1.0
7.5	0.7	0.0	0.0	0.0	0.7	1.0	1.4
8	3.3	0.0	0.0	0.0	3.3	5.3	1.6
8.5	6.3	0.0	0.0	0.0	6.3	12.2	1.9
9	10.2	0.0	0.0	0.0	10.2	24.3	2.4
9.5	12.1	0.0	0.0	0.0	12.1	33.3	2.7
10	13.1	0.0	0.0	0.0	13.1	43.0	3.3
10.5	8.7	0.3	0.0	0.0	9.1	34.8	3.8
11	4.9	1.0	0.0	0.0	5.9	26.7	4.6
11.5	3.4	2.3	0.0	0.0	5.7	30.1	5.3
12	1.8	4.4	0.0	0.0	6.2	38.0	6.1
12.5	0.9	6.7	0.0	0.6	7.6	54.9	7.3
13	0.2	7.4	0.0	1.7	7.6	65.1	8.5
13.5	0.1	10.9	0.1	6.2	11.1	107.7	9.7
14	0.1	11.5	0.2	9.3	11.8	136.4	11.5
14.5	0.0	13.1	0.5	10.5	13.5	173.8	12.9
15	0.1	9.5	1.2	10.4	10.9	163.1	15.0
15.5	0.0	7.0	1.0	8.0	8.0	135.9	16.9
16	0.0	5.5	1.4	6.7	6.8	130.7	19.2
16.5	0.0	2.1	1.7	3.8	3.8	80.3	21.3
17	0.0	1.3	1.2	2.6	2.6	60.4	23.7
17.5	0.0	0.2	0.9	1.1	1.1	28.5	26.4
18	0.0	0.0	0.2	0.2	0.2	7.1	30.1
18.5	0.0	0.0	0.1	0.1	0.1	1.9	31.0
19	0.0	0.0	0.2	0.2	0.2	6.2	33.0
Number (billions)	66.7	83.3	8.5	61.2	158.5	1401.3	
Weight (thousand t)	216.9	1012.4	171.9	926.2	1401.3		
Mean length (cm)	9.8	14.1	16.2	15.0	12.4		
Mean weight (g)	3.3	12.2	20.2	15.1	8.8		

Table 5.3.2.2 Assessment of abundance of adult capelin of age groups 1-3. 1/11-25/11 1997.

Length (cm)	Age/Year class 1 1996	2 1995	3 1994	Total number (10^9)	Weight (10^3 t)	Mean weight (g)
12.5	0.0	0.6	0.0	0.6	4.8	7.4
13	0.0	1.7	0.0	1.7	14.7	8.6
13.5	0.0	6.1	0.1	6.2	60.4	9.8
14	0.1	9.0	0.2	9.3	107.0	11.6
14.5	0.0	10.0	0.4	10.4	134.7	12.9
15	0.1	9.0	1.2	10.3	155.5	15.0
15.5	0.0	7.0	0.9	8.0	134.9	16.9
16	0.0	5.4	1.3	6.7	129.3	19.2
16.5	0.0	2.1	1.7	3.8	80.3	21.3
17	0.0	1.3	1.2	2.6	60.4	23.7
17.5	0.0	0.2	0.9	1.1	28.5	26.4
18	0.0	0.0	0.2	0.2	7.1	30.1
18.5	0.0	0.0	0.1	0.1	1.9	31.0
19	0.0	0.0	0.2	0.2	6.2	33.0
Number (billions)	0.3	52.5	8.4	61.2	925.7	
Weight (thousand t)	3.5	751.8	170.3	925.7		
Mean length (cm)	14.4	14.8	16.2	15.0		
Mean weight (g)	12.8	14.3	20.3	15.1		

Table 5.3.2.3 Assessment of abundance of juvenile capelin of age groups 1-3. 1/11-25/11 1997.

	Age/year class			Total		Mean
	1	2	3	number	Weight	weight
Length (cm)	1996	1995	1994	(10^9)	(10^3 t)	(g)
6.5	0.4	0.0	0.0	0.0	0.0	0.8
7	0.8	0.0	0.0	0.8	0.8	1.0
7.5	0.7	0.0	0.0	0.7	1.0	1.4
8	3.3	0.0	0.0	3.3	5.3	1.6
8.5	6.3	0.0	0.0	6.3	12.2	1.9
9	10.2	0.0	0.0	10.2	24.3	2.4
9.5	12.1	0.0	0.0	12.1	33.3	2.7
10	13.1	0.0	0.0	13.1	43.0	3.3
10.5	8.7	0.3	0.0	9.1	34.8	3.8
11	4.9	1.0	0.0	5.9	26.7	4.6
11.5	3.4	2.3	0.0	5.7	30.1	5.3
12	1.8	4.4	0.0	6.2	38.0	6.1
12.5	0.9	6.0	0.0	6.9	50.2	7.3
13	0.2	5.7	0.0	5.9	50.5	8.5
13.5	0.0	4.9	0.0	4.9	47.6	9.7
14	0.1	2.5	0.0	2.6	29.6	11.5
14.5	0.0	3.1	0.0	3.1	39.6	12.9
15	0.0	0.5	0.0	0.5	7.6	15.0
15.5	0.0	0.0	0.1	0.1	1.0	16.9
16	0.0	0.1	0.0	0.1	1.5	19.2
16.5	0.0	0.0	0.0	0.0	0.0	21.3
17	0.0	0.0	0.0	0.0	0.0	23.7
17.5	0.0	0.0	0.0	0.0	0.0	26.4
Number (billions)	66.5	30.80	0.15	97.40		
Weight (thousand t)	213.6	262.0	1.6	477.200	477.2	8.5
Mean length (cm)	9.8	12.9	15.4	10.8		
Mean weight (g)	3.2	8.5	16.7	4.9		

Table 5.4.1 The calculated number (billions) of capelin on 1 August 1978–1998 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	197.2	*263.1	*202.9
2 immature	24.0	10.3	10.1	9.7	16.6	20.1	35.2	45.1	28.7	*41.1
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	241.9	*291.8	*251.7
Number mature	95.2	58.6	38.7	74.4	77.1	98.0	73.0	125.1	130.5	109.3
Weight immat	438	309	542	702	747	702	1019	1188	*1107	*955
Weight mature	1663	1173	751	1273	11311	1585	1268	2056	2203	2019

	Year
Age/maturity	1998
1 juvenile	
2 immature	
2 mature	**94.3
3 mature	**30.8
4 mature	
Number immat.	
Number mature	**125.1
Weight immat	
Weight mature	**2087

* Preliminary

** Predicted

Table 5.4.2 The calculated number (billions) of capelin on 1 January 1979–1998 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

* 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	129.3	19.0
1995	111.9	90.3	30.8	**125.2	
1996	128.5				

* 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
Age 2	14.3
Age 3	20.3

Table 5.5.1.3 Predictions of fishable stock abundance and TACs for the 1982/83–1997/98 seasons. The last column gives 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	82/83	83/84	84/85	85/86	86/87	87/88	88/89	89/90
Year classes	80-79	81-80	82-81	83-82	84-83	85-84	86-85	87-86
Age 2	26.6	63.0	43.4	67.8	34.9	55.5	64.8	43.2
Age 3	4.1	0.0	26.3	20.2	55.0	13.7	29.0	25.5
Fishable stock	549	1065	1373	1637	1926	1268	1800	1350
Calculated TAC	17	465	733	963	1215	642	1105	713
Advised TAC	0	573	897	1311	1333	1115	1036	550

Season	90/91	91/92	92/93	93/94	94/95	95/96	96/97	97/98
Year classes	88-87	89-88	90-89	91-90	92-91	93-92	94-93	95-94
Age 2	31.1	39.4	56.4	93.1	89.6	92.5	90.0	83.8
Age 3	8.2	3.7	18.3	22.6	27.0	14.9	35.0	30.9
Fishable stock	724	755	1398	2123	2170	1916	2352	2019
Calculated TAC	170	197	755	1385	1427	1200	1635	1265
Advised TAC	265	740	*900	1250	850	1390	1600	1265

* 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

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).

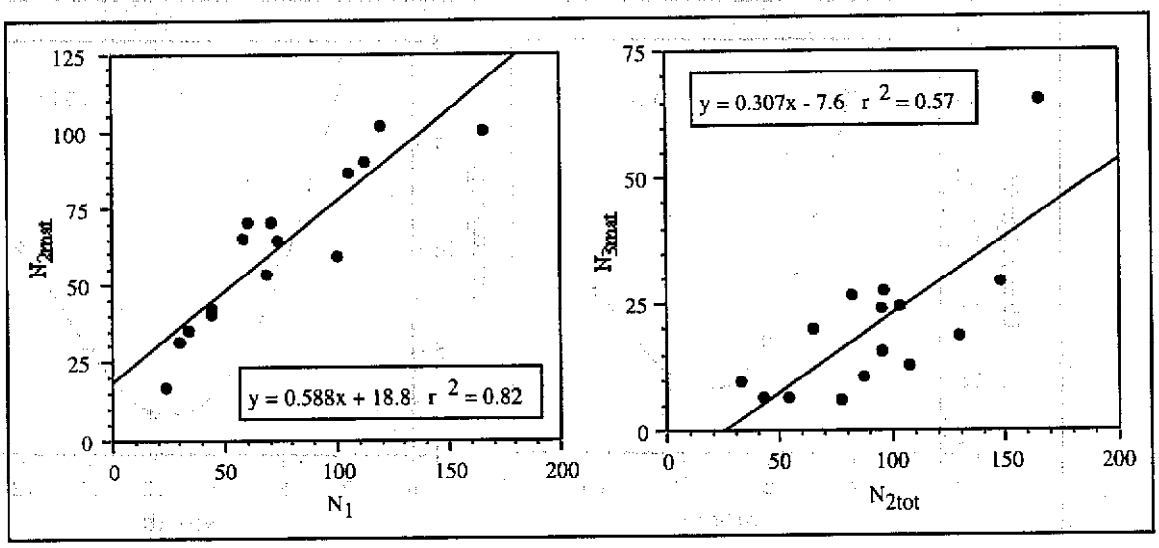


Figure 5.5.3.2 The relationship between the mean weight of maturing 2-group capelin in autumn and the total numbers in the maturing stock (left hand figure) and the total numbers in maturing stock and the mean weight of maturing 3-group capelin (right hand figure).

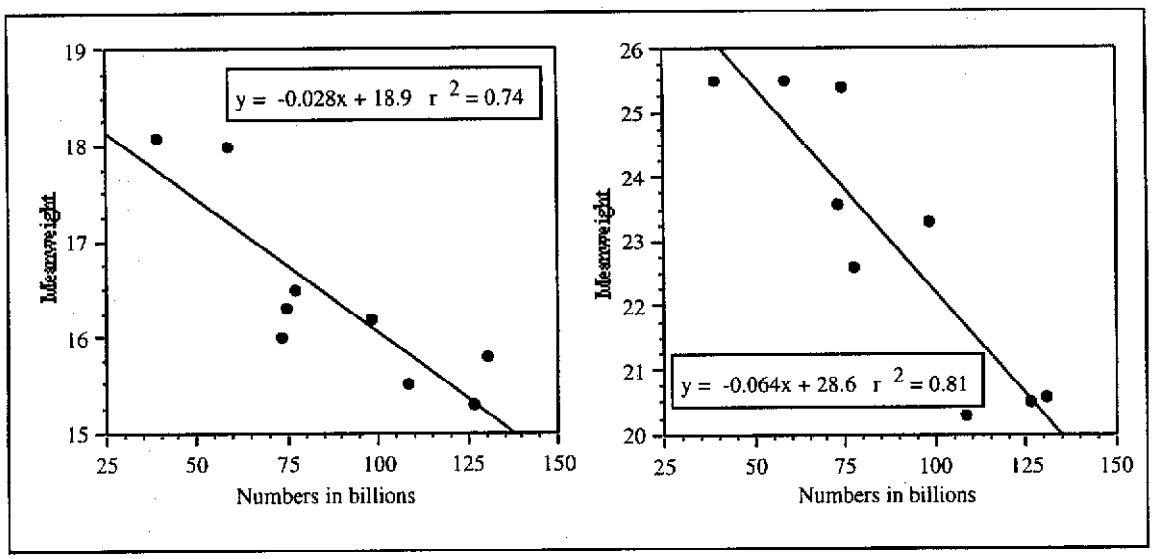
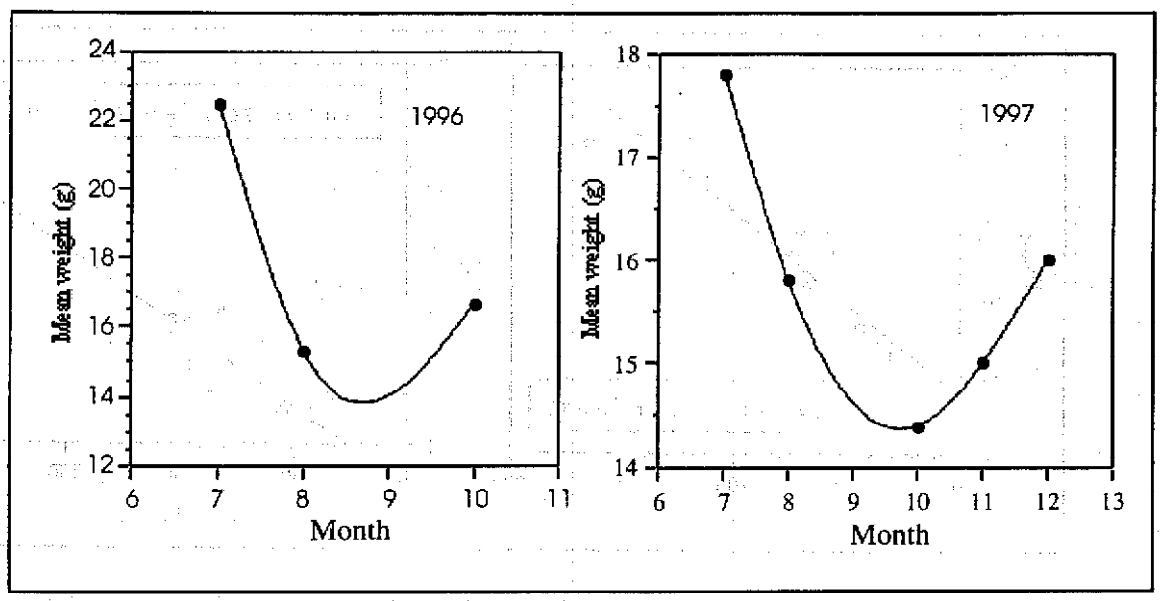


Figure 5.7.1 Changes of mean weight in the catch with time during the summer/autumn season, 1996 and 1997.



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). In 1995 it was stated that several populations of blue whiting could appear in the spawning area, but preliminary analysis did not show any genetic substructure among the blue whiting from west of the British Isles to Gibraltar. The study has continued as an EU-project and further analysis identified two main components in the spawning area. The location of a separation line has not been defined, but genetic analysis of samples from the spawning area will be accelerated in the coming year (J. Mork, pers. com.).

6.2 Fisheries in 1997

Estimates of the total landings of blue whiting in 1997 from the fisheries by countries are given in Tables 6.2.2–6.2.5 and summarized in Table 6.2.1. The total landings from all blue whiting fisheries in 1997 were 634,206 tonnes, almost the same as in 1996. This is 94,000 tonnes more than ACFM gave as management advice for TAC for 1997, which was based on a *status quo* forecast corresponding to 540,000 tonnes in 1997.

The majority of the blue whiting catches was taken, as usual, in the spawning area and consisted of 476,423 tonnes. The landings in 1997 from the directed fisheries increased by 9% from 1996. Russia more than doubled its catches in the Norwegian Sea and the United Kingdom did the same in the spawning area. Landings from the mixed industrial fisheries decreased to almost half of that in 1996, due to lower catches by Norway and Denmark in the North Sea.

Landings of 30,122 tonnes from the southern fisheries, i.e. taken by Spain and Portugal, represent an increase of almost 20% from 1996.

A sampling project was carried on in 1997 to estimate the discards of Spanish trawl fleets in ICES Divisions VIIIc and IXa (EU Project 95/094). The estimates were obtained by observers on board of both single and pair trawlers. Sampling on pair trawlers directed to blue whiting was improved in 1997, if compared with the previous experience in 1994. Preliminary results of this project as well as the sampling level and sampling coverage were presented to the Working Group (ref. WD). Estimated discards for pair trawlers were 11% in weight and 14% in number of the total catch of each Spanish fleet, and for single trawlers were 63% in weight and 80% in number. Discards were not included in the assessment due to the lack of information in other years.

6.3 Biological Characteristics

6.3.1 Length composition of catches

Data on length compositions of the 1997 commercial catches of the blue whiting stock by ICES divisions and quarter of the year were presented by Norway, Russia, The Netherlands, Denmark, Spain and Portugal (Tables 6.3.1.1–6.3.1.6). The length of blue whiting varied over season and areas.

The majority of the fishes from the directed fisheries had the length range 19–26 cm. Nevertheless, some of the Norwegian catches from ICES divisions VIIbc and VIa consisted mostly of fish with length from 26–30 cm. The length composition from the mixed industrial fisheries was from 15–22 cm in the 1st–3rd quarters of the year and increased to 20–27 cm in the 4th quarter.

Spain and Portugal caught blue whiting with length range of 14–41 cm and a modal length of 22 cm.

6.3.2 Age composition of catches

For the directed fisheries in the northern area in 1997 age compositions were provided by Norway, Russia and The Faroes, which counted for 76% of the catches. Appropriate Norwegian age compositions were used to allocate the landings of the other nations. For The Netherlands the age-length keys were used on their own length distributions. The age composition in the directed fisheries is given in Table 6.3.2.1.

Age compositions for the mixed industrial fisheries in 1997 were provided by Norway and The Faroes, which counted for 51% of the catches. For all the other nations Norwegian age-length keys were used for allocation. The age composition is given in Table 6.3.2.2.

Spanish age-length keys were used to derive catch-at-age data for Portuguese and Spanish landings in the Southern area (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 the landings in the Southern area, were assumed to give the overall age composition of total landings from the blue whiting stock. The number at age group as 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 and Spain.. 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 since 1981–1997 as used in the stock assessment. The weight in the stock was assumed to be the same as 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

6.4.1.1 Surveys in the spawning season

1997

During a Norwegian acoustic survey, with the R.V. "G.O. Sars from 6–20 April, to study herring behaviour and migration in the Norwegian Sea", rather high concentrations of blue whiting were recorded in the area from the Norwegian coast westwards to 0°E/W (Figure 6.4.1.1.1). Samples from eight pelagic trawl catches of blue whiting averaged 20.3 cm and 52 g. The total abundance in the area surveyed amounted to 27 $x10^9$ individuals or 1.4 mill. tonnes (Misund *et al.* 1997).

1998

During the period 24 March–26 April 1998 Norway carried out an acoustic survey with the R.V. "Johan Hjort" on the blue whiting stock to the west and northwest of The British Isles. The main objectives for the survey were to estimate the spawning stock size, to record the distribution and migration pattern of the stock and to ascertain its age, length and maturity compositions (Monstad, 1998).

Since the early 1970s this type of survey has been carried out by one or more nations, of which Norway and Russia have been the only nations conducting them in the last decade. However, in 1997 neither Norway nor Russia carried out acoustic surveys in the spawning area west of the British Isles.

In 1998 the area was surveyed from south to north. The shelf edge area from latitude 48°30' N was criss-crossed northwards to the Shetland-Faroe waters, including the eastern slope of the Rockall bank (Figure 6.4.1.1.2), using a pre-calibrated 38 kHz echo sounder (Simrad EK 500) connected to the BEI-system (Bergen Echo Integrator).

Blue whiting was recorded more or less along the whole slope area surveyed, i.e. from 48°30' to 62°00', including the eastern slope of the Rockall bank (Figure 6.4.1.1.3). The highest concentrations were observed southwest and north of the Hebrides where the international fleet operated in mid April. The blue whiting were mostly recorded in schools at depths from 300–750m and as a 50 m wide belt varying between 300 and 600m depths.

The biomass was estimated at 5.5 mill. tonnes (Table 6.4.1.1.1) representing 79.9 x 10-9 individuals. The spawning stock size was calculated to be 4.7 mill. tonnes or 56.6 x 10-9 individuals which is 0.2 mill. tonnes more then measured by Norway in 1996 (Monstad *et al.* 1996).

Length and age distributions are shown on Figures 6.4.1.1.4 and 6.4.1.1.5 for the various sub-areas (marked on Figure 6.4.1.1.3) and for the total area respectively. In the south, i.e. over the Porcupine bank area and southwards, the 1 year olds made up 80% of the numbers. In the Hebrides area where the abundance was highest, the 3 year olds (1995 year

class), contributed 60% of the numbers. Further north this year class still dominated, but contributions of 2 and 4 year olds were also notable. For the entire survey area 44% the 1995, 23% of the 1996 and 24% of 1997 year classes contributed to the abundance estimate. Future recruitment to the spawning stock was promising. The year classes 1994 and older seemed to be on their way out of the stock.

6.4.1.2 Surveys in the feeding season

1997

a) In the period from 1 May -1 June Norway participated with R.V. "G.O. Sars", in co-operation with three other vessels, i.e. from EU, The Faroes and Iceland, in the international acoustic herring survey in the Norwegian Sea, planned under "The ICES planning group on Surveys on Pelagic Fish in the Norwegian Sea". The survey tracks with trawl stations for the participating vessels are shown on Figure 6.4.1.2.1. Blue whiting observed distributed over large parts of the survey area (Holst, 1997). The combined recordings of all 4 vessels are shown on Figure 6.4.1.2.2 (Vilhjalmsson *et al.* 1997). Blue whiting occurred at depths of 100–500 m. The adult stock was situated south of the Faroes, migrating northwards from the spawning grounds, and young blue whiting of the 995 and 1996 year classes dominated in the trawl catches north of 62^0 N.

The distribution was more easterly than that of herring recorded in the same period. North of the Faroe Isles from about 63°N to 70°N the western boundary of blue whiting distribution was about 2°W. The young blue whiting were distributed outside the coastal shelf, and no blue whiting were observed in coastal areas off Norway between approximately 62°30'N and 68°00'N.

The local high concentration of blue whiting at approx. 70°N 16°E could represent a northern spawning component since mature individuals were caught in this area.

b) During the period 28 May–17 June 1997, the Norwegian R.V. "Johan Hjort" conducted an acoustic survey on mackerel in the area from Norway to west of The Faroe Isles and southwards along the shelf edge off the Hebrides, as shown on Figure 6.4.1.2.3. (Skagen and Monstad, 1998). Concentrations of blue whiting were also observed, and concentrations were recorded more or less throughout the whole survey area, with the highest densities observed between The Faroe Isles and Shetland (Figure 6.4.1.2.4). The acoustic estimate of blue whiting longer than 15 cm was 2.6 mill tonnes which represented a 47.8 x 10^9 individuals.

Young fish dominated in the area. The total length distribution and age composition of fish larger than 15 cm are shown on Figure 6.4.1.2.5. The majority of the concentrations belonged to the strong year classes of 1995 and 1996, which contributed with 40% and 57% respectively. The remaining fish were 3–5 years old. In addition, 0-group blue whiting were caught on a number of trawl stations west of the Hebrides, ranging in lengths from 3–13 cm.

c) In June the Russian R.V. "Atlantida", participating in the international acoustic herring survey, also recorded blue whiting. (Vilhjalmsson *et al.* 1997). The vessel operated in the area between 7°W and 4°E from 63°N to 68°N and further recording while steaming northeast-wards to approx. 12° E. Blue whiting was found distributed in the eastern part of the surveyed area with the main concentrations south of 65°N and east of 01°00'W (Figure 6.4.1.2.6) in scattered layers at depths from 150 m to 300 m. The 1995 year class was dominant in most catches.

d) In the period 20 July–17 August, Norway again participated with R.V. "G.O. Sars" in the ICES-coordinated investigation on pelagic fish in the Norwegian Sea, with emphasis on herring, and among others, blue whiting was also recorded (Monstad *et al.* 1997).

The area from the coast of Norway to the mid Norwegian Sea was covered between 61° and 74°N (the Faroe-Shetland area to 74°N) mostly by transects of SE-NW direction (Figure 6.4.1.2.7). The integrator system BEI (Bergen Echo System) connected to a EK-500/ES-38B-BM echo sounder was used to record fish and plankton.

Recordings of blue whiting were made throughout the whole survey, with the limit of distribution only observed off Lofoten Islands towards the east, and towards the northwest between 73° and 74°N. The distribution and biomass per rectangle are shown on Figure 6.4.1.2.8. The highest concentrations were recorded in the south, especially in the Faroes-Shetland area. Further north along the continental slope the concentrations decreased in density towards northwest. Blue whiting was mostly recorded at depths between 200 and 400 m during daytime. At night time blue whiting dispersed upwards in the water column and occasionally appeared in the upper sea surface layer.

The estimated biomass of 3.9 mill. tonnes corresponded to an abundance of 59.5 x 10^9 individuals, of which approx. 85% belonged to the 1995 and 1996 year classes.

The 1 and 2 year old fish dominated in the recorded concentrations, contributing 51% and 43% by numbers respectively (Figure 6.4.1.2.9). The 1995 year class as 0-group was considered a very rich year class, and in the 1996 survey contributed more than 80% in numbers.

Usually the youngest and smallest fish appear in the south and near the continental shelves, but in 1997 1 year olds were the most numerous in the south and the north (Sub-areas II and V marked on Figure 6.4.1.2.8), contributing with 59% and 47% respectively.

0-group blue whiting were observed in the southern area only at the shelf northwest of Shetland a single trawl haul of half an hour duration at the surface as a catch of 52 kg of the 1997 year class. The length ranged from 9.5–13.0 cm with a mean length 11.1 cm.

6.4.1.3 Discussion

In 1997 several acoustic surveys were carried out in the Norwegian Sea to survey pelagic fish species with special emphasis on Norwegian spring spawning herring. Although only a small area was covered, the survey in April showed that significant numbers of the 1995 and 1996 year classes of blue whiting were in the area. These observations were confirmed by the international surveys in May. Blue whiting, mainly of the two rich year classes, were found distributed over a wide area on the warmer side of the Norwegian Sea from 59° N to 72° N in May. The adult part of the stock was mostly located to south of the Faroes, at this time.

In the end of May and first half of June the adult year classes observed earlier in The Faroes area had dispersed into the Norwegian Sea. The 1995 and 1996 year classes remained in the area where they were dominant. The 1995 year class was also the most dominant one in the catches over a large area in the Norwegian Sea in this period.

In July and August the distribution of blue whiting in the Norwegian Sea was comparable with distributions observed in May and June, except for the higher contribution of older individuals in the central part of the surveyed area. The estimated biomass of 3.9 mill. tonnes contained approximately 85% of the abundant year classes 1995 and 1996, of which the latter one was the more abundant. This higher estimate compared to the 1.8 mill. tonnes in 1995 and 1.7 mill. tonnes in 1996 is partly due to the larger area surveyed in 1997. This was especially the case in the south where the majority of the biomass was recorded, consisting mainly of the rich 1995 and 1996 year classes. Due to insufficient coverage the estimate might be consider an underestimate. The Russian estimate in summer 1996 was significantly higher than the Norwegian one in 1997, being 5.6 mill. tonnes.

These 1996 and 1997 estimates in the feeding area during summer are the highest observed of the blue whiting stock size since the early 1980s.

Biomass estimates of blue whiting in the spawning area since 1983 are given in Table 6.4.1.1.1 with corresponding spawning stock sizes in brackets. The difference in the estimates, which has been discussed several times in previous Working Group reports, may be caused by differences in the acoustic equipment, weather conditions during the surveys, size of the survey area and timing of the surveys with respect to spawning progression and hence the migration.

The estimates as discussed in earlier reports, do not coincide with the VPA results. They are, however, to be taken as indices, and for most years they present valuable indications of trends in stock size. There was 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 due to extremely rough weather during the survey period, the spawning stock increased further up to 1995. The once very rich 1989 year class is now out of the stock, and hence the size of the spawning stock has been reduced. However, the new rich year classes of 1995 and 1996 are now entering the spawning stock.

The 1998 estimate was 0.2 mill. tonnes higher than the one obtained by Norway in 1996, resulting in current spawning stock size of 4.7 mill. tonnes. However, the abundance in 1998 of 79.9 x 10^9 and 56.6 x 10^9 individuals for the total and the spawning stock respectively, are the highest measured in this decade. The mean weight and length, however, are the lowest measured which is due to the rather high number of young fish observed in the total, as well as the dominance of 3 year olds among the mature individuals.

Up to mid April 1998 the Norwegian fleet alone had landed almost 400,000 tonnes from the Porcupine bank area and the area west of the Hebrides. Of these, 240,000 tonnes were reported to be caught in international waters from west of the Porcupine bank to the southwestern part of the Rockall bank. For this reason and others, such as several periods of rough weather giving reduced recordings, the spawning stock size estimate can be regarded as an underestimate.

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 down to 750 m. depth. Stratified mean catch and standard error in Spanish and Portuguese surveys are shown in Tables 6.4.2.1 and 6.4.2.2.

6.4.3 Catch per unit of effort

Data on CPUE from the fisheries in the northern area were submitted by Norway. These data were combined by vessel tonnage class, area and month. The data were added to the time series of overall aggregated CPUE values across areas in the Norwegian blue whiting fisheries and presented in Figure 6.4.3.1.

The CPUE data increase in 1996 and slightly decrease in 1997. The increase compared to previous years can be explained by strong recruitment from the rich year classes 1995–96, which are distributed in the Norwegian Sea.

Data on CPUE of 1997 from two bottom trawl fleets were submitted by Spain (Galician single and pair trawl) and shown in Figure 6.4.3.2. The CPUE values have been stable in the 1990s.

6.4.4 Stock assessment

The same six tuning series used in 1997 were considered this year: two series from the spawning area west of British Isles (Norwegian acoustic and Russian acoustic surveys), one series from the acoustic surveys in the Norwegian Sea, two from Spain (bottom trawl survey and CPUE from pair trawlers) and one from the Portuguese survey (bottom trawl). As in 1997, some age groups were excluded from some of the tuning series, i.e. the data outside the frames in Table 6.4.4.1.

Both ICA-runs (WD by Patterson) and XSA-runs were made for the blue whiting stock. This year, however, it was decided to base the stock assessment on ICA-runs. While the directed fisheries have been well represented by samples, the mixed fisheries, which concentrate more on the youngest age groups, have not. It was therefore preferable to apply a program that can handle unreliable catch data. ICA allows uncertainty in the catch data and allows down weighting of uncertain age groups in the catch data and in the index data. Another advantage of basing the assessment on ICA, is that ICP produces stochastic projections which NEAFC requested.

The XSA-analysis is presented in Appendix 1.

6.4.4.1 ICA-analysis

A first run was made including all tuning series giving a quite high $F_{3-7} = 0.7$. Separate runs were therefore made for each of the 6 tuning series showing that the Portuguese tuning series and the Spanish survey series produced considerably higher estimates of terminal F_{3-7} than the other tuning series (Figure 6.4.4.1.1). A decision was made to leave these series out since several data points were already excluded from these series in last year's assessment. The final run was made with the following options:

- 4 years with separable constraint.
- Weighting of 0-group: 0.1, 1 year olds: 0.5, the rest: 1, in the catch data.
- Equal weights for all years in the catch data.
- Linear catchability model for all 4 fleets.
- Equal weighting on all fleets.
- Correlated errors in age groups in surveys.

As the results show (Tables 6.4.4.1.1 and 6.4.4.1.2 and Figure 6.4.4.1.2), the 1995 and 1996 year classes seem stronger than estimated in 1997. In the 1997 assessment, the 0-group of the 1996 year class was estimated, using XSA, to be 16 billion specimens. In this assessment the ICA 0-group estimate of the 1996 year class of 41 billion is almost twice the size of the rich 1983 and 1989 0-groups of 24 and 26 billion specimens respectively. Neither the Norwegian nor the Russian surveys in the spawning area cover the youngest age groups. To date only two survey indices, the CPUE from Spanish pair trawlers and the acoustic surveys in the Norwegian Sea, have covered the 1995 year class. The 1996 year class has only been covered by the acoustic survey. With such few data points, these estimates are believed to be uncertain, even though this is not reflected in the statistics (Table 6.4.4.1.1 and Figure 6.4.4.1.3).

As these recent year classes have started contributing to the spawning stock, the ICA-run shows an increase in spawning stock biomass to 2.0 million t compared to the previous two years, while the XSA shows a decrease to 1.8 million t. The ICA-run also shows an increase in fishing mortality. A mean F_{3-7} of 0.4 is beyond the level of what this working group suggests for an F_{pa} (see Section 6.7).

6.5 Short-Term Projection

Based on the final ICA run, a deterministic short-term projection was made, using the IFAP prediction programme, with the input stated in Table 6.5.1. The weight in stock and catch and the exploitation pattern were taken from the average of the three last years' values. The recruitment in 1999 was set equal to the recruitment in 1998, which is a geometric mean of the recruitment values for the 10 last years estimated by ICA. A proportion of F and M before spawning of 0.0 has been used for several years in the stock assessment of blue whiting. This stock spawns from late February until early May and fishing takes place in the spawning season as well as later in the year, and these proportions should, therefore, be calculated and included in the input data to the next assessment.

The results are given in Table 6.5.2. An assumed a catch of 750,000 t. in 1998 generates an F in 1998 equal to one in 1997. The SSB in 1998 is predicted to be 2.7 million t. Continuing this fishing mortality in 1999 predicts a catch of about 920,000 t. This exploitation rate implies an increase of SSB to 3.1 million t. in 1999, but both the total stock and the spawning stock will decrease somewhat in year 2000. Fishing at F_{med} (0.32) in 1999 predicts a catch of 760,000 t. Also in this case the total and the spawning stock will decrease somewhat from 1999 to 2000.

6.6 Medium-Term Projection

Based on the final ICA run, a medium-term projection by use of the ICP program (WD by Patterson) was run. The projection was made for a 10-year period, starting in 1998 with the same input data as in the short-term prediction (Section 6.5). The maturity ogive, the natural mortality and the weight-at-age were taken as average for the period 1994-1997. An "Ockham" stock-recruitment relationship was used, i.e. the geometric mean recruitment over the observed SSB range and a linear decrease down to the origin for lower SSBs. Independent errors of the stock-recruitment relationship were applied, and this relationship was used for the year 1997 onwards. Seven runs were made, with 200 simulations per run; 4 with various F-constraints and 3 with catch ceilings at 634,000 (1997 catch), 800,000 and 1 million tonnes. The results are summarised in Table 6.6.1 and 6.6.2. Figures 6.6.1–6.6.14 show the results of the projection for the various runs.

When the F is kept below 0.21, the model gives a low probability that the SSB will fall below the suggested B_{lim} of 1.5 million t. F's above this level, on the other hand, generate increasing risks of SSB falling below B_{lim} during the 10 years period: The *status quo* F (0.41) gives a 5% probability for this to happen in 1999, increasing to 24% at the end of the period.

If the catches are kept at the 1997 level (634,000 t), the model generates moderate probabilities of the SSB to fall below B_{lim}. Increasing the annual catches to 1 million tonnes, generates more than 50% probability for this to happen.

6.7 Precautionary Reference Points

The Study Group on the Precautionary Approach to Fisheries Management [SGPAFM] (ICES CM 1998/ACFM:10) suggested $B_{lim} = B_{loss} = 1.5$ million t. for blue whiting; corresponding B_{pa} was calculated with the formula $B_{pa} = B_{lim}e^{1.645\sigma}$, using a σ of 0.25, giving $B_{pa} = 2.25$ million t. F_{lim} was set equal to F_{loss} (0.32), and F_{pa} was calculated by $F_{pa} = F_{lim}e^{-1.645\sigma}$, using the same value for σ, giving a F_{pa} of 0.21.

However, the SGPAFM further suggested to use F_{med} for F_{pa} if F_{med} goes through a cloud of points which appears to come from the right-hand limb of a stock-recruitment relationship. A stock-recruitment relationship for blue whiting seem to fall in this category (Figure 6.7.1). There is no clear trend in recruitment with SSBs above B_{loss}.

Furthermore, this stock has been fished with an average exploitation rate of F_{3-7} at 0.325, i.e. approximately equal to F_{med} (Figure 6.7.2), without any apparent negative effects on the recruitment (Figure 6.4.1.2.5).

As explained in Section 6.5 input data to stock assessment will be re-evaluated. This might possibly change the F_{med} and other reference points.

The present Working Group therefore suggests that F_{pa} be set equal to 0.32 (the present estimate of F_{med}), B_{pa} at 2.25 million t. ($B_{loss}e^{1.645\sigma}$) and B_{lim} at 1.5 million t. (the present value of B_{loss}) as suggested by SGPAFM (Figure 6.7.1).

In the medium-term prognosis (1998–2007), an $F = F_{med}$, is seen to generate a probability of 14% that SSB will fall below B_{lim} at the end of the projection period (Table 6.6.1, run 3).

6.8 Spatial, Temporal and Zonal Distribution

During the summer 1997 the concentrations of blue whiting were distributed more northerly and westerly then in 1995 and 1996. This observations were confirmed by several acoustic surveys during June–August.

During the survey in the spawning area by R.V. "Johan Hjort" in spring 1998 (WD by Monstad), concentrations of blue whiting were also observed at the eastern slope of the Rockall bank.

Investigations in spring/summer 1997 and winter/spring 1998 have clearly showed that the 1995 and the 1996 year classes are well above the average year class strength, in the next years to come will make up the major part of the mature blue whiting population.

The total international catch of blue whiting in 1978–1997 divided into areas within and beyond national fisheries jurisdiction of NEAFC are presented in Table 6.8.1.

6.9 Management Considerations

The SSB in 1997 is estimated at 2 million tonnes. As shown in the short-term projections (Section 6.5), assuming a catch in 1998 of 750,000 t., the spawning stock will increase from 2.7 million t in 1998 to 3.1 million t in 1999 due to the recruitment of the strong 1995 and 1996 year classes. However, the SSB will decrease again in year 2000 for all Fs above 0.16. Fishing at F_{pa} (0.32) will decrease the SSB to 2.8 million t, while fishing at the present level (0.41) will reduce the SSB in year 2000 to 2.6 million t. This level is higher than the SSBs estimated in the last decade.

The medium-term projection (Section 6.6) shows, however, that an F at the present level will reduce the SSB and increase the risk of the SSB to fall below B_{lim} (1.5 million t) during the projection period (Figure 6.6.8). Therefore, although the stock is not in any immediate danger of being overfished, a continued fishing pressure at the present level may cause a reduction of SSB to levels below the lowest observed level of 1.5 million t within a short time period. Therefore, a harvesting control rule prescribing a reduction of F to very low levels when the SSB is reduced below B_{lim} should be agreed upon.

The Working Group, therefore, recommends that the exploitation level should be reduced to F_{pa} (0.32). Reducing the F to this level in 1999 will generate a catch in 1999 equal to that assumed for 1998, i.e. 750,000 t.

6.10 NEAFC Requests

Precautionary reference points

This part of the NEAFC request is dealt with in Section 6.7. The Working Group suggests that F_{pa} be set equal to 0.32 (the present estimate of F_{med}), B_{pa} at 2.25 million t. ($B_{loss}e^{1.645\sigma}$, where σ equals 0.25) and B_{lim} at 1.5 million t. (the present value of B_{loss}) as suggested by SGPAFM.

Short-term projections

A short-term projection (Table 6.5.2), presuming a catch in 1998 of 750,000 t shows that:

- Fishing at the present level of F (0.41) generates a catch of 923,000 t in 1999, a total stock size of 3.6 million t and a spawning stock size of 2.6 million t in year 2000.
- Fishing at F_{med} (0.32) generates a catch of 760,000 t in 1999, a total stock size of 3.7 million t and a spawning stock size of 2.8 million t in year 2000.

Medium-term projections

The program used in the medium-term projections does not allow for a simultaneous variation of Fs and catch ceilings. Therefore, these parameters were varied one at the time while the other was kept constant. For details, refer to Section 6.6, Tables 6.6.1 and 6.6.2 and Figures 6.6.1–6.6.14.

- F = 0.1 implies no risk to SSB falling below 1.5 million t, and generates average catches at the end of the period of about 470,000 t (95% confidence limits of 290,000 t to 855,000 t).

- F = 0.21 implies a low risk that the SSB will fall below 1.5 million t, and generates average catches at the end of the period of about 670,000 t (95% confidence limits of 435,000 t to 1160,000 t).
- F = 0.32 implies moderate risk of SSB falling below 1.5 million t, and generates average catches at the end of the period of about 700,000 t (95% confidence limits of 373,000 t to 1370,000 t).
- Catch ceiling of 634,000 t (*status quo* catch) implies moderate risk of SSB falling below 1.5 million t, and this catch level can be kept throughout the period with a high probability.
- Catch ceiling of 800,000 t implies high risk of SSB falling below 1.5 million t, and there is about 25% probability that this catch level cannot be kept throughout the period.
- Catch ceiling of 1,000,000 t implies very high risk of SSB falling below 1.5 million t, and there is more than 25% probability that this catch level cannot be sustained throughout the period.

Harvesting regimes

Having defined an F_{pa} , B_{pa} and B_{lim} (Section 6.7) the following harvest regime is suggested:

- F higher than F_{pa}: The fishing pressure should be reduced to F_{pa}.
- B lower than B_{pa}: The fishing pressure should be reduced so that the stock is rebuilt with a high probability, using linear decrease of F towards zero when B decreases towards B_{loss}.

6.11 Sampling

Investigation	Number Samples	Length Measurements	Aged Individuals
Fishery 1997	178	38864	3527
Survey North Sea/Br I	106	5509	200
Survey Norwegian Sea	46	3300	1529
Survey Lofoten/Vester.	42	1385	50
Southern Fishery	561	59884	1454
Southern Survey*	87	6187	

* Spanish data not available

Table 6.2.1. Landings (tonnes) of BLUE WHITING from the main fisheries, 1988-1997, as estimated by the Working Group.
This table contain catch of UK, instead of only Scotland

Area	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Norwegian Sea fishery ('Subareas I+II and Duivisions Va,XIVa-b) 3)	55,829	42,615	2,106	78,703	62,312	43,240	22,674	23,733	23,447	62,570
Fishery in the spawning area (Divisions Vb, VIa, VIb, VIIbc and VIIg-k)	421,636	473,165	463,495	218,946	317,237	347,101	378,704	423,282	469,926	476,423
Industrial mixed fishery (Divisions IVa-c, Vb and IIIa)	45,143	75,958	63,192	39,872	65,974	58,082	28,563	104,004	119,359	65,091
Subtotal northern fishery	522608	591738	528793	337521	445523	448423	429941	551019	612,732	604,084
Southern fishery (Subareas VIII+IX, Divisions VIId,e)	30,838	33,695	32,817	32,003	28,722	32,256	29,473	27,664	25,099	30,122
Grand total	553446	625,433	561,610	369,524	474,245	480,679	459,414	578,683	637,831	634,206

1) Including directed fishery also in Divisions VIIg-k, IVa and Subarea XII.
2) Excluding directed fishery also in Division VIIg-k.
3) Including Icelandic industrial fishery in Division Va: in 1989, 1995 and 1996.

Table 6.2.2 Landings (tonnes) of BLUE WHITING from the directed fisheries in the Norwegian Sea (Subareas II and Division Va) 1988-1997, as estimated by the Working Group.

Country	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Faroes	-	1,047	-	-	-	-	-	-	345	-
Germany	3	1341	-	-	-	-	2	3	32	-
Iceland 3)	-	4,977	-	-	-	-	-	369	302	10,464
Netherlands	-	-	-	-	-	-	-	72	25	-
Norway	-	-	566	100	912	240	-	-	58	1,386
Poland	10	-	-	-	-	-	-	-	-	-
USSR/Russia 1)	55,816	35,250	1,540	78,603	61,400	43,000	22,250	23,289	22,308	50,559
Estonia	-	-	-	-	-	-	-	-	377	161
Latvia	-	-	-	-	-	-	422	-	-	-
Total	55,829	42,615	2,106	78,703	62,312	43,240	22,674	23,733	23,447	62,570

1)From 1992 only Russia
2) Includes Vb.
3) Icelandic mixed fishery in Va.

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-area XII) 1988 - 1997, as estimated by the Working Group.

Country	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Denmark	797	25	-	-	3,167	-	770	-	269	-
Faroes	79,339	70,711	43,405	10,208	12,731	14,984	22,548	26,009	18,258	22,480
France	-	2,190	-	-	-	1,195	-	720	-	-
Germany	5,263	4,073	1,699	349	1,307	91	0	6,310	6,844	4,724
Ireland	245	-	-	-	-	-	3	-	-	-
Netherland	800	2,078	7,280	17,359	11,034	18,436	21,076	26,703	17,644	23,676
Norway	208,416	258,386	281,036	114,866	148,733	198,916	226,235	261,272	337,434	318,531
UK	5,071	8,020	6,006	3,541	6,849	2,032	4,465	10,583	14,325	33,398
USSR/Russia 2)	121,705	127682	124,069	72,623	115,600	96,000	94,531	83,931	64,547	68,097
Japan	-	-	-	-	918	1,742	2,574	-	-	-
Estonia	-	-	-	-	6,156	1,033	4,342	7,754	10,605	5,517
Latvia	-	-	-	-	10,742	10,626	2,160	-	-	-
Lithauen	-	-	-	-	-	2,046	-	-	-	-
Total	421,636	473,165	463,495	218,946	317,237	347,101	378,704	423,282	469,926	476,423

1) Including direced fishery also in Division IVa. (H6)
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 and Vb,1988-1997, as estimated by the WG.

Country	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Denmark	18,144	26,605	27,052	15,538	31,189	41,053	19,686	12,439	51,832	26,270
Faroes	492	3,325	5,281	355	705	1,522	1,794	-	6,068	6,066
Germany 1)	280	3	-	-	25	9	-	-	-	-
Netherlands	-	-	20	-	2	46	-	-	-	793
Norway	24,898	42,956	29,336	22,644	31,977	12,333	3,408	78,565	57,458	27,394
Sweden	1,229	3,062	1,503	1,000	2,058	2,867	3,675	13,000	4,000	4,568
UK 1)	100	7	0	335	18	252	0	0	1	-
Total	45,143	75,958	63,192	39,872	65,974	58,082	28,563	104,004	119,359	65,091

1) Including directed fishery also in Division IVa.
2) Including mixed industrial fishery in the Norwegian Sea
3) Unprecise estimates. Reported catch of 34265 t in 1993; the mean of 1992 and 1994, i.e. 2,867 t, is used in the VPA-RUN.

Table 6.2.5 Landings (tonnes) of BLUE WHITING from the Southern areas (Subareas VIII and IX) as estimated by the Working Group.

Country	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Netherlands			450	10						
Portugal	5,979	3,557	2,864	2,813	4,928	1,236	1,350	2,285	3,561	2,439
Spain	24,847	30,108	29,490	29,180	23,794	31,020	28,118	25,379	21,538	27,683
UK	12	29	13				5			
France		1								
Total	30838	33695	32817	32003	28722	32256	29473	27664	25099	30122

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Table 6.3.1.1 Length distribution
Norwegian directed fisheries 1997, Blue whiting

	VIIb,c 1 dir.	VIb 1 dir.	VIIb,c 2 dir.	VIa 2 dir.	IVa 2 dir.	Vb 2 dir.	IIa 3 dir.
14						3	
15						12	
16					1	34	
17					6	55	2
18					27	101	14
19					77	139	101
20	2	4	1		41	94	109
21	21	19	8	4	12	78	69
22	25	10	9	6	14	84	96
23	9	13	9	7	13	93	168
24	9	7	6	3	3	61	206
25	21	14	21	17	5	17	115
26	57	27	30	24	12	11	45
27	47	36	56	41	23	13	27
28	67	34	60	53	23	9	11
29	52	23	64	55	28	15	15
30	35	33	51	47	22	13	8
31	42	29	66	59	27	15	13
32	30	18	44	37	16	12	18
33	37	9	50	47	12	6	7
34	32	9	39	38	7	3	6
35	12	7	26	25	6	2	6
36	8	4	13	13	3	1	6
37	6	2	14	14	4	1	2
38	3	1	8	8			2
39	1	1	0	0			4
40	2		2	2			
41	2		1	1			
42			1	1			
Sum	518	300	577	500	382	872	1050

Table 6.3.1.2 Length distribution, commercial samples Norway 1997
Mixed industrial fishery

	Area IVa			
cm	1. Quarter	2. Quarter	3. Quarter	4. Quarter
10	0	0	0	
11	0	0	0	
12	4	0	1	
13	2	0	1	
14	15	3	3	
15	46	12	19	1
16	69	26	17	14
17	77	47	14	25
18	78	41	46	22
19	56	38	90	70
20	53	24	108	188
21	71	28	76	290
22	63	27	53	284
23	54	23	51	186
24	23	28	63	221
25	8	7	46	322
26	1	2	25	247
27	0	0	21	130
28	3	2	5	84
29	5	1	3	55
30	1	0	4	61
31	2	0	5	77
32	0	0	3	66
33	1	0	3	34
34	2	0	2	30
35	1	0	3	42
36	0	0	0	32
37	0	0	0	14
38	0	0	0	11
39	0	0	0	7
40	0	0	1	5
41	0	0	0	2
42	0	0	0	1
43	0	0	0	2
Sum	635	309	663	2523

Table 6.3.1.3 Length distribution of blue whiting, Russia 1997. Directed fishery.

Area	Vb2	IIa	IIb	IIa	I	IIa	IIb	IVa	Vb'
Quarter	1	2	2	3	4	4	4	4	4
10		8							
11		20							
12		24	5			1			
13		21	4	9				1	
14		40	43	50		1	2	1	
15		118	50	98		1	3		7
16	1	140	76	121	1	2	10	6	48
17	1	156	54	54		19	12	52	163
18		155	41	35		100	10	216	356
19	2	149	31	99		309	8	297	537
20	3	247	43	511		713	19	166	343
21	27	278	28	1010		1397	27	339	659
22	61	409	23	627		1823	131	639	1236
23	43	271	9	330		1340	185	596	1071
24	30	134	6	213		1261	457	592	797
25	13	131	3	108		1133	353	428	747
26	8	77	3	67		739	162	236	385
27	18	54		34		377	113	81	180
28	21	40	1	14		184	53	37	87
29	21	50		10		72	58	23	45
30	24	84	1	7	2	45	46	15	41
31	15	94	2	16	1	52	50	23	39
32	5	107	1	27		27	45	18	46
33	4	44	3	19		28	41	9	23
34	7	35	3	12	1	27	45	11	16
35	7	53	4	13	1	8	32	10	23
36	1	34	2	2	2	30	37	17	21
37	4	27	2		1	17	32	5	13
38		19	3		2	4	15	15	9
39		5	1				14	7	9
40		5				1	2	1	3
41		2							1
42									
43									1
Total	316	3031	442	3486	11	9711	1962	3841	6906

Table 6.3.1.4 Length distribution of blue whiting of Danish commercial catches.

Area	III a	IVa	III a	III a	IVa
Quarter	**1**	**1**	**3**	**4**	**4**
12		1			
13		16			
14	3	59			
15	5	65			
16	3	62			1
17	2	29	3		1
18	1	23	23		3
19		5	75		8
20		3	75		14
21	2	14	45		31
22	2	10	11		26
23		12	15		18
24		4	19		9
25	1		24	1	5
26		2	21	1	9
27			8	1	1
28		2	3		1
29			3	1	
30		2	1		
31			5		
32			8	1	1
33		1	3		
34			4		
35	1				
36			2		
37			1		
Total	20	310	349	5	128

Table 6.3.1.5 Length distribution commercial samples, Netherlands, 1997.

Area	VI a	VII b,c	VII b,c	VII j
Quarter	**2**	**1**	**2**	**2**
17				17
18		1		19
19		21		21
20	5	17	2	72
21	11	23	29	76
22	26	22	37	61
23	27	14	27	40
24	10	4	13	26
25	17	1	12	14
26	26	2	22	12
27	44		23	8
28	37	1	20	8
29	30		11	8
30	35		16	5
31	18		10	9
32	24		4	6
33	22		7	
34	15		3	3
35	12		4	1
36	17		4	
37	12		1	
38	9		1	
39	6			
40	4			
41	2			
Total	409	106	246	406

Table 6.3.1.6 Length composition (thousands) of commercial blue whiting catches of Portugal and Spain in 1997.

A

PORTUGAL					
	Quarter				
Length	1	2	3	4	Total
10	0	0	0	0	0
11	0	0	0	0	0
12	0	0	0	0	0
13	0	0	0	0	0
14	0	0	7	0	7
15	41	0	21	3	64
16	138	0	6	4	148
17	703	2	14	23	742
18	1915	132	27	37	2111
19	4601	935	161	20	5716
20	5067	2620	1019	186	8891
21	2965	3359	3733	1353	11410
22	1127	2062	2929	1449	7567
23	506	684	1157	698	3045
24	309	158	418	298	1183
25	227	50	188	112	577
26	168	13	60	29	270
27	103	13	28	26	170
28	75	8	18	15	115
29	70	10	7	5	92
30	62	6	5	1	74
31	49	4	9	1	63
32	41	3	10	1	55
33	25	1	6	0	32
34	2	3	2	0	8
35	2	2	1	0	5
36	1	1	1	0	2
37	1	1	0	0	1
38	0	1	0	0	1
39	0	1	0	0	1
40	0	0	0	0	0
TOTAL	18198	10069	9826	4259	42352
Landings (t)	927	602	623	287	2439
N samples	52	68	55	50	225
Fish sampled	6408	7526	6022	5087	25043

B

SPAIN					
	Quarter				
Length	1	2	3	4	Total
10	0	0	0	0	0
11	0	0	0	0	0
12	0	0	0	0	0
13	0	0	0	0	0
14	0	0	0	107	107
15	0	0	0	1339	1339
16	228	0	4	5412	5643
17	3559	7	60	9105	12731
18	9214	70	47	4908	14240
19	14367	884	142	3214	18607
20	14618	7328	2761	5085	29792
21	17203	17779	7716	6781	49479
22	15249	27846	14925	7251	65270
23	10513	25370	19412	7737	63032
24	6484	15001	15536	6351	43372
25	4554	8156	10196	5750	28656
26	2185	2657	4221	2772	11836
27	1047	1454	1931	1497	5930
28	592	1292	706	484	3073
29	435	754	531	264	1985
30	321	537	195	119	1172
31	210	401	153	43	806
32	191	330	45	23	589
33	124	338	19	5	486
34	58	47	17	2	125
35	22	38	4	1	64
36	13	34	4	2	53
37	5	3	1	0	9
38	10	2	0	0	12
39	1	31	0	0	32
40	0	0	0	0	1
TOTAL	101202	110359	78626	68253	358439
Landings (t)	6925	9194	6935	4629	27683
N samples	85	85	84	82	336
Fish sampled	8612	9096	9000	8133	34841

C

	SPAIN			PORTUGAL	
Length	Bottom trawl	Pair trawl	Long line	Bottom trawl	TOTAL
10	0	0	0	0	0
11	0	0	0	0	0
12	0	0	0	0	0
13	0	0	0	0	0
14	107	0	0	7	114
15	1303	36	0	64	1404
16	5381	263	0	148	5791
17	11053	1678	0	742	13473
18	11554	2685	0	2111	16351
19	11459	7148	0	5716	24323
20	8972	20816	4	8891	38683
21	9906	39553	20	11410	60888
22	13941	51297	33	7567	72837
23	13874	49122	36	3045	66077
24	9990	33351	31	1183	44555
25	5447	23161	47	577	29233
26	2688	9109	39	270	12106
27	1231	4659	40	170	6100
28	535	2512	27	115	3188
29	355	1598	32	92	2076
30	190	954	28	74	1246
31	122	664	21	63	870
32	43	522	24	55	644
33	42	430	14	32	518
34	30	76	19	8	132
35	2	51	11	5	69
36	0	45	7	2	55
37	0	4	5	1	10
38	0	9	3	1	13
39	0	30	1	1	32
40	0	0	1	0	1
TOTAL	108225	249772	442	42351.79	400790.54
Landings (t)	7104	20514	65	2438.955	30122.203
N samples	195	121	20	225	561
Fish sampled	18036	14924	1881	25043	59884

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 - 1997.

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

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, 1988-1997.

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

Table 6.3.2.3 BLUE WHITING. Catch in number (millions) by age group in the Southern area, 1988-1997.

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

Table 6.3.2.4 Blue Whiting. Total catch in numbers at age (millions) 1981-1997.

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

Table 6.3.3.1 Blue Whiting. Mean weights at age for the total catch 1981-1997.

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
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
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
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
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
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
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
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
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
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
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
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

Table 6.4.1.1.1 Blue whiting biomass estimates (mill.tonnes) in the Spawning Area. Spawning Stock size in brackets.

Year	Russia	Norway	Faroes	Combined
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)	-	-
Mean	4.8 (4.4)	5.1 (4.6)		5.3 (4.9)

* with calibration factor 1.38

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

Kg/haul	30-100 m		101-200 m		201-500 m		TOTAL 30-500 m	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1985	9.50	5.87	119.75	45.99	68.18	13.79	92.83	28.24
1986	9.74	7.13	45.41	12.37	29.54	8.70	36.93	7.95
1987	-	-	-	-	-	-	-	-
1988	2.90	2.59	154.12	38.69	183.07	141.94	143.30	45.84
1989	14.17	12.03	76.92	17.08	18.79	6.23	59.00	11.68
1990	6.25	3.29	52.54	9.00	18.80	4.99	43.60	6.60
1991	64.59	34.65	126.41	26.06	46.07	18.99	97.10	17.16
1992	6.37	2.59	44.12	6.64	29.50	6.16	34.60	4.23
1993	1.06	0.63	14.07	3.73	51.08	22.02	22.59	6.44
1994	8.04	5.28	37.18	8.45	25.42	5.27	29.70	5.19
1995	19.97	13.87	36.43	4.82	15.97	4.10	28.52	3.66
1996	7.27	3.95	49.23	7.19	92.54	17.76	54.52	6.36
1997	6.20	3.63	44.21	10.61	60.18	17.54	42.81	7.78

Number/haul	30-100 m		101-200 m		201-500 m		TOTAL 30-500 m	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1985	267	181.71	3669	1578.86	1377	262.98	2644	963.20
1986	368	237.56	2486	1006.67	752	238.87	1763	616.40
1987	-	-	-	-	-	-	-	-
1988	83	71.74	6112	1847.36	7276	6339.88	5694	2086.00
1989	629	537.29	3197	876.75	566	213.11	2412	599.00
1990	220	115.48	2219	426.46	578	185.43	1722	276.00
1991	2922	1645.73	5563	1184.69	1789	847.33	4214	780.88
1992	124	50.81	1412	233.99	845	199.12	1069	146.87
1993	14	8.61	257	69.61	894	427.77	401	124.53
1994	346	234.12	2002	456.50	997	245.91	1487	689.00
1995	1291	864.97	2004	341.48	485	137.81	1493	240.37
1996	147	82.71	1167	167.20	2097	385.23	1263	142.30
1997	183	99.28	1425	359.12	1254	330.37	1194	228.06

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

		20-100 m		100-200 m		200-500 m		500-750 m		20-500 m		20-750 m	
Year	Month	y	sy	y	sy	y	sy	y	sy	y	sy	y	sy
1979	June	0	0	33	23	86	35	-	-	31	12	-	-
	October/November	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

Table 6.4.4.1 Tuning data for the blue whiting assessment. Input values for the XSA are framed.

BLUE WHITING-COMBINED

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Norway Spawning Area/Acoustic

81	97									
1	1	0.17	0.25							
2	11									
1	2368	7511	3219	3626	4551	4625	3626	2590	1776	1332
0	0	0	0	0	0	0	0	0	0	0
1	297	2108	2723	6511	3735	3650	3153	2279	1182	531
1	11130	1514	1616	1719	1858	1128	567	440	348	80
0	0	0	0	0	0	0	0	0	0	0
1	954	7183	7340	1159	383	251	373	151	174	73
1	4042	8050	22357	4697	282	417	385	159	27	111
1	6960	8799	12271	20285	7323	723	617	326	398	126
1	6745	22270	9973	10504	7803	933	293	177	46	148
1	14169	12670	11228	5587	6556	3273	516	183	108	81
1	11147	6340	8497	7407	4558	2019	545	96	16	33
1	1232	26123	4719	1574	1386	610	616	257	19	0
1	4489	3321	26771	2643	1270	557	426	108	22	12
1	1603	2950	4476	11354	1742	1687	908	770	207	0
1	8538	9874	7906	6861	9467	1795	1083	482	149	48
1	8781	7433	8371	2399	4455	4111	1202	459	162	105
0	0	0	0	0	0	0	0	0	0	0

USSR Spawning Area/Acoustic

82	97											
1	1	0.17	0.25									
3	11											
1	540	2750	1340	1380	1570	2350	1730	1290	650	1092	1092	1092
1	2330	2930	9390	3880	1970	1370	780	660	100	253	253	253
1	2900	800	1100	4200	2200	1200	1700	1200	500	108	108	108
1	13220	930	580	1780	860	610	580	540	110	47	47	47
1	18750	23180	2540	610	620	750	640	710	720	56	56	56
1	4480	19170	5860	1070	500	810	860	670	560	28	28	28
1	3710	4550	8610	4130	1270	480	250	260	330	0.001	0.001	0.001
1	11910	7120	6670	6970	4580	2750	1880	810	410	0.001	0.001	0.001
1	9740	12140	5740	2580	1470	220	80	10	10	0.001	0.001	0.001
1	10300	5350	5130	2630	1770	870	300	220	0	0.001	0.001	0.001
1	20010	6700	1350	440	390	170	0	0	0	0.001	0.001	0.001
1	4728	12337	5304	2249	1316	621	386	150	0	0.001	0.001	0.001
0	0	0	0	0	0	0	0	0	0	0	0	0
1	12657	10028	8942	2651	1093	408	131	14	14	0.001	0.001	0.001
1	15285	10629	4897	6940	1482	653	85	0	19	0.001	0.001	0.001
0	0	0	0	0	0	0	0	0	0	0	0	0

CPUE Spanish Pair Trawlers

83	97					
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

Spanish Survey (Bottom trawl)

85	97							
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
0	0	0	0	0	0	0	0	0
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	49.8	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	1308	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

Norwegian Sea/Acoustic

81	97											
1	1	0.6	0.75									
0	11											
1	0.001	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	398	468	756	1404	576	468	432	324	216	108
1	1862	30380	13915	833	392	539	539	343	49	49	49	49
1	2256	5969	23876	12502	658	423	188	235	141	376	141	47
1	5040	2324	2380	7224	6944	1876	952	336	308	140	196	56
1	3192	8204	4032	5180	5572	1204	224	168	56	84	28	28
1	8760	4992	2880	2640	3480	912	120	96	24	48	0.001	0.001
1	20430	1172	1125	812	379	410	212	22	32	0.001	8	1
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
1	0.001	792	1134	6939	766	247	172	90	11	18	1	3
1	0.001	830	125	1070	6392	1222	489	246	58	88	71	0.001
0	0	0	0	0	0	0	0	0	0	0	0	0
1	0.001	6974	2811	1999	1209	1622	775	173	61	1	15	0.001
1	0.001	23464	1057	899	649	436	505	755	89	41	50	0.001
1	30227	25638	1524	779	300	407	260	137	123	105	20	0.001

Portuguese Survey (Bottom Trawl)

85	97					
1	1	0.75	0.83			
0	5					
1	719	1467	306	129	18	6
0	0	0	0	0	0	0
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

Table 6.4.4.1.1 Output Generated by ICA Version 1.4

Blue whiting comb. (run: ICAHAR16/I16)

Catch in Number

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

x 10 ^ 6

Catch in Number

AGE	1989	1990	1991	1992	1993	1994	1995	1996
0	1949.0	83.0	161.0	19.0	198.0	42.0	3307.0	824.3
1	865.0	1611.0	267.0	408.0	263.0	307.0	296.0	1874.5
2	718.0	703.0	1024.0	654.0	305.0	108.0	354.0	528.9
3	1340.0	672.0	514.0	1642.0	621.0	368.0	422.0	626.0
4	791.0	753.0	302.0	569.0	1571.0	389.0	465.0	531.9
5	837.0	520.0	363.0	217.0	411.0	1222.0	616.0	320.1
6	708.0	577.0	258.0	154.0	191.0	281.0	800.0	492.5
7	139.0	299.0	159.0	110.0	107.0	174.0	254.0	656.5
8	50.0	78.0	49.0	80.0	65.0	90.0	160.0	230.1
9	25.0	27.0	5.0	32.0	38.0	79.0	60.0	97.4
10	38.0	95.0	10.0	12.0	17.0	31.0	42.0	81.7

x 10 ^ 6

Catch in Number

AGE	1997
0	207.6
1	2090.5
2	1490.1
3	886.7
4	566.6
5	290.0
6	246.8
7	276.6
8	399.1
9	102.3
10	170.0

x 10 ^ 6

Predicted Catch in Number

AGE	1994	1995	1996	1997
0	138.1	691.2	1204.3	207.6
1	232.9	403.6	1653.2	2327.8
2	144.4	320.7	451.4	1486.0
3	339.5	429.4	761.8	858.4
4	549.8	526.1	513.9	715.7
5	796.7	613.1	442.7	334.4
6	272.5	832.6	478.3	265.3
7	154.0	283.1	638.8	280.3
8	86.8	163.7	218.4	373.3
9	79.7	56.5	77.2	77.2

x 10 ^ 6

Table 6.4.4.1.1 (continued)

Weights at age in the catches (Kg)

AGE	1981	1982	1983	1984	1985	1986	1987	1988
0	.03800	.01800	.02000	.02600	.01600	.03000	.02300	.03100
1	.05200	.04500	.04600	.03500	.03800	.04000	.04800	.05300
2	.06500	.07200	.07400	.07800	.07400	.07300	.08600	.07600
3	.10300	.11100	.11800	.08900	.09700	.10800	.10600	.09700
4	.12500	.14300	.14000	.13200	.11400	.13000	.12400	.12800
5	.14100	.15600	.15300	.15300	.15700	.16500	.14700	.14200
6	.15500	.17700	.17600	.16100	.17700	.19900	.17700	.15700
7	.17000	.19500	.19500	.17500	.19900	.20900	.20800	.17900
8	.17800	.20000	.20000	.18900	.20800	.24300	.22100	.19900
9	.18700	.20400	.20400	.18600	.21800	.24600	.22200	.22200
10	.21300	.23100	.22800	.20600	.23700	.25700	.25400	.26000

Weights at age in the catches (Kg)

AGE	1989	1990	1991	1992	1993	1994	1995	1996
0	.01400	.03400	.03600	.02400	.02800	.03300	.02200	.01800
1	.05900	.04500	.05500	.05700	.06600	.06100	.06400	.04100
2	.07900	.07000	.09100	.08300	.08200	.08700	.09100	.08000
3	.10300	.10600	.10700	.11900	.10900	.10800	.11800	.10200
4	.12600	.12300	.13600	.14000	.13700	.13700	.14300	.11600
5	.14800	.14700	.17400	.16700	.16300	.16400	.15400	.14700
6	.15800	.16800	.19000	.19300	.17700	.18900	.16700	.17000
7	.17100	.17500	.20600	.22600	.20000	.20700	.20300	.21400
8	.20300	.21400	.23000	.23500	.21700	.21700	.20600	.23000
9	.22400	.21700	.23200	.28400	.22500	.24700	.23600	.23800
10	.25300	.25600	.26600	.29400	.28100	.25400	.25600	.27900

Weights at age in the catches (Kg)

AGE	1997
0	.03100
1	.04700
2	.07200
3	.10200
4	.12100
5	.14000
6	.16600
7	.17700
8	.18300
9	.20300
10	.23200

Weights at age in the stock (Kg)

AGE	1981	1982	1983	1984	1985	1986	1987	1988
0	.03800	.01800	.02000	.02600	.01600	.03000	.02300	.03100
1	.05200	.04500	.04600	.03500	.03800	.04000	.04800	.05300
2	.06500	.07200	.07400	.07800	.07400	.07300	.08600	.07600
3	.10300	.11100	.11800	.08900	.09700	.10800	.10600	.09700
4	.12500	.14300	.14000	.13200	.11400	.13000	.12400	.12800
5	.14100	.15600	.15300	.15300	.15700	.16500	.14700	.14200
6	.15500	.17700	.17600	.16100	.17700	.19900	.17700	.15700
7	.17000	.19500	.19500	.17500	.19900	.20900	.20800	.17900
8	.17800	.20000	.20000	.18900	.20800	.24300	.22100	.19900
9	.18700	.20400	.20400	.18600	.21800	.24600	.22200	.22200
10	.21100	.22800	.22600	.20100	.23300	.25300	.25400	.25000

Table 6.4.4.1.1 (continued)

Weights at age in the stock (Kg)

AGE	1989	1990	1991	1992	1993	1994	1995	1996
0	.01400	.03400	.03600	.02400	.02800	.03300	.02200	.01800
1	.05900	.04500	.05500	.05700	.06600	.06100	.06400	.04100
2	.07900	.07000	.09100	.08300	.08200	.08700	.09100	.08000
3	.10300	.10600	.10700	.11900	.10900	.10800	.11800	.10200
4	.12600	.12300	.13600	.14000	.13700	.13700	.14300	.11600
5	.14800	.14700	.17400	.16700	.16300	.16400	.15400	.14700
6	.15800	.16800	.19000	.19300	.17700	.18900	.16700	.17000
7	.17100	.17500	.20600	.22600	.20000	.20700	.20300	.21400
8	.20300	.21400	.23000	.23500	.21700	.21700	.20600	.23000
9	.22400	.21700	.23200	.28400	.22500	.24700	.23600	.23800
10	.23800	.26900	.13300	.29600	.29100	.25400	.25600	.27900

Weights at age in the stock (Kg)

AGE	1997
0	.03100
1	.04700
2	.07200
3	.10200
4	.12100
5	.14000
6	.16600
7	.17700
8	.18300
9	.20300
10	.23200

Natural Mortality (per year)

AGE	1981	1982	1983	1984	1985	1986	1987	1988
0	.20000	.20000	.20000	.20000	.20000	.20000	.20000	.20000
1	.20000	.20000	.20000	.20000	.20000	.20000	.20000	.20000
2	.20000	.20000	.20000	.20000	.20000	.20000	.20000	.20000
3	.20000	.20000	.20000	.20000	.20000	.20000	.20000	.20000
4	.20000	.20000	.20000	.20000	.20000	.20000	.20000	.20000
5	.20000	.20000	.20000	.20000	.20000	.20000	.20000	.20000
6	.20000	.20000	.20000	.20000	.20000	.20000	.20000	.20000
7	.20000	.20000	.20000	.20000	.20000	.20000	.20000	.20000
8	.20000	.20000	.20000	.20000	.20000	.20000	.20000	.20000
9	.20000	.20000	.20000	.20000	.20000	.20000	.20000	.20000
10	.20000	.20000	.20000	.20000	.20000	.20000	.20000	.20000

Natural Mortality (per year)

AGE	1989	1990	1991	1992	1993	1994	1995	1996
0	.20000	.20000	.20000	.20000	.20000	.20000	.20000	.20000
1	.20000	.20000	.20000	.20000	.20000	.20000	.20000	.20000
2	.20000	.20000	.20000	.20000	.20000	.20000	.20000	.20000
3	.20000	.20000	.20000	.20000	.20000	.20000	.20000	.20000
4	.20000	.20000	.20000	.20000	.20000	.20000	.20000	.20000
5	.20000	.20000	.20000	.20000	.20000	.20000	.20000	.20000
6	.20000	.20000	.20000	.20000	.20000	.20000	.20000	.20000
7	.20000	.20000	.20000	.20000	.20000	.20000	.20000	.20000
8	.20000	.20000	.20000	.20000	.20000	.20000	.20000	.20000
9	.20000	.20000	.20000	.20000	.20000	.20000	.20000	.20000
10	.20000	.20000	.20000	.20000	.20000	.20000	.20000	.20000

Table 6.4.4.1.1 (continued)

Natural Mortality (per year)

AGE	1997
0	.20000
1	.20000
2	.20000
3	.20000
4	.20000
5	.20000
6	.20000
7	.20000
8	.20000
9	.20000
10	.20000

Proportion of fish spawning

AGE	1981	1982	1983	1984	1985	1986	1987	1988
0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
1	.1100	.1100	.1100	.1100	.1100	.1100	.1100	.1100
2	.4000	.4000	.4000	.4000	.4000	.4000	.4000	.4000
3	.8200	.8200	.8200	.8200	.8200	.8200	.8200	.8200
4	.8600	.8600	.8600	.8600	.8600	.8600	.8600	.8600
5	.9100	.9100	.9100	.9100	.9100	.9100	.9100	.9100
6	.9400	.9400	.9400	.9400	.9400	.9400	.9400	.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

Proportion of fish spawning

AGE	1989	1990	1991	1992	1993	1994	1995	1996
0	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
1	.1100	.1100	.1100	.1100	.1100	.1100	.1100	.1100
2	.4000	.4000	.4000	.4000	.4000	.4000	.4000	.4000
3	.8200	.8200	.8200	.8200	.8200	.8200	.8200	.8200
4	.8600	.8600	.8600	.8600	.8600	.8600	.8600	.8600
5	.9100	.9100	.9100	.9100	.9100	.9100	.9100	.9100
6	.9400	.9400	.9400	.9400	.9400	.9400	.9400	.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

Proportion of fish spawning

AGE	1997
0	.0000
1	.1100
2	.4000
3	.8200
4	.8600
5	.9100
6	.9400
7	1.0000
8	1.0000
9	1.0000
10	1.0000

Table 6.4.4.1.1 (continued)
AGE-STRUCTURED INDICES

FL06: Norway Spawning Area/Acoustic (Cat

AGE	1981	1982	1983	1984	1985	1986	1987	1988
2	2368.	999990.	297.	11130.	999990.	954.	4042.	6960.
3	7511.	999990.	2108.	1514.	999990.	7183.	8050.	8799.
4	3219.	999990.	2723.	1616.	999990.	7340.	22357.	12271.
5	3626.	999990.	6511.	1719.	999990.	1159.	4697.	20285.
6	4551.	999990.	3735.	1858.	999990.	383.	282.	7323.
7	4625.	999990.	3650.	1128.	999990.	251.	417.	723.
8	3626.	999990.	3153.	567.	999990.	373.	385.	617.
9	2590.	999990.	2279.	440.	999990.	151.	159.	326.
10	1776.	999990.	1182.	348.	999990.	174.	27.	398.

FL06: Norway Spawning Area/Acoustic (Cat

AGE	1989	1990	1991	1992	1993	1994	1995	1996
2	6745.	14169.	11147.	1232.	4489.	1603.	8538.	8781.
3	22270.	12670.	6340.	26123.	3321.	2950.	9874.	7433.
4	9973.	11228.	8497.	4719.	26771.	4476.	7906.	8371.
5	10504.	5587.	7407.	1574.	2643.	11354.	6861.	2399.
6	7803.	6556.	4558.	1386.	1270.	1742.	9467.	4455.
7	933.	3273.	2019.	810.	557.	1687.	1795.	4111.
8	293.	516.	545.	616.	426.	908.	1083.	1202.
9	177.	183.	96.	257.	108.	770.	482.	459.
10	46.	108.	16.	19.	22.	207.	149.	162.

FL06: Norway Spawning Area/Acoustic (Cat

AGE	1997
2	999990.
3	999990.
4	999990.
5	999990.
6	999990.
7	999990.
8	999990.
9	999990.
10	999990.

FL07: USSR Spawning Area/Acoustic (Catch

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

Table 6.4.4.1.1 (continued)

FL07: USSR Spawning Area/Acoustic (Catch

AGE	1990	1991	1992	1993	1994	1995	1996	1997
3	9740.	10300.	20010.	4728.	999990.	12657.	15285.	999990.
4	12140.	5350.	6700.	12337.	999990.	10028.	10629.	999990.
5	5740.	5130.	1350.	5304.	999990.	8942.	4897.	999990.
6	2580.	2630.	440.	2249.	999990.	2651.	6940.	999990.
7	1470.	1770.	390.	1316.	999990.	1093.	1482.	999990.
8	220.	870.	170.	621.	999990.	408.	653.	999990.
9	80.	300.	999990.	386.	999990.	131.	85.	999990.
10	10.	220.	999990.	150.	999990.	14.	999990.	999990.

FL10: Norwegian Sea acoustic - Blue Whit

AGE	1981	1982	1983	1984	1985	1986	1987	1988
1	182.	184.	22356.	30380.	5969.	2324.	8204.	4992.
2	728.	460.	396.	13916.	23876.	2380.	4032.	2880.
3	4542.	1242.	468.	833.	12502.	7224.	5180.	2640.
4	3874.	4715.	756.	392.	658.	6944.	5572.	3480.
5	2678.	3611.	1404.	539.	423.	1876.	1204.	912.
6	2834.	3128.	576.	539.	188.	952.	224.	120.
7	2964.	2323.	468.	343.	235.	336.	168.	96.
8	2756.	1679.	432.	49.	141.	308.	56.	24.

FL10: Norwegian Sea acoustic - Blue Whit

AGE	1989	1990	1991	1992	1993	1994	1995	1996
1	1172.	999990.	999990.	792.	830.	999990.	6974.	23464.
2	1125.	999990.	999990.	1134.	125.	999990.	2811.	1057.
3	812.	999990.	999990.	6939.	1070.	999990.	1999.	899.
4	379.	999990.	999990.	766.	6392.	999990.	1209.	649.
5	410.	999990.	999990.	247.	1222.	999990.	1622.	436.
6	212.	999990.	999990.	172.	489.	999990.	775.	505.
7	22.	999990.	999990.	90.	248.	999990.	173.	755.
8	32.	999990.	999990.	11.	58.	999990.	61.	69.

FL10: Norwegian Sea acoustic - Blue Whit

AGE	1997
1	25638.
2	1524.
3	779.
4	300.
5	407.
6	260.
7	137.
8	123.

FL08: CPUE Spanish Pair Trawlers (Catch:

AGE	1983	1984	1985	1986	1987	1988	1989	1990
2	16392.	27286.	23823.	14131.	13153.	21473.	18486.	19407.
3	9311.	14845.	14126.	14745.	6664.	18436.	17160.	5194.
4	7476.	4836.	6256.	7113.	2938.	6391.	8374.	1803.
5	6326.	1755.	1232.	1278.	1029.	1300.	3760.	1357.
6	1718.	1750.	217.	505.	166.	781.	1003.	451.

Table 6.4.4.1.1 (continued)

FL08: CPUE Spanish Pair Trawlers (Catch:

AGE	1991	1992	1993	1994	1995	1996	1997
2	15370.	24235.	13991.	6066.	14409.	14557.	15875.
3	4989.	9671.	22493.	15917.	6833.	14449.	11134.
4	2329.	4316.	7979.	7474.	4551.	3931.	3698.
5	1045.	1194.	1354.	2990.	1990.	3639.	1046.
6	440.	462.	658.	1055.	623.	1834.	450.

Fishing Mortality (per year)

AGE	1981	1982	1983	1984	1985	1986	1987	1988
0	.0096	.1727	.0202	.0481	.1112	.0086	.0448	.0047
1	.0833	.0369	.1622	.1395	.1443	.0830	.1112	.0723
2	.0991	.1195	.1930	.2476	.1780	.1262	.0986	.1318
3	.1597	.1269	.1656	.2339	.3342	.2440	.1584	.1443
4	.1117	.1865	.1566	.2377	.2412	.5603	.4198	.2188
5	.2840	.1211	.1470	.2307	.2703	.5617	.4917	.5736
6	.3185	.2259	.1995	.3383	.4397	.4714	.3884	1.0622
7	.3020	.2462	.3873	.2642	.3340	.5475	.5320	.4387
8	.3380	.2896	.4547	.4907	.2813	.4658	.7826	.5669
9	.3079	.2489	.4134	.4756	.4668	.5031	.4731	.4957
10	.3079	.2489	.4134	.4756	.4668	.5031	.4731	.4957

Fishing Mortality (per year)

AGE	1989	1990	1991	1992	1993	1994	1995	1996
0	.0873	.0086	.0253	.0038	.0271	.0167	.0257	.0328
1	.1138	.0966	.0344	.0827	.0657	.0403	.0620	.0791
2	.1677	.1275	.0820	.1103	.0820	.0466	.0717	.0914
3	.3835	.2338	.1294	.1829	.1453	.1233	.1898	.2420
4	.2793	.3869	.1564	.2065	.2668	.1851	.2848	.3632
5	.4536	.2993	.3263	.1609	.2260	.2102	.3234	.4124
6	.7192	.6572	.2378	.2235	.2076	.2299	.3537	.4511
7	.7395	.7820	.3772	.1509	.2388	.2575	.3961	.5052
8	.5106	1.3594	.2736	.3310	.1251	.3106	.4779	.6095
9	.5788	.5779	.2621	.2889	.2587	.2221	.3417	.4358
10	.5788	.5779	.2621	.2889	.2587	.2221	.3417	.4358

Fishing Mortality (per year)

AGE	1997
0	.0340
1	.0819
2	.0947
3	.2507
4	.3762
5	.4272
6	.4672
7	.5233
8	.6313
9	.4515
10	.4515

Table 6.4.4.1.1 (continued)

Population Abundance (1 January)

AGE	1981	1982	1983	1984	1985	1986	1987	1988
0	5552.	24355.	24139.	13702.	12281.	10808.	8580.	10863.
1	3557.	4502.	16777.	19369.	10691.	8997.	8773.	6717.
2	4061.	2679.	3552.	11679.	13793.	7577.	6779.	6427.
3	5076.	3011.	1947.	2398.	7465.	9452.	5468.	5029.
4	3480.	3542.	2172.	1351.	1554.	4375.	6063.	3821.
5	2434.	2548.	2407.	1520.	872.	1000.	2046.	3263.
6	2249.	1500.	1848.	1701.	988.	545.	467.	1024.
7	1963.	1339.	980.	1240.	993.	521.	278.	259.
8	2425.	1188.	857.	545.	779.	582.	247.	134.
9	2394.	1416.	728.	445.	273.	482.	299.	92.
10	6047.	3356.	1081.	738.	760.	1101.	566.	140.

x 10 ^ 6

Population Abundance (1 January)

AGE	1989	1990	1991	1992	1993	1994	1995	1996
0	25690.	10736.	7097.	5591.	8155.	9187.	30015.	41147.
1	8852.	19275.	8715.	5665.	4561.	6498.	7397.	23950.
2	5116.	6468.	14328.	6894.	4270.	3497.	5110.	5692.
3	4612.	3542.	4662.	10807.	5055.	3221.	2732.	3894.
4	3564.	2573.	2295.	3353.	7369.	3579.	2331.	1850.
5	2513.	2207.	1431.	1607.	2233.	4621.	2435.	1436.
6	1505.	1307.	1340.	845.	1120.	1459.	3066.	1443.
7	290.	600.	555.	865.	554.	745.	949.	1762.
8	137.	113.	225.	312.	609.	357.	472.	523.
9	62.	67.	24.	140.	183.	440.	214.	239.
10	95.	237.	48.	53.	82.	171.	159.	253.

x 10 ^ 6

Population Abundance (1 January)

AGE	1997	1998
0	6851.	10719.
1	32601.	5422.
2	18117.	24592.
3	4253.	13493.
4	2503.	2710.
5	1054.	1407.
6	778.	563.
7	752.	399.
8	871.	365.
9	233.	379.
10	512.	388.

x 10 ^ 6

Weighting factors for the catches in number

AGE	1994	1995	1996	1997
0	.1000	.1000	.1000	.1000
1	.5000	.5000	.5000	.5000
2	1.0000	1.0000	1.0000	1.0000
3	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000
6	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000
8	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000

Table 6.4.4.1.1 (continued)

Predicted Age-Structured Index Values

FL06: Norway Spawning Area/Acoustic (Ca Predicted

AGE	1981	1982	1983	1984	1985	1986	1987	1988
2	2605.	999990.	2234.	7262.	999990.	4833.	4349.	4094.
3	7932.	999990.	3038.	3689.	999990.	14511.	8546.	7884.
4	8312.	999990.	5138.	3141.	999990.	9511.	13575.	8923.
5	5368.	999990.	5463.	3391.	999990.	2080.	4319.	6771.
6	4740.	999990.	3993.	3570.	999990.	1111.	969.	1846.
7	3877.	999990.	1901.	2468.	999990.	978.	524.	497.
8	4903.	999990.	1691.	1066.	999990.	1145.	454.	258.
9	3807.	999990.	1133.	684.	999990.	735.	459.	141.
10	2815.	999990.	492.	331.	999990.	492.	255.	63.

FL06: Norway Spawning Area/Acoustic (Ca Predicted

AGE	1989	1990	1991	1992	1993	1994	1995	1996
2	3235.	4124.	9224.	4412.	2749.	2268.	3297.	3657.
3	6876.	5449.	7331.	16805.	7923.	5072.	4243.	5981.
4	8219.	5801.	5431.	7851.	17037.	8417.	5369.	4192.
5	5349.	4852.	3128.	3637.	4986.	10350.	5326.	3082.
6	2916.	2566.	2871.	1817.	2416.	3131.	6413.	2957.
7	522.	1072.	1079.	1763.	1108.	1486.	1838.	3336.
8	267.	185.	461.	631.	1287.	726.	926.	998.
9	93.	101.	38.	224.	294.	712.	338.	371.
10	42.	104.	22.	25.	39.	81.	74.	115.

FL06: Norway Spawning Area/Acoustic (Ca Predicted

AGE	1997
2	999990.
3	999990.
4	999990.
5	999990.
6	999990.
7	999990.
8	999990.
9	999990.
10	999990.

FL07: USSR Spawning Area/Acoustic (Catc Predicted

AGE	1982	1983	1984	1985	1986	1987	1988	1989
3	4571.	2931.	3559.	10850.	14000.	8246.	7607.	6634.
4	7128.	4397.	2689.	3091.	8140.	11618.	7636.	7034.
5	5197.	4882.	3030.	1723.	1859.	3860.	6051.	4781.
6	2943.	3646.	3259.	1854.	1015.	885.	1686.	2662.
7	2549.	1811.	2351.	1856.	931.	499.	474.	497.
8	2349.	1637.	1032.	1544.	1109.	440.	250.	258.
9	3179.	1579.	953.	585.	1025.	641.	197.	130.
10	2882.	897.	604.	624.	897.	464.	114.	76.

Table 6.4.4.1.1 (continued)

FL07: USSR Spawning Area/Acoustic (Catc Predicted

AGE	1990	1991	1992	1993	1994	1995	1996	1997
3	5258.	7073.	16214.	7644.	999990.	4094.	5771.	999990.
4	4965.	4648.	6719.	14581.	999990.	4595.	3588.	999990.
5	4336.	2795.	3250.	4455.	999990.	4760.	2754.	999990.
6	2343.	2621.	1659.	2206.	999990.	5855.	2700.	999990.
7	1021.	1027.	1679.	1055.	999990.	1750.	3177.	999990.
8	179.	446.	611.	1246.	999990.	896.	967.	999990.
9	141.	53.	999990.	410.	999990.	472.	517.	999990.
10	190.	41.	999990.	70.	999990.	134.	999990.	999990.

FL10: Norwegian Sea acoustic - Blue Whi Predicted

AGE	1981	1982	1983	1984	1985	1986	1987	1988
1	1342.	1753.	6002.	7036.	3871.	3395.	3248.	2553.
2	1064.	692.	873.	2768.	3426.	1949.	1777.	1647.
3	2372.	1439.	906.	1066.	3101.	4173.	2557.	2375.
4	1886.	1825.	1142.	672.	772.	1751.	2669.	1926.
5	1245.	1454.	1350.	806.	450.	424.	909.	1372.
6	935.	664.	833.	698.	379.	204.	185.	258.
7	753.	534.	355.	488.	373.	169.	91.	91.
8	571.	289.	187.	116.	191.	126.	43.	27.

FL10: Norwegian Sea acoustic - Blue Whi Predicted

AGE	1989	1990	1991	1992	1993	1994	1995	1996
1	3272.	999990.	999990.	2138.	1741.	999990.	2831.	9062.
2	1280.	999990.	999990.	1792.	1132.	999990.	1364.	1499.
3	1853.	999990.	999990.	4972.	2385.	999990.	1251.	1721.
4	1725.	999990.	999990.	1704.	3596.	999990.	1124.	846.
5	1146.	999990.	999990.	893.	1187.	999990.	1212.	673.
6	478.	999990.	999990.	375.	502.	999990.	1245.	549.
7	83.	999990.	999990.	367.	222.	999990.	342.	590.
8	29.	999990.	999990.	74.	165.	999990.	101.	102.

FL10: Norwegian Sea acoustic - Blue Whi Predicted

AGE	1997
1	12312.
2	4760.
3	1869.
4	1135.
5	489.
6	293.
7	249.
8	168.

FL08: CPUE Spanish Pair Trawlers (Catch Predicted

AGE	1983	1984	1985	1986	1987	1988	1989	1990
2	8004.	25605.	31310.	17650.	16012.	14929.	11673.	15057.
3	5030.	5988.	17728.	23483.	14178.	13134.	10686.	8844.
4	3845.	2296.	2637.	6330.	9411.	6557.	5935.	4060.
5	2511.	1521.	855.	848.	1797.	2750.	2250.	2134.
6	1147.	985.	544.	295.	263.	413.	720.	645.

Table 6.4.4.1.1 (continued)

FL08: CPUE Spanish Pair Trawlers (Catch Predicted

AGE	1991	1992	1993	1994	1995	1996	1997
2	34122.	16188.	10170.	8476.	12232.	13492.	42874.
3	12264.	27682.	13194.	8500.	6975.	9685.	10531.
4	4064.	5790.	12347.	6247.	3871.	2955.	3970.
5	1365.	1665.	2240.	4671.	2326.	1312.	956.
6	815.	518.	692.	891.	1761.	789.	422.

Fitted Selection Pattern

AGE	1981	1982	1983	1984	1985	1986	1987	1988
0	.0858	.9261	.1288	.2025	.4613	.0154	.1067	.0214
1	.7457	.1980	1.0360	.5868	.5983	.1480	.2648	.3303
2	.8875	.6405	1.2328	1.0415	.7379	.2253	.2349	.6025
3	1.4300	.6805	1.0577	.9838	1.3859	.4354	.3774	.6595
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	2.5425	.6494	.9391	.9706	1.1209	1.0025	1.1714	2.6215
6	2.8513	1.2114	1.2742	1.4231	1.8233	.8412	.9252	4.8548
7	2.7037	1.3201	2.4735	1.1114	1.3851	.9772	1.2673	2.0048
8	3.0258	1.5525	2.9041	2.0644	1.1665	.8314	1.8644	2.5911
9	2.7566	1.3344	2.6405	2.0007	1.9357	.8979	1.1271	2.2655
10	2.7566	1.3344	2.6405	2.0007	1.9357	.8979	1.1271	2.2655

Fitted Selection Pattern

AGE	1989	1990	1991	1992	1993	1994	1995	1996
0	.3125	.0221	.1620	.0182	.1017	.0903	.0903	.0903
1	.4076	.2497	.2197	.4004	.2461	.2178	.2178	.2178
2	.6004	.3295	.5244	.5343	.3072	.2517	.2517	.2517
3	1.3729	.6045	.8274	.8856	.5445	.6664	.6664	.6664
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.6238	.7737	2.0859	.7789	.8471	1.1356	1.1356	1.1356
6	2.5747	1.6988	1.5205	1.0821	.7781	1.2419	1.2419	1.2419
7	2.6472	2.0215	2.4115	.7305	.8951	1.3909	1.3909	1.3909
8	1.8277	3.5140	1.7491	1.6029	.4688	1.6781	1.6781	1.6781
9	2.0719	1.4939	1.6756	1.3992	.9695	1.2000	1.2000	1.2000
10	2.0719	1.4939	1.6756	1.3992	.9695	1.2000	1.2000	1.2000

Fitted Selection Pattern

AGE	1997
0	.0903
1	.2178
2	.2517
3	.6664
4	1.0000
5	1.1356
6	1.2419
7	1.3909
8	1.6781
9	1.2000
10	1.2000

Table 6.4.4.1.1 (continued)

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	5551940	4798656	4057854	909556	.2241	.2352	98
1982	24355350	3890683	2973430	576419	.1939	.1813	93
1983	24139150	3500014	2036076	570072	.2800	.2112	101
1984	13701550	3394252	1787346	641776	.3591	.2610	101
1985	12281460	3432824	2084390	695596	.3337	.3239	99
1986	10807590	3747677	2486578	826986	.3326	.4770	97
1987	8580350	3238908	2075367	664434	.3202	.3980	100
1988	10862910	2910723	1756435	553413	.3151	.4875	99
1989	25689510	2933825	1670706	625433	.3744	.5150	95
1990	10736260	3128673	1565774	561610	.3587	.4718	100
1991	7096830	3530955	1895396	369524	.1950	.2454	99
1992	5591220	3540256	2444191	474245	.1940	.1849	99
1993	8155050	3310209	2318717	480672	.2073	.2169	100
1994	9187320	3259171	2204694	459414	.2084	.2012	100
1995	30014920	3522602	1992753	578693	.2904	.3095	100
1996	41147310	3871191	1848123	637825	.3451	.3948	101
1997	6851250	4521050	2020773	634206	.3138	.4089	99

IFAP run code: I16

No of years for separable analysis : 4
Age range in the analysis : 0 . . . 10
Year range in the analysis : 1981 . . . 1997
Number of indices of SSB : 0
Number of age-structured indices : 4

Parameters to estimate : 55
Number of observations : 462

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	.1851	17	.1310	.2615	.1552	.2208	.1880
2	1995	.2848	16	.2046	.3963	.2406	.3371	.2889
3	1996	.3632	17	.2554	.5165	.3035	.4347	.3691
4	1997	.3762	21	.2477	.5714	.3040	.4656	.3849
Separable Model: Selection (S) by age								
5	0	.0903	59	.0280	.2914	.0497	.1642	.1080
6	1	.2178	29	.1214	.3907	.1617	.2934	.2277
7	2	.2517	22	.1608	.3941	.2003	.3164	.2584
8	3	.6664	21	.4390	1.0115	.5386	.8245	.6817
	4	1.0000		Fixed : Reference Age				
9	5	1.1356	20	.7615	1.6933	.9261	1.3923	1.1594
10	6	1.2419	20	.8364	1.8440	1.0151	1.5194	1.2674
11	7	1.3909	19	.9471	2.0427	1.1432	1.6922	1.4179
12	8	1.6781	18	1.1588	2.4301	1.3892	2.0270	1.7083
	9	1.2000		Fixed : Last true age				

Table 6.4.4.1.1 (continued)

Separable model: Populations in year 1997

13	0	6851255	112	750180	62571221	2216490	21177489	12951295
14	1	32601251	44	13740601	77350441	20979307	50661424	35927722
15	2	18117232	27	10495866	31272701	13713110	23935788	18833699
16	3	4253135	21	2808462	6440949	3441515	5256162	4349558
17	4	2502945	18	1750978	3577848	2085848	3003447	2544879
18	5	1053596	17	754803	1470668	888743	1249029	1068960
19	6	778096	17	550864	1099060	652392	928021	790269
20	7	752415	18	519617	1089509	622916	908834	765956
21	8	870648	20	585561	1294534	711131	1065948	888662
22	9	232695	23	147640	366751	184493	293491	239049

Separable model: Populations at age

23	1994	439799	31	235656	820784	319891	604653	462657
24	1995	214196	23	134343	341514	168828	271755	220350
25	1996	239458	21	157637	363746	193460	296392	244968

Age-structured index catchabilities

FL06: Norway Spawning Area/Acoustic (Ca

Linear model fitted. Slopes at age :

26	2	Q	.6831E-03	24	.5423E-03	.1392E-02	.6831E-03	.1105E-02	.8942E-03
27	3	Q	.1685E-02	24	.1338E-02	.3430E-02	.1685E-02	.2724E-02	.2205E-02
28	4	Q	.2550E-02	23	.2025E-02	.5188E-02	.2550E-02	.4120E-02	.3336E-02
29	5	Q	.2441E-02	23	.1939E-02	.4967E-02	.2441E-02	.3945E-02	.3194E-02
30	6	Q	.2350E-02	24	.1866E-02	.4781E-02	.2350E-02	.3797E-02	.3074E-02
31	7	Q	.2195E-02	24	.1743E-02	.4469E-02	.2195E-02	.3548E-02	.2872E-02
32	8	Q	.2263E-02	24	.1796E-02	.4615E-02	.2263E-02	.3663E-02	.2964E-02
33	9	Q	.1769E-02	24	.1402E-02	.3626E-02	.1769E-02	.2873E-02	.2322E-02
34	10	Q	.5179E-03	24	.4110E-03	.1057E-02	.5179E-03	.8387E-03	.6785E-03

FL07: USSR Spawning Area/Acoustic (Catc

Linear model fitted. Slopes at age :

35	3	Q	.1626E-02	22	.1309E-02	.3175E-02	.1626E-02	.2556E-02	.2091E-02
36	4	Q	.2182E-02	22	.1757E-02	.4261E-02	.2182E-02	.3430E-02	.2807E-02
37	5	Q	.2182E-02	22	.1756E-02	.4260E-02	.2182E-02	.3429E-02	.2806E-02
38	6	Q	.2145E-02	22	.1727E-02	.4189E-02	.2145E-02	.3372E-02	.2759E-02
39	7	Q	.2090E-02	22	.1682E-02	.4083E-02	.2090E-02	.3286E-02	.2689E-02
40	8	Q	.2191E-02	22	.1763E-02	.4283E-02	.2191E-02	.3446E-02	.2820E-02
41	9	Q	.2467E-02	23	.1967E-02	.4958E-02	.2467E-02	.3953E-02	.3211E-02
42	10	Q	.9436E-03	24	.7467E-03	.1942E-02	.9436E-03	.1537E-02	.1241E-02

FL10: Norwegian Sea acoustic - Blue Whi

Linear model fitted. Slopes at age :

43	1	Q	.4568E-03	23	.3659E-03	.9053E-03	.4568E-03	.7252E-03	.5912E-03
44	2	Q	.3206E-03	22	.2575E-03	.6301E-03	.3206E-03	.5061E-03	.4134E-03
45	3	Q	.5957E-03	22	.4788E-03	.1168E-02	.5957E-03	.9388E-03	.7674E-03
46	4	Q	.6688E-03	22	.5378E-03	.1310E-02	.6688E-03	.1053E-02	.8612E-03
47	5	Q	.7088E-03	22	.5699E-03	.1389E-02	.7088E-03	.1117E-02	.9129E-03
48	6	Q	.5902E-03	22	.4744E-03	.1157E-02	.5902E-03	.9301E-03	.7603E-03
49	7	Q	.5386E-03	22	.4328E-03	.1057E-02	.5386E-03	.8495E-03	.6942E-03
50	8	Q	.3385E-03	22	.2718E-03	.6663E-03	.3385E-03	.5349E-03	.4368E-03

FL08: CPUE Spanish Pair Trawlers (Catch

Linear model fitted. Slopes at age :

51	2	Q	.2742E-02	17	.2316E-02	.4618E-02	.2742E-02	.3900E-02	.3321E-02
52	3	Q	.3102E-02	17	.2623E-02	.5204E-02	.3102E-02	.4400E-02	.3751E-02
53	4	Q	.2116E-02	17	.1790E-02	.3545E-02	.2116E-02	.2999E-02	.2558E-02
54	5	Q	.1241E-02	17	.1050E-02	.2080E-02	.1241E-02	.1759E-02	.1500E-02
55	6	Q	.7576E-03	17	.6406E-03	.1271E-02	.7576E-03	.1074E-02	.9161E-03

Table 6.4.4.1.1 (continued)
RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	1994	1995	1996	1997
0	-1.190	1.565	-.379	.000
1	.276	-.310	.126	-.108
2	-.290	.099	.158	.003
3	.081	-.017	-.196	.032
4	-.346	-.123	.035	-.234
5	.428	.005	-.324	-.142
6	.031	-.040	.029	-.072
7	.122	-.109	.027	-.013
8	.036	-.023	.052	.067
9	-.009	.060	.232	.282

AGE-STRUCTURED INDEX RESIDUALS

FL06: Norway Spawning Area/Acoustic (Ca

Age	1981	1982	1983	1984	1985	1986	1987	1988
2	-.096	*******	-2.018	.427	*******	-1.623	-.073	.531
3	-.055	*******	-.365	-.891	*******	-.703	-.060	.110
4	-.949	*******	-.635	-.665	*******	-.259	.499	.319
5	-.392	*******	.175	-.679	*******	-.585	.084	1.097
6	-.041	*******	-.067	-.653	*******	-1.065	-1.234	1.378
7	.176	*******	.652	-.783	*******	-1.360	-.228	.374
8	-.302	*******	.623	-.631	*******	-1.122	-.166	.872
9	-.385	*******	.699	-.441	*******	-1.583	-1.061	.836
10	-.461	*******	.876	.049	*******	-1.040	-2.244	1.849

FL06: Norway Spawning Area/Acoustic (Ca

Age	1989	1990	1991	1992	1993	1994	1995	1996
2	.735	1.234	.189	-1.276	.490	-.347	.952	.876
3	1.175	.844	-.145	.441	-.869	-.542	.845	.217
4	.193	.660	.448	-.509	.452	-.632	.387	.692
5	.675	.141	.862	-.838	-.635	.093	.253	-.250
6	.984	.938	.462	-.271	-.643	-.586	.390	.410
7	.580	1.116	.627	-.778	-.688	.127	-.024	.209
8	.094	1.027	.168	-.023	-1.105	.224	.157	.186
9	.639	.594	.920	.139	-1.003	.078	.354	.214
10	.101	.037	-.336	-.256	-.561	.937	.706	.344

FL06: Norway Spawning Area/Acoustic (Ca

Age	1997
2	*******
3	*******
4	*******
5	*******
6	*******
7	*******
8	*******
9	*******
10	*******

Table 6.4.4.1.1 (continued)

FL07: USSR Spawning Area/Acoustic (Catc

Age	1982	1983	1984	1985	1986	1987	1988	1989
3	-2.136	-.230	-.205	.198	.292	-.610	-.718	.585
4	-.952	-.406	-1.212	-1.201	1.047	.501	-.518	.012
5	-1.355	.654	-1.013	-1.089	.312	.418	.353	.333
6	-.757	.062	.254	-.040	-.509	.190	.896	.962
7	-.485	.084	-.066	-.769	-.407	.002	.986	2.220
8	.000	-.178	.150	-.928	-.391	.610	.653	2.365
9	-.609	-.705	.578	-.009	-.471	.295	.239	2.670
10	-.804	-.306	.687	-.144	-.233	.368	.823	2.370

FL07: USSR Spawning Area/Acoustic (Catc

Age	1990	1991	1992	1993	1994	1995	1996	1997
3	.617	.376	.210	-.480	*******	1.129	.974	*******
4	.894	.141	-.003	-.167	*******	.780	1.086	*******
5	.281	.607	-.879	.174	*******	.631	.576	*******
6	.097	.003	-1.327	.019	*******	-.792	.944	*******
7	.364	.544	-1.460	.221	*******	-.471	-.763	*******
8	.207	.668	-1.279	-.696	*******	-.787	-.392	*******
9	-.566	1.727	*******	-.061	*******	-1.281	-1.805	*******
10	-2.942	1.685	*******	.759	*******	-2.259	*******	*******

FL10: Norwegian Sea acoustic - Blue Whi

Age	1981	1982	1983	1984	1985	1986	1987	1988
1	-1.998	-2.254	1.315	1.463	.433	-.379	.926	.670
2	-.379	-.409	-.791	1.615	1.941	.200	.820	.559
3	.650	-.147	-.661	-.246	1.394	.549	.706	.106
4	.720	.949	-.412	-.539	-.159	1.377	.736	.592
5	.766	.909	.039	-.402	-.062	1.488	.281	-.408
6	1.108	1.550	-.369	-.259	-.700	1.539	.191	-.765
7	1.370	1.471	.276	-.353	-.462	.684	.608	.057
8	1.574	1.760	.840	-.859	-.301	.896	.263	-.118

FL10: Norwegian Sea acoustic - Blue Whi

Age	1989	1990	1991	1992	1993	1994	1995	1996
1	-1.027	*******	*******	-.993	-.741	*******	.901	.951
2	-.129	*******	*******	-.458	-2.203	*******	.723	-.349
3	-.825	*******	*******	.333	-.802	*******	.469	-.650
4	-1.515	*******	*******	-.800	.575	*******	.073	-.265
5	-1.028	*******	*******	-1.285	.029	*******	.291	-.434
6	-.812	*******	*******	-.779	-.026	*******	-.474	-.083
7	-1.325	*******	*******	-1.407	.112	*******	-.681	.247
8	.110	*******	*******	-1.902	-1.048	*******	-.505	-.395

FL10: Norwegian Sea acoustic - Blue Whi

Age	1997
1	.733
2	-1.139
3	-.875
4	-1.330
5	-.184
6	-.118
7	-.596
8	-.313

Table 6.4.4.1.1 (continued)

FL08: CPUE Spanish Pair Trawlers (Catch

Age	1983	1984	1985	1986	1987	1988	1989	1990
2	.717	.064	-.273	-.222	-.197	.363	.460	.254
3	.616	.908	-.227	-.465	-.755	.339	.474	-.532
4	.665	.745	.864	.117	-1.164	-.026	.344	-.812
5	.924	.143	.365	.411	-.557	-.749	.514	-.453
6	.404	.575	-.919	.538	-.462	.638	.331	-.358

FL08: CPUE Spanish Pair Trawlers (Catch

Age	1991	1992	1993	1994	1995	1996	1997
2	-.798	.404	.319	-.335	.164	.076	-.994
3	-.899	-1.052	.533	.627	-.021	.400	.056
4	-.557	-.294	-.437	.179	.162	.286	-.071
5	-.267	-.333	-.503	-.446	-.156	1.020	.090
6	-.617	-.115	-.051	.169	-1.039	.843	.064

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 1994 to 1997

Variance	.0899
Skewness test stat.	.6041
Kurtosis test statistic	.8360
Partial chi-square	.1056
Significance in fit	.0000
Degrees of freedom	15

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR FL06: Norway Spawning Area/Acoustic (Ca

Linear catchability relationship assumed

Age	2	3	4	5	6	7	8	9	10
Variance	.1106	.0475	.0370	.0398	.0701	.0532	.0457	.0681	.1070
Skewness test stat.	-1.2822	.4365	-.4968	.4903	.1863	-.5979	-.4765	-1.0347	-.5865
Kurtosis test statisti	-.3529	-.7296	-1.1516	-.7006	-.7815	-.5217	-.3879	-.5471	.4384
Partial chi-square	.1770	.0709	.0548	.0619	.1215	.0981	.0928	.1590	.2830
Significance in fit	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
Number of observations	14	14	14	14	14	14	14	14	14
Degrees of freedom	13	13	13	13	13	13	13	13	13
Weight in the analysis	.1111	.1111	.1111	.1111	.1111	.1111	.1111	.1111	.1111

Table 6.4.4.1.1 (continued)

DISTRIBUTION STATISTICS FOR FL07: USSR Spawning Area/Acoustic (Catc

Linear catchability relationship assumed

Age	3	4	5	6	7	8	9	10
Variance	.0868	.0792	.0670	.0573	.0992	.1043	.1761	.2829
Skewness test stat.	-1.5967	-.2037	-1.3511	-.3633	1.3498	1.6336	1.1892	-.7141
Kurtosis test statisti	.8675	-.8992	-.7271	-.4250	.7934	.9729	.2596	-.1759
Partial chi-square	.1322	.1227	.1072	.0966	.1929	.2263	.4107	.6545
Significance in fit	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
Number of observations	14	14	14	14	14	14	13	12
Degrees of freedom	13	13	13	13	13	13	12	11
Weight in the analysis	.1250	.1250	.1250	.1250	.1250	.1250	.1250	.1250

DISTRIBUTION STATISTICS FOR FL10: Norwegian Sea acoustic - Blue Whi

Linear catchability relationship assumed

Age	1	2	3	4	5	6	7	8
Variance	.1868	.1477	.0629	.0943	.0679	.0849	.0954	.1272
Skewness test stat.	-.8933	-.0272	.4498	-.3641	.3394	1.4731	.1010	.2097
Kurtosis test statisti	-.7480	-.1354	-.7420	-.7193	-.1704	-.3222	-.5571	-.3479
Partial chi-square	.3087	.2539	.1060	.1659	.1326	.1830	.2199	.3251
Significance in fit	.0000	.0000	.0000	.0000	.0000	.0000	.0000	.0000
Number of observations	14	14	14	14	14	14	14	14
Degrees of freedom	13	13	13	13	13	13	13	13
Weight in the analysis	.1250	.1250	.1250	.1250	.1250	.1250	.1250	.1250

DISTRIBUTION STATISTICS FOR FL08: CPUE Spanish Pair Trawlers (Catch

Linear catchability relationship assumed

Age	2	3	4	5	6
Variance	.0446	.0774	.0660	.0604	.0672
Skewness test stat.	-1.0342	-.4824	-.5956	.8075	-.5797
Kurtosis test statisti	-.2180	-.9672	-.4325	.7079	-.7707
Partial chi-square	.0628	.1157	.1096	.1121	.1427
Significance in fit	.0000	.0000	.0000	.0000	.0000
Number of observations	15	15	15	15	15
Degrees of freedom	14	14	14	14	14
Weight in the analysis	.2000	.2000	.2000	.2000	.2000

Table 6.4.4.1.1 (continued)

ANALYSIS OF VARIANCE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	278.2109	462	55	407	.6836
Catches at age	5.0582	40	25	15	.3372
Aged Indices					
FL06: Norway Spawning Area/Acoustic (C	67.7512	126	9	117	.5791
FL07: USSR Spawning Area/Acoustic (Cat	93.1413	109	8	101	.9222
FL10: Norwegian Sea acoustic - Blue Wh	90.1670	112	8	104	.8670
FL08: CPUE Spanish Pair Trawlers (Catc	22.0931	75	5	70	.3156

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	5.9325	462	55	407	.0146
Catches at age	1.3481	40	25	15	.0899
Aged Indices					
FL06: Norway Spawning Area/Acoustic (C	.8364	126	9	117	.0071
FL07: USSR Spawning Area/Acoustic (Cat	1.4553	109	8	101	.0144
FL10: Norwegian Sea acoustic - Blue Wh	1.4089	112	8	104	.0135
FL08: CPUE Spanish Pair Trawlers (Catc	.8837	75	5	70	.0126

Table 6.4.4.1.2 STOCK SUMMARY BLUE WHITING

Year	Recruits Age 0 millions	Total Biomass 1000 tonnes	Spawning Biomass 1000 tonnes	Landings 1000 tonnes	Yield/SSB ratio	Mean F Ages 3-7
1981	5552	4799	4058	910	0.22	0.24
1982	24355	3891	2973	576	0.19	0.18
1983	24139	3500	2036	570	0.28	0.21
1984	13702	3394	1787	642	0.36	0.26
1985	12282	3433	2084	696	0.33	0.32
1986	10808	3748	2487	827	0.33	0.48
1987	8580	3239	2075	664	0.32	0.40
1988	10863	2911	1756	553	0.32	0.49
1989	25690	2934	1671	625	0.32	0.52
1990	10736	3129	1566	562	0.37	0.47
1991	7097	3531	1895	370	0.36	0.25
1992	5591	3540	2444	474	0.20	0.18
1993	8155	3310	2319	481	0.19	0.22
1994	9187	3259	2205	459	0.21	0.20
1995	30015	3523	1993	579	0.29	0.31
1996	41147	3871	1848	638	0.35	0.39
1997	6851	4521	2021	634	0.31	0.41

Table 6.5.1

Blue whiting, combined stock

Prediction with management option table: Input data

Year: 1998								
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	10719.000	0.2000	0.0000	0.0000	0.0000	0.031	0.0340	0.031
1	5422.000	0.2000	0.1100	0.0000	0.0000	0.047	0.0820	0.047
2	24592.000	0.2000	0.4000	0.0000	0.0000	0.072	0.0950	0.072
3	13493.000	0.2000	0.8200	0.0000	0.0000	0.102	0.2510	0.102
4	2710.000	0.2000	0.8600	0.0000	0.0000	0.121	0.3760	0.121
5	1407.000	0.2000	0.9100	0.0000	0.0000	0.140	0.4270	0.140
6	563.000	0.2000	0.9400	0.0000	0.0000	0.166	0.4670	0.166
7	399.000	0.2000	1.0000	0.0000	0.0000	0.177	0.5230	0.177
8	365.000	0.2000	1.0000	0.0000	0.0000	0.183	0.6310	0.183
9	379.000	0.2000	1.0000	0.0000	0.0000	0.203	0.4510	0.203
10+	388.000	0.2000	1.0000	0.0000	0.0000	0.232	0.4510	0.232
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Year: 1999								
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	10719.000	0.2000	0.0000	0.0000	0.0000	0.031	0.0340	0.031
1	.	0.2000	0.1100	0.0000	0.0000	0.047	0.0820	0.047
2	.	0.2000	0.4000	0.0000	0.0000	0.072	0.0950	0.072
3	.	0.2000	0.8200	0.0000	0.0000	0.102	0.2510	0.102
4	.	0.2000	0.8600	0.0000	0.0000	0.121	0.3760	0.121
5	.	0.2000	0.9100	0.0000	0.0000	0.140	0.4270	0.140
6	.	0.2000	0.9400	0.0000	0.0000	0.166	0.4670	0.166
7	.	0.2000	1.0000	0.0000	0.0000	0.177	0.5230	0.177
8	.	0.2000	1.0000	0.0000	0.0000	0.183	0.6310	0.183
9	.	0.2000	1.0000	0.0000	0.0000	0.203	0.4510	0.203
10+	.	0.2000	1.0000	0.0000	0.0000	0.232	0.4510	0.232
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	.	0.2000	0.0000	0.0000	0.0000	0.031	0.0340	0.031
1	.	0.2000	0.1100	0.0000	0.0000	0.047	0.0820	0.047
2	.	0.2000	0.4000	0.0000	0.0000	0.072	0.0950	0.072
3	.	0.2000	0.8200	0.0000	0.0000	0.102	0.2510	0.102
4	.	0.2000	0.8600	0.0000	0.0000	0.121	0.3760	0.121
5	.	0.2000	0.9100	0.0000	0.0000	0.140	0.4270	0.140
6	.	0.2000	0.9400	0.0000	0.0000	0.166	0.4670	0.166
7	.	0.2000	1.0000	0.0000	0.0000	0.177	0.5230	0.177
8	.	0.2000	1.0000	0.0000	0.0000	0.183	0.6310	0.183
9	.	0.2000	1.0000	0.0000	0.0000	0.203	0.4510	0.203
10+	.	0.2000	1.0000	0.0000	0.0000	0.232	0.4510	0.232
Unit	Millions	-	-	-	-	Kilograms	-	Kilograms

Notes: Run name : MANXAN02
Date and time: 05MAY98:19:36

Table 6.5.2

Blue whiting, combined stock

Prediction with management option table

Year: 1998					Year: 1999					Year: 2000	
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
0.9993	0.4085	4656752	2718312	750000	0.0000	0.0000	4483210	3110901	0	4551186	3467512
.	.	.	.	.	0.1000	0.0409	.	3110901	105892	4438660	3369350
.	.	.	.	.	0.2000	0.0818	.	3110901	208486	4329686	3274413
.	.	.	.	.	0.3000	0.1226	.	3110901	307897	4224140	3182585
.	.	.	.	.	0.4000	0.1635	.	3110901	404237	4121902	3093754
.	.	.	.	.	0.5000	0.2044	.	3110901	497613	4022854	3007813
.	.	.	.	.	0.6000	0.2453	.	3110901	588127	3926886	2924659
.	.	.	.	.	0.7000	0.2862	.	3110901	675880	3833889	2844194
.	.	.	.	.	0.8000	0.3270	.	3110901	760966	3743761	2766321
.	.	.	.	.	0.9000	0.3679	.	3110901	843478	3656402	2690949
.	.	.	.	.	1.0000	0.4088	.	3110901	923504	3571716	2617990
.	.	.	.	.	1.1000	0.4497	.	3110901	1001128	3489611	2547358
.	.	.	.	.	1.2000	0.4906	.	3110901	1076434	3409997	2478973
.	.	.	.	.	1.3000	0.5314	.	3110901	1149500	3332791	2412755
.	.	.	.	.	1.4000	0.5723	.	3110901	1220401	3257909	2348629
.	.	.	.	.	1.5000	0.6132	.	3110901	1289212	3185272	2286522
.	.	.	.	.	1.6000	0.6541	.	3110901	1356003	3114803	2226364
.	.	.	.	.	1.7000	0.6950	.	3110901	1420841	3046430	2168087
.	.	.	.	.	1.8000	0.7358	.	3110901	1483792	2980081	2111627
.	.	.	.	.	1.9000	0.7767	.	3110901	1544920	2915688	2056920
.	.	.	.	.	2.0000	0.8176	.	3110901	1604285	2853185	2003908
-	-	Tonnes	Tonnes	Tonnes	-	-	Tonnes	Tonnes	Tonnes	Tonnes	Tonnes

Notes: Run name : MANXAN02
Date and time : 05MAY98:19:36
Computation of ref. F: Simple mean, age 3 - 7
Basis for 1998 : TAC constraints

Table 6.6.1 Blue whiting, results of medium term projection. Risk of SSB falling below B_{lim} of 1,500,000 tonnes in various years in the projection period.

Run no.	F	Catch ceiling(t)	Risk of SSB falling below B_{lim} of 1,500,000 tonnes in				
			1999	2001	2003	2005	2007
1	0.1	-	0.00	0.00	0.00	0.00	0.00
2	$0.21(F_{loss}e^{-1.645\sigma})$	-	0.00	0.02	0.01	0.03	0.03
3	0.32 (F_{loss})	-	0.02	0.07	0.11	0.14	0.14
4	0.41 (F_{sq})	-	0.05	0.12	0.17	0.22	0.24
5	-	634,000 (C_{sq})	0.02	0.04	0.04	0.08	0.09
6	-	800,000	0.05	0.10	0.16	0.20	0.23
7	-	1,000,000	0.05	0.21	0.34	0.48	0.54

Table 6.6.2 Blue whiting, results of medium term projection. Catch in the last year of the projection period.

Run no.	F	Catch ceiling (t)	Catch in year 2007 ('000 t.)				
			Percentiles				
			5%	25%	50%	75%	95%
1	0.1	-	290	390	471	587	855
2	$0.21(F_{loss}e^{-1.645\sigma})$	-	435	549	668	836	1160
3	0.32 (F_{loss})	-	373	575	696	892	1370
4	0.41 (F_{sq})	-	322	554	725	957	1280
5	-	634,000 (C_{sq})	634	634	634	634	634
6	-	800,000	518	799	800	800	800
7	-	1,000,000	140	982	1000	1000	1000

Table 6.8.1 Total catches of BLUE WHITING in 1978–1997 divided into areas within and beyond areas of national fisheries juridiction of NEAFC contracting parties, as estimated by the Working Group members.

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%)	

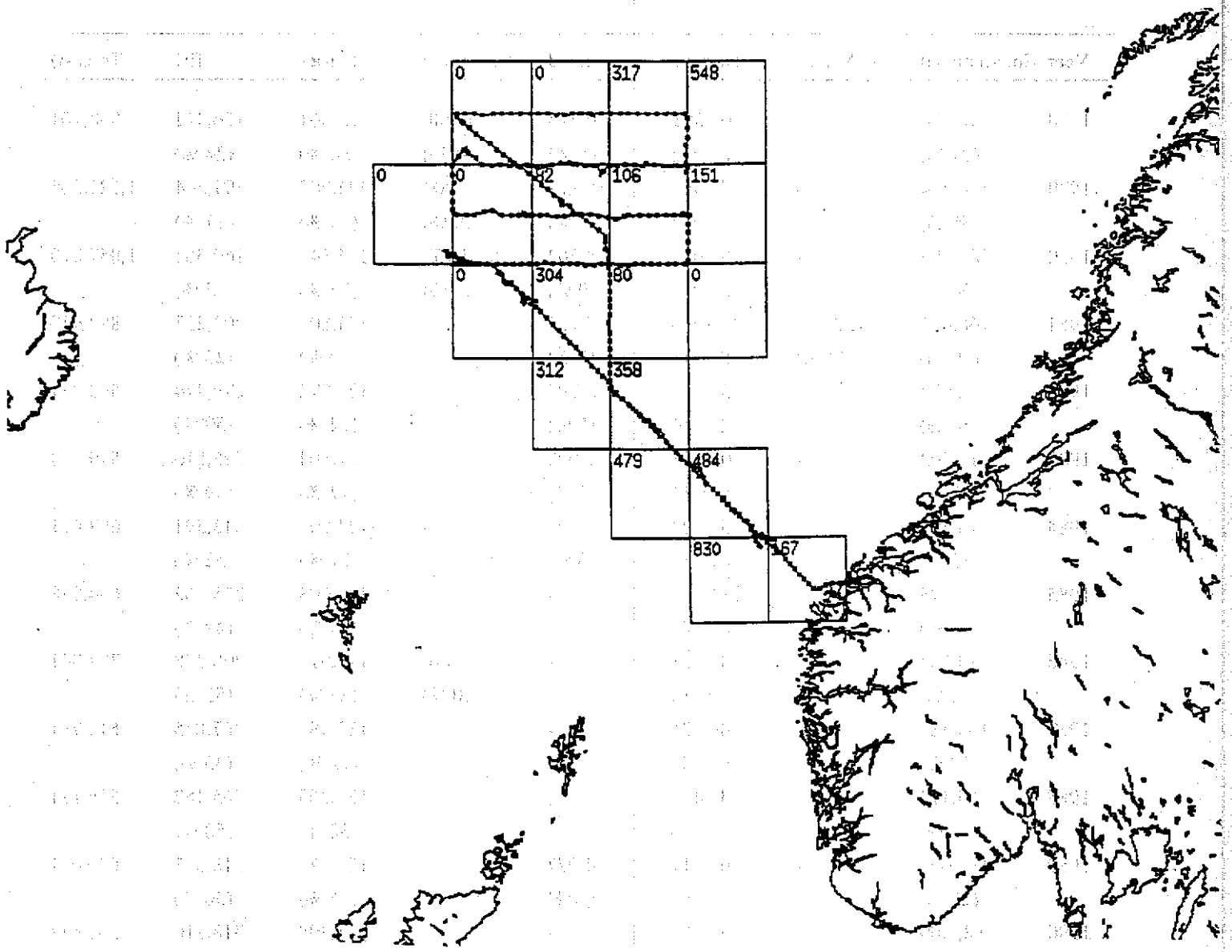


Figure 6.4.1.1.1 Cruise track and blue whiting distribution. Mean S_A-values by rectangle. R.V. "G.O. Sars" 6–20/4 1997.

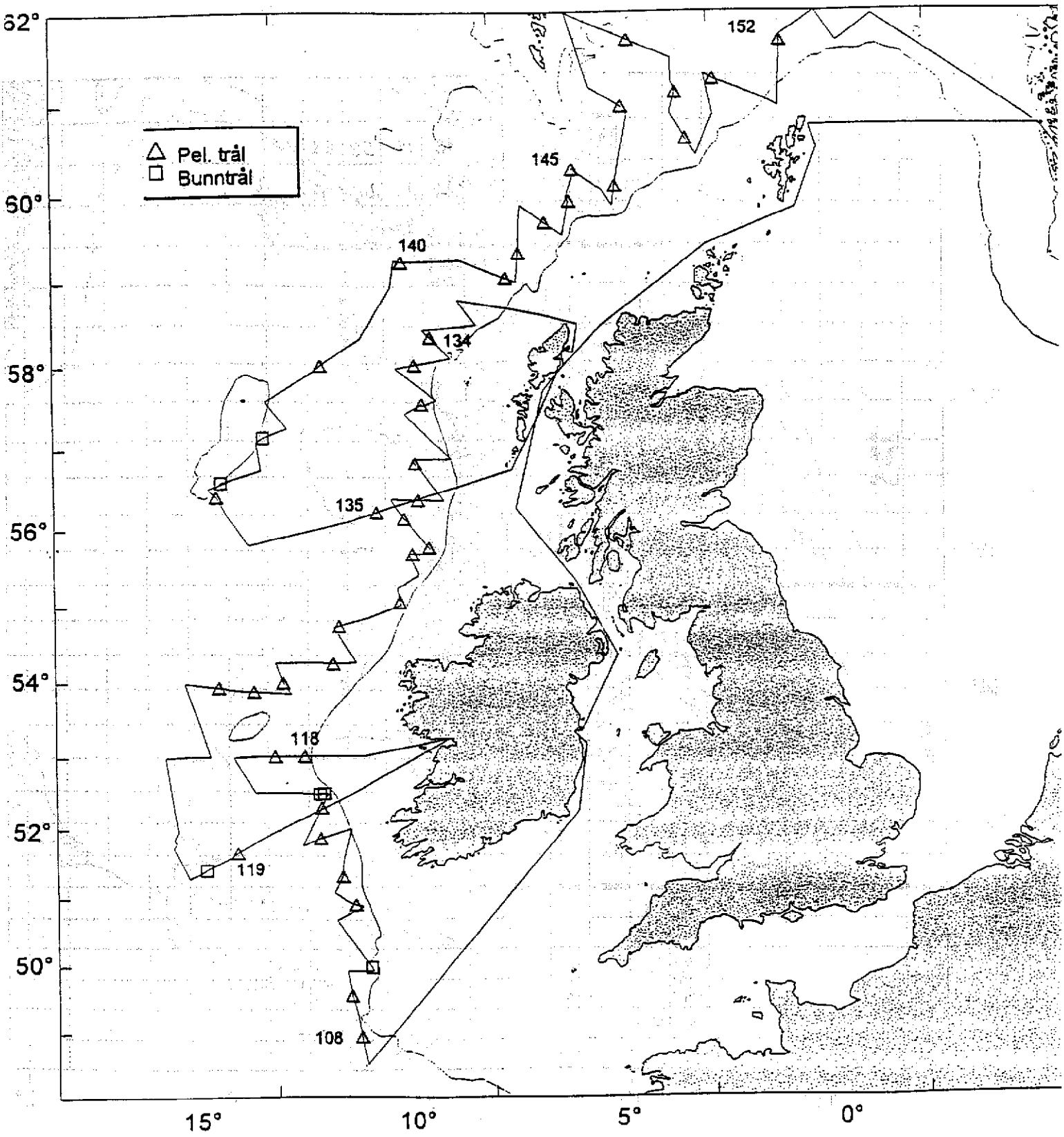


Figure 6.4.1.1.2 Cruise track and trawl stations, R.V. "Johan Hjort" 24/3–26/4 1998.

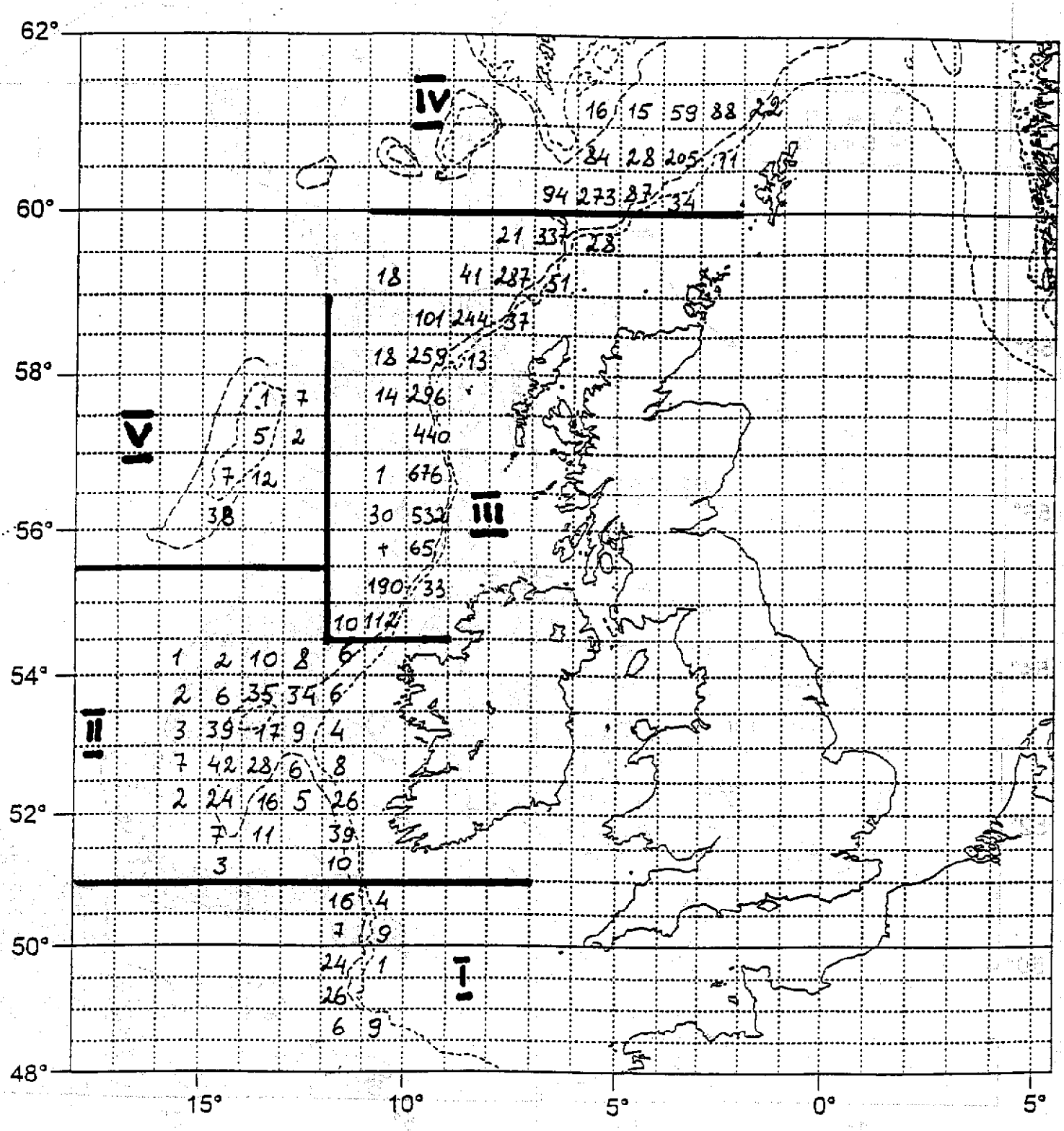


Figure 6.4.1.1.3 Biomass estimate (1,000 tonnes) of blue whiting during spring 1998.

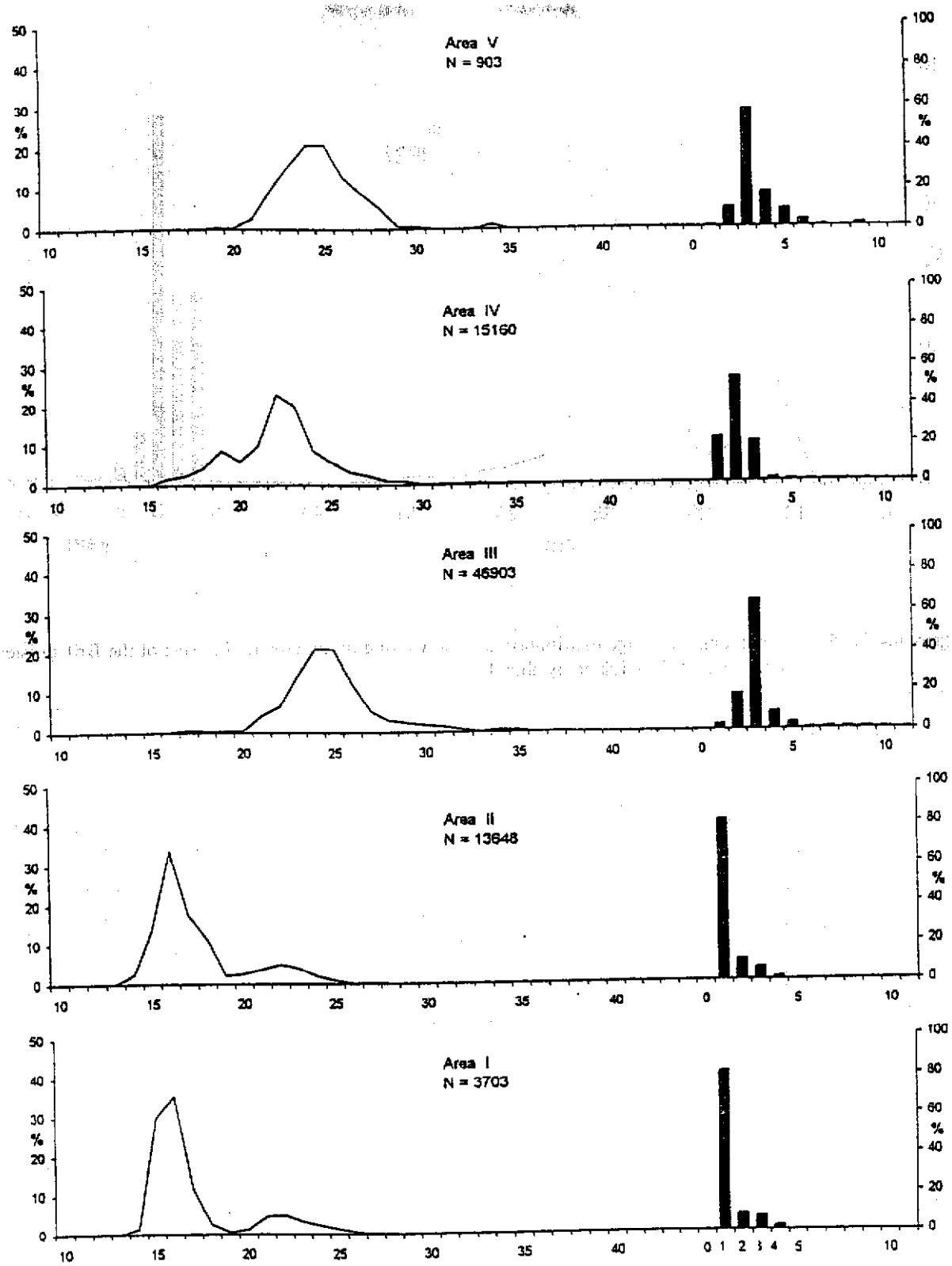


Figure 6.4.1.1.4 Length and age distribution of blue whiting by Sub-areas (marked on Figure 6.4.1.1.3) in the area to the west of the British isles, spring 1998. N x 10^{-6}, weighted by abundance.

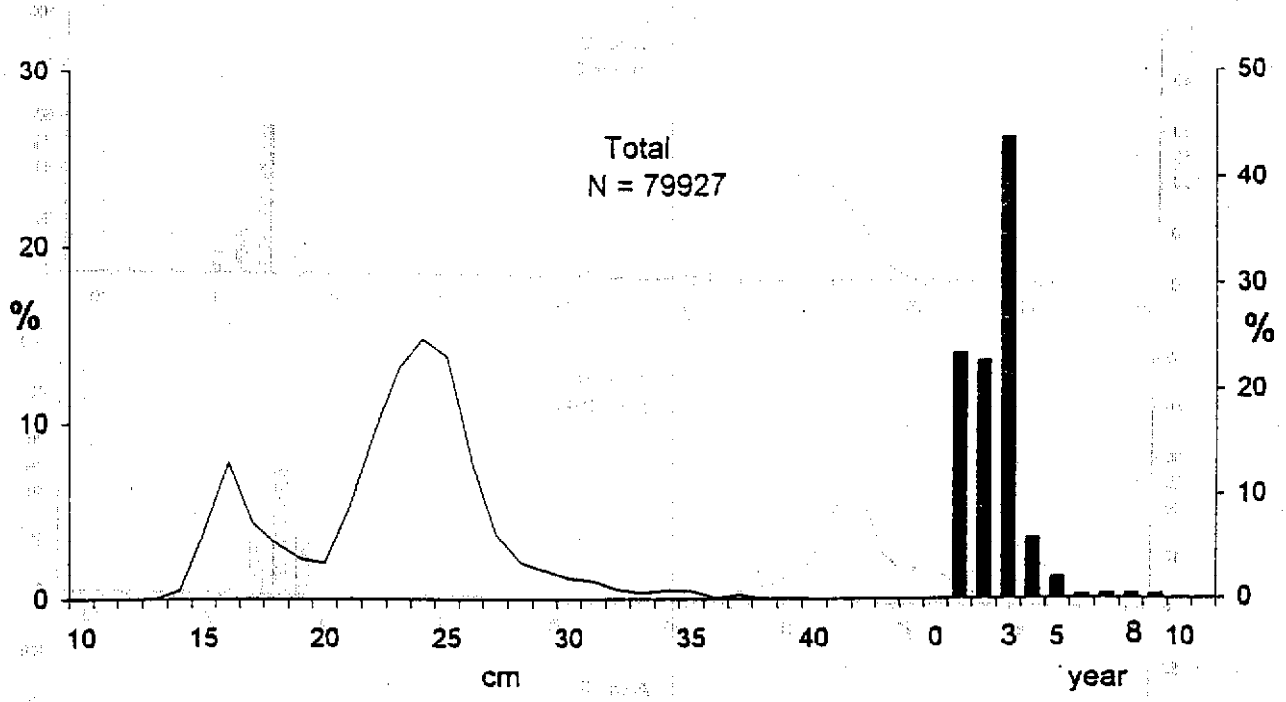


Figure 6.4.1.1.5 Total length and age distribution of blue whiting in the area to the west of the British isles, spring 1998. N x 10^{-6}, weighted by abundance.

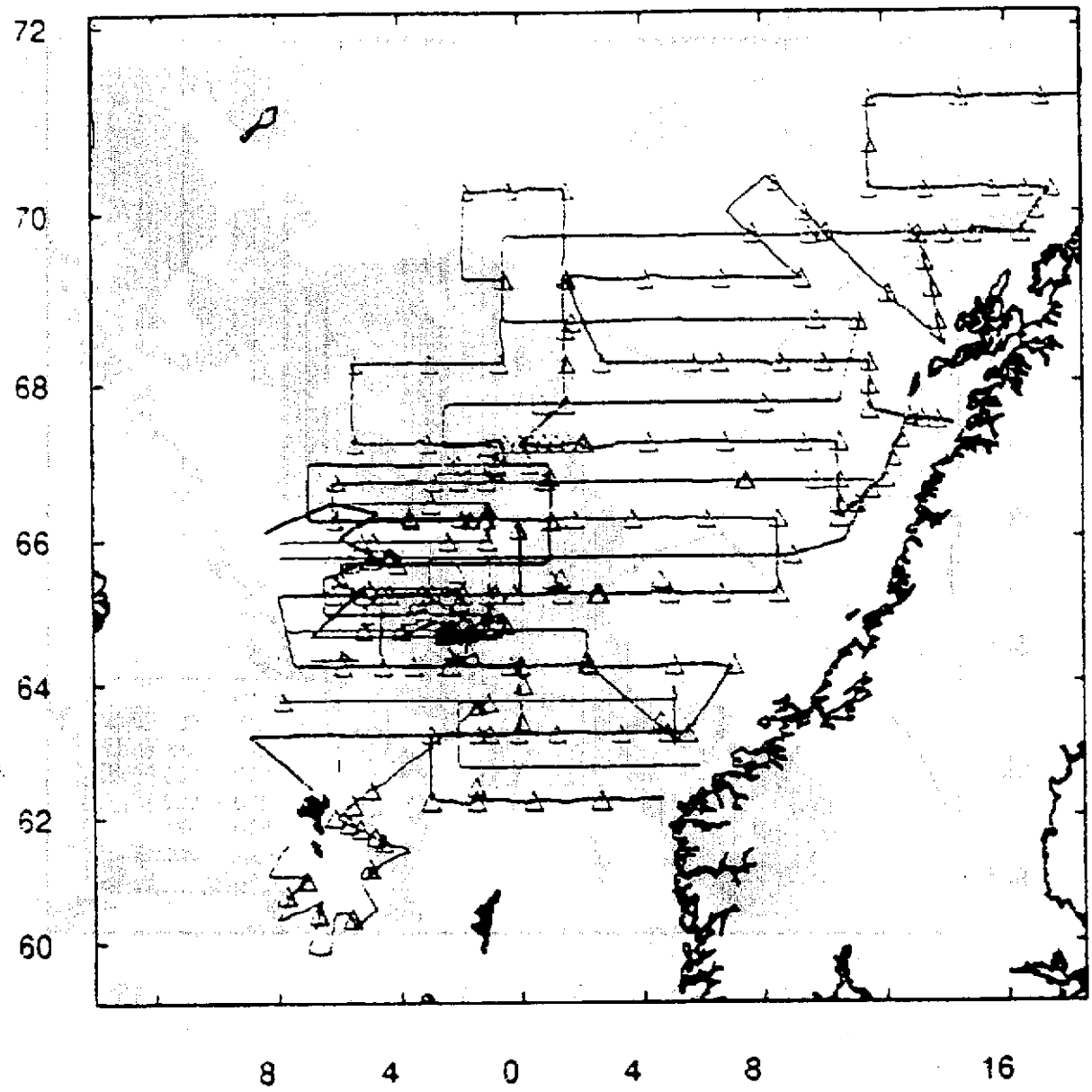


Figure 6.4.1.2.1 Cruise tracks and pelagic trawl stations in the international acoustic herring survey in the Norwegian Sea in May 1997.

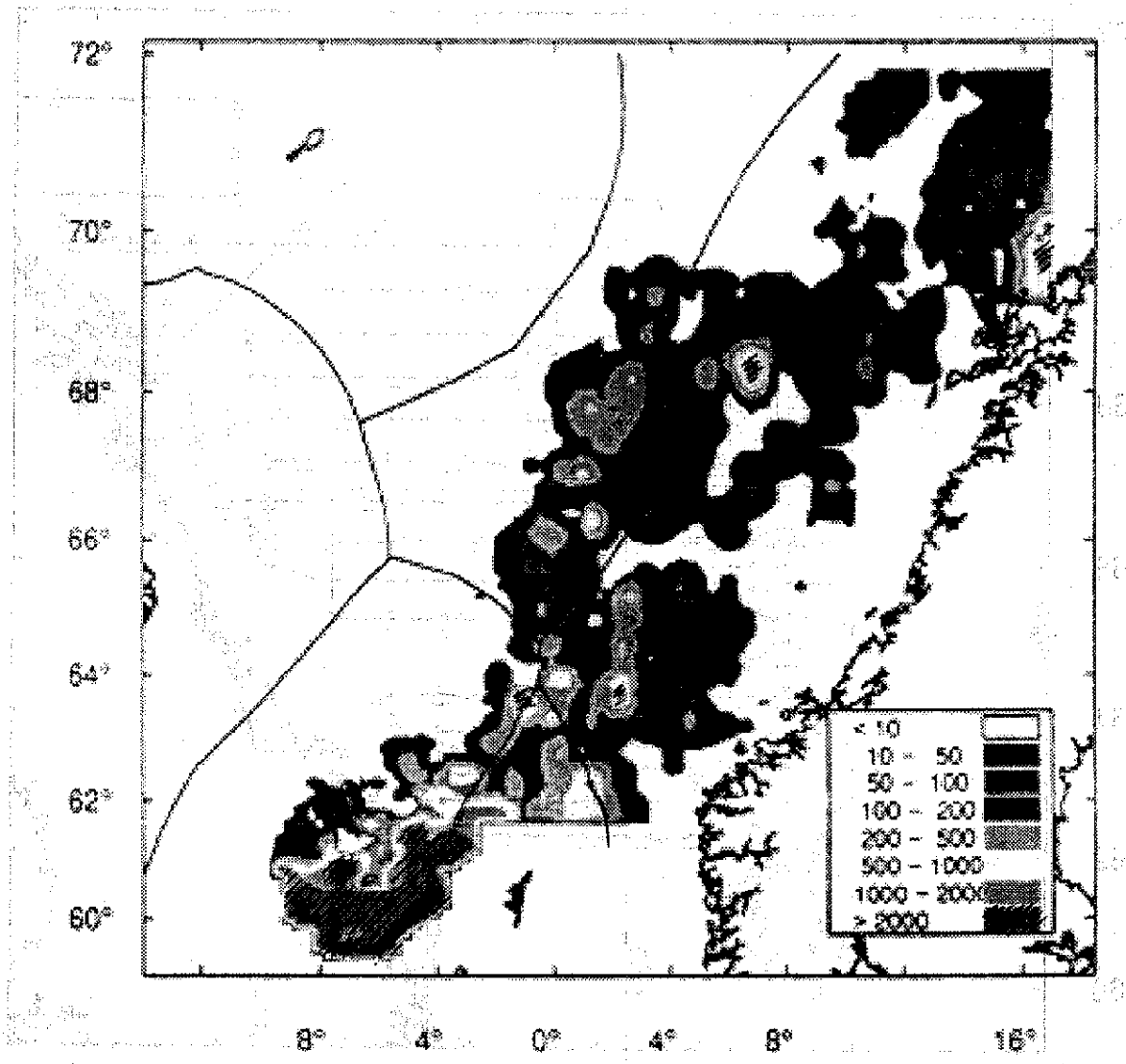


Figure 6.4.1.2.2 Distribution and abundance (S^A values) of blue whiting in May 1997. Coverage was not complete in the southern and in the northeastern areas.

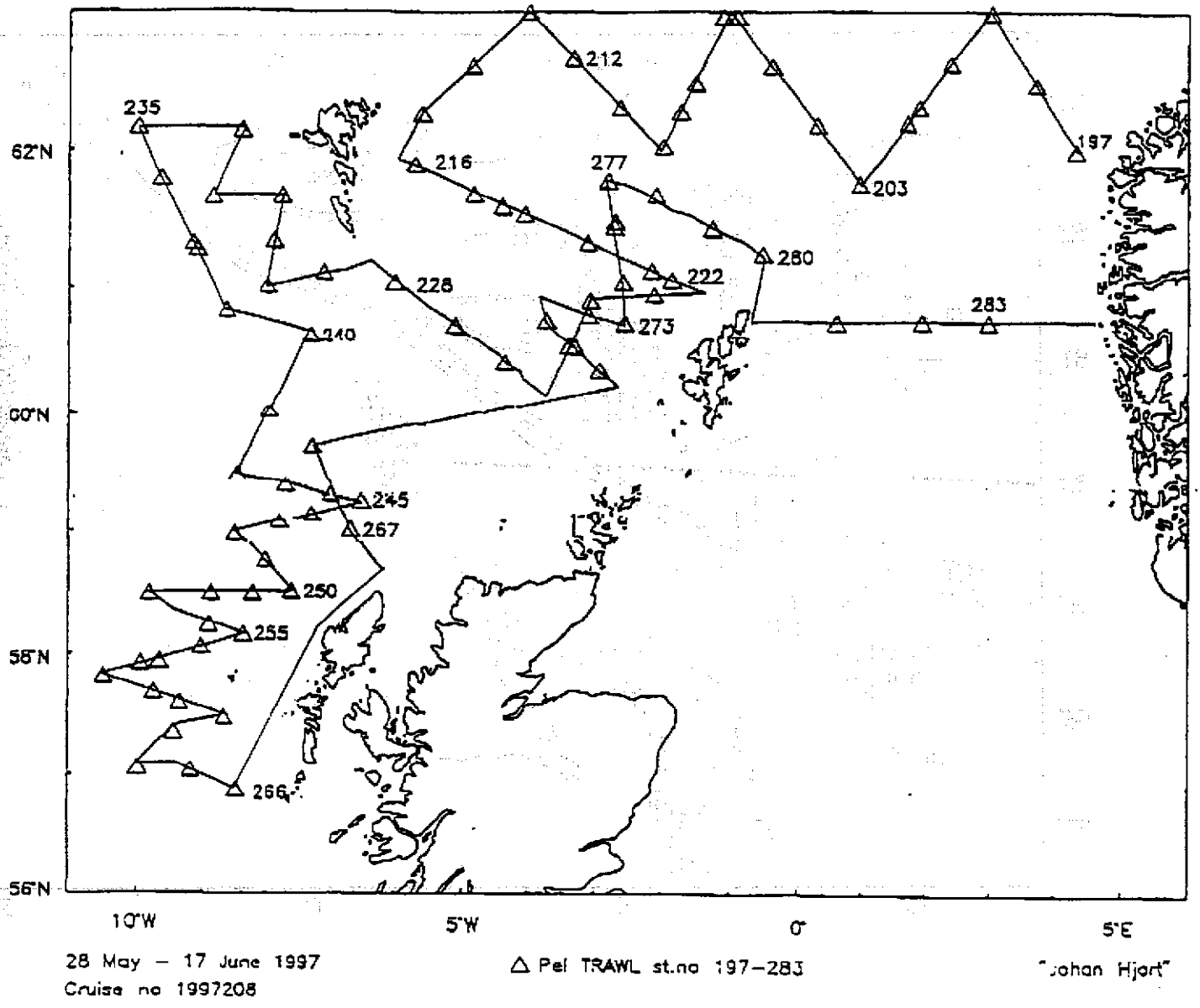


Figure 6.4.1.2.3 Cruise track and pelagic trawl stations of R.V. "Johan Hjort", 28/5–17/6 1997.

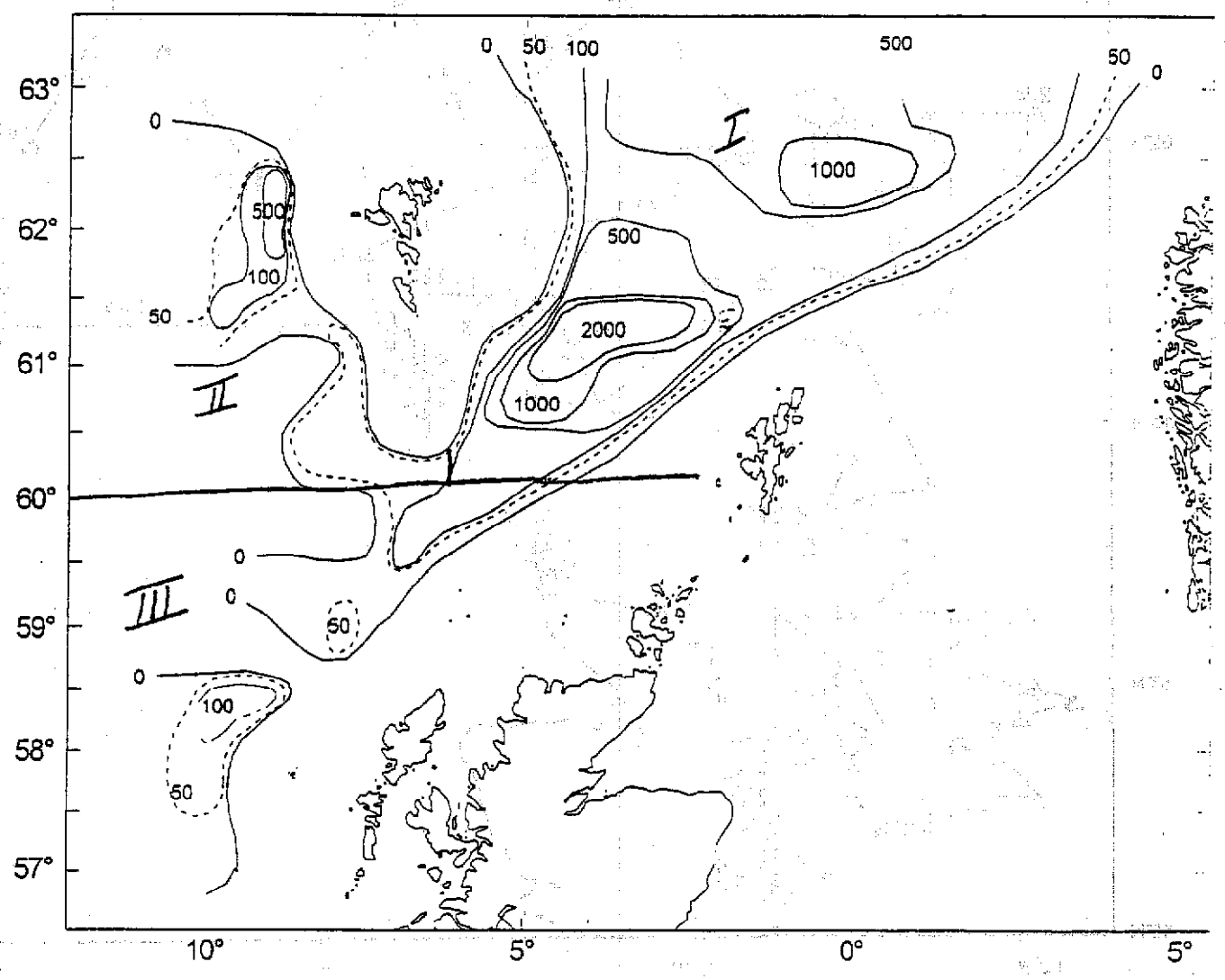


Figure 6.4.1.2.4 Distribution of blue whiting, S^A values, May–June 1997.

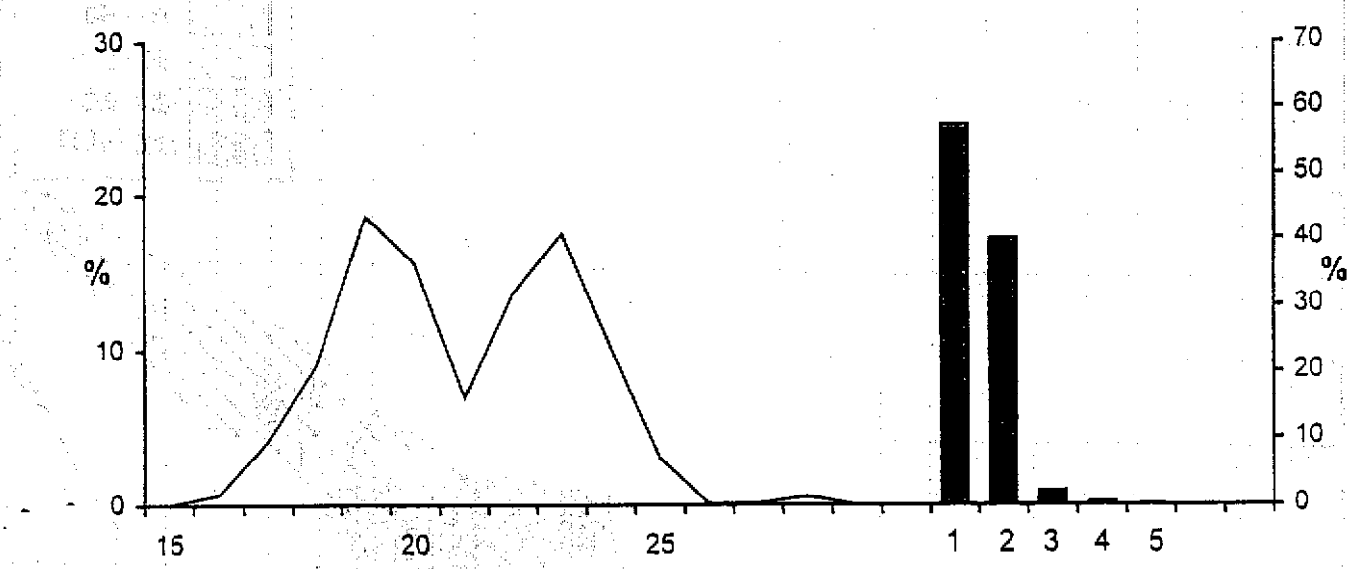


Figure 6.4.1.2.5 Total length and age distribution of blue whiting, May–June 1997. N = 47.8 x 10^{-9}.

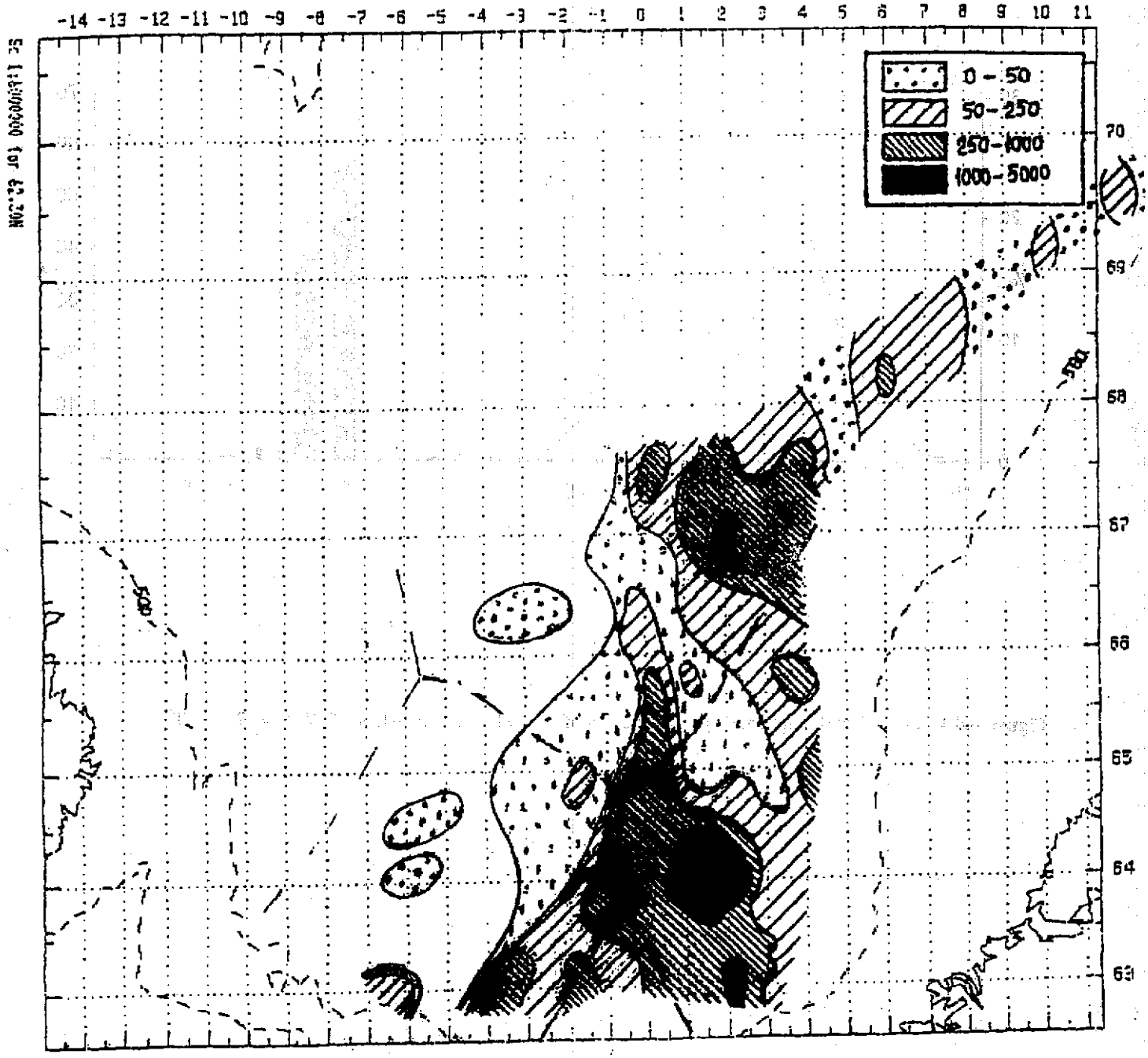


Figure 6.4.1.2.6 Blue whiting distribution in June 1997, recorded by R.V. "Atlantida".

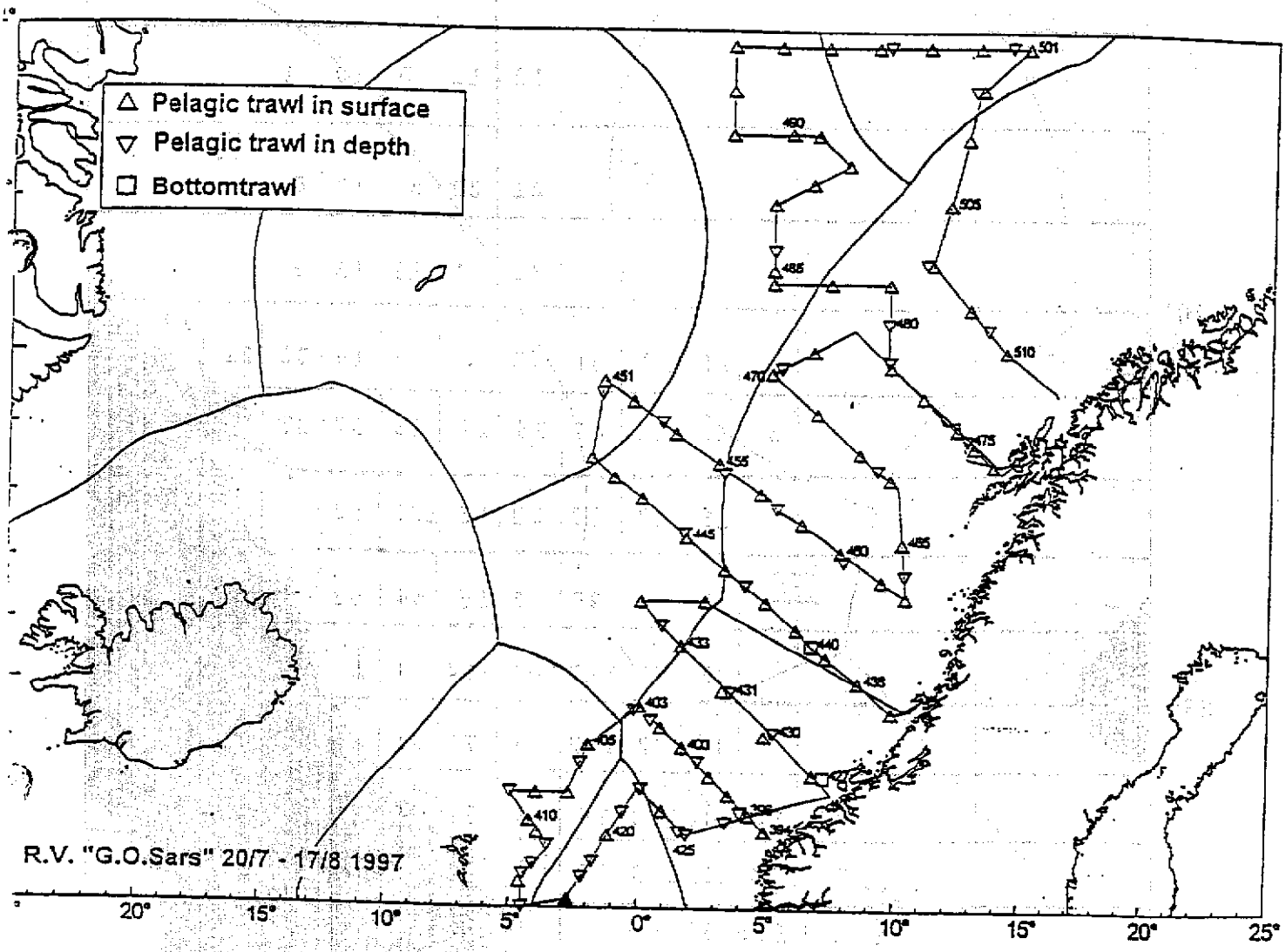


Figure 6.4.1.2.7 Cruise track and trawl stations of R.V. "G.O. Sars" 20/7–17/8 1997.

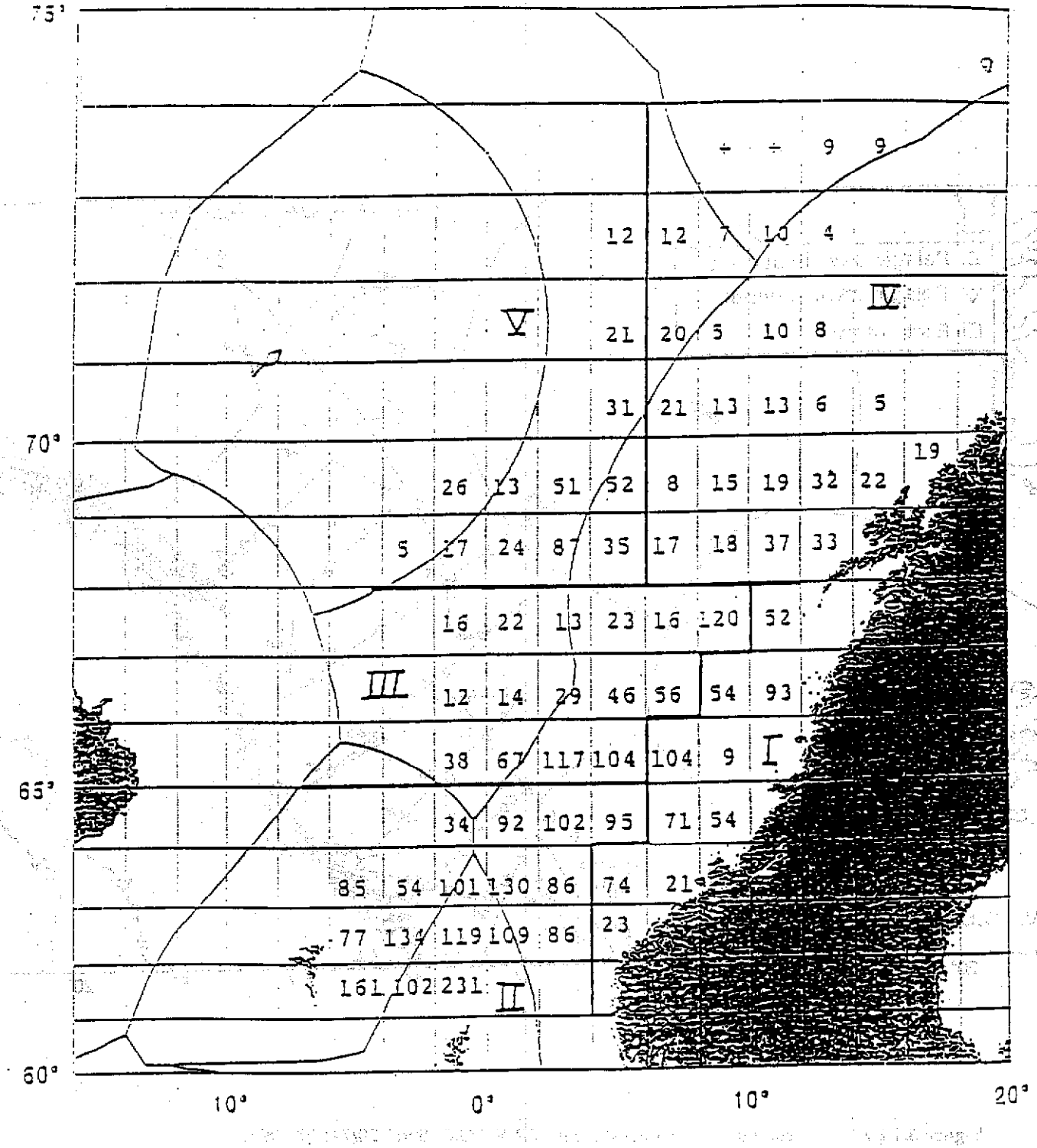


Figure 6.4.1.2.8 Biomass estimate (1,000 tonnes) of blue whiting, July–August 1997.

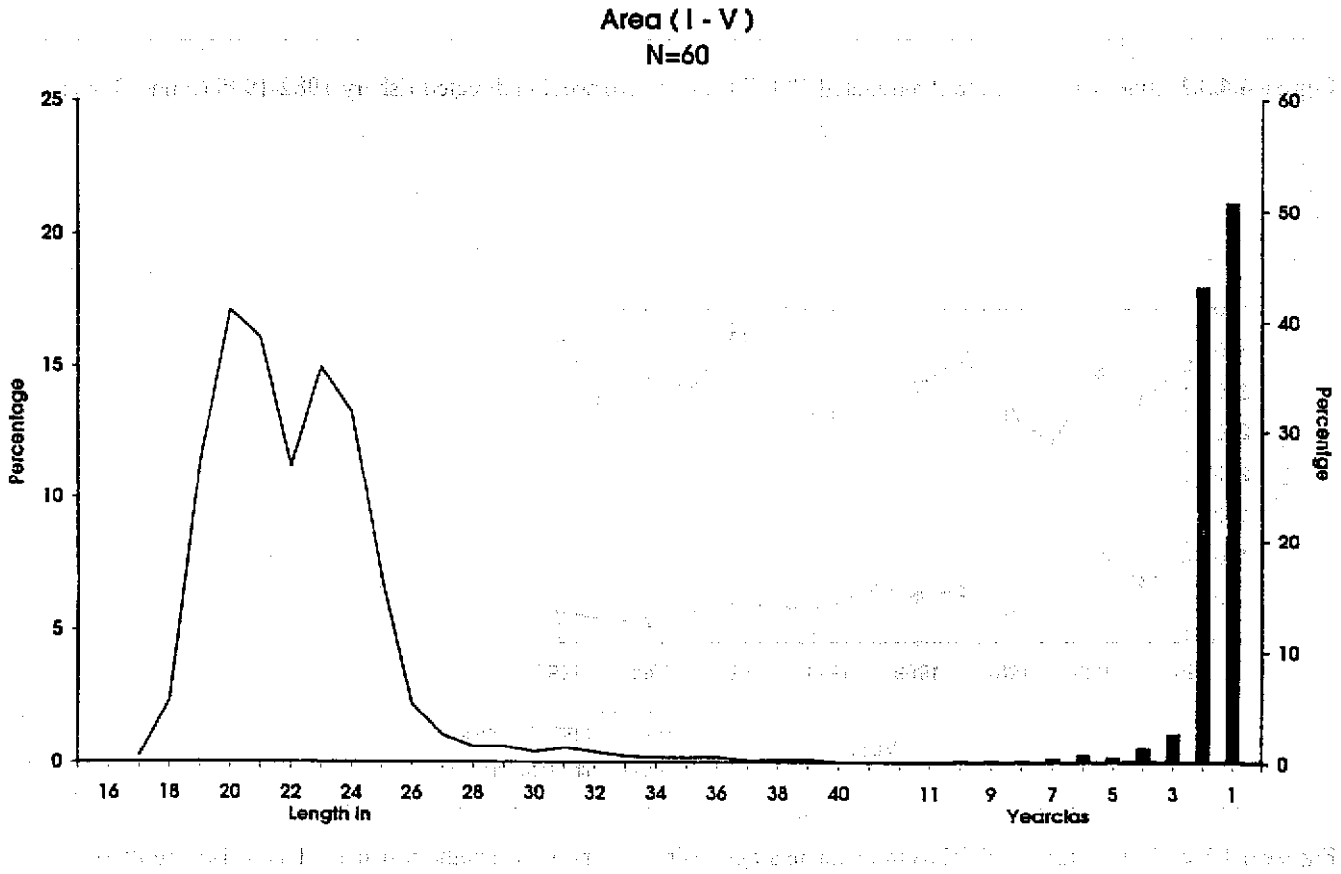


Figure 6.4.1.2.9 Total length and age distribution of blue whiting, July–August 1997. N = 10^9.

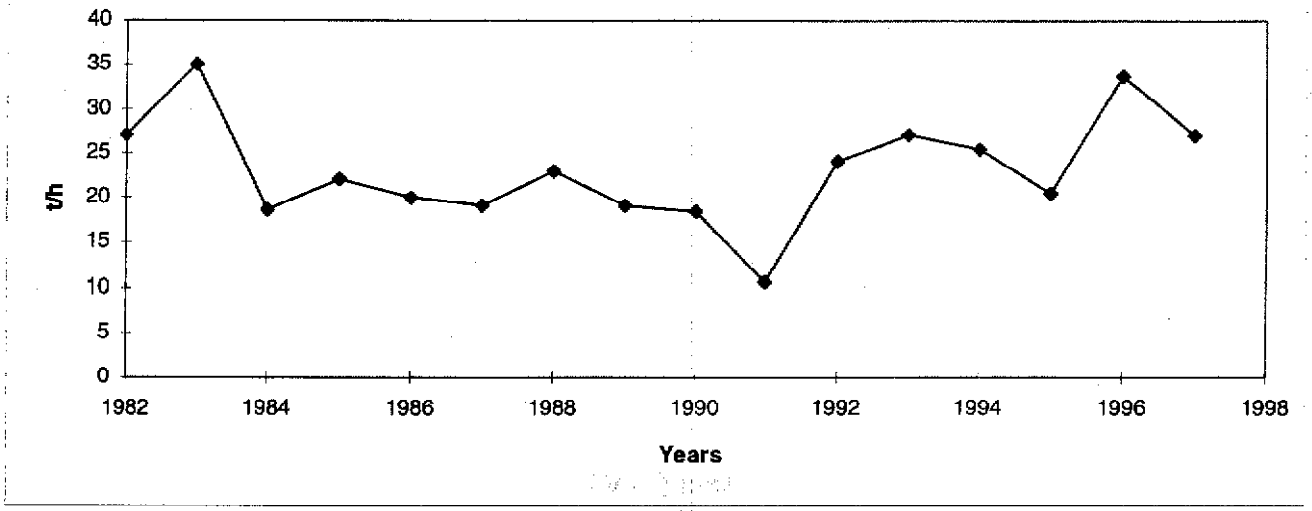


Figure 6.4.3.1 Blue whiting. Overall agregated CPUE from the Norwegian directed fishery 1982-1995 (tonnes/hour)

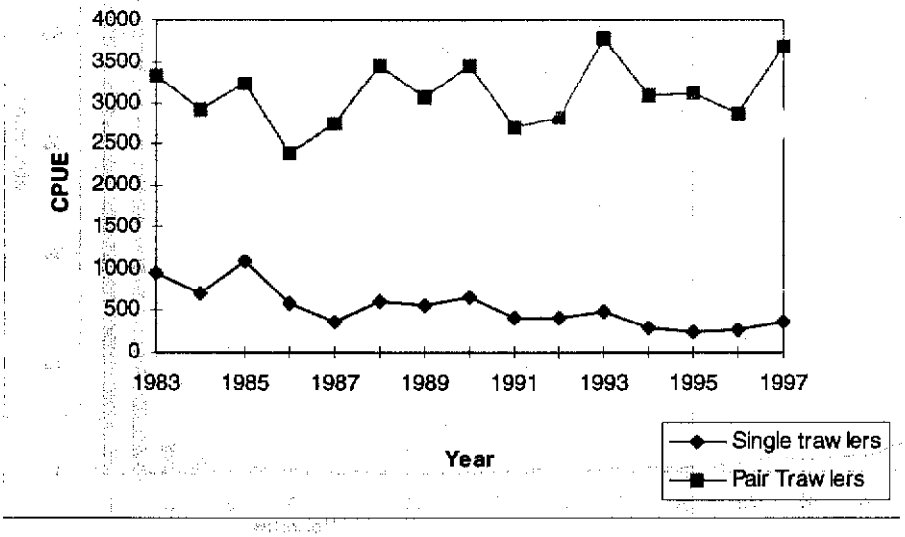


Figure 6.4.3.2 Blue whiting. CPUE from Galician single pair trawlers in the southern fishery (Div VIIIc and IXa).

Figure 6.4.4.1.1 Blue whiting: plot of terminal F 1997 for each fleet

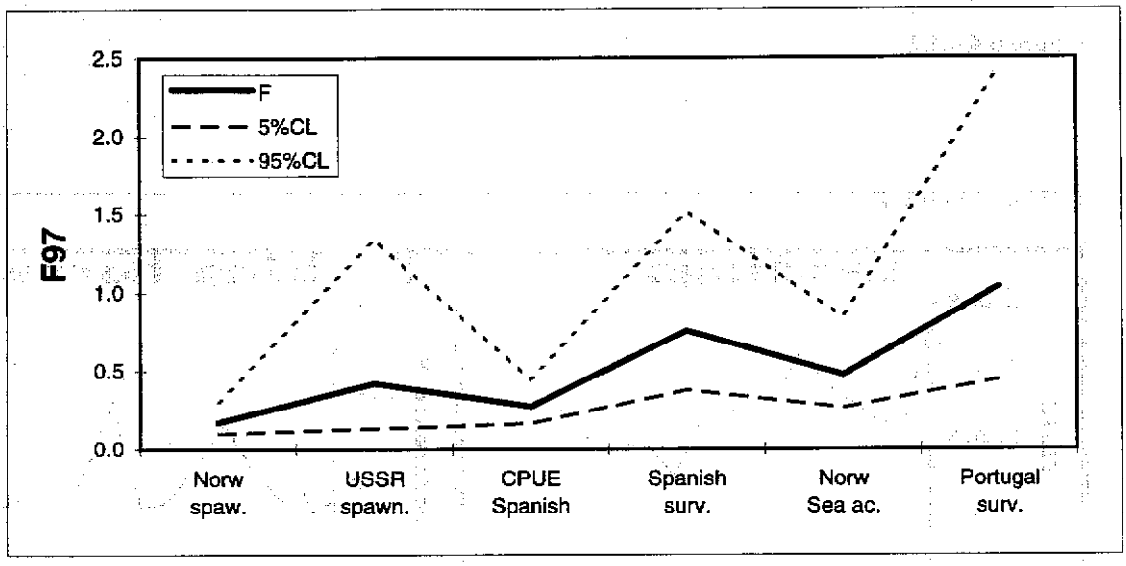


Figure 6.4.4.1.2

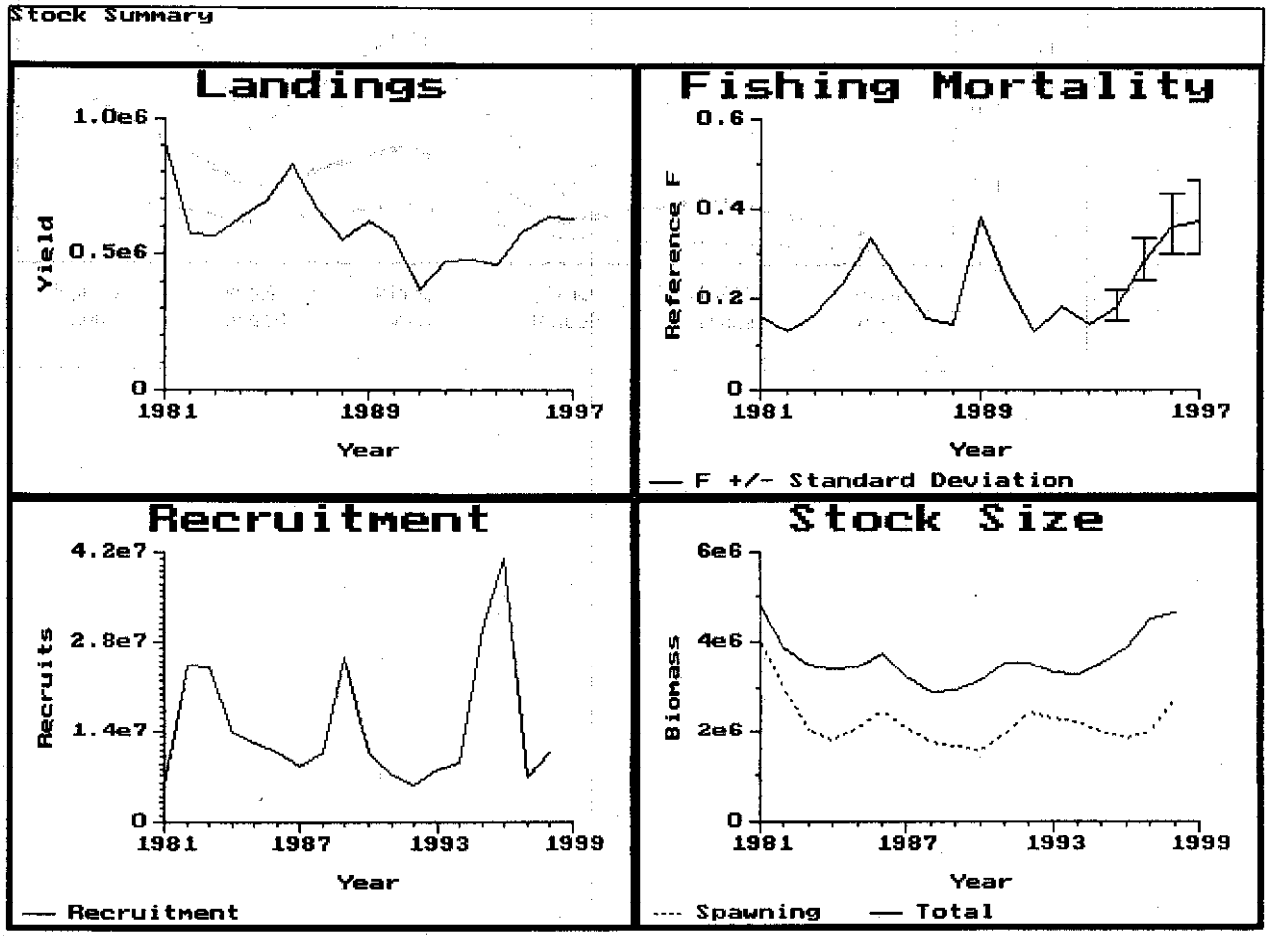


Figure 6.4.4.1.3

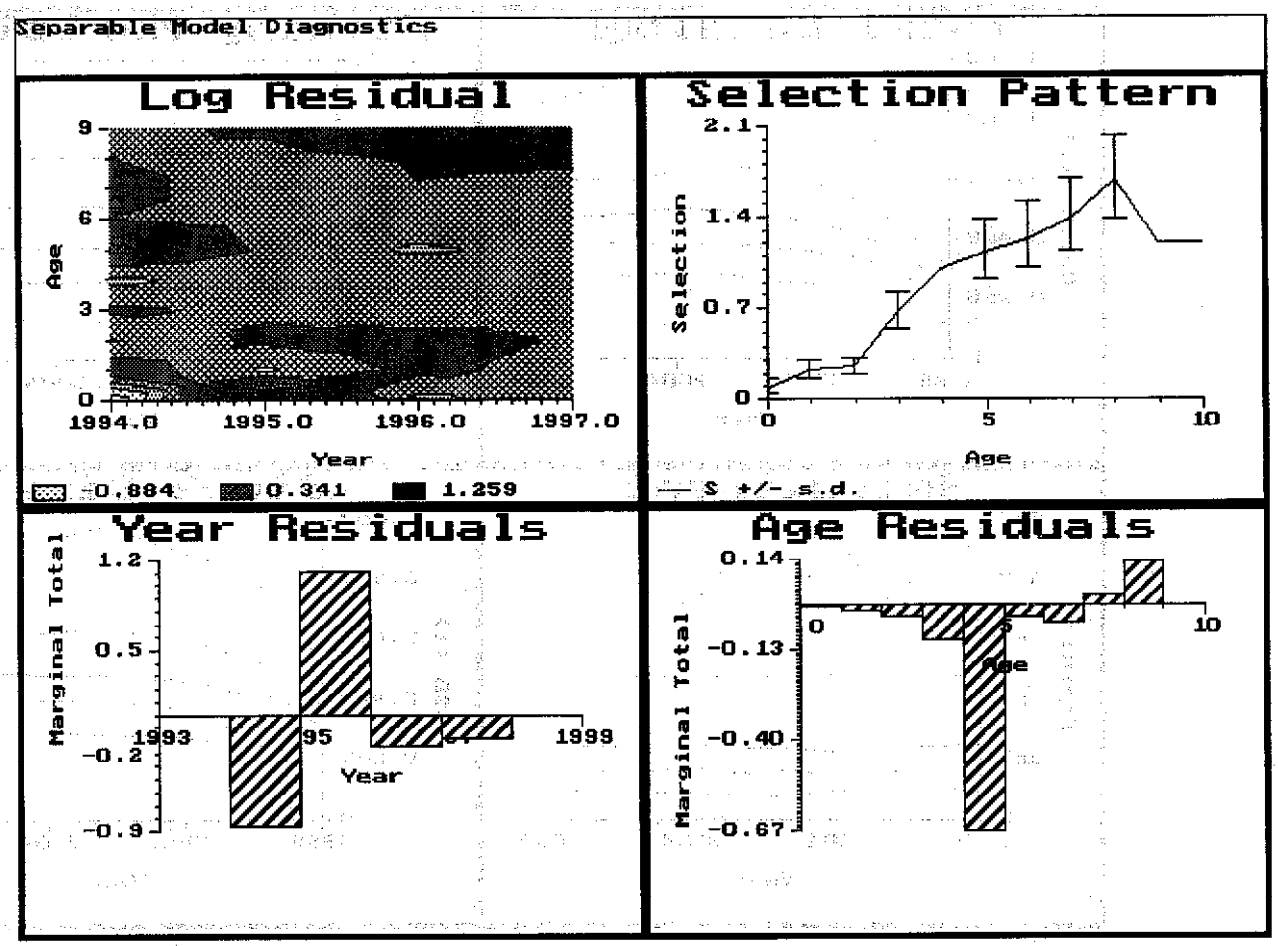


Figure 6.6.1 Run 1

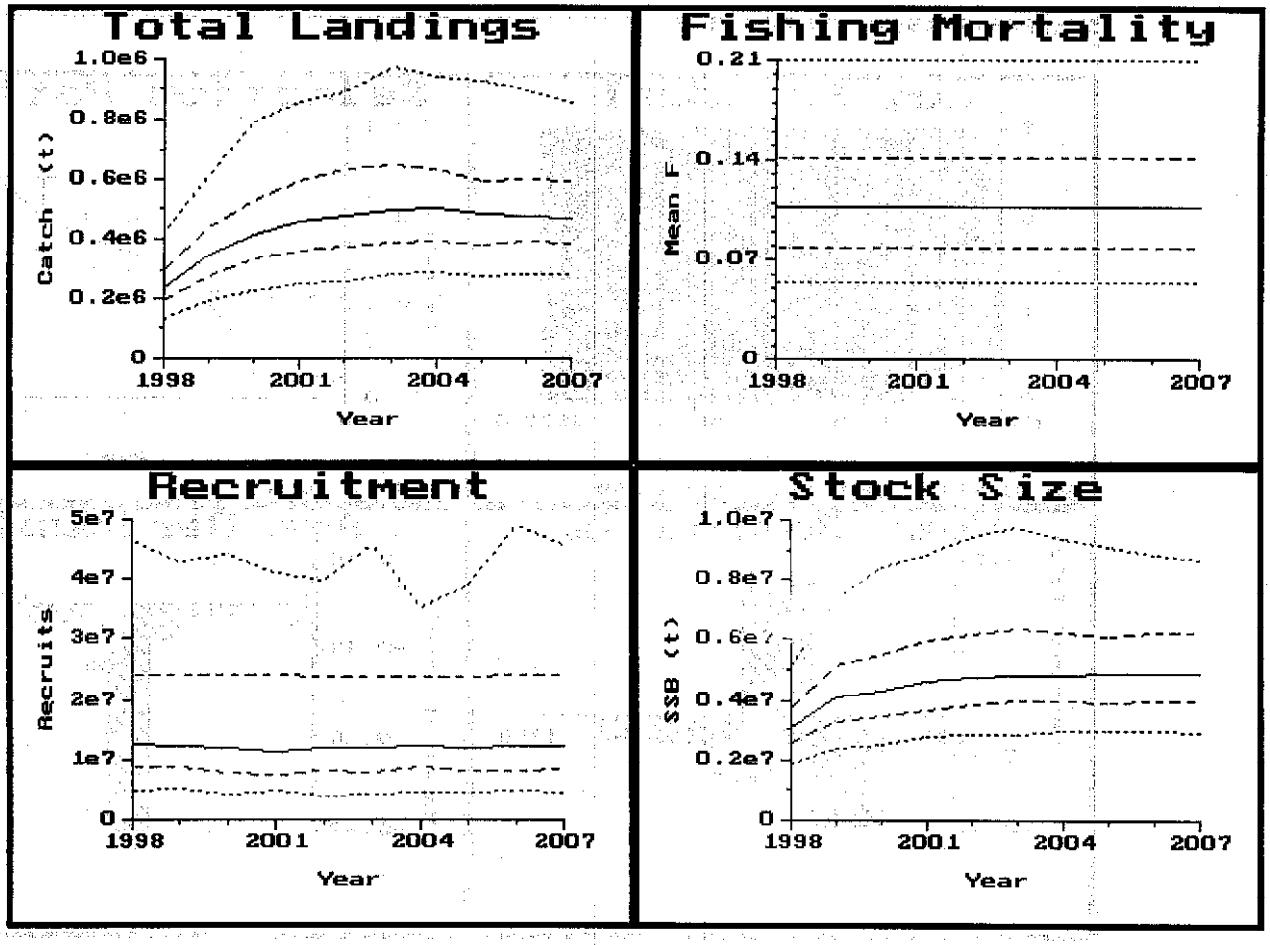


Figure 6.6.2 Run 1

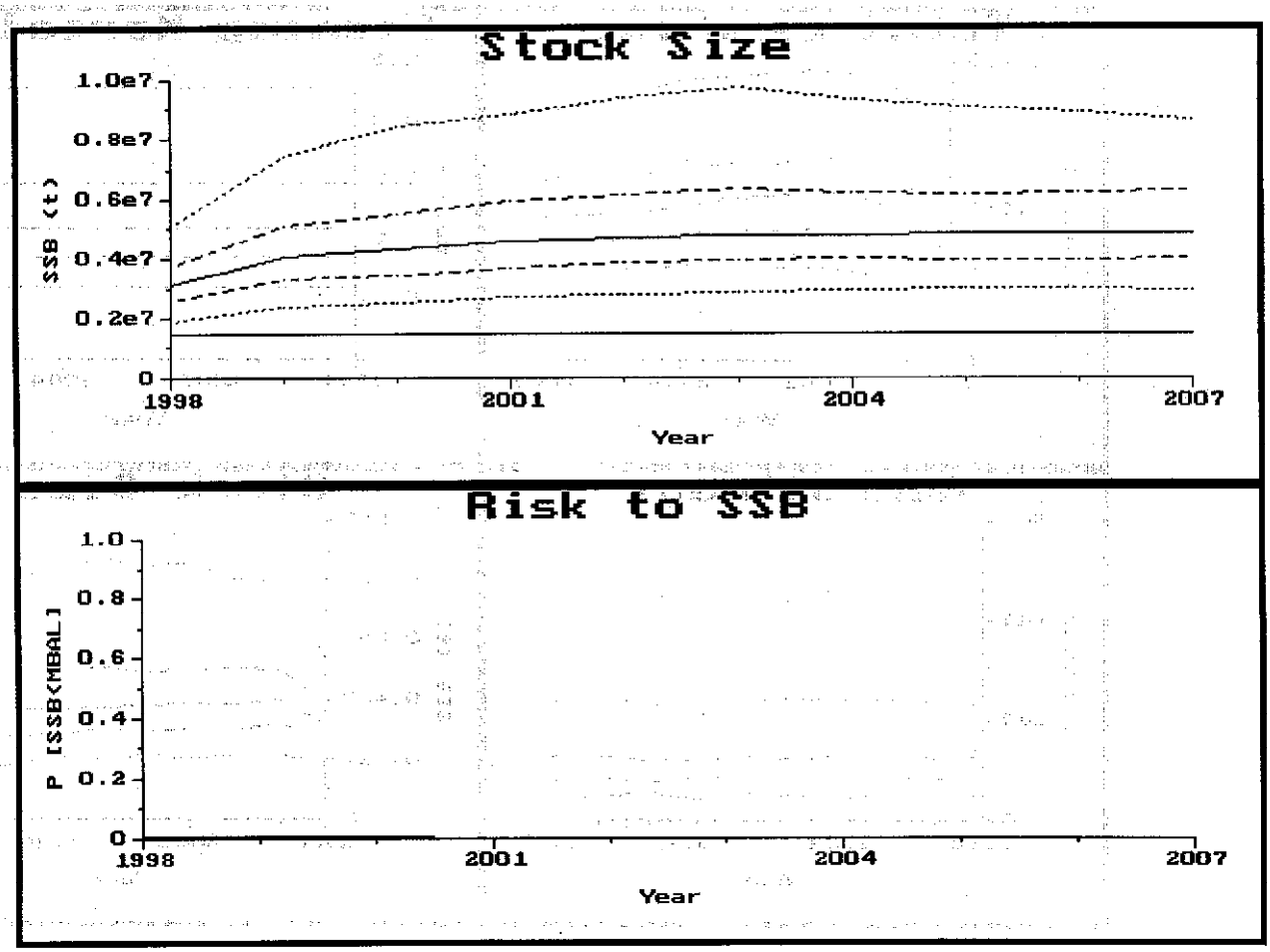


Figure 6.6.3 Run 2

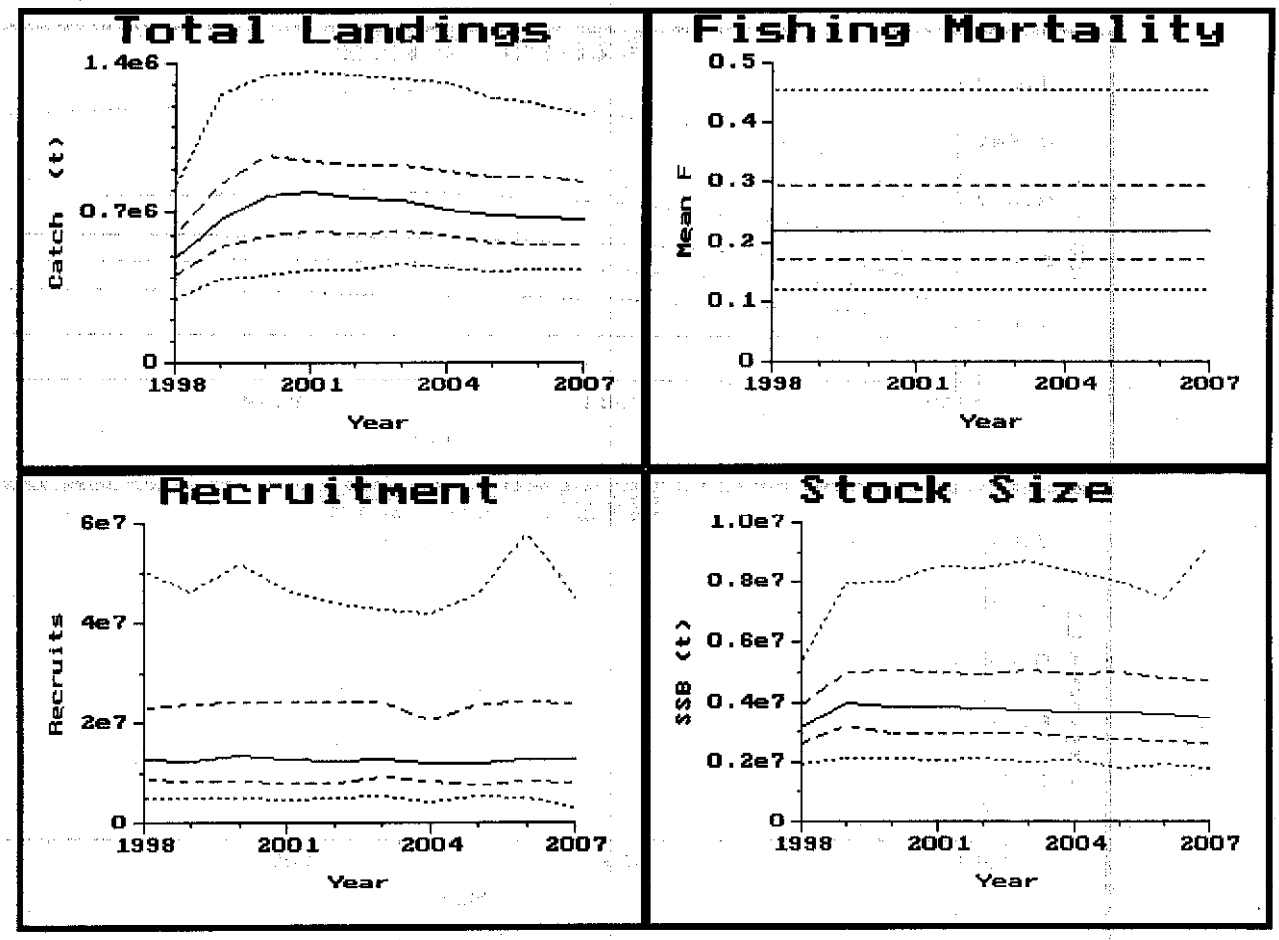


Figure 6.6.4 Run 2

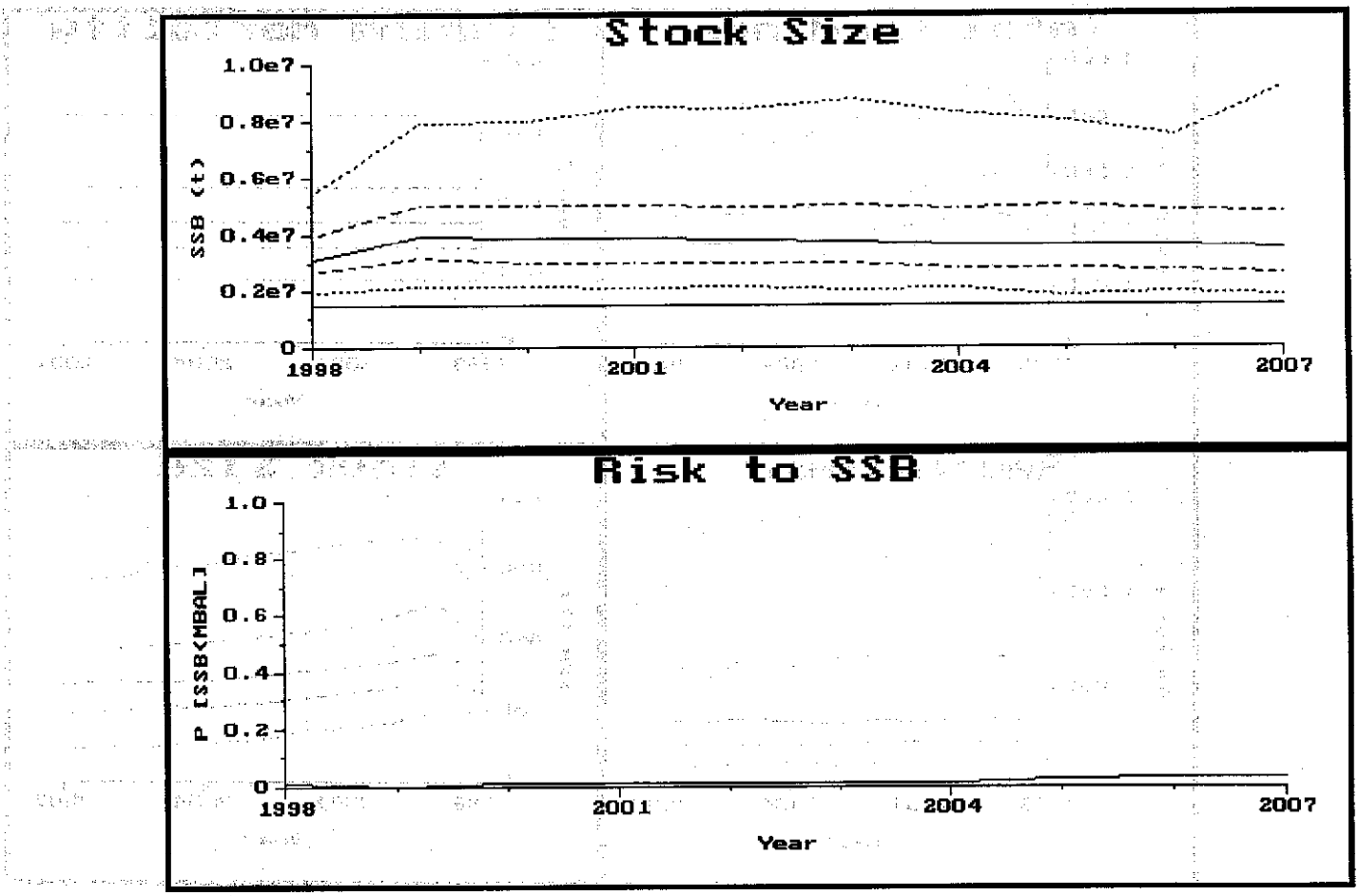


Figure 6.6.5 Run 3

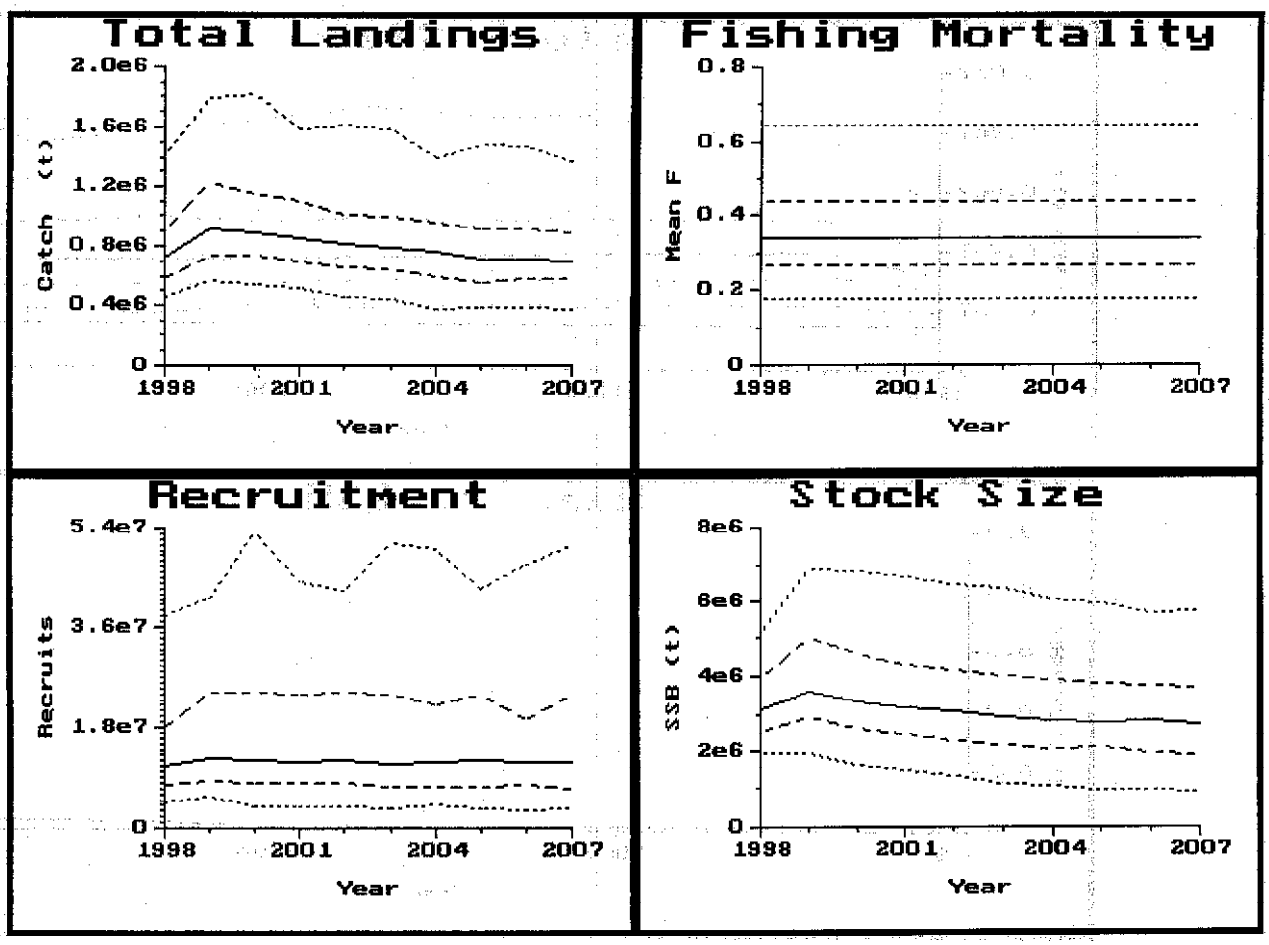


Figure 6.6.6 Run 3

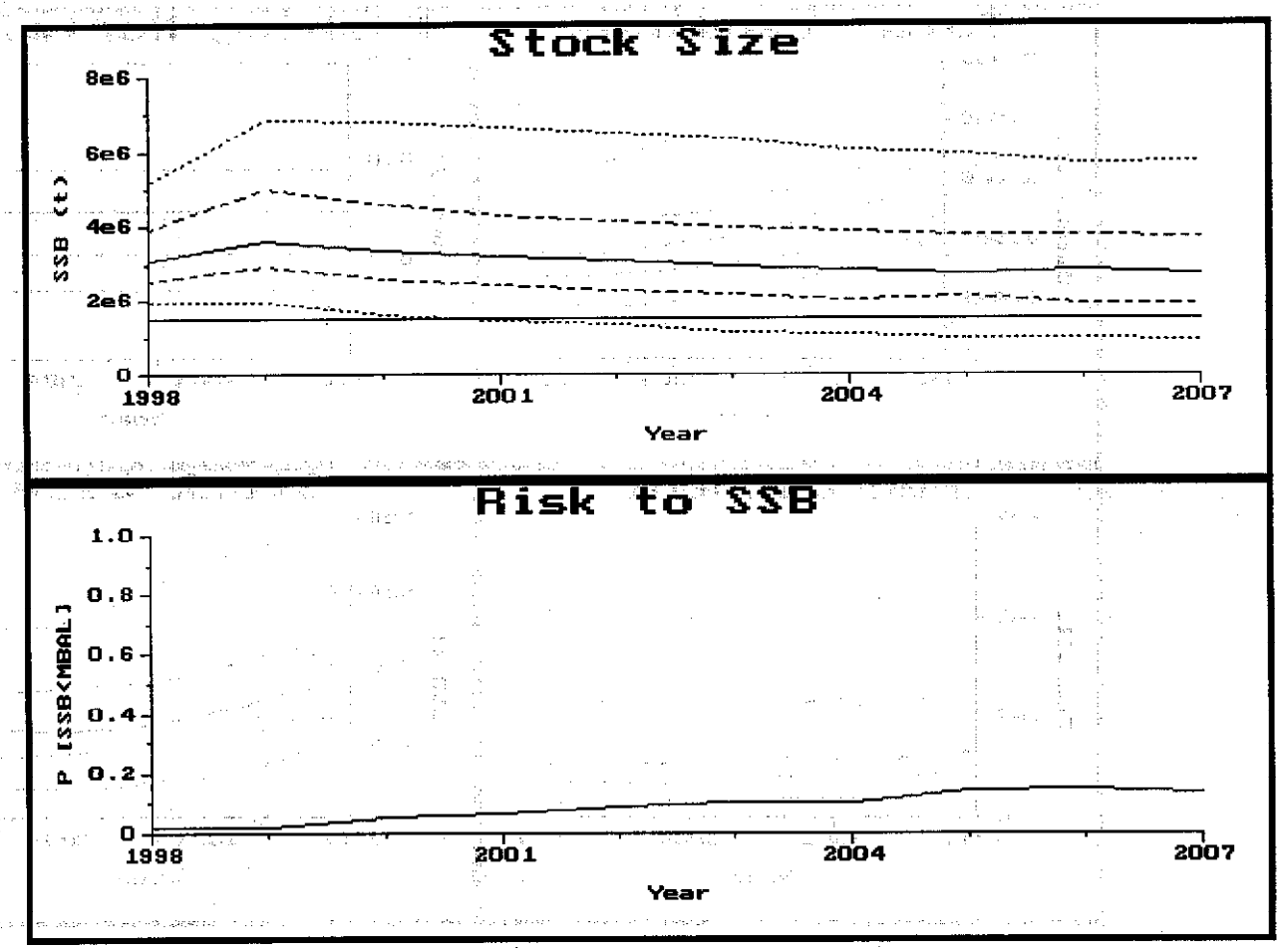


Figure 6.6.7 Run 4

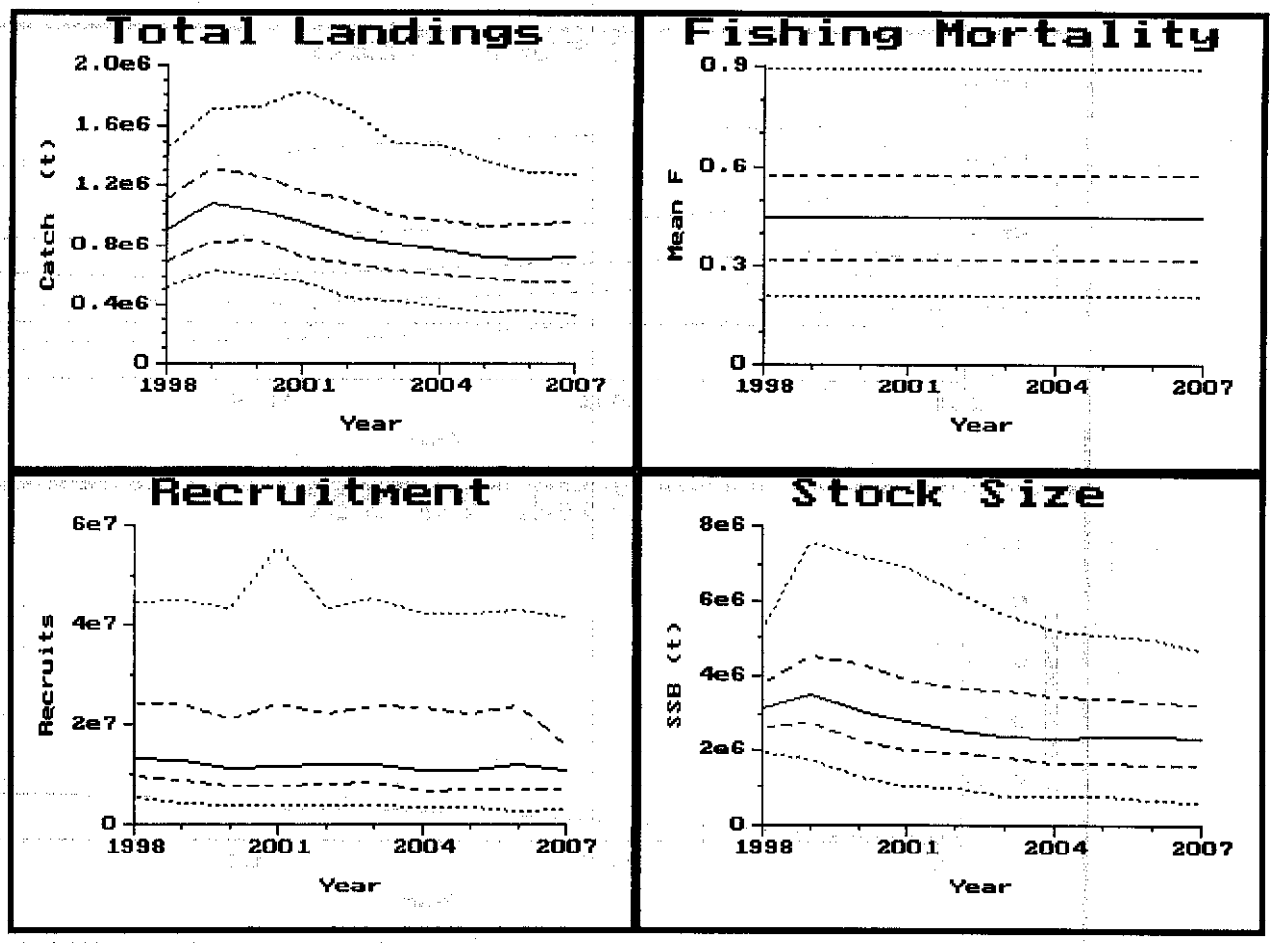


Figure 6.6.8 Run 4

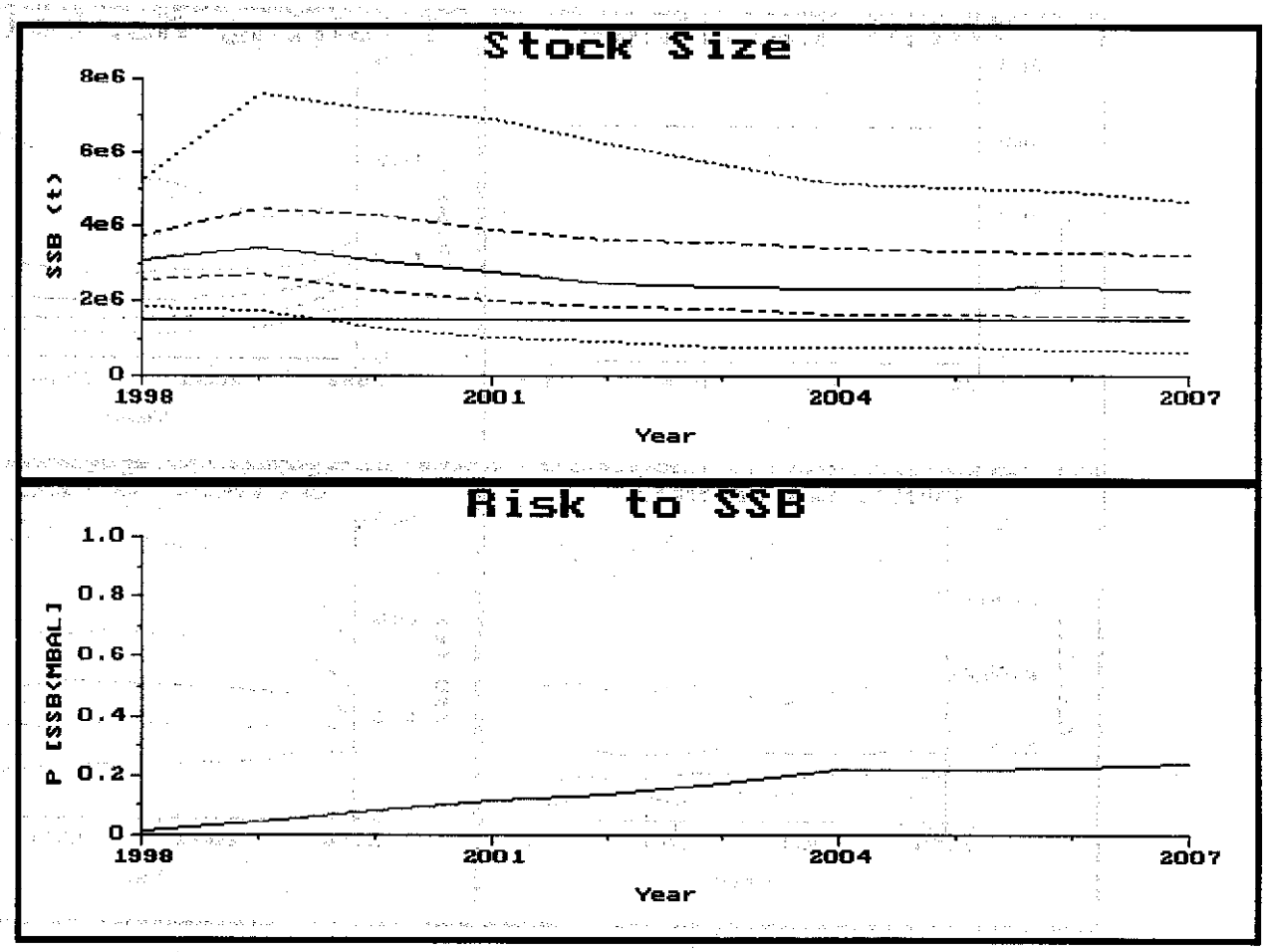


Figure 6.6.9 Run 5

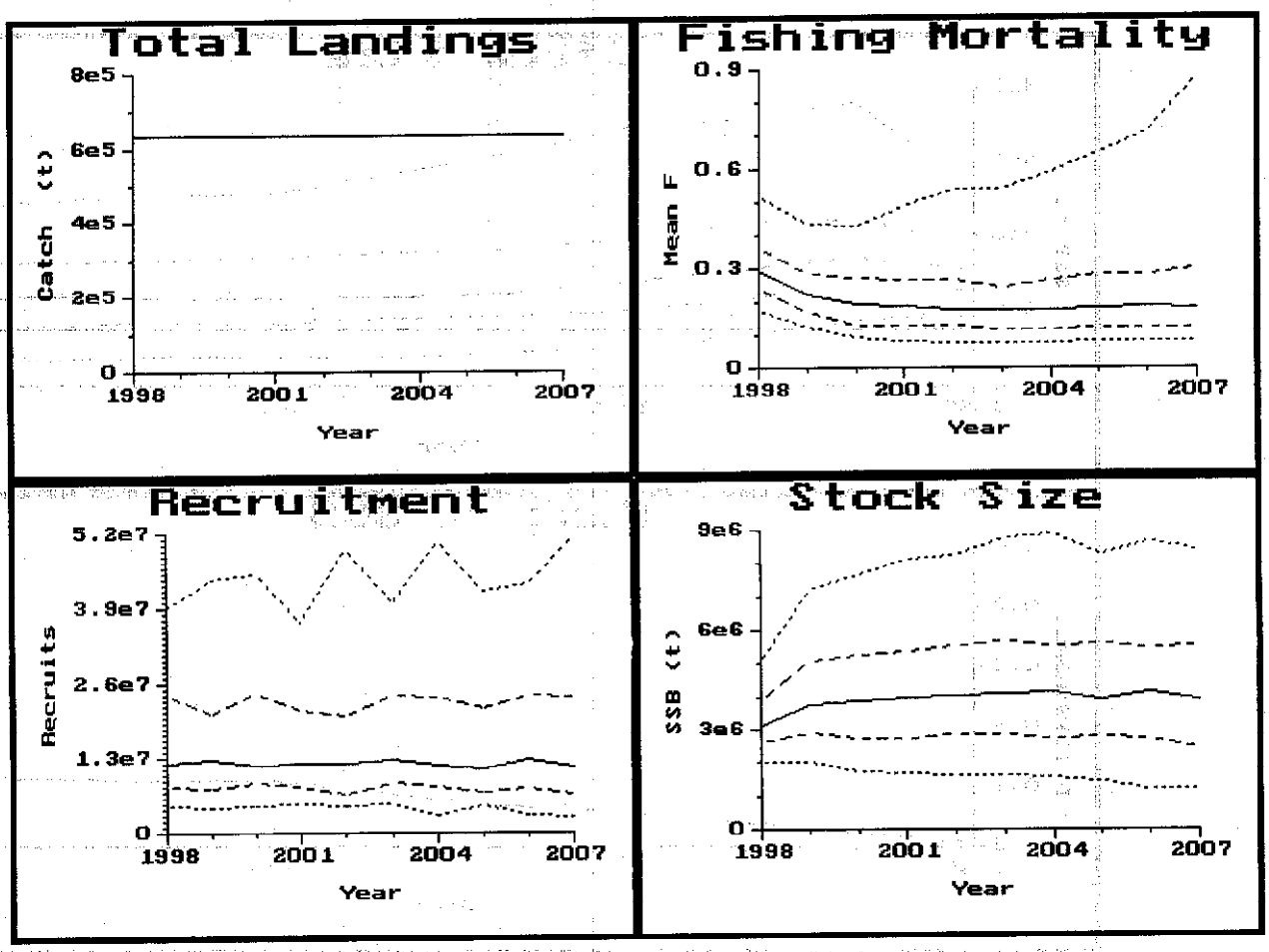


Figure 6.6.10 Run 5

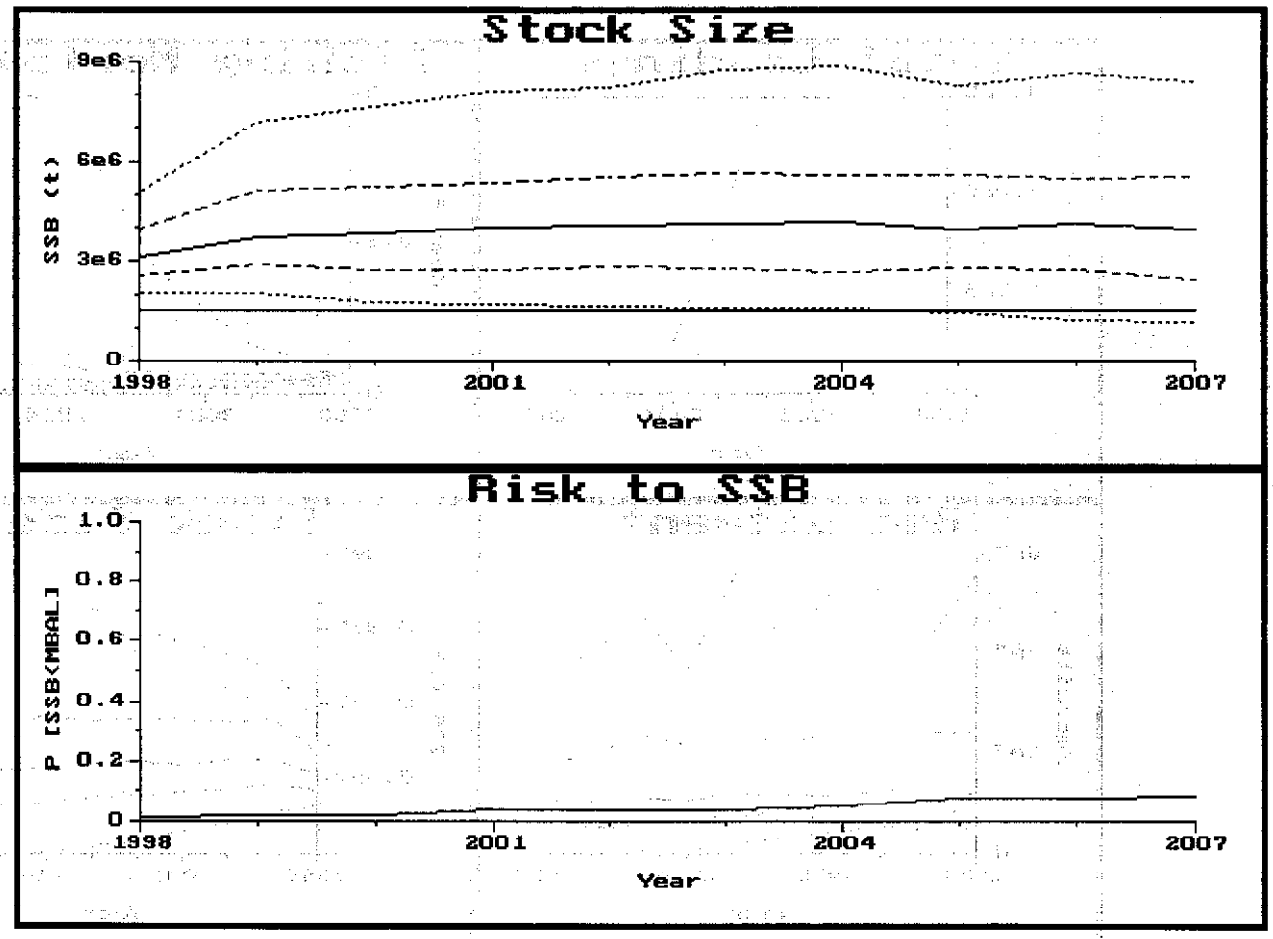


Figure 6.6.11 Run 6

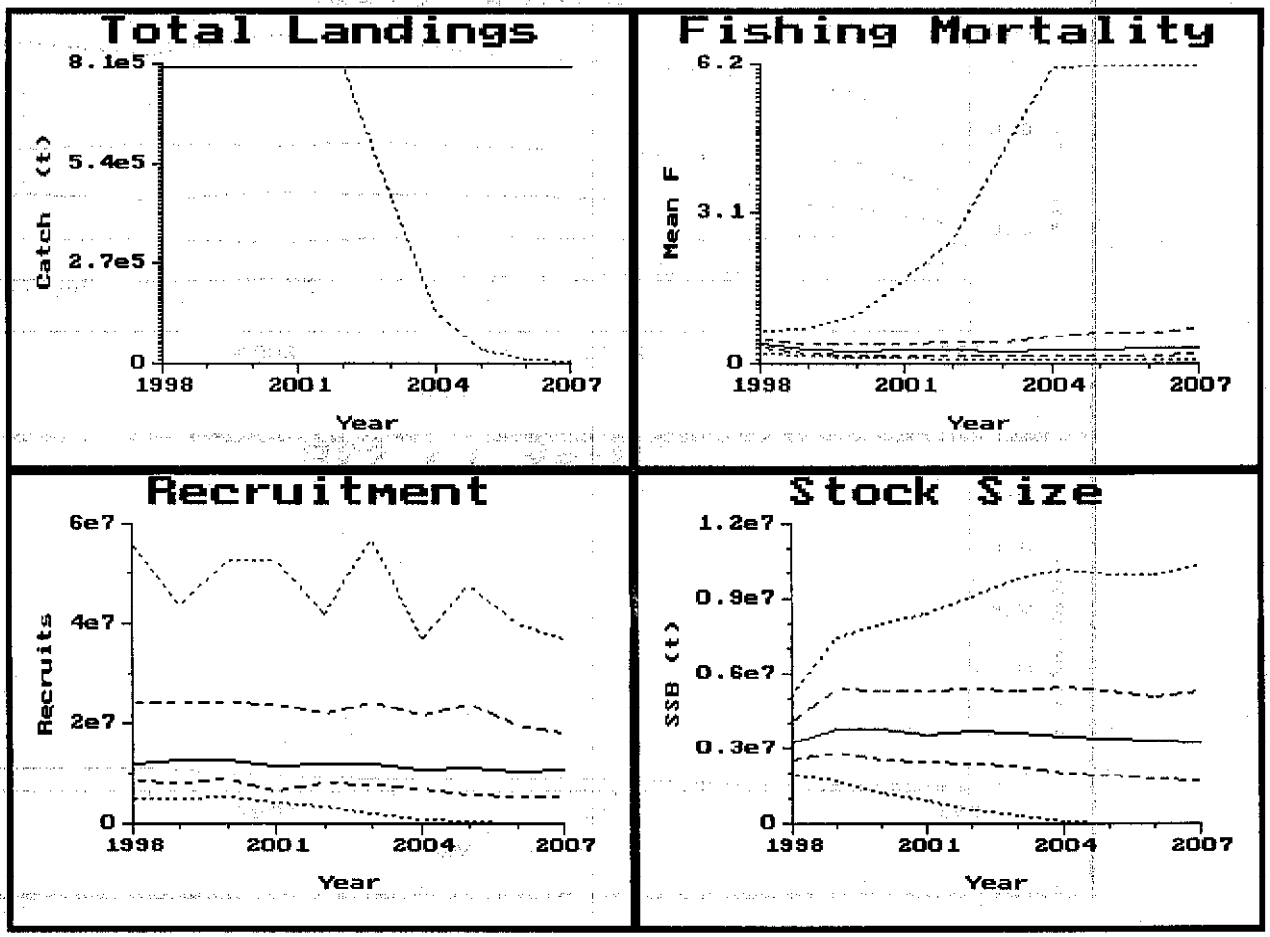


Figure 6.6.12 Run 6

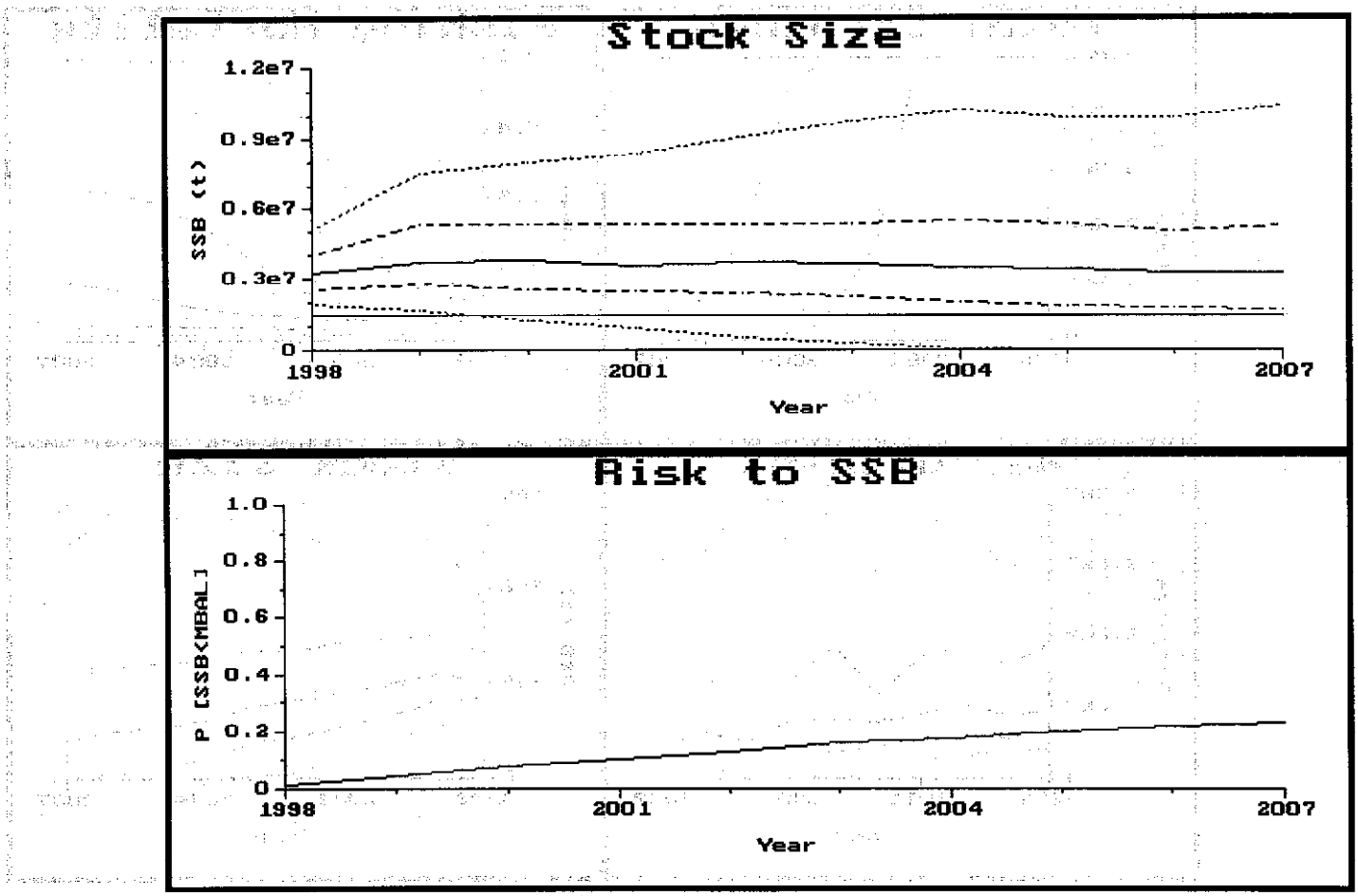


Figure 6.6.13 Run 7

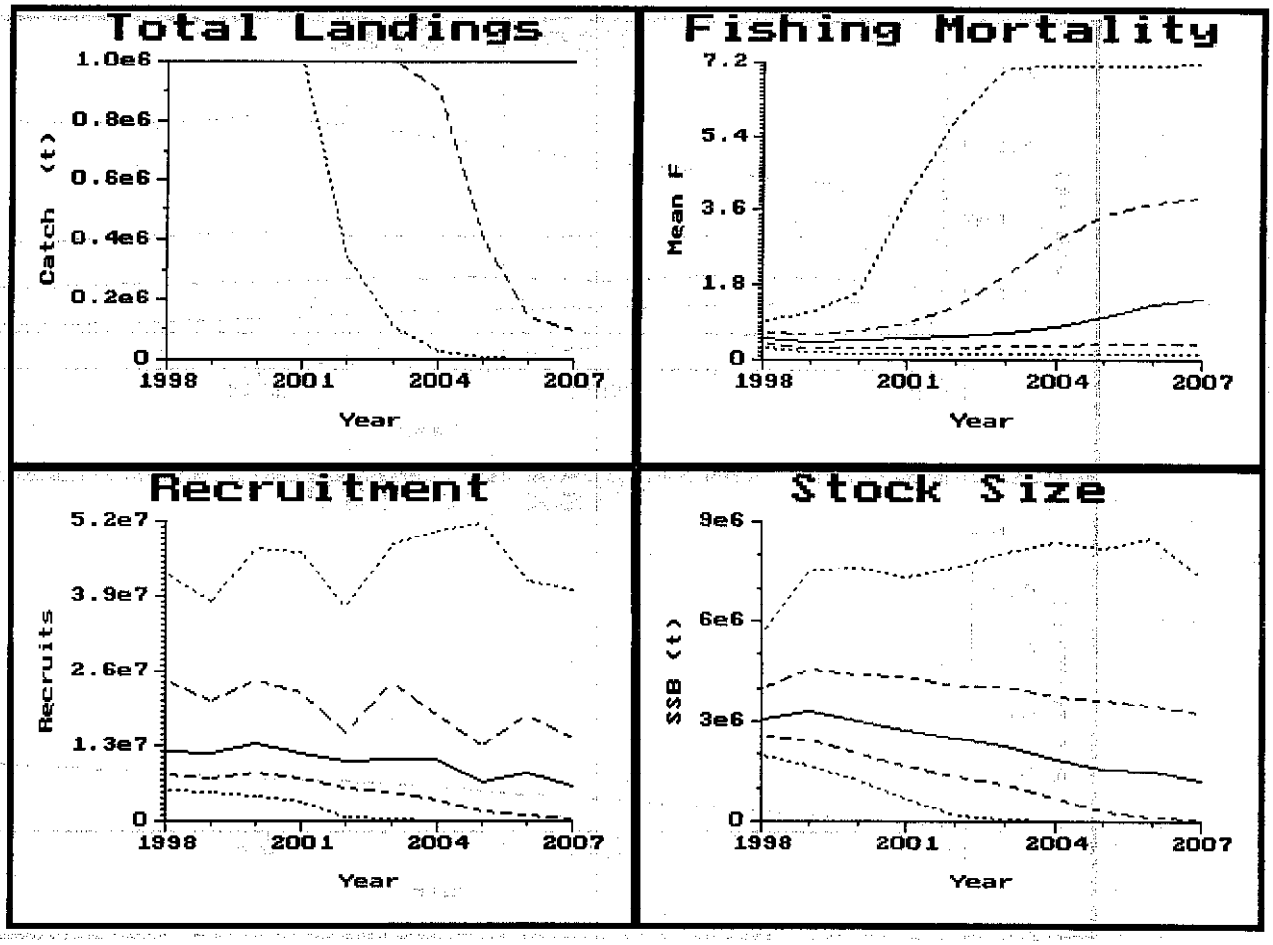
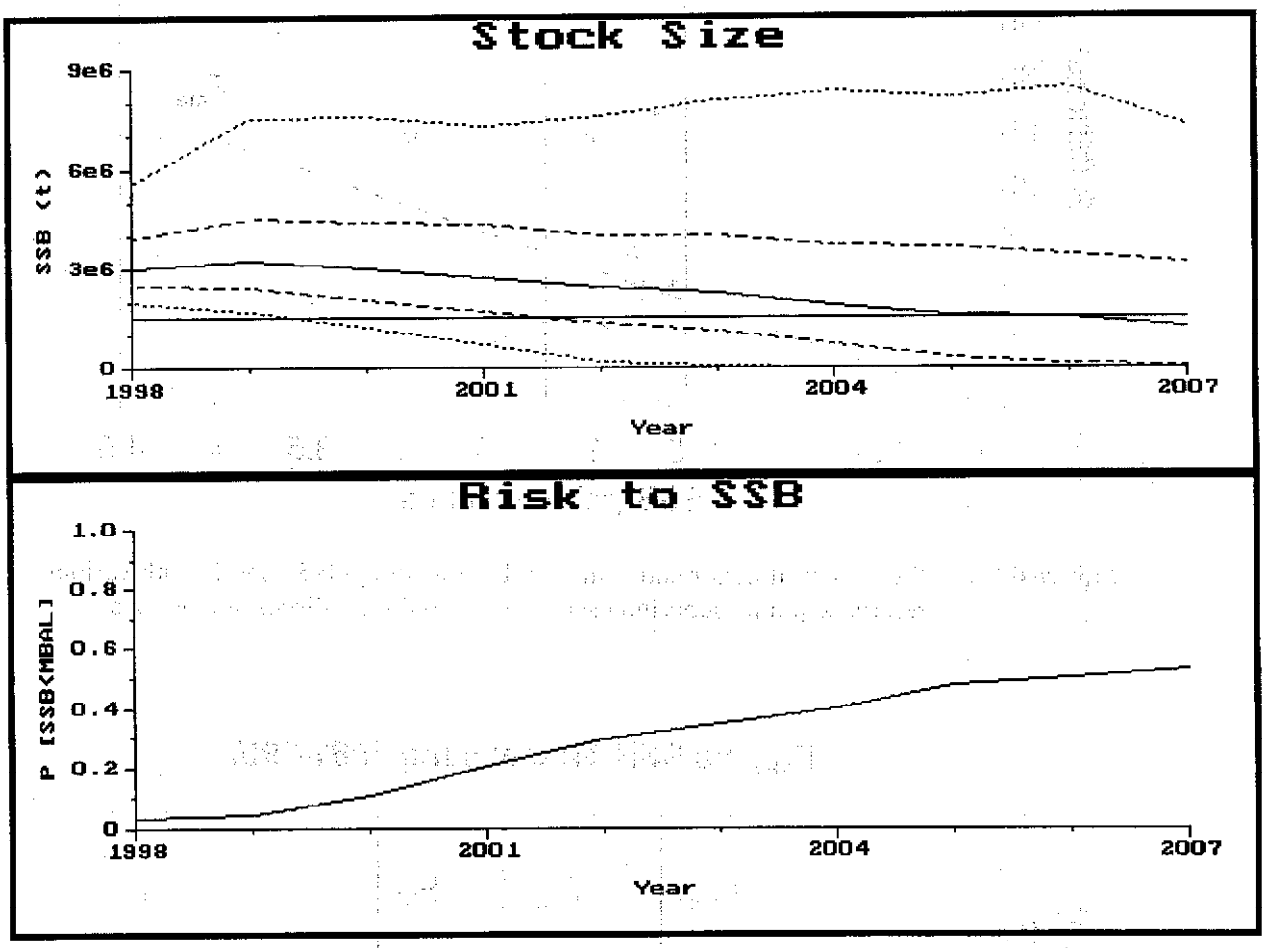


Figure 6.6.14 Run 7



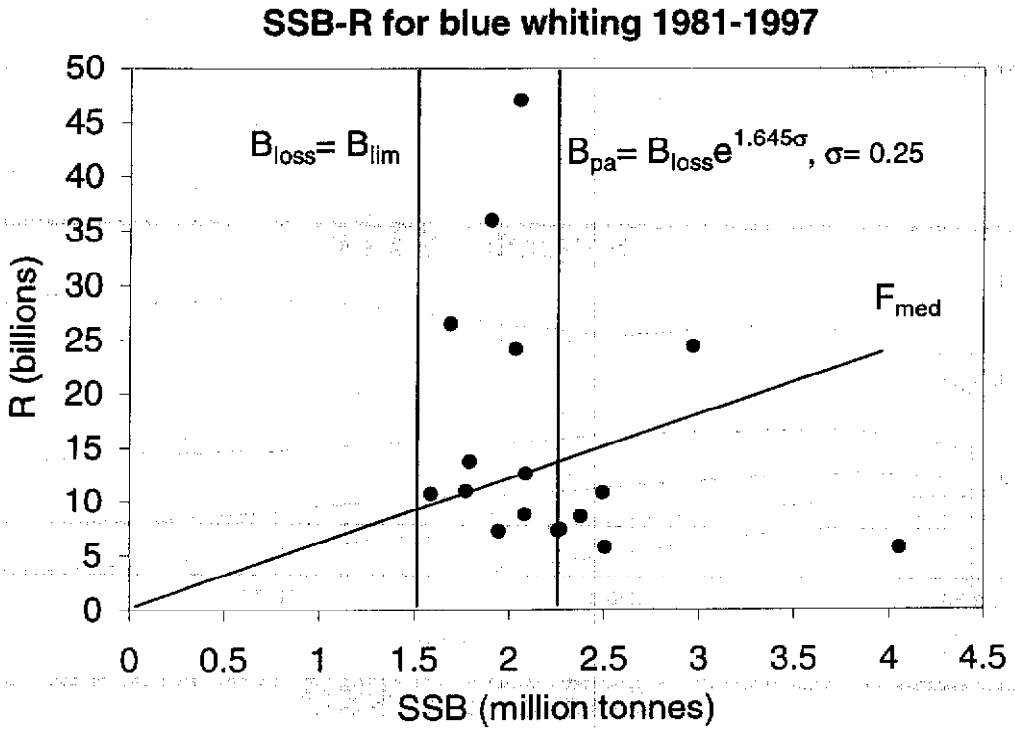


Figure 6.7.1 Stock-recruitment relationship for blue whiting (1981-1997) with various reference points superimposed. See sec. 6.8 for a discussion on these.

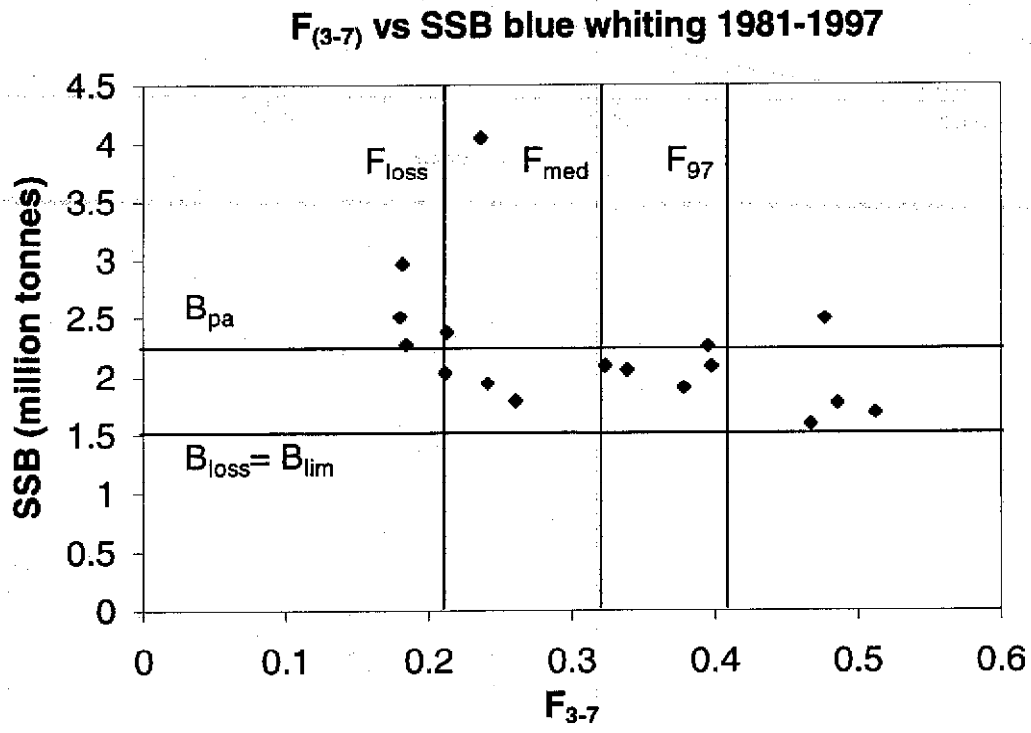


Figure 6.7.2 Terminal F_{3-7} vs SSB relationship for blue whiting (1981-1997) with various reference points superimposed. See sec. 6.8 for a discussion on these.

7 ECOLOGICAL CONSIDERATIONS

7.1 Barents Sea

7.1.1 Climate

There was a period of warming up in the Barents Sea from 1989 to 1991 (Figure 7.1.1.1). After 1991, the temperature decreased but stayed above the long-term mean up to 1994. In 1995 there was a short period of warming followed by a cooling in 1996. In 1997 the temperature increased to the long term mean in the central part of the Barents Sea while there was a cooling both in the western and eastern parts. In 1997 Norwegian research vessels were not allowed into the Russian EEZ resulting in an interruption of the long time series of temperature and salinity data from the Semøyene-N section. Observations from the joint 0-group and capelin surveys in August-September showed a temperature reduction in the eastern part of the Barents Sea compared to August-September 1996. An increased inflow of Atlantic water is predicted for 1998 with increased temperatures in the western part of the ocean.
Conclusions:

- Temperatures in the central part of the Barents Sea were around the long term mean, while cooling took place in the western and eastern parts of the ocean in 1997.
- Temperatures are predicted to be around the long term mean in the western and central parts in 1998. In the northern and eastern parts of the Barents Sea relatively low temperatures will continue to dominate.

7.1.2 Zooplankton

The standing stock of zooplankton has been monitored in the Barents Sea 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 7.1.2.1 and 7.1.2.2 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. The interpretation of this is that there will be prospects for good feeding conditions for pelagic fish in spring and summer 1998.

Conclusions:

- Increased abundance of zooplankton biomass in the Barents Sea in 1997 compared to 1996.
- Reasonably good feeding conditions are predicted for pelagic fish in 1998.

7.1.3 Cod consumption

Bogstad and Mehl (1997) calculated the consumption of various prey species by cod using stomach content data from the joint IMR-PINRO stomach content data base, a model for the gastric evacuation rate of cod and data on sea temperature and the abundance and geographical distribution of cod. The consumption is calculated for three main areas in the Barents Sea and for the first and second half of the year, for age groups 1–11+ separately. On average 6,000 stomachs have been sampled annually since 1984. The calculated consumption from 1984 onwards, based on the same method but updated with new data, is given in Table 7.1.3.1. Those calculations are taken from a Working Document to the spring 1998 ACFM meeting where the assessment of North-east Arctic Cod was revised by including 1997 data. Table 7.1.3.1 shows that the consumption of capelin by cod has increased from 1996 to 1997, while the consumption of juvenile herring by cod has decreased. This is consistent with the development in stock size of these species in the Barents Sea.

The consumption estimates in Table 7.1.3.1 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).

7.2 Norwegian Sea

7.2.1 Climate

The Norwegian Sea is a complex and dynamic system. Both warm Atlantic water and cold Arctic water enter the system (Figure 7.2.1.1). The warm water is mainly entering the system through three different branches; the most easterly one along the break of the Norwegian Shelf, another branch against the middle of the sea, and the most westerly one, the

Irminger Current, branches off towards Iceland. The flux of the warm water entering the system is very much dependent on the passage of the low pressure systems over the Atlantic (expressed by the NAO index).The flux in these branches and the amount of cold fresh water coming in through the Fram strait entering the system as the East Icelandic current will to a large extent determine the ocean climate.

When large cold and fresh watermasses are entering the system like they have done since the late sixties, the incoming warm water to the central and western parts of the Norwegian Sea will to some extent be blocked. This will result in a cold climate in this part of the ocean. Another implication of this is that these fresh and cold watermasses will prohibit sinking of surface water and renewing of bottom water during wintertime. If the amount of cold watermasses entering the system is reduced, more warm and saline water will enter the central parts of the Sea. These watermasses will be so heavy after cooling during wintertime that they will sink and pull new watermasses into the system.

As indicated earlier large amounts of cold water have been entering the system since the late sixties. This is shown in Figure 7.2.1.2 as a fluctuating declining trend at station M since the sixties.

There may be a change in this cooling trend since data from the autumn 1997 show an increase in the sea temperatures at station M. However, it is too early to say if this is just an episode or a sign of a more permanent change of the climate in the central and western parts of the ocean.

The eastern branch of incoming warm Atlantic watermasses is relatively strong with temperatures above the long term mean at three different sections along the Norwegian coast in 1997 (Figure 7.2.1.3).

The overall effect of the lower temperatures since the sixties may be reduced primary and secondary production. This may also have influenced fish production in the area.

Conclusions:

- Temperatures were below the long term mean in the western and central parts of the Norwegian Sea in the first part of 1997, however, data from the summer and autumn 1997 show a change in this pattern with increased sea temperatures at station M.
- Temperatures above the long term mean in the eastern parts of the sea throughout 1997.
- Temperatures in the central Norwegian Sea have been raising since early 1997.

7.2.2 Zooplankton

The standing stock of zooplankton was measured on the joint international survey for herring in May 1997 (Vilhjalmsson *et al.* 1997). There was a significant reduction in zooplankton biomass compared to previous years. The mean zooplankton biomass for the whole Norwegian Sea in May 1996 and 1997 is shown in Figure 7.2.2.1 which shows a significant reduction in all size groups in 1997 compared to 1996. A Norwegian survey in summer resulted in a higher mean zooplankton abundance in 1997 compared to 1996 (Figure 7.2.2.2). Figure 7.2.2.3 describes the development of the zooplankton community in 1995–97. One conclusion is that the zooplankton production started later in 1997 than in 1996. The overall production may have been somewhat smaller in 1997 than in 1996, however, not to that extent that was indicated by the result of the May cruise alone.

Conclusions:

- Somewhat smaller standing stock of zooplankton in 1997 compared to 1996.
- Plankton bloom started later in 1997 than the previous years.

7.3 Icelandic Waters

7.3.1 Climate

After a period of warm climate in the northern North-Atlantic which began in the early twenties, the marine climate of Icelandic waters deteriorated suddenly in the mid-sixties. This was manifested in decreased influence of warm Atlantic water in the north Icelandic shelf area, increased influence of arctic water from the East Greenland Current, which in turn intensified the strength and extension of the cold waters of the East Icelandic Current in the area east and northeast of Iceland. The new situation made it impossible for the Norwegian spring spawning herring to reach their former feeding areas north and northeast of Iceland, which indeed also became a veritable desert with regard to primary production and zooplankton abundance. A partial reversal of the marine climate north of Iceland occurred during the

first half of the seventies, but since then climatic conditions have been unstable with alternating warm and cold years. Figure 7.3.1.1 gives an overview of these features.

Cool conditions prevailed in spring 1997 in the areas north and east of Iceland and the westernmost part of the feeding migration of the Norwegian spring spawning herring could only reach as far west as 7°W. However, there was a rapid warming of the near-surface layer in June and July 1997 and in August of that year an annual survey of the marine environment around Iceland recorded a pronounced increase of Atlantic water north of Iceland and higher salinity in this area as well as off the south and west coast of Iceland than had been recorded since the early 1960s.

In the latter half July 1997 an Icelandic vessel, purse-seining for capelin, made a catch of about 150 tonnes of Norwegian spring spawning herring at about 67°45N, 13°W. In the following week several other vessels fishing on capelin schools in neighbouring areas reported the occurrence of individual herring in their capelin catch. Samples of these stray individuals also showed that they belonged to the Norwegian spring spawning stock. It thus appears that a small part of the Norwegian spring spawning herring population were able to take advantage of the improved climatic conditions of the north Iceland area.

The warm conditions and high salinity prevailed around Iceland during the routine annual environmental surveys in November/December 1997 and February 1998. The East Icelandic Current was weak and much farther offshore than at any time during the previous decades. In February, however, a thin surface layer of cold, low salinity water was observed over the outer half of the shelf to the north and northeast of Iceland. Due to prevailing south- and southwesterly winds in January-March 1998, the flow of drift ice south through the Iceland-Greenland Channel was slowed. Ice piled up northwest of Iceland and off the western north coast, and was carried by the East Icelandic Current east to the Langanes promontory on the northeast coast. It remains to be seen how long the resulting surface layer of cold, low-salinity water will last and what the effect of this phenomenon will have on biological production processes in spring and early summer 1998.

Conclusions:

- Pronounced increase of Atlantic water around Iceland during the autumn 1997.
- Some uncertainty attached to the further development of the Atlantic inflow.
- East Icelandic Current was weak and much farther offshore than at any time during the previous decades.
- A thin surface layer of cold, low salinity water was observed over the outer half of the shelf to the north and northeast of Iceland in February 1998.

Table 7.1.3.1 The North-east arctic COD stock's consumption of various prey species in 1984-1997 (1000 tonnes)

Year	Other	Amphipods	Krill	Shrimp	Capelin	Herring	Polar cod	Cod	Haddock	Redfish	G. halibut	Total
1984	511	27	111	439	735	77	15	23	51	370	0	2359
1985	1153	168	57	154	1619	180	3	33	47	226	0	3639
1986	659	1214	106	140	828	132	140	83	109	312	0	3725
1987	669	1060	65	188	224	32	200	24	4	316	0	2782
1988	407	1233	308	128	331	8	90	9	2	220	0	2736
1989	725	822	238	129	578	3	32	8	10	228	0	2772
1990	1553	136	85	190	1591	7	6	20	16	237	0	3841
1991	1101	70	81	190	2878	8	12	27	20	314	7	4707
1992	1043	105	166	389	2528	323	100	53	106	192	22	5027
1993	822	268	737	331	3147	169	284	287	74	101	2	6221
1994	732	620	780	571	1175	161	662	233	52	82	0	5069
1995	928	1064	571	397	689	126	275	426	126	210	2	4815
1996	1030	602	1013	417	645	46	57	518	101	116	0	4544
1997	718	1149	644	343	1369	5	19	311	147	85	2	4791

Figure 7.1.1.1 Mean temperature and salinity between 50 and 200 m in August/September in the section Fugløy-Bjørnøya, Vardø-North and Semøyene-North, 1964–97.

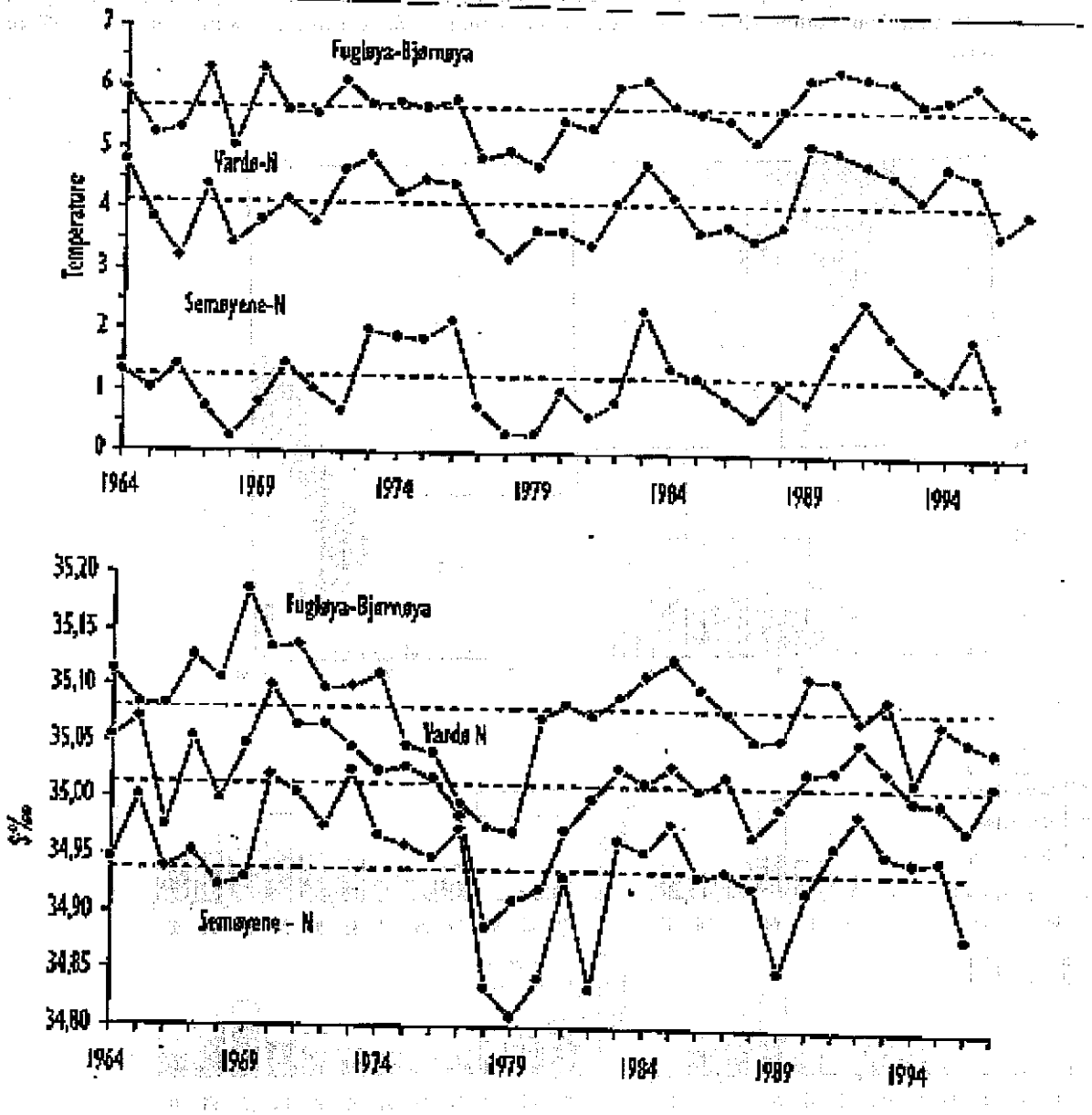


Figure 7.1.2.1 Mean values of size separated zooplankton biomass, gm^{-2} (ash free dry weight 1986–90, dry weight 1991–97), from bottom -0 m in the Barents Sea regions 2–8. Ash free dry weight is about 80% of dry weight.

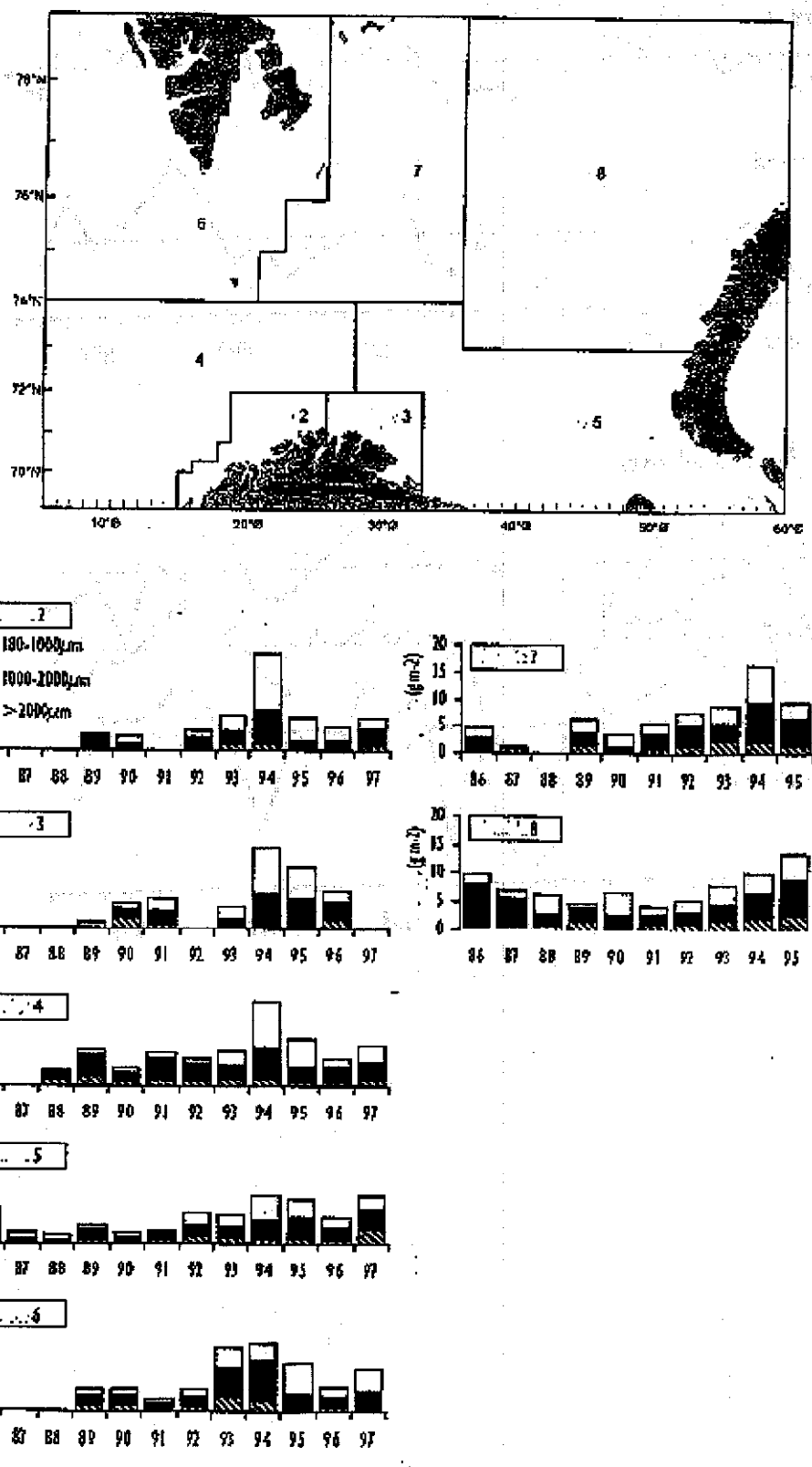


Figure 7.1.2.2 Total zooplankton biomass, mean values for the whole Barents Sea, from 1994–1997.

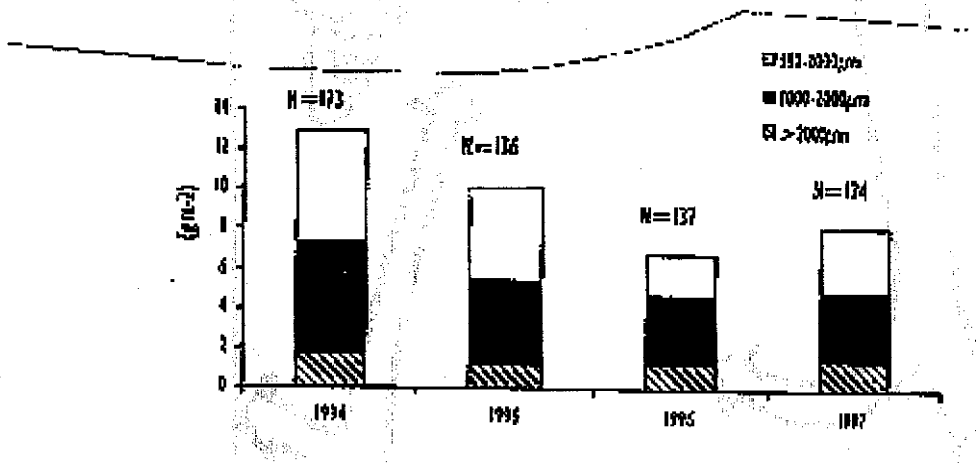


Figure 7.2.1.1 The dominant features of the circulation pattern in the Norwegian Sea.

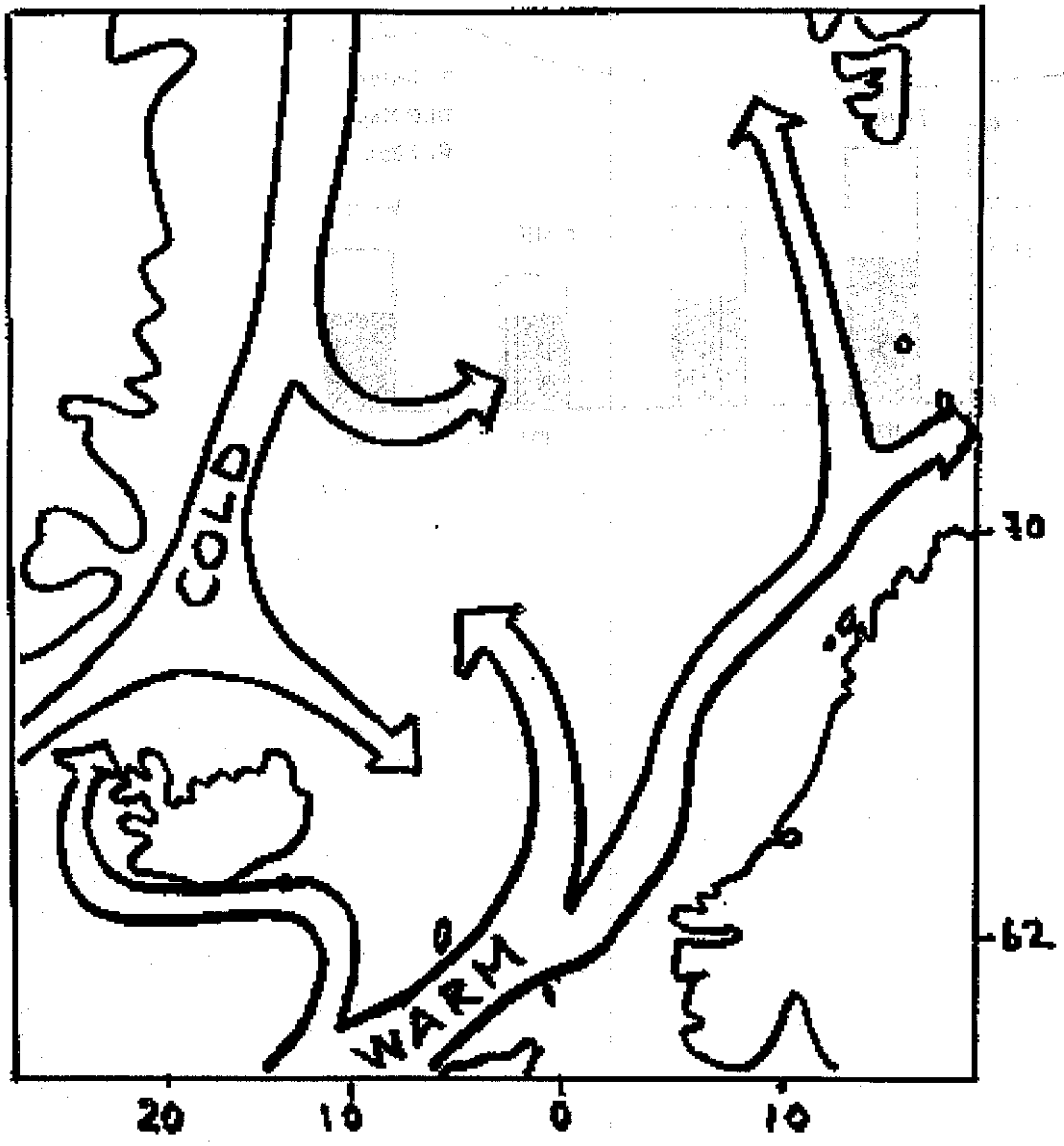


Figure 7.2.1.2 Time series of annual mean values of temperature and salinity at 150 m depth at Ocean Weather Station M in the Norwegian Sea, in position 66°N, 02°E.

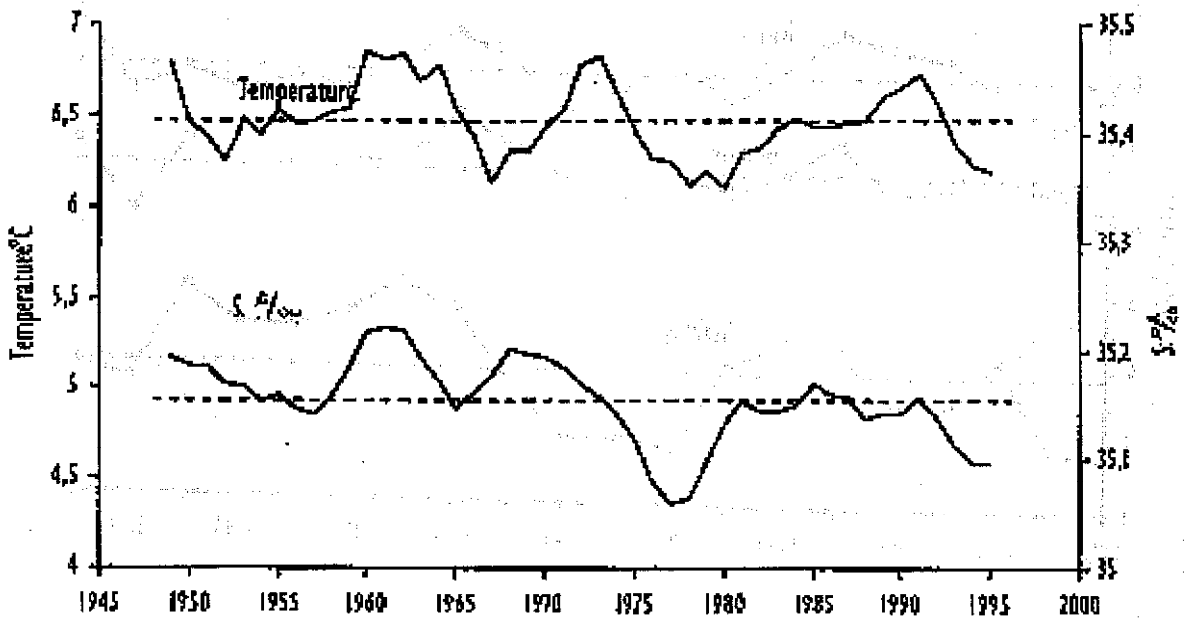


Figure 7.2.1.3 Temperature and salinity, observed in July/August, in the core of Atlantic water in the sections Svinøy-NW, Gimsøy-NW and Sørkapp-W, averaged between 50 and 200 m depth.

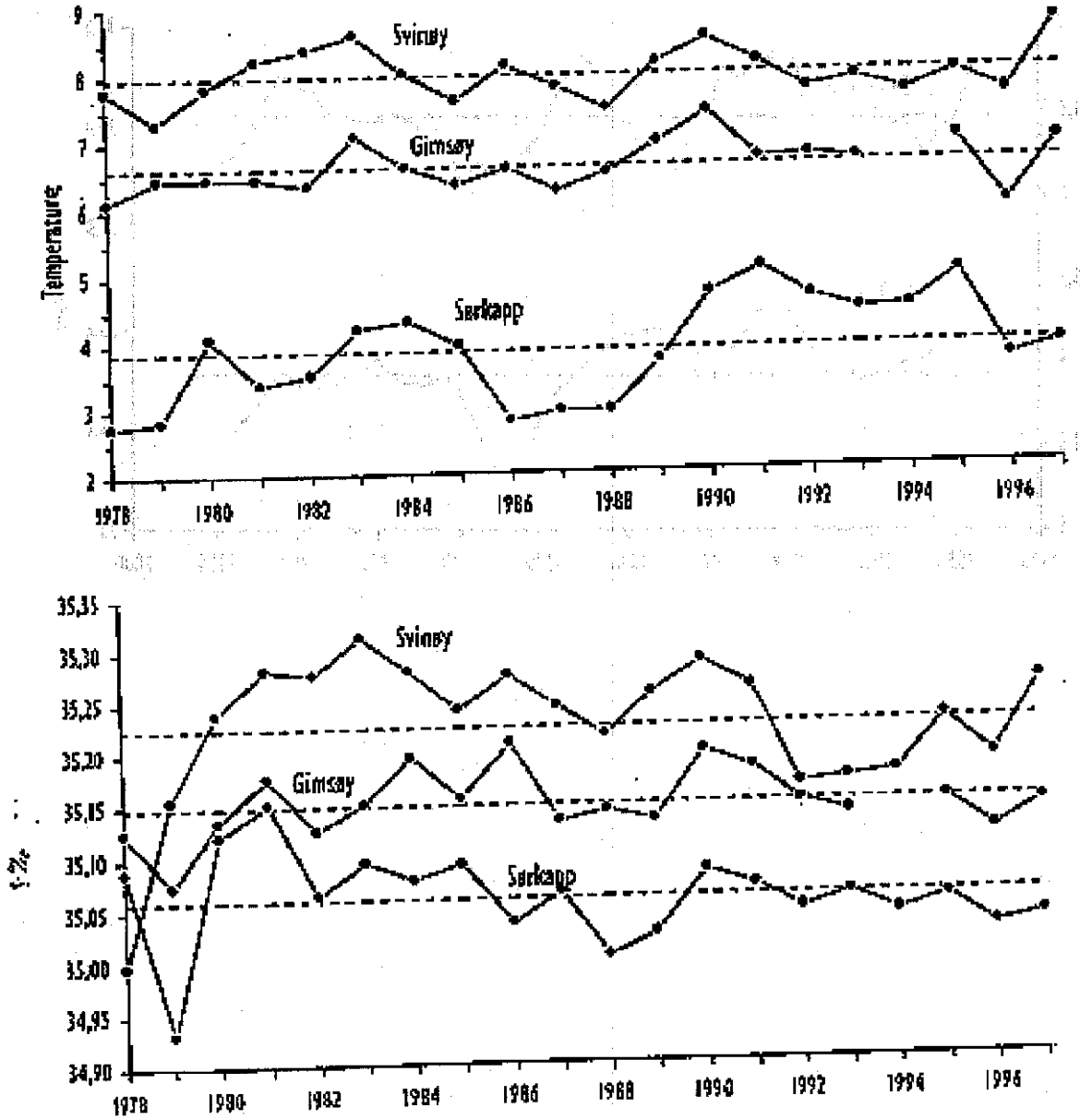


Figure 7.2.2.1 Zooplankton biomass (g dry weight m^{-2}) of size fractions and total zooplankton in the Norwegian Sea May 1996 and 1997.

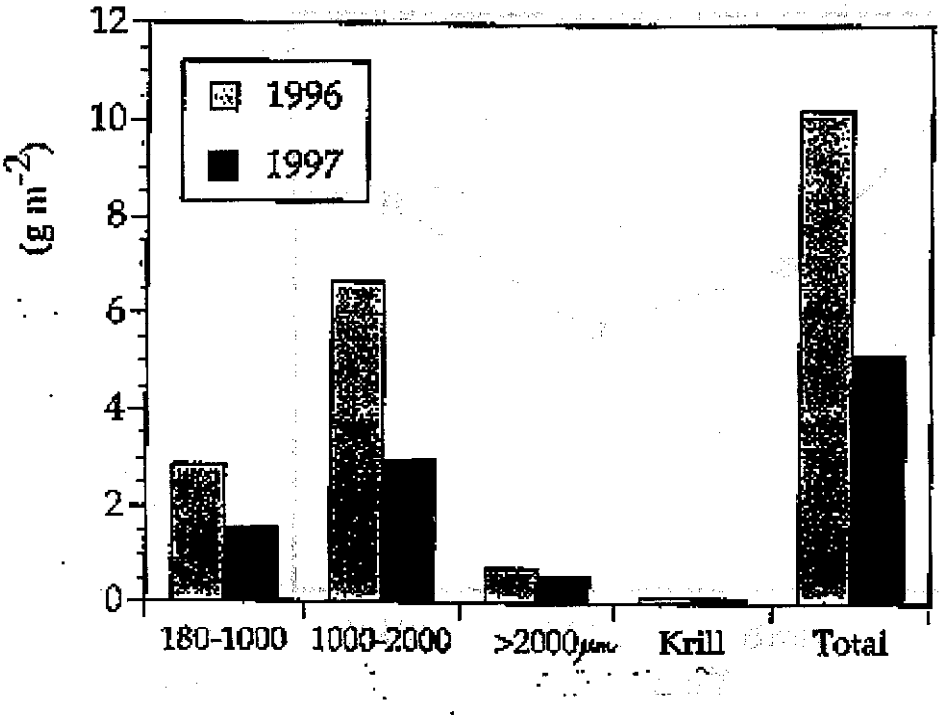


Figure 7.2.2.2 Zooplankton biomass (g dry weight m^{-2}) of size fractions and total zooplankton in the Norwegian Sea in summer 1994–1997.

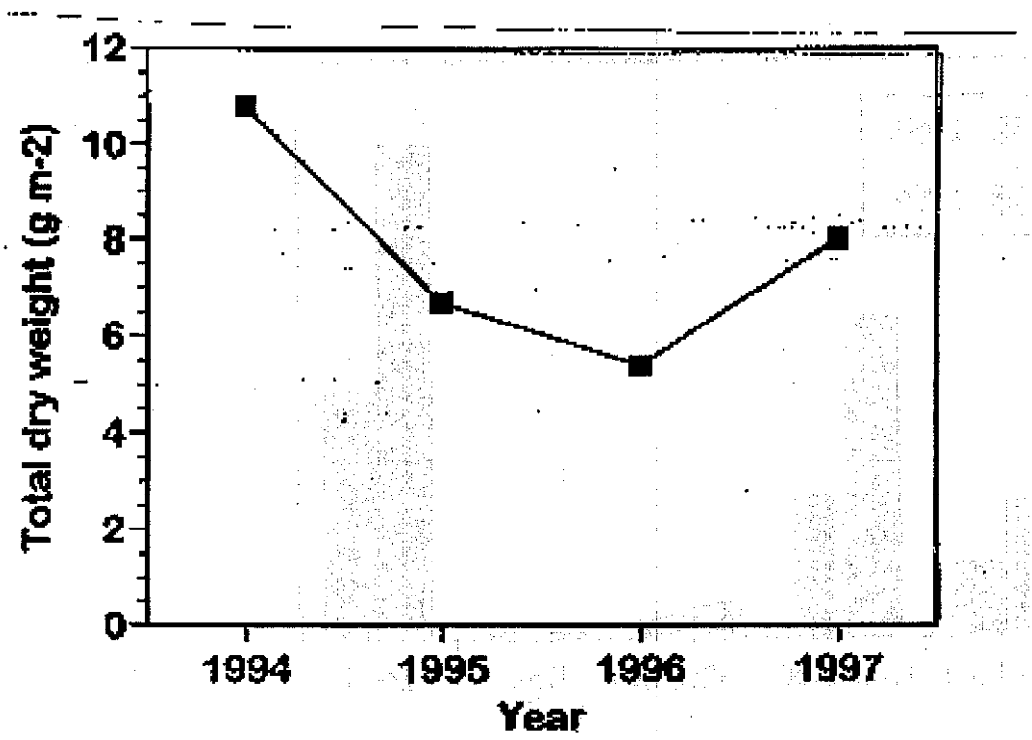


Figure 7.2.2.3 Plankton biomass (g dry weight m^{-2}) at the Svinøy transect in 1995 and 1997.

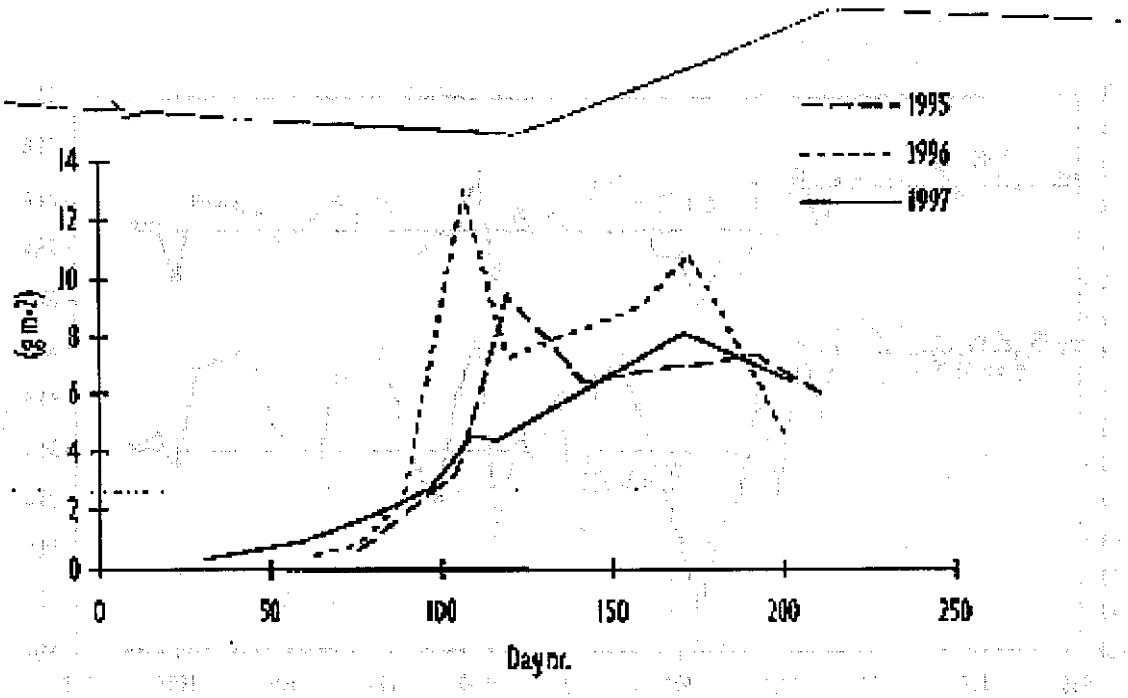
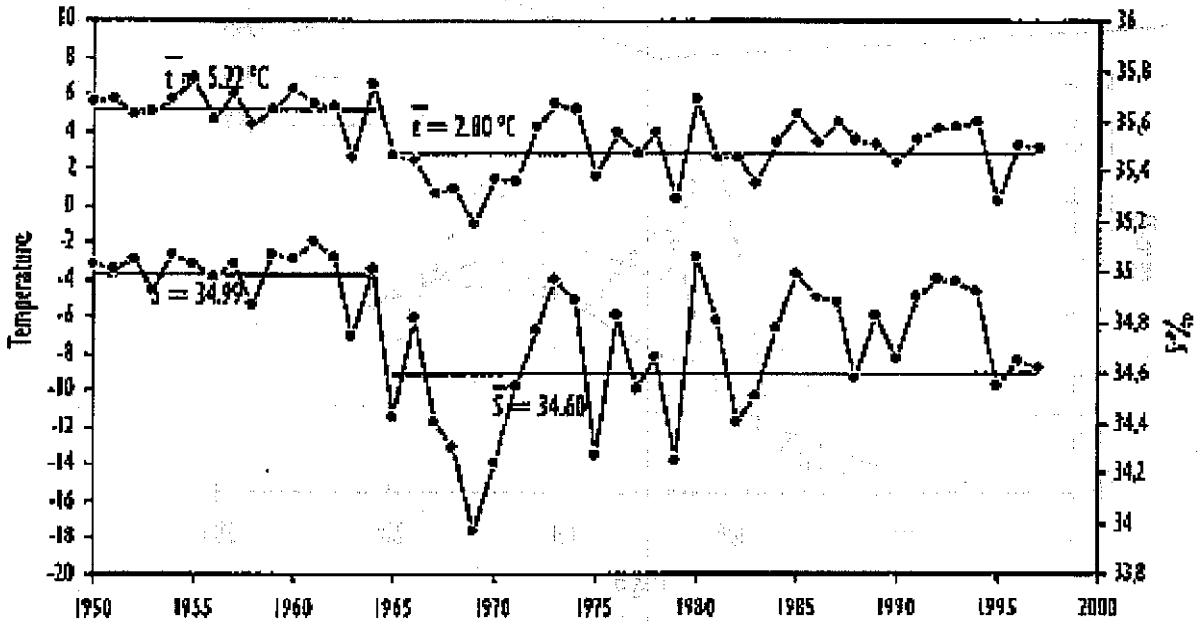


Figure 7.3.1.1 Temperature and salinity variations at 50 m depth off Siglunes, northern Iceland in May/June 1985–1997



8 OTHER

8.1 Quality Control

The Working Group discussed several options on how the quality of assessments could be improved.

8.1.1 International catch-at-age and weight-at-age

Currently data coordinators make *ad hoc* allocations of age structures to catches that are not adequately sampled. The calculations are usually done on spreadsheets which are notoriously error-prone and difficult to document, and so it can be difficult to reproduce calculations. A programme was adopted (Working Document by K.R. Patterson) which automated routine calculations, prepared standard tables for the report and documented the choices made by the data coordinator in allocating age structures to unsampled catches.

8.1.2 Data submission work book

A data submission work book from the Mackerel, Horse Mackerel, Sardine and Anchovy Working Group was examined. This work book is a spreadsheet-based series of standard forms and is specific for catch species. These forms would be completed by scientists responsible for collating the basic data such as landings, sampling summaries, catch numbers, length distribution by fleet and by quarter and catch by rectangle for their country and transmitted electronically to the data coordinator. The Working Group decided that the coordinator for the stocks would work by correspondence (leader I. Røttingen) to develop a similar work book for each stock prior to the next Working Group meeting.

8.1.3 Deadline for data

It was agreed that a deadline of approximately one month prior to the next Working Group meeting would be adopted for submission of catch and sampling data to the coordinator.

8.1.4 Follow-up work by correspondence

S. Tjelmeland and K. Patterson (and others, if interested) will work by correspondence investigating topics related to error structure in the models used for Norwegian spring-spawning herring.

8.2 Timing and Duration of Meeting

For some years, this Working Group and its predecessor met in the fall but in recent years the meeting has been in the spring. Neither time is appropriate for all stocks. The advantages and disadvantages of the timing of the meeting for each stock are as follows:

Icelandic Summer-Spawning Herring: This assessment must be held prior to the spring ACFM meeting because the Icelandic management season begins in September.

Norwegian Summer-Spawning Herring: Since the timing of the Working Group meeting was changed, there has been NEAFC requests for information on biology and distribution which is not available until after spring and summer surveys. A fall meeting would be best.

Barents Sea Capelin: Data from the fall survey are used to provide advice directly to ACFM (on the upcoming fishing season). The data and advice are reviewed by the Working Group the following spring. A fall Working Group meeting after the fall survey and before the ACFM meeting would be most appropriate.

Capelin in the Iceland-East Greenland-Jan Mayen Area: Preliminary TACs for the August–March period are based on abundance estimates from surveys the year before. Final TACs are assigned in the mid-season of the fishery based on surveys in November and/or January. Thus, neither a spring nor a fall meeting, immediately prior to the ACFM meeting, offers an advantage over the other.

Blue Whiting: At present, the Norwegian spawner survey is completed just before the spring Working Group meeting and as a result, it is not used in the analytical assessment until the following year. A fall meeting would overcome this.

For three stocks, Barents Sea capelin, Norwegian spring-spawning herring and blue whiting, a spring Working Group meeting is not optimal and the ACFM should consider rescheduling this Working Group meeting in the fall. This would require assigning the assessment of the Icelandic summer-spawning herring to another Working Group that meets in the spring.

If the Working Group meeting cannot be rescheduled to the fall, an additional two days should be added to the spring meeting to meet an increasing workload. If a fall meeting is scheduled, extra days would not be necessary, assuming the Icelandic summer-spawning herring assessment is moved to another Working Group.

The possibility of two meetings each year was rejected because of the extra travel requirements and associated costs and the potential reduction in peer review if Working Group members did not attend both meetings.

8.3 Capelin Symposium

During last year's meeting, the Working Group suggested that a symposium titled "Capelin - What are They Good For? Biology, Management and the Ecological Role of Capelin" be held in Iceland in year 2000 with Hjalmar Vilhjalmsson as convener. The Working Group suggested that this symposium be organised by ICES. Detailed rationale for this suggestion are in last year's Working Group report. The Working Group reiterates its support for this suggestion.

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Appendix 1

Blue Whiting: Extended Survivors Analysis (XSA)

In total, the 6 tuning series used by the Working Group to tune the VPA, the same as used in 1996, were two series from the spawning area west of the British Isles (Norwegian and Russian acoustic surveys), one series from the acoustic surveys in the Norwegian Sea, two from Spain (bottom trawl survey and CPUE from pair trawlers) and one from the Portuguese survey (bottom trawl) (Table A1.1). Data for 1997 were available only for the acoustic surveys in the Norwegian Sea and for the Spanish and Portuguese tuning fleets.

The XSA was run trying several options regarding:

1. the age at which catchability is independent of year class strength;
2. the definition of the catchability plateau;
3. the ages included in the tuning fleets;
4. F shrinkage.

The new options were confronted with those adopted in the 1996 assessment.

1. Selection of the age at which catchability is independent of year class strength.

This selection was based on a test run considering all ages (except for the last true age, i.e. 0 to 8) as dependent on year class strength. A statistical analysis of the slopes of the regression lines (for each fleet and age) was carried out. Based on the results of these tests, age 2 was considered to be the first fully recruited age.

Nevertheless, taking into account the characteristics of the several blue whiting fisheries, another test run was carried out using age 3 as the first fully recruited age. Since this selection did not improve the results of the catchability analysis it was decided to adopt age 2 (also adopted in 1996 assessment) as the first age at which catchability is independent of year class strength.

2. The definition of the catchability plateau.

The mean log catchability by age group was plotted for each fleet (Figure A1.1). A decreasing trend in the catchability with age is observed in all the tuning fleets from the southern area (possibly a consequence of the lower abundance of the older age groups).

Three catchability plateaus were tested: ages 4, 6 (adopted in 1996 assessment) and 8. Setting a constant catchability for ages ≥ 4 resulted in very large standard errors for the mean log catchability at age for the southern fleets. The selection of age 8 as the catchability plateau did not improve the results comparatively with the selection of age 6. Therefore, age 6 was adopted as the catchability plateau.

3. The ages included in the tuning fleets.

The log catchability residuals of the model using the previous options were analysed. The ages generating large residuals within each fleet were excluded from the analysis. The final input tuning data is presented in Table A1.1 within a frame.

4. F shrinkage.

The retrospective analysis showed a large variation on the F values through the years, with a period with larger F values (1986–1990) followed by a period with lower F values (1991–1996). This resulted in a systematically large overestimation of the F.

Two different options were taken and compared with what was done in the 1996 assessment (which used the last 5 years for F shrinkage):

i) increase the number of years for F shrinkage to 10 years, as an attempt to average the effect of the large and low F values;
ii) decrease the number of years for F shrinkage, in order to exclude the effect of the variations in the F values. No shrinkage, 3 and 5 years were tried.

The weight of the shrinkage mean was also varied using standard errors (SE) of 0.5 and 0.7 with each of the previous options.The down-weigthing of the shrinkage mean (SE=0.7) improved the results in general.

The last 5 age groups were used for F shrinkage in all the cases.

The use of a large number of years (5 and 10) resulted in strongly smoothed F values which seem unrealistic. An important part of the blue whiting fisheries rely on young age classes (0-2 years old). Large variations in the F values related to recruitment strength are therefore expected.

Using no shrinkage resulted in unusually large F values in some of the years.

The scenario of F shrinkage using the last 3 years and a SE=0.7 gave reasonably consistent results (Figure A1.2) and was therefore adopted.

The final run used the options listed in the text table below. The tuning diagnostics are presented in Table A1.2 and plots of the log catchability residuals are presented in Figure A1.3.

Age groups not fully recruited:	0-1 years old
Catchability constant for ages:	≥ 6 years old
Ages excluded from tuning:	Norwegian Sea acoustic surveys - ages 0 and 9
	Spanish and Portuguese tuning series - ages 0-1
Weighting of tuning fleets:	inverse of variance
F shrinkage:	last 3 years, 5 ages (SE=0.7)

The VPA results are given in Tables A1.3 to A1.5. Overall, the estimated values are consistent with the 1996 assessment and indicate:

- three peaks in the recruitment (82-83, 89 and 95-96) with similar strengths;
- a stable total stock biomass and slightly decreasing stock numbers;
- a decreasing trend in spawning stock biomass;
- a decrease in F from the last year.

The SSB estimated for 1997 is 1.79 million tonnes 74% of that predicted in 1996 (2.43 million tonnes). Part of the 1995 strong year class (40%) joined the spawning stock in 1997. An increase in the SSB was therefore expected. The decrease in the mean weights-at-age observed in 1997 may partly explain this difference.

Table A1.1 Tuning data for the blue whiting assessment. Input values for the XSA are framed.

BLUE WHITING-COMBINED

108

Norway Spawning Area/Acoustic

81 97

1 1 0.17 0.25

2 11

1	2368	7511	3219	3626	4551	4625	3626	2590	1776	1332
0	0	0	0	0	0	0	0	0	0	0
1	297	2108	2723	6511	3735	3650	3153	2279	1182	531
1	11130	1514	1616	1719	1858	1128	567	440	348	80
0	0	0	0	0	0	0	0	0	0	0
1	954	7183	7340	1159	383	251	373	151	174	73
1	4042	8050	22357	4697	262	417	385	159	27	111
1	6960	6799	12271	20285	7323	723	617	326	398	126
1	6745	22270	9973	10504	7803	933	293	177	46	148
1	14169	12670	11228	5587	6556	3273	516	183	108	81
1	11147	6340	8487	7407	4558	2019	545	96	16	33
1	1282	26123	4719	1574	1386	810	616	257	19	0
1	4469	3321	26771	2643	1270	557	426	108	22	12
1	1603	2950	4476	11354	1742	1687	908	770	207	0
1	8538	9874	7906	6881	9467	1795	1063	482	149	48
1	8781	7433	8371	2399	4455	4111	1202	459	162	105
0	0	0	0	0	0	0	0	0	0	0

USSR Spawning Area/Acoustic

82 97

1 1 0.17 0.25

3 11

1	540	2750	1340	1380	1570	2350	1730	1290	650
1	2330	2930	9390	3880	1970	1370	760	660	100
1	2900	800	1100	4200	2200	1200	1700	1200	500
1	13220	930	580	1780	860	810	580	540	110
1	18750	23180	2540	610	620	750	640	710	720
1	4480	19170	5860	1070	500	810	860	670	560
1	3710	4550	8610	4130	1270	480	250	260	330
1	11910	7120	6670	6970	4580	2750	1680	810	410
1	9740	12140	5740	2580	1470	220	80	10	10
1	10300	5350	5130	2830	1770	870	300	220	0
1	20010	6700	1350	440	390	170	0	0	0
1	4728	12337	5304	2249	1316	621	396	150	0
0	0	0	0	0	0	0	0	0	0
1	12657	10028	8842	2851	1093	408	131	14	14
1	15285	10629	4897	6940	1482	653	85	0	19
0	0	0	0	0	0	0	0	0	0

CPUE Spanish Pair Trawlers

83 97

1 1 0 1

1 6

1	7196	16392	9311	7476	8326	1718
1	13710	27268	14845	4838	1755	1750
1	14573	29823	14126	6256	1232	217
1	3721	14131	14745	7113	1278	505
1	25328	13153	6864	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	1184	462
1	4036	13991	22493	7979	1354	658
1	543	8066	15917	7474	2990	1055
1	9090	14409	6833	4551	1990	623
1	3905	14557	14449	3931	3639	1834
1	8742	15875	11134	3898	1046	450

Spanish Survey (Bottom trawl)

85 97

1 1 0.67 0.75

0 7

1	1748.4	508.9	265.4	104	11.4	3.5	1	0.5
1	1572.8	26.7	67.5	63.2	28.7	2	2.6	0.2
0	0	0	0	0	0	0	0	0
1	4070.6	368.7	344.9	37.3	7.2	3	5	0.3
1	1923.3	163	51.2	28.6	3.8	2.9	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	239.3	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	118.1	12	4.4	2.3	0.3
1	508.8	564.5	106.3	10.2	3.6	0.4	0.1	0.1

Norwegian Sea/Acoustic

81 97

1 1 0.6 0.75

0 11

1	0.001	182	728	4542	3874	2678	2834	2984	2756	2054	1300	1082
1	3880	184	460	1242	4715	3611	3128	2323	1679	874	414	253
1	8280	22956	396	468	756	1404	576	468	432	324	216	108
1	1862	30380	13916	833	392	539	539	343	49	49	49	49
1	2256	5969	23876	12502	658	423	188	235	141	376	141	47
1	5040	2324	2360	7224	6944	1876	952	336	308	140	196	56
1	3192	8204	4032	5160	5572	1204	224	168	56	84	28	28
1	8760	4992	2880	2640	3480	912	120	96	24	48	0.001	0.001
1	20430	1172	1125	812	379	410	212	22	32	0.001	6	1
0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0
1	0.001	792	1134	6939	766	247	172	90	11	18	1	3
1	0.001	830	125	1070	6392	1222	489	248	58	88	71	0.001
0	0	0	0	0	0	0	0	0	0	0	0	0
1	0.001	6974	2811	1999	1209	1622	775	173	81	1	15	0.001
1	0.001	23464	1057	899	649	436	505	755	89	41	50	0.001
1	30227	25638	1524	779	300	407	260	137	123	105	20	0.001

Portuguese Survey (Bottom Trawl)

85 97

1 1 0.75 0.83

0 5

1	719	1467	306	129	18	6
0	0	0	0	0	0	0
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

Table A1.2 Blue whiting: XSA diagnostics

Catch data for 17 years. 1981 to 1997. Ages 0 to 10.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
Norway Spawning Area	1981	1997	2	9	0.17	0.25
USSR Spawning Area/A	1982	1997	3	9	0.17	0.25
CPUE Spanish Pair Tr	1983	1997	2	6	0	1
Spanish Survey (Bott	1985	1997	2	7	0.67	0.75
Norwegian Sea acoust	1981	1997	1	8	0.6	0.75
Portuguese survey (B	1985	1997	2	5	0.75	0.83

Time series weights :

Tapered time weighting applied
Power = 3 over 20 years

Catchability analysis :

Catchability dependent on stock size for ages < 2

Regression type = C
Minimum of 5 points used for regression
Survivor estimates shrunk to the population mean for ages < 2

Catchability independent of age for ages >= 6

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 3 years or the 5 oldest ages.

S.E. of the mean to which the estimates are shrunk = .700

Minimum standard error for population
estimates derived from each fleet = .300

Prior weighting not applied

Lowestoft VPA Version 3.1

3/05/1998 15:08

Retrospective XSA run

BLUE WHITING 1998 WG ANON COMBSEX PLUSGROUP

CPUE data from file C:\VPA_L\DATA\BW-TUN.DAT

Terminal year for this assessment : 1997

Tuning had not converged after 30 iterations

Total absolute residual between iterations
29 and 30 = .00021

Final year F values

Age	0	1	2	3	4	5	6	7	8	9
Iteration 29	0.0303	0.1663	0.1626	0.2357	0.242	0.343	0.3019	0.462	0.9517	0.7687
Iteration 30	0.0303	0.1663	0.1626	0.2357	0.242	0.343	0.3018	0.4619	0.9517	0.7687

1

Regression weights

	0.751	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Fishing mortalities

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
0	0.005	0.085	0.009	0.024	0.004	0.025	0.005	0.177	0.048	0.03
1	0.073	0.116	0.094	0.034	0.078	0.064	0.049	0.042	0.144	0.166
2	0.132	0.17	0.13	0.08	0.111	0.077	0.034	0.073	0.098	0.163
3	0.17	0.385	0.238	0.132	0.178	0.146	0.125	0.18	0.178	0.236
4	0.229	0.345	0.39	0.159	0.212	0.258	0.128	0.229	0.362	0.242
5	0.561	0.486	0.402	0.33	0.164	0.233	0.329	0.307	0.244	0.343
6	1.012	0.692	0.748	0.357	0.226	0.213	0.248	0.373	0.431	0.302
7	0.413	0.656	0.722	0.47	0.251	0.242	0.307	0.371	0.603	0.462
8	0.414	0.464	1.008	0.241	0.458	0.231	0.333	0.516	0.687	0.952
9	0.549	0.35	0.494	0.148	0.242	0.414	0.49	0.363	0.699	0.769

1

XSA population numbers (Thousands)

YEAR \ AGE	0	1	2	3	4	5	6	7	8	9
1988	1.08E+07	6.68E+06	6.45E+06	4.34E+06	3.69E+06	3.35E+06	1.07E+06	2.75E+05	1.73E+05	8.63E+04
1989	2.63E+07	8.76E+06	5.08E+06	4.63E+06	2.99E+06	2.40E+06	1.57E+06	3.19E+05	1.49E+05	9.35E+04
1990	1.07E+07	1.98E+07	6.39E+06	3.51E+06	2.58E+06	1.74E+06	1.21E+06	6.42E+05	1.36E+05	7.66E+04
1991	7.55E+06	8.72E+06	1.47E+07	4.60E+06	2.27E+06	1.43E+06	9.51E+05	4.69E+05	2.55E+05	4.06E+04
1992	5.71E+06	6.04E+06	6.90E+06	1.11E+07	3.30E+06	1.58E+06	8.42E+05	5.45E+05	2.40E+05	1.64E+05
1993	8.96E+06	4.66E+06	4.58E+06	5.06E+06	7.63E+06	2.19E+06	1.10E+06	5.50E+05	3.47E+05	1.24E+05
1994	9.82E+06	7.16E+06	3.58E+06	3.47E+06	3.58E+06	4.82E+06	1.42E+06	7.28E+05	3.53E+05	2.26E+05
1995	2.26E+07	8.00E+06	5.58E+06	2.83E+06	2.51E+06	2.58E+06	2.84E+06	9.06E+05	4.38E+05	2.07E+05
1996	1.93E+07	1.55E+07	6.28E+06	4.25E+06	1.94E+06	1.63E+06	1.55E+06	1.60E+06	5.12E+05	2.14E+05
1997	7.69E+06	1.51E+07	1.10E+07	4.67E+06	2.91E+06	1.10E+06	1.05E+06	8.26E+05	7.18E+05	2.11E+05

Estimated population abundance at 1st Jan 1998

0.00E+00	8.11E+06	1.05E+07	7.64E+06	3.02E+06	1.97E+06	6.41E+05	6.34E+05	4.26E+05	2.27E+05

Taper weighted geometric mean of the VPA populations:

1.15E+07	9.26E+06	6.62E+06	4.62E+06	3.09E+06	1.93E+06	1.19E+06	6.45E+05	3.46E+05	1.73E+05

Standard error of the weighted Log(VPA populations) :

0.4838	0.4622	0.4405	0.4223	0.4373	0.4461	0.433	0.5236	0.6316	0.8184

1

Log catchability residuals.

Fleet : Norway Spawning Area

Age	1981	1982	1983	1984	1985	1986	1987
1	No data for this fleet at this age						
2	-0.23	99.99	-2.17	0.28	99.99	-1.73	-0.07
3	-0.08	99.99	-0.5	-0.98	99.99	-0.79	-0.1
4	-0.98	99.99	-0.77	-0.87	99.99	-0.42	0.34
5	-0.47	99.99	0.2	-0.72	99.99	-0.66	0
6	-0.26	99.99	-0.03	-0.67	99.99	-1.29	-1.38
7	-0.25	99.99	0.43	-0.77	99.99	-1.52	-0.58
8	-0.57	99.99	0.29	-0.84	99.99	-1.06	-0.27
9	-0.93	99.99	-0.12	-1.12	99.99	-1.59	-1.1

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	No data for this fleet at this age									
2	0.39	0.61	1.11	0.03	-1.41	0.29	-0.51	0.73	0.64	99.99
3	0.19	1.1	0.78	-0.2	0.34	-0.94	-0.69	0.74	0.05	99.99
4	0.22	0.24	0.52	0.32	-0.63	0.28	-0.78	0.16	0.51	99.99
5	1.02	0.68	0.36	0.82	-0.87	-0.66	0.03	0.15	-0.46	99.99
6	1.22	0.83	0.93	0.73	-0.37	-0.73	-0.66	0.37	0.23	99.99
7	0.14	0.29	0.86	0.64	-0.47	-0.85	-0.01	-0.15	0.15	99.99
8	0.44	-0.14	0.63	-0.11	0.12	-0.56	0.1	0.1	0.08	99.99
9	0.53	-0.2	0.06	-0.02	-0.42	-0.97	0.42	0.01	-0.01	99.99

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6	7	8	9
Mean Log q	-7.1539	-6.3149	-5.8337	-5.9713	-5.9503	-5.9503	-5.9503	-5.9503
S.E(Log q)	0.9145	0.6864	0.5194	0.635	0.8422	0.6502	0.4665	0.6836

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	0.89	0.158	8.12	0.19	14	0.86	-7.15
3	1.09	-0.16	5.46	0.26	14	0.79	-6.31
4	0.97	0.086	6.14	0.44	14	0.53	-5.83
5	0.65	1.04	8.94	0.52	14	0.41	-5.97
6	0.55	1.449	9.56	0.56	14	0.44	-5.95
7	0.96	0.104	6.35	0.44	14	0.65	-6.05
8	1.53	-1.372	2.52	0.45	14	0.67	-6.02
9	1.39	-1.139	4	0.51	14	0.84	-6.23
1							

Fleet : USSR Spawning Area/A

Age	1981	1982	1983	1984	1985	1986	1987
1	No data for this fleet at this age						
2	No data for this fleet at this age						
3	99.99	-2.33	-0.48	-0.42	-0.01	0.08	-0.77
4	99.99	-1.08	-0.59	-1.47	-1.41	0.84	0.29
5	99.99	-1.37	0.59	-1.15	-1.32	0.14	0.24
6	99.99	-0.85	0.15	0.28	-0.1	-0.69	0.09
7	99.99	-0.72	-0.05	0.03	-0.72	-0.48	-0.26
8	99.99	-0.37	-0.41	0.05	-0.72	-0.23	0.61
9	99.99	-0.7	-1.05	0.37	-0.03	-0.01	0.73

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	-0.76	0.39	0.43	0.2	-0.01	-0.67	99.99	0.9	0.68	99.99
4	-0.66	0.02	0.71	-0.03	-0.17	-0.39	99.99	0.51	0.86	99.99
5	0.18	0.25	0.4	0.47	-1	0.06	99.99	0.43	0.27	99.99
6	0.78	0.86	0.13	0.31	-1.38	-0.02	99.99	-0.77	0.81	99.99
7	0.84	2.02	0.2	0.65	-1.06	0.14	99.99	-0.51	-0.73	99.99
8	0.33	2.24	-0.09	0.5	-1.03	-0.15	99.99	-0.74	-0.39	99.99
9	0.4	2.3	-0.63	1.25	99.99	0.44	99.99	-1.16	-1.56	99.99

Mean log catchability and standard error of ages with catchability
independent of year class strength and constant w.r.t. time

Age	3	4	5	6	7	8	9
Mean Log q	-6.2296	-5.9433	-5.9886	-6.0865	-6.0865	-6.0865	-6.0865
S.E(Log q)	0.6752	0.7124	0.6273	0.7265	0.87	0.8711	1.1777

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
3	1.17	-0.278	4.68	0.25	14	0.83	-6.23
4	0.92	0.169	6.68	0.35	14	0.69	-5.94
5	0.58	1.175	9.51	0.5	14	0.36	-5.99
6	0.87	0.278	7.13	0.36	14	0.67	-6.09
7	44.49	-2.212	******	0	14	32.27	-6.09
8	3.73	-1.658	-11.82	0.04	14	2.97	-6.09
9	2.51	-1.35	-3.02	0.1	13	2.81	-6.01
1							

Fleet : CPUE Spanish Pair Tr

Age	1981	1982	1983	1984	1985	1986	1987
1	No data for this fleet at this age						
2	99.99	99.99	0.7	0.05	-0.28	-0.19	-0.05
3	99.99	99.99	0.61	0.94	-0.19	-0.43	-0.66
4	99.99	99.99	0.77	0.78	0.94	0.18	-1.09
5	99.99	99.99	1.08	0.22	0.34	0.43	-0.53
6	99.99	99.99	0.59	0.71	-0.88	0.43	-0.48
7	No data for this fleet at this age						
8	No data for this fleet at this age						
9	No data for this fleet at this age						

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	No data for this fleet at this age									
2	0.37	0.47	0.27	-0.82	0.41	0.26	-0.35	0.08	-0.01	-0.45
3	0.56	0.52	-0.46	-0.82	-1.02	0.59	0.62	0	0.34	0.01
4	0.12	0.65	-0.71	-0.44	-0.17	-0.37	0.26	0.17	0.34	-0.18
5	-0.72	0.64	-0.09	-0.19	-0.24	-0.4	-0.36	-0.15	0.88	0.07
6	0.55	0.29	-0.23	-0.18	-0.07	0.01	0.24	-0.92	0.79	-0.28
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6
Mean Log q	-5.9106	-5.8417	-6.2719	-6.7748	-7.2313
S.E(Log q)	0.4023	0.6097	0.5325	0.4952	0.5223

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	2.14	-2.14	-5.25	0.27	15	0.74	-5.91
3	5.55	-2.162	-37.42	0.02	15	2.92	-5.84
4	2.69	-1.909	-8.36	0.12	15	1.28	-6.27
5	1.8	-1.377	0.62	0.23	15	0.86	-6.77
6	1.06	-0.14	6.84	0.38	15	0.58	-7.23
1							

Fleet : Spanish Survey (Bott

Age	1981	1982	1983	1984	1985	1986	1987
1	No data for this fleet at this age						
2	99.99	99.99	99.99	99.99	0.37	-0.4	99.99
3	99.99	99.99	99.99	99.99	0.91	0.12	99.99

4	99.99	99.99	99.99	99.99	0.78	0.9	99.99
5	99.99	99.99	99.99	99.99	0.84	0.41	99.99
6	99.99	99.99	99.99	99.99	0.51	1.93	99.99
7	99.99	99.99	99.99	99.99	-0.11	-0.37	99.99
8	No data for this fleet at this age						
9	No data for this fleet at this age						

Age		1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
	1	No data for this fleet at this age									
	2	1.37	-0.27	-0.63	-1.43	0.9	0.85	-2.38	0.17	1.93	-0.31
	3	0.34	0.16	-0.65	-0.17	0.12	-0.49	-0.32	0	1.5	-0.99
	4	-0.52	-0.87	0.32	0.83	0.62	-1.5	0.07	0.21	0.73	-0.97
	5	-0.36	-0.15	-0.04	0.86	0.94	-0.79	-0.36	0.11	0.52	-1.42
	6	2.44	-0.14	-1.78	0.89	1.35	-1.37	-0.1	-1.11	0.88	-1.95
	7	0.56	0.18	0.44	1.05	0.86	-0.66	-0.49	-1.07	-1.07	-1.6
	8	No data for this fleet at this age									
	9	No data for this fleet at this age									

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time .

Age	2	3	4	5	6	7
Mean Log q	-10.9741	-11.7375	-12.3209	-13.0288	-13.8533	-13.8533
S.E(Log q)	1.2579	0.6923	0.8258	0.7391	1.4508	0.9105

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	1	0.001	10.98	0.1	12	1.33	-10.97
3	0.78	0.474	12.53	0.37	12	0.57	-11.74
4	-3.23	-2.402	23.39	0.04	12	2.17	-12.32
5	1.49	-0.632	12.32	0.16	12	1.14	-13.03
6	-2.03	-1.246	14.34	0.02	12	2.86	-13.85
7	-5.2	-2.522	9.58	0.02	12	3.64	-14.08
1							

Fleet : Norwegian Sea acoust

Age		1981	1982	1983	1984	1985	1986	1987
	1	-0.21	-0.42	-0.09	-0.14	-0.05	-0.11	0.22
	2	-0.29	-0.38	-0.72	1.68	2.01	0.31	1.05
	3	0.82	-0.03	-0.61	-0.15	1.49	0.65	0.86
	4	1.01	1.19	-0.24	-0.44	-0.01	1.52	0.89
	5	0.94	1.25	0.33	-0.19	0.05	1.66	0.45
	6	1.23	1.76	0.04	0.1	-0.44	1.65	0.39
	7	1.24	1.47	0.38	0.02	-0.15	0.86	0.54
	8	1.12	1.09	0.3	-1.24	-0.32	0.85	0.01
	9	No data for this fleet at this age						

Age		1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
	1	0.32	-0.43	99.99	99.99	-0.19	0.08	99.99	0.25	0.02	0.08
	2	0.64	-0.03	99.99	99.99	-0.37	-2.19	99.99	0.72	-0.36	-0.51
	3	0.39	-0.71	99.99	99.99	0.42	-0.68	99.99	0.55	-0.66	-0.86
	4	0.81	-1.12	99.99	99.99	-0.6	0.71	99.99	0.14	-0.14	-1.4
	5	-0.23	-0.75	99.99	99.99	-1.06	0.27	99.99	0.43	-0.47	-0.08
	6	-0.59	-0.62	99.99	99.99	-0.52	0.25	99.99	-0.13	0.08	-0.27
	7	0.14	-1.32	99.99	99.99	-0.72	0.28	99.99	-0.49	0.57	-0.57
	8	-0.78	-0.31	99.99	99.99	-1.86	-0.72	99.99	-0.71	-0.63	-0.21
	9	No data for this fleet at this age									

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	2	3	4	5	6	7	8
Mean Log q	-8.1318	-7.545	-7.4867	-7.4619	-7.6875	-7.6875	-7.6875
S.E(Log q)	1.1061	0.7505	0.9041	0.7182	0.6574	0.7132	0.9057

Regression statistics :

Ages with q dependent on year class strength

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Log q
1	0.34	3.638	13.12	0.81	14	0.24	-7.4

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	0.41	1.487	12.57	0.47	14	0.43	-8.13
3	0.66	0.939	10.27	0.5	14	0.49	-7.55
4	0.53	1.493	11.04	0.58	14	0.44	-7.49
5	1.26	-0.296	5.69	0.16	14	0.96	-7.46
6	1.46	-0.651	4.79	0.22	14	1	-7.69
7	0.73	0.875	9.27	0.59	14	0.53	-7.75
8	0.66	1.358	9.78	0.69	14	0.46	-8.18
1							

Fleet : Portuguese survey (B

Age	1981	1982	1983	1984	1985	1986	1987
1	No data for this fleet at this age						
2	99.99	99.99	99.99	99.99	-0.23	99.99	0.76
3	99.99	99.99	99.99	99.99	0.14	99.99	0.21
4	99.99	99.99	99.99	99.99	0.01	99.99	-0.85
5	99.99	99.99	99.99	99.99	-0.45	99.99	0.09
6	No data for this fleet at this age						
7	No data for this fleet at this age						
8	No data for this fleet at this age						
9	No data for this fleet at this age						

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1	No data for this fleet at this age									
2	0.17	0.82	0.39	-1.04	-0.51	1.15	-2.22	0.72	-0.65	0.92
3	-0.99	0.78	1.55	0.76	0.08	0.39	-0.57	0.52	-1.55	-1.01
4	-2.63	0.38	2.36	1.52	1.36	-0.36	0.3	0.7	-1.88	-1.29
5	-1.87	0.73	1.74	1.42	1.26	0.05	-0.37	0.54	-0.99	-2.32
6	No data for this fleet at this age									
7	No data for this fleet at this age									
8	No data for this fleet at this age									
9	No data for this fleet at this age									

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	2	3	4	5
Mean Log q	-10.2026	-10.7053	-11.0508	-11.1696
S.E(Log q)	1.0456	0.9247	1.4722	1.3016

Regression statistics :

Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
2	0.9	0.135	10.76	0.17	12	0.99	-10.2
3	1.13	-0.134	10.1	0.11	12	1.1	-10.71
4	2.14	-0.461	6.58	0.02	12	3.3	-11.05
5	0.99	0.007	11.19	0.11	12	1.37	-11.17

1

Fleet disaggregated estimates of survivors :

Age 0 Catchability dependent on age and year class strength

Year class = 1997

Fleet	Est Sur	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Norway Spawning Area	1	0	0	0	0	0	0
USSR Spawning Area/A	1	0	0	0	0	0	0
CPUE Spanish Pair Tr	1	0	0	0	0	0	0
Spanish Survey (Bott	1	0	0	0	0	0	0
Norwegian Sea acoust	1	0	0	0	0	0	0
Portuguese survey (B	1	0	0	0	0	0	0
P shrinkage mean	9258687	0.46				0.696	0.02
F shrinkage mean	2353209	0.7				0.304	0.077

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
6108523	0.39	15.64	2	40.544	0.03

1

Age 1 Catchability dependent on age and year class strength

Year class = 1996

Fleet	Est Sur	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Norway Spawning Area	1	0	0	0	0	0	0
USSR Spawning Area/A	1	0	0	0	0	0	0
CPUE Spanish Pair Tr	1	0	0	0	0	0	0
Spanish Survey (Bott	1	0	0	0	0	0	0
Norwegian Sea acoust	11293890	0.3	0	0	1	0.567	0.155
Portuguese survey (B	1	0	0	0	0	0	0
P shrinkage mean	6622530	0.44				0.31	0.251
F shrinkage mean	23247560	0.7				0.123	0.078

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
10457230	0.23	0.28	3	1.177	0.166

1

Age 2 Catchability constant w.r.t. time and dependent on age

Year class = 1995

Fleet	Est Sur	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F

Norway Spawning Area	1	0	0	0	0	0	0
USSR Spawning Area/A	1	0	0	0	0	0	0
CPUE Spanish Pair Tr	4858991	0.419	0	0	1	0.287	0.245
Spanish Survey (Bott	5582487	1.317	0	0	1	0.029	0.216
Norwegian Sea acoust	7480201	0.291	0.134	0.46	2	0.521	0.166
Portuguese survey (B	19245930	1.095	0	0	1	0.042	0.068
F shrinkage mean	19088860	0.7				0.121	0.068

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
7637594	0.22	0.21	6	0.965	0.163

1

Age 3 Catchability constant w.r.t. time and dependent on age

Year class = 1994

Fleet	Est Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Norway Spawning Area	5742149	0.958	0	0	1	0.036	0.131
USSR Spawning Area/A	1	0	0	0	0	0	0
CPUE Spanish Pair Tr	3007023	0.35	0.012	0.03	2	0.279	0.237
Spanish Survey (Bott	2108104	0.636	1.198	1.88	2	0.089	0.323
Norwegian Sea acoust	3215691	0.273	0.275	1.01	3	0.435	0.223
Portuguese survey (B	1275122	0.726	0.177	0.24	2	0.067	0.488
F shrinkage mean	4581857	0.7				0.094	0.161

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
3018049	0.19	0.17	11	0.915	0.236

1

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 1993

Fleet	Est Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Norway Spawning Area	2477105	0.576	0.324	0.56	2	0.099	0.188
USSR Spawning Area/A	3700081	0.709	0	0	1	0.067	0.13
CPUE Spanish Pair Tr	1967057	0.298	0.136	0.46	3	0.392	0.232
Spanish Survey (Bott	2642372	0.515	0.811	1.58	3	0.136	0.177
Norwegian Sea acoust	960389	0.542	0.529	0.98	3	0.121	0.428
Portuguese survey (B	888745	0.659	0.73	1.11	3	0.079	0.455
F shrinkage mean	1881121	0.7				0.105	0.241

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1872806	0.19	0.18	16	0.965	0.242

1

Age 5 Catchability constant w.r.t. time and dependent on age

Year class = 1992

Fleet	Est Su	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Norway Spawning Area	975884	0.398	0.283	0.71	3	0.116	0.238
USSR Spawning Area/A	1541614	0.517	0.021	0.04	2	0.068	0.157
CPUE Spanish Pair Tr	636415	0.265	0.146	0.55	4	0.303	0.345
Spanish Survey (Bott	349053	0.44	0.588	1.34	4	0.115	0.561

Norwegian Sea acoust	693248	0.264	0.101	0.38	4	0.261	0.321
Portuguese survey (B	173098	0.61	0.734	1.2	4	0.055	0.923
F shrinkage mean	765340	0.7				0.082	0.295

Weighted prediction :

Survivors at end of year		Int s.e	Ext s.e	N	Var Ratio	F
	641382	0.15	0.15	22	1.016	0.343

1

Age 6 Catchability constant w.r.t. time and dependent on age

Year class = 1991

Fleet	Est Sur	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Norway Spawning Area	524331	0.345	0.217	0.63	4	0.141	0.355
USSR Spawning Area/A	911727	0.497	0.116	0.23	2	0.075	0.219
CPUE Spanish Pair Tr	840989	0.241	0.215	0.89	5	0.323	0.236
Spanish Survey (Bott	621420	0.421	0.389	0.92	5	0.1	0.307
Norwegian Sea acoust	467622	0.26	0.201	0.77	5	0.245	0.39
Portuguese survey (B	600401	0.603	0.504	0.84	4	0.043	0.316
F shrinkage mean	528014	0.7				0.071	0.353

Weighted prediction :

Survivors at end of year		Int s.e	Ext s.e	N	Var Ratio	F
	633857	0.14	0.11	26	0.77	0.302

1

Age 7 Catchability constant w.r.t. time and age (fixed at the value for age) 6

Year class = 1990

Fleet	Est Sur	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Norway Spawning Area	276994	0.326	0.284	0.87	5	0.156	0.644
USSR Spawning Area/A	580105	0.42	0.409	0.97	3	0.105	0.359
CPUE Spanish Pair Tr	625510	0.242	0.171	0.7	5	0.286	0.337
Spanish Survey (Bott	275654	0.414	0.387	0.94	6	0.129	0.646
Norwegian Sea acoust	344463	0.384	0.208	0.54	5	0.171	0.546
Portuguese survey (B	516579	0.605	0.234	0.39	4	0.038	0.395
F shrinkage mean	465987	0.7				0.116	0.43

Weighted prediction :

Survivors at end of year		Int s.e	Ext s.e	N	Var Ratio	F
	426356	0.15	0.11	29	0.745	0.462

1

Age 8 Catchability constant w.r.t. time and age (fixed at the value for age) 6

Year class = 1989

Fleet	Est Sur	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Norway Spawning Area	276785	0.32	0.053	0.17	6	0.166	0.835
USSR Spawning Area/A	129540	0.429	0.163	0.38	4	0.097	1.332
CPUE Spanish Pair Tr	114105	0.25	0.135	0.54	5	0.203	1.427
Spanish Survey (Bott	104065	0.423	0.249	0.59	6	0.091	1.497
Norwegian Sea acoust	262876	0.425	0.186	0.44	5	0.162	0.864
Portuguese survey (B	156103	0.618	0.24	0.39	4	0.026	1.198
F shrinkage mean	534836	0.7				0.255	0.516

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
227129	0.21	0.14	31	0.634	0.952

1

Age 9 Catchability constant w.r.t. time and age (fixed at the value for age) 6

Year class = 1988

Fleet	Est Sur	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
Norway Spawning Area	68162	0.279	0.154	0.55	7	0.244	0.858
USSR Spawning Area/A	65522	0.387	0.13	0.34	5	0.109	0.881
CPUE Spanish Pair Tr	73203	0.248	0.187	0.75	5	0.171	0.817
Spanish Survey (Bott	50531	0.408	0.261	0.64	6	0.074	1.041
Norwegian Sea acoust	53593	0.305	0.135	0.44	5	0.148	1.003
Portuguese survey (B	143727	0.625	0.252	0.4	4	0.023	0.497
F shrinkage mean	157010	0.7				0.232	0.464

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
80034	0.19	0.1	33	0.509	0.769

Table A1.3 Blue whiting: F-at-age from XSA for 1981-1997

Run title 1998 WG ANON COMBSEX PLUSGROUP

At 3/05/1998 15:08

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1981	1982	1983	1984	1985	1986	1987
AGE							
0	0.0094	0.1712	0.0199	0.0492	0.1252	0.0086	0.0452
1	0.0794	0.0364	0.1605	0.138	0.1482	0.0945	0.1111
2	0.0994	0.1134	0.1904	0.2447	0.1758	0.1302	0.1139
3	0.1689	0.1273	0.1562	0.2301	0.3297	0.2406	0.1643
4	0.1252	0.1994	0.1573	0.2216	0.2362	0.5511	0.4133
5	0.2768	0.1379	0.1591	0.2323	0.2474	0.5484	0.4776
6	0.2834	0.2184	0.2331	0.3761	0.4459	0.417	0.3726
7	0.2308	0.2113	0.3711	0.3234	0.3887	0.5616	0.4382
8	0.296	0.2047	0.3695	0.4605	0.3707	0.5924	0.8282
9	0.2614	0.2088	0.2607	0.3482	0.4219	0.7943	0.7208
+gp	0.2614	0.2088	0.2607	0.3482	0.4219	0.7943	0.7208
FBAR 3-	0.217	0.1789	0.2153	0.2767	0.3296	0.4638	0.3732

Table 8 Fishing mortality (F) at age

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	FBAR 95-97
AGE											
0	0.0047	0.0855	0.0086	0.0238	0.0037	0.0247	0.0047	0.1767	0.0483	0.0303	0.0851
1	0.0729	0.1155	0.0944	0.0344	0.0775	0.0645	0.0486	0.0418	0.1437	0.1663	0.1172
2	0.1318	0.1697	0.1296	0.08	0.1106	0.0766	0.0339	0.0726	0.0976	0.1626	0.111
3	0.1702	0.3855	0.2375	0.1319	0.178	0.1458	0.1246	0.1798	0.1777	0.2357	0.1977
4	0.2289	0.3452	0.3898	0.159	0.2116	0.2584	0.128	0.2295	0.3619	0.242	0.2778
5	0.561	0.486	0.402	0.3297	0.1645	0.2333	0.3286	0.3066	0.2442	0.343	0.2979
6	1.0118	0.6918	0.7485	0.3566	0.226	0.2133	0.2475	0.3727	0.4313	0.3018	0.3686
7	0.4127	0.6557	0.7225	0.4704	0.2513	0.2423	0.3074	0.3707	0.6026	0.4619	0.4784
8	0.414	0.4643	1.0079	0.2407	0.4576	0.231	0.3326	0.516	0.6869	0.9517	0.7182
9	0.549	0.3503	0.4938	0.1483	0.2422	0.4142	0.4897	0.3828	0.699	0.7687	0.6168
+gp	0.549	0.3503	0.4938	0.1483	0.2422	0.4142	0.4897	0.3828	0.699	0.7687	
0 FBAR 3	0.4769	0.5128	0.5001	0.2895	0.2063	0.2186	0.2272	0.2919	0.3635	0.3169	

Table A1.4 Blue whiting: stock size from XSA for 1981-1997

Run title 1998 WG ANON COMBSEX PLUSGROUP

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Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year) Numbers*10**-4

YEAR	1981	1982	1983	1984	1985	1986	1987
AGE							
0	564588	2466595	2447799	1343084	1102896	1084850	853523
1	373383	457902	1701699	1964547	1046781	796747	880599
2	406488	282355	361507	1186659	1401137	738951	593507
3	484420	301316	206380	244673	760636	962205	531167
4	313598	334990	217199	144539	159151	447851	619306
5	250455	226531	224682	151949	94813	102885	211309
6	250312	155470	161580	156899	98618	60615	48675
7	249880	154357	102315	104783	88193	51696	32707
8	273473	162419	102308	57799	62083	48952	24138
9	277664	166534	108366	57885	29859	35085	22163
+gp	697162	392617	159901	95137	82438	79080	41395
TOTA	4141423	5101088	5793735	5507955	4926605	4408917	3858488

Table 10 Stock number at age (start of year) Numbers*10**-4

YEAR	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	GMST 81-95	AMST 81-95
AGE													
0	1075203	2629609	1074685	755462	571195	896126	982028	2255789	1933309	769026	0	1181278	1340229
1	667950	876139	1976589	872368	603945	465936	715798	800216	1547690	1508277	610852	836152	946707
2	645148	508416	639054	1472525	690104	457575	357662	558272	628369	1097527	1045725	609068	686624
3	433623	462964	351288	459603	1112904	505847	347017	283063	425048	466610	763759	443989	496474
4	369011	299463	257795	226806	329786	762620	357955	250819	193608	291354	301805	307947	339393
5	335397	240320	173607	142930	158400	218512	482209	257846	163246	110384	187281	200636	218123
6	107314	156700	121022	95086	84157	110017	141681	284236	155369	104691	64138	122391	135492
7	27456	31942	64232	46876	54501	54964	72770	90562	160307	82644	63386	68203	81816
8	17278	14878	13575	25534	23978	34707	35318	43812	51179	71846	42636	41973	62683
9	8633	9350	7657	4056	16433	12423	22555	20734	21411	21082	22713	25931	53293
+gp	12940	14106	26678	7640	5980	5647	8654	14412	17718	33715	20801		
TOTA	3699952	5243888	4706183	4108887	3651383	3524375	3523648	4859761	5297255	4557156	3123096		

Table A1.5 Blue whiting: stock summary table from XSA for 1981-1997

Run title 1998 WG ANON COMBSEX PLUSGROUP

At 3/05/1998 15:08

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECRUIT: Age 0	TOTALBIO	TOTSPBI(	LANDINGS	YIELD/SSI	FBAR 3- 7
1981	5645880	5220759	4475131	909556	0.2032	0.217
1982	24665952	4167916	3242977	576419	0.1777	0.1789
1983	24477990	3705378	2224226	570072	0.2563	0.2153
1984	13430835	3452287	1833786	641776	0.35	0.2767
1985	11028958	3418846	2084179	695596	0.3338	0.3296
1986	10848499	3611903	2388068	826986	0.3463	0.4638
1987	8535226	3132889	2012154	664434	0.3302	0.3732
1988	10752026	2851672	1714289	553413	0.3228	0.4769
1989	26296092	2885609	1630889	625433	0.3835	0.5128
1990	10746853	3076536	1504531	561610	0.3733	0.5001
1991	7554619	3506385	1838471	369525	0.201	0.2895
1992	5711952	3510901	2387186	474245	0.1987	0.2063
1993	8961261	3309775	2270785	480672	0.2117	0.2186
1994	9820279	3300615	2177883	459414	0.2109	0.2272
1995	22557892	3440802	2009354	578693	0.288	0.2919
1996	19333090	3208640	1847349	637825	0.3453	0.3635
1997	7690255	3293085	1790283	634206	0.3542	0.3169
Arith. Mean	13415156	3476117	2201855	603522	0.2875	0.3211
0 Units	(Thousar	(Tonnes	(Tonnes	(Tonnes)		

Figure A1.1 Blue whiting: Mean log catchability-at-age for each of the tuning fleets

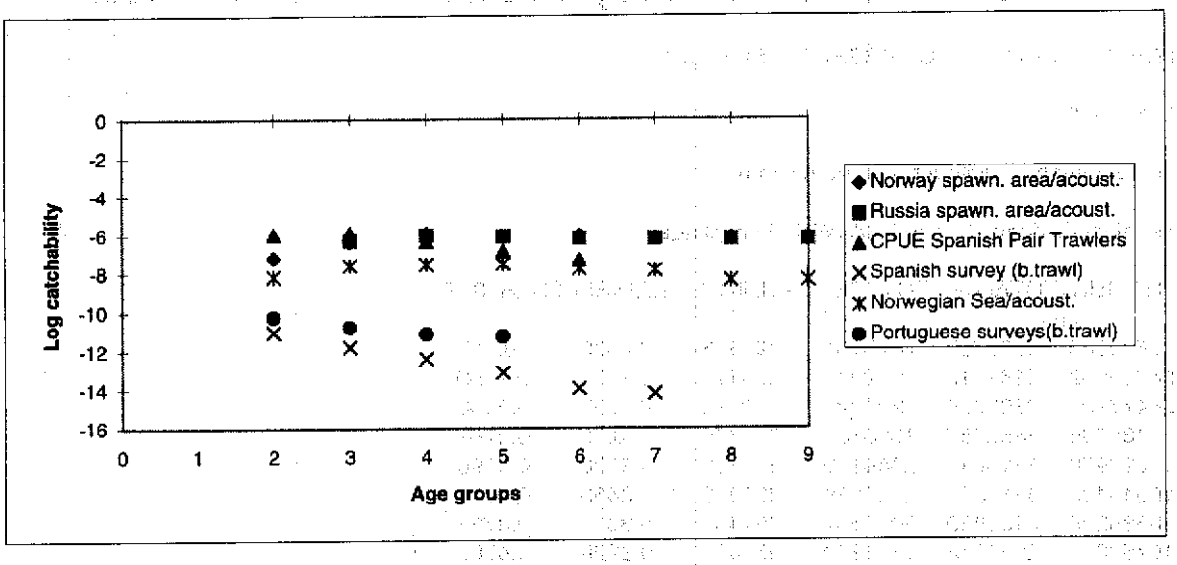

Figure A1.2 Blue whiting: Results of retrospective analysis, with terminal F's derived from XSA with F shrinkage to the last 3 and 5 ages (S.E.=0.7)

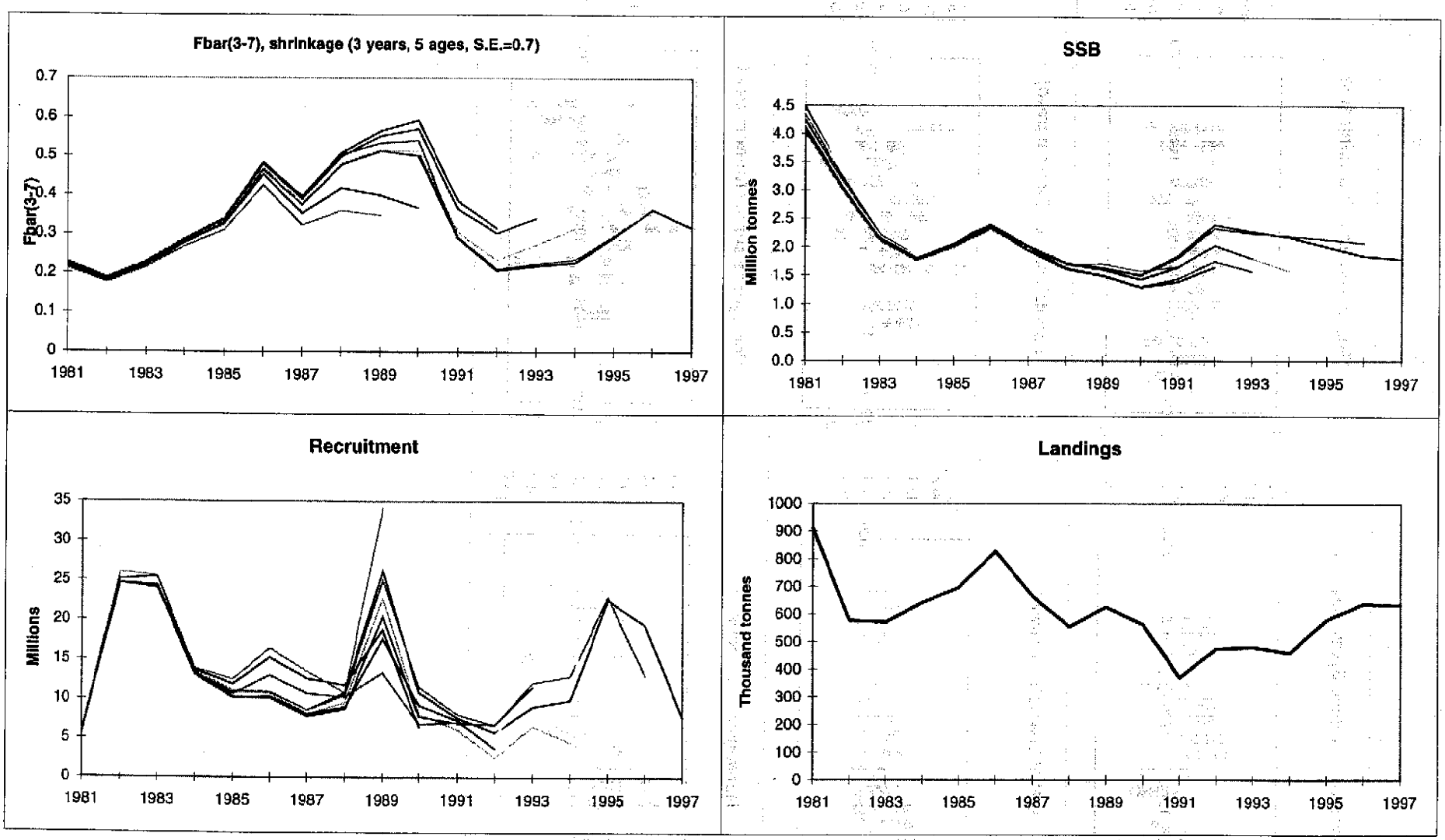

Figure A1.3 Blue whiting. Log catchability residuals for the tuning fleets used in the XSA runs.