ICES NWWG WD nr. 5

Sebastes marinus – an update

By

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8 SEBASTES MARINUS

8.1 Landings and Trends in the Fisheries

The total catch of golden redfish (*S. marinus*) (Divisions Va, Vb, in the Sub-areas VI and XIV) decreased from about 130 000 t in 1982 to about 40 000 t 1998 (Table 8.1.1). The catch in 1999 was about 42 000 t. and increased further to about 44 000 in 2000 The decline from 1982 of about 70% has more or less been continuous. Since 1990 the overall decrease in the catch has been about 45%. The increase in 1999-2000 are due to increased catches in Sub-areas Va and VI (Table 8.1.1).

In Division Va catches have declined from about 63 000 t in 1990 t, stabilising around 34 000-36 000 t in 1996-1998. In 1999 an increase to about 40 000 t was observed and was around 41 000 in 2000. In 2001, the catch decreased to around 35 thous. tonnes, the lowest catch in the area since 1996. The low catch in 1994 was partly due to area closures imposed on the fishery by Iceland in order to reduce the catches of *S. marinus* but also to reduce the effort on the nursery grounds. However, landings in 1995 increased to approximately 42 000 t. The catches of S. marinus in Va in the period 1996-2001 are the lowest since 1978. The length distributions in the Icelandic landings in 1989-2001 along with measurements from the commercial trawler fleet are shown in Figure 8.1.1. Number of measured fish by statistical square are given in Figure 8.1.2, and the fishing grounds are shown in Figure 8.1.3. About 90-95% of the total *S. marinus* catches in area Va have in recent years been taken by bottom trawlers (both fresh fish and freezer trawlers; length 48-65 m) targeting on redfish. The remainder is taken partly as bycatch in the gillnet and longline fishery. In 2001, as in previous years, most of the catches were taken along the shelf of W, SW and to SE of Iceland, mostly between 12ºW and 27ºW (Figure 8.1.3).

In Division Vb, catches were highest in 1985 (approx. 9 000 t). Catches declined to about 2,100 t in 1991, and have since remained at 2,300-2,600 t (Table 8.1.1). In 1999 and 2000 only 1,400 t and 1,500 were caught. Most of the *S. marinus* catches in Vb have been taken by pair trawlers and single trawlers (< 1000 HP). The CPUE decreased from 1996-1999 by 40% but increased by 13% in 2000 (Figure 8.1.4). No length distribution from the catches was available for 2000.

The catches in Sub-area VI increased since 1978, reaching almost 600 t in 1987. A decline was observed to a low of 40 t in 1992. In 1995-1996 the catches again reached more than 600 t, the highest catches observed in the whole period (Table 8.1.1). The provisional catch in 1999 and 2000 were about 775 t. Trawlers have taken the major proportion of the catches. No length distribution was available from the catch.

In Sub-area XIV catches have been more variable than in the other Sub-areas and Divisions. Since the highest catch on record (31 000 t), in 1982 a rapid decrease was observed to about 2 000 t in 1985. During the next 10 years catches varied between 600 and 4 200 t. In 1995-1997 almost no directed fishery for *S. marinus* or *S. mentella* occurred. A minor directed fishery occurred in 1998 and catches increased to 175 t. In 2000 the catch is estimated to be less than 100 t. from direct redfish fishery of large bottom trawlers targeting at *S. mentella*. Some bycatch is reported from the shrimp fishery in the area.

The following text-table shows the fishery related sampling by gear type and Divisions.

Area	Nation	Gear	Landings	Samples	Fish measured
Va	Iceland	Bottom trawl	34,693	262	52,444
Va	Germany/UK	Bottom trawl	232		

Va	Faroe	Line/hooks	62
Vb	Faroe	Bottom trawl	
XIV	Germany	Bottom trawl	
VI	UK	Bottom trawl	
XIV	Norway	Longline	

8.2 Assessment

8.2.1 Trends in CPUE and survey indices

Figure 8.2.1 shows the *S. marinus* abundance index with 95% confidence intervals using Icelandic groundfish survey (IGS), data (<400 m depth). The index is a biomass index of the fishable stock, computed by using a sharp fishable stock ogive (from 34-36 cm, L_{50} = 35 cm) The survey (see Pálsson *et.al*, 1989) is stratified (Figure 8.2.3). In Table 8.2.1 the contribution of each stratum to the index is given. The index indicates a decrease in the fishable biomass from 1999, and is now comparable with 1996-1998. The lowest index was in 1995, only about 30% of the maximum in 1987. The increase in the survey index in 1999 was not supported by the results in March 2000 and 2001, but in 2002, the index increased significantly again. The results since 1995 might indicate that the measured catchable biomass estimate have been increasing slowly from the record low index of 1995.

Length distribution from IGS shows that the peak (Figure 8.2.4) which has been followed during the last years (first in 1987) now has reached the fishable stock. The slow increase in the survey index since 1995 therefore reflects the recruitment of a strong year class (1985 year class and now also the 1990 year class). This indication of strong year classes is also confirmed by age readings, which have been going on since 1998.

The 1985 year class have been dominating the catches since 1995 (Figure 8.2.5), and in 2001 that yearclass contributed almost 30% of the total catch in Va. The survey results have also shown that 1990/1991 year classes are strong, and contributed also with nearly 30% of the total weight in the catch in 2001. The 1990 yearclass (age 11) contributes about 15% of the total catches in 2000, according to the age readings. The average Z, estimated from this 7 year series of catch at age data is 0.24 for age groups 15+ and with about 0.21 for age 20+. In WD XX in the NWWG reoport 2001, age reading results are compared between readers and otolith preparation methods in terms of bias and precision. There were significant differences between readers and between methods, mainly in the higher ages (> 20 years). Precision estimates, involving the high longevity of redfish, were relatively good compared to previous age reading comparisons on redfish species.

Indices of CPUE for the Icelandic trawl fleet for the period 1985-2001 are estimated from a GLIM multiplicative model, taking into account changes in the Icelandic trawl catch due to vessel, statistical square, month and year effects. All hauls at depths above 500 m with redfish, exceeding 10% of the total catch were included in the CPUE estimation (Figure 8.2.6). Also, a simple CPUE was calculated (sum of catch / sum of hours trawled for each year, each haul where redfish exceeded 10% of the total catch in each haul). The results from the trawler fleet reflect the situation shown in the groundfish survey. Although the CPUE was low in recent years it increased in 1997 and was relatively stable in 1998-2000. A considerably increase was observed in 2001 and the GLIM index is now above 80% of the1986 value, which is the first year in the series. The raw index is now higher than it was in 1986

In summary, the Icelandic groundfish survey as well as the CPUE data seem to indicate a considerable decline in the fishable biomass of *S. marinus* during the period from 1986 to 1994. The stock seems to have started to recover slowly, but it is still low according to the survey index. Large proportion of the catches in recent years is caught from two yearclasses.

The Icelandic groundfish survey indices (U) may be assumed to be related to overall biomass (B) by a simple linear relationship (U=kB). If catches are assumed to be proportional to stock size and effort (Y=cEB), then it follows that catch over survey index is proportional to effort (Y/U=aE, see Table 8.2.3) and this allows a one-year prediction of catch assuming a status-quo effort level.

Although calculated confidence limits in the groundfish survey is quite low, year to year variation incatchability/availability will affect the results drastically while using only the last observation value as a basis for extrapolation of catches in the coming year, based on a constant effort. By using a running average over few years (3 as a minimum), one would reduce the variation in the catch prediction, based on the above assumptions. The following text table gives the running mean of the IGS index given in Table 8.2.3.

The following text table gives the running mean of the IGS index given in Table 8.2.3.

	Year															
	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
3 year running average	1097	1053	986	810	704	567	493	464	406	438	471	539	598	577	536	503

In Division Vb, CPUE of *S. marinus* were available from the Faroes groundfish survey 1983- 2000 After an increase in the period from 1995-1998 there is decrease in 1999 and 2000. The results also indicate a high variation in the series, and on average, only 43 hauls are behind the value each year (20-61 hauls). The value in 1999 and 2000 is only about 70% of the average value for the whole period since 1983 (Figure 8.2.6).

For the period 1982-2001, abundance and biomass indices from the German groundfish survey for *S. marinus* >17 cm are illustrated in Figures 8.2.7 and 8.2.8. From 1986-1995, an almost continuous reduction in survey biomass has occurred. However, in 1998 and 2000 a weak signal of possible recovery was observed, although the values are very low compared with the period before 1990. It can be taken from Figures 8.2.7 and 8.2.8 that the redfish around Greenland were mainly distributed off the East coast, while the minor abundance and biomass indices off West Greenland decreased to almost zero. The length frequencies from the German groundfish survey in are illustrated for West and East Greenland in Figures 8.2.10-8.2.11, along with the length distributions in the IGS. The adults seem to remain almost depleted in East Greenland waters.

During the annual Greenland halibut survey (400-1500m) in XIVb in June/July 2000, *S. marinus* was only observed between 400 and 600 m. *S. marinus* was caught in 12 of the 55 hauls taken. The length distribution ranged from 19 to 54 cm with a peak in the length of 29 cm.

8.2.2 Alternative assessment methods

At the 1999 working group meeting, an alternative model (BORMICON(BOReal MIgration and CONsumption model)) was applied to the stock. The model is described in WD 18 in ICES CM 1999/ACFM:17 and has been presented in different forum during the last years. A paper submitted to Scientia Marina will hopefully be printed in next months.

The main characteristics that distinguish the model from most stock assessment model is that it stores the number and mean weight of fish in each age and length group, not only in each age group as traditional models do. After the growth has been modelled, it is then distributed. Then, certain proportion of the fishes does not grow, some proportion is allowed to grow one length group, some proportion 2 length groups etc. All fleets (predators) in the model have length based selection pattern. This means that fleets catch only the largest individuals of each recruiting age group and therefore affect mean weight at age. The model does not use catch in number directly as input data but rather length distributions, otolith samples and other data used to calculate catch in numbers. An objective function is then used to minimise the discrepancy between the model output and these data. This means that the model can use data that are not sampled regularly enough to calculate catch in number.

In calculation for the past, the total amount caught is specified, but in simulations into the future proportion caught (the fishing mortality) is specified. The formulation used is a relatively simple one and its main characteristics are:

- One area
- Two fleets catching each species, a commercial fleet and a survey. Selection patterns of both fleets are described by a logistic function, whose parameters are estimated
- Growth is described by the von Bertalanffy function.

Data used in the objective function to be minimised are:

- Length distributions from commercial catch and survey
- Age-length keys p(*a*/L) from commercial catch and survey
- Length-disaggregated survey indices
- Mean length at age from survey, and commercial catches
- Understocking (Not enough biomass exists to cover the catch).

Estimated parameters are then:

- Initial number in each age group
- Recruitment each year
- Parameters in the growth equation
- Selection patterns of commercial fleet and survey. Two parameters for each fleet.

Simulation period is from 1970 to 2001. Two time steps are used each year.

The BORMICON model was run using the same settings as last year. Results from the runs are shown in figures 8.2.12 and and 8.2.13 and comparison with last years results in figure 8.2.14. As may be seen the stock estimate this year is lower than last year, the difference probably driven by the survey and possibly length distributions from the catch. (In last years assessment the length distributions in the year 2000 were not included). Survey indices for this species have shown an increasing trend since 1993, but with lot of noise on top of the trend. (Table 8.2.5). In spite of increase in the index from 2001 to 2002 the index is still below the values in 2000 and especially 1999 and could be pulling the results down. The CV of the survey index in 2002 is on the other hand lower than has been for a number of years.

Natural mortality is set to 0.15 for the youngest decreasing gradually to 0.05 for age 5 and older. Alternatives with other values on natural mortalities (M=0.1 for age 5+) were tested. They gave worse fit, and are therefore not incorporated here. The ages used are 1 to 30 years. The oldest age is treated as a plus group. Recruitment was at age 1. Prior to 1989 length at recruitment was 7.1 cm, but 8.1 cm in later years. This was supposed to reflect length of the 1985 and 1990 year classes in the groundfish survey.

As in last years model runs the 1991 yearclass is nearly as big as the 1990 yearclass which has been considered much bigger of those 2. To look at this problem length at recruitment was estimated sepreately for the 1990 and 1991 yearclass and the selection of the commercial fleet allowed to change annually since 1998. The results are shown in figures 8.2.14, 8.2.15 - 8.2.17. The figures show that the difference between the 1990 and 1991 yearclass has now increased and the stock size is closer to what was estimated last year. The estimated value of L50 is shown in Table 8.2.4. The change in recent years could indicate that the fishermen are keeping/targeting smaller fish, the model is wrong or that the data comes increasingly from sampling programs aimed towards area closures but the samples included are a mixture of harbour samples and samples taken by inspector aboard the vessels. The first mentioned possibility could explain some of the difference as some of the trawlers have, during the last years been equipped with a "small-redfish fillet-machine".

Using a fixed selection pattern and estimating length recruitment for the 1990 and 1991 yearclass increases the difference between the 1990 and 1991 yearclass (though not as much as when the selection is variable) but the catchable biomass does not change from the base case.

The groundfish survey in March 2002 does not indicate any improvement in redfish recruitment which has been bad since 1990-1991. The estimated average yearclass size in 1992-2001 is 80 million (at age 0). Maximum yield per recruit is 250g so this recruitment can only sustain an annual catch of 20000 tonnes. According to the predictions here the stock is going to be stable for the next years with an annual catch of 30-35 thousand tonnes. This value might though have to be reduced every year that no sign of good recruitment are seen.

Finally the runs shown here have used M = 0.05. M = 0.1gives similar or better fit. Figure 8.2.18 shows the results using M=0.1.

In 2001 the model was also run with the total S.marinus catch in ICES divisions XIV, Va and Vb. This addition increased the estimated stock size as the catch is increased. The proportion of the catch taken in Division Va has though been relatively stable since 1985, with about 85-90% taken in Va. As the tuning data are identical, similar trends in the stock size are to be expected in recent years, with about 10% higher biomass in 2000 than when using only the data from Va.

The main indicator for recruitment is the groundfish survey, which does not indicate that any strong yearclass is on the way after the 1990/1991 year class. Here the 1990/91 year class similar to with the 1985 year class. Much less data are available to estimate the recruitment prior to 1985. Simulations were used to determine the value of F_{max}. A yearclass was started in 1970 and caught using fixed fishing mortality and the estimated selection pattern. The total yield from the yearclass was then calculated.. F_{max} was calculated 0.165 using 40 years simulations, and $F_{0.1}$was estimated to be 0.09. F here is not fishing mortality but close to it when small time steps are used or mortalities are small. It is also the mortality of a fish where the selection is 1.

Different catch options were tested in the future simulations for fixed catch. As may be seen on Figure 8.2.12, 8.2.13 and 8.14-8.17, the catchable biomass will increase until 2005, using fixed catch after the year 2002 for all catch options below 40 000 t. The total biomass will at the end of the period be lower than it is now for catches exceeding about 35°000 t annually.

From the above mentioned runs, it is clear that if the groundfish survey is to be accepted as a measure of recruitment, no new large year class will recruit within the next 10 years.

8.2.3 State of the stock and catch projections

All available survey information and CPUE data from Division Va show that the *S. marinus* stock decreased considerably from 1985 to the lowest recorded biomass in 1995. An improvement in fishable biomass has, however, been seen in the recent years due to improved recruitment. During the last few years, the 1985year class has contributed significantly to the fishable stock, and the 1990 yearclass did also contribute significantly to the fishable biomass in next years. It is expected that those yearclasses will be dominant in the catches in the next few years. In Division Vb the CPUE from the Faroes groundfish survey were not available for the last year, but it shows an increase in last years for the available period. CPUE is however still at very low level. The adult stock of *S. marinus* in Sub-area XIV has nearly been exhausted in the most recent years. There are no indications of any considerable recruitment in area XIV.

By assuming same effort in 2003 as it was in 2001 (see chapter 8.2.1) the predicted catch in Va will be around 33 000 tonnes,using the following formula, $Catch_{2002}$ = Average Survey $index_{2000\text{-}2002}$ * $Effort_{2001}$.

Based on the BORMICON model the fishable biomass will increase in the next few years, but will decrease thereafter for every catch option above about 35 000 t. This is due to the poor recruitment after the 1990/91 year class. Based on the results from the BORMICON model, a TAC of about 35°000 t in next 5 years would keep the fishable stock size above UPa at the end of that period.

In Division Vb the CPUE from the Faroes groundfish survey shows a similar trend as the Icelandic (increase in 1996-1998, but decrease in 1999 and 2000), but in Sub-area XIV the fishable stock of *S. marinus* is almost depleted.

In order to protect the new incoming year class, any fishing effort on this component should be kept low to allow the stock not to decrease in the nearest future. It should also be kept in mind that, based on the groundfish survey there is no indication of new, strong, year classes after the 1990 year class. Therefore as described in 8.2.2, the year classes, 1985 and 1990 needs to be preserved, since it is unlikely that other year classes than these will contribute substantially to catches in the next years. Therefore, the Working Group recommends **that the catches should be kept low in order to keep the stock within safe biological limits.**

8.3 Biological reference points

S. marinus is mainly caught in Division Va and the relative state of the stock can be assessed through survey and CPUE index series from that Division. ACFM accepted the proposal of the working group of defining reference points in terms of current state with respect to $U_{lim} = U_{max} /5$ and U_{pa} = 60% of U_{max}. U_{pa} corresponds to the fishable biomass associated with the last strong year class. Based on survey data, the highest recorded biomass was reached in 1987. Based on these definitions, the stock has been below, but close to U_{pa} during the last years. Based on the BORMICON model the corresponding values for reference points (for the period 1985-1999) are then U_{max}= 250 (in 1985); U_{lim}= 50 and U_{pa}= 150, and the stock seems to have been below U_{pa} in the period from 1993- 1996. The survey index series is only available back to 1985.

8.4 "Giant" *S. marinus*.

In March 1996 a new fishery with longlines and gillnets started on the Reykjanes Ridge deeper than 500 meters. In addition to traditional bottom longlines, vertical longlines were used on the steep sea mountains. One or two vessels also used gillnets. One of the main species caught in this fishery were the "giant" *Sebastes marinus* (see chapter 7.1). The main fishery has taken place from within the Icelandic EEZ (north to approx. 63°N) and southwards in international waters to approx. 56°N, although occasionally "giant" redfish have been caught south to 52°30'N. ACFM decided in 1997 to treat all *S. marinus* in ICES Sub-areas V, XII and XIV, including the 'giant', as one management unit.

The only landing statistics presented in 1996 were by Iceland, the Faroes and Norway (Table 8.4.1). The total reported landings of "giant" *S. marinus* taken by these countries in Sub-areas XII and XIV in 1996 was 900 t. The fishery since then decreased, with only minor catches reported by Norway in 1997 and there were no reporting of "giant" catch since then. Taking all available information and knowledge into account, it is the view of the Working Group that the demersal *S.marinus* caught on the Reykjanes Ridge in international waters, of which nearly 100% have been documented to belong to a separate genetic pool, the 'giants', should be managed separately and in a very conservative and cautious way.

Table 8.1.1. *S. marinus*. Landings (in tonnes) by area used by the Working Group.

Year	Va	Vb	VI	XII	XIV	Grand Total
1978	31,300	2,039	313	0	15,477	49,129
1979	56,616	4,805	6	0	15,787	77,214
1980	62,052	4,920	2	0	22,203	89,177
1981	75,828	2,538	3	0	23,608	101,977
1982	97,899	1,810	28	0	30,692	130,429
1983	87,412	3,394	60	0	15,636	106,502
1984	84,766	6,228	86	0	5,040	96,120
1985	67,312	9,194	245	0	2,117	78,868
1986	67,772	6,300	288	0	2,988	77,348
1987	69,212	6,143	576	0	1,196	77,127
1988	80,472	5,020	533	0	3,964	89,989
1989	51,852	4,140	373	0	685	57,050
1990	63,156	2,407	382	0	687	66,632
1991	49,677	2,140	292	0	4,255	56,364
1992	51,464	3,460	40	0	746	55,710
1993	45,890	2,621	101	0	1,738	50,350
1994	38,669	2,274	129	0	1,443	42,515
1995	41,516	2,581	606	0	62	44,765
1996	33,558	2,316	664	0	59	36,597
1997	36,342	2,839	542	0	37	39,761
1998	36,771	2,565	379	0	109	39,825
1999	39,824	1,436	773	0	7	42,040
2000	41,110	1,558	776	0	89	43,533
2001	34,986					

Table 8.2.1. Index on fishable stock of *S. marinus* in the Icelandic groundfish survey by depth.

Depth interv / year	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
< 100m	7	2	2	1	1	2	2	1	1	1	0	1	1	2	1	2	2	2
100-200m	91	86	124	95	101	68	76	62	48	58	36	44	60	57	56	47	33	64
200-400m	140	180	150	110	118	81	53	59	50	51	45	76	71	71	107	69	67	74
400-500m	24	12	10	4	11	22	8	9	17	1	11	21	34	3	44	8	6	11
Total 0 - 400m	237	268	276	206	220	151	130	122	98	110	81	121	133	130	164	117	101	140
Total	262	281	287	228	234	187	141	133	117	112	93	143	166	133	208	125	107	151

Table 8.2.2. *S. marinus*. Catch in Va in weight (tonnes) by age.

Year/ Age	1995	1996	1997	1998	1999	2000	2001
7	59	0	33	24	0	0	230
8	366	354	229	285	367	118	252
9	1572	808	483	598	1492	595	604
10	9312	3622	1039	1213	1244	3977	2322
11	2698	8943	2704	1134	1820	1894	10057
12	1314	2072	11563	3257	2651	2524	2101
13	3548	1300	2820	12548	2330	1610	2174
14	5684	1459	1366	2086	15703	2292	1298
15	6000	4398	3123	2039	1171	14272	776
16	1743	5641	3621	2411	1235	1778	10173
17	859	921	3024	3410	1884	1234	439
18	371	388	896	2048	2769	1843	623
19	1148	268	644	1015	2317	2379	785
20	1158	337	960	726	1219	2201	1160
21	511	1210	448	521	487	571	667
22	684	1033	544	390	231	619	287
23	1447	803	691	425	347	226	273
24	673	0	595	662	226	124	73
25	773	0	753	516	948	585	75
26	370	0	271	400	281	503	64
27	354	0	140	425	587	248	156
28	736	0	208	359	175	493	112
29	0	0	155	54	107	471	102
30	134	0	31	226	234	451	183

Table 8.2.3. *S. marinus* Results from the Icelandic groundfish survey in Va, total catch in Va and effort towards *S. marinus*.

Year	Survey index	Catch (Va)	Effort
1985	1000	67,312	67
1986	1131	67,772	60
1987	1165	69,212	60
1988	869	80,472	93
1989	928	51,852	56
1990	637	63,156	99
1991	549	49,677	91
1992	515	51,464	100
1993	414	45,890	111
1994	464	38,669	84
1995	342	41,516	122
1996	511	33,558	66
1997	561	36,342	65
1998	549	36,771	67
1999	692	39,824	58
2000	494	41,110	83
2001	426	34,986	82
2002	590		

Table 8.2.4. Results of the BORMICON model. BASE CASE, estimated value of L_{50}.

Year	<1998	1998	1999	2000	2001
L_{50}	34.43	34.94	34.63	34.09	33.56

Table 8.2.5 . Index of total biomass of *S.marinus* from the groundfish survey in March and CV in the estimate

Year	index	CV
1985	333.00	0.094
1986	373.55	0.134
1987	350.08	0.114
1988	283.57	0.103
1989	337.59	0.151
1990	310.72	0.313
1991	203.42	0.104
1992	173.50	0.093
1993	203.53	0.143
1994	189.67	0.125
1995	163.40	0.138
1996	227.79	0.211
1997	278.97	0.310
1998	227.64	0.158
1999	377.87	0.206
2000	260.77	0.202
2001	221.08	0.153
2002	255.36	0.122

Table 8.4.1 Catches of "giant" *S. marinus* in Divisions XII and XIV. No catches are reported in 1998-1999.

	XII		XIV	
	1996	1997	1996	1997
Norway	76	21	750	22
Faroes[1]			80	
Total	76	21	830	22

1) Includes area XII

Catch figures for other areas or nations are not available for the meeting.

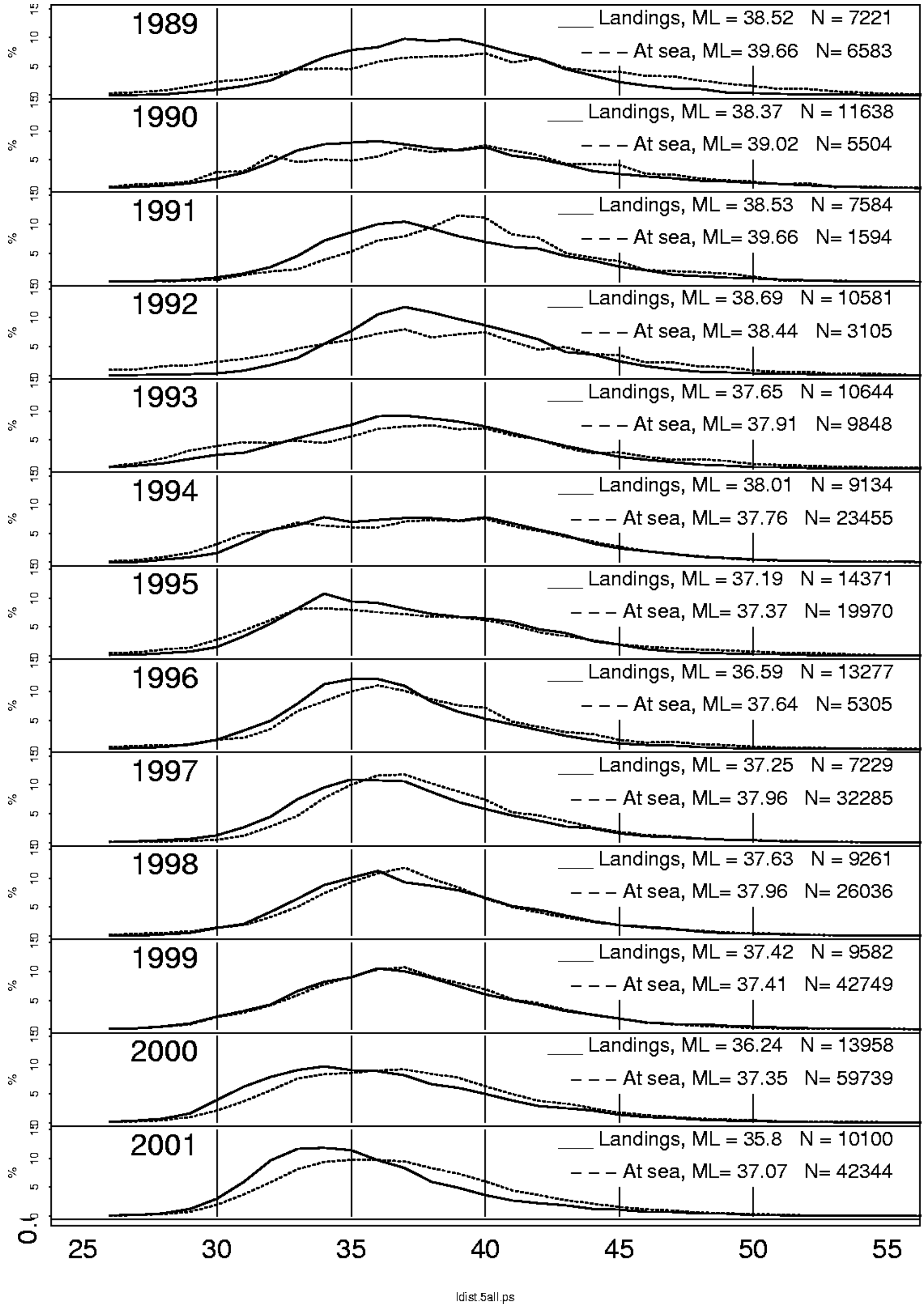


Figure 8.1.1. *S. marinus*. Length distribution from Icelandic landings and from samples taken at sea from the trawler fleet 1989-2001

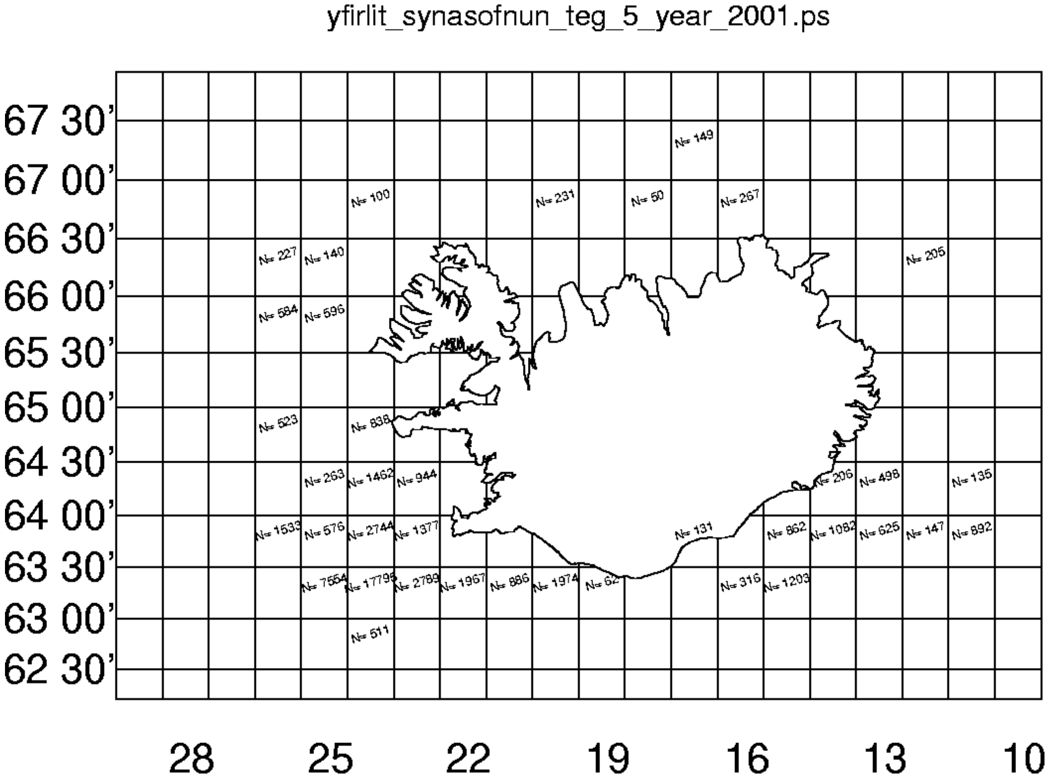


Figure 8.1.2. Number of measrured *S. marinus* in 2001 by statistical square.

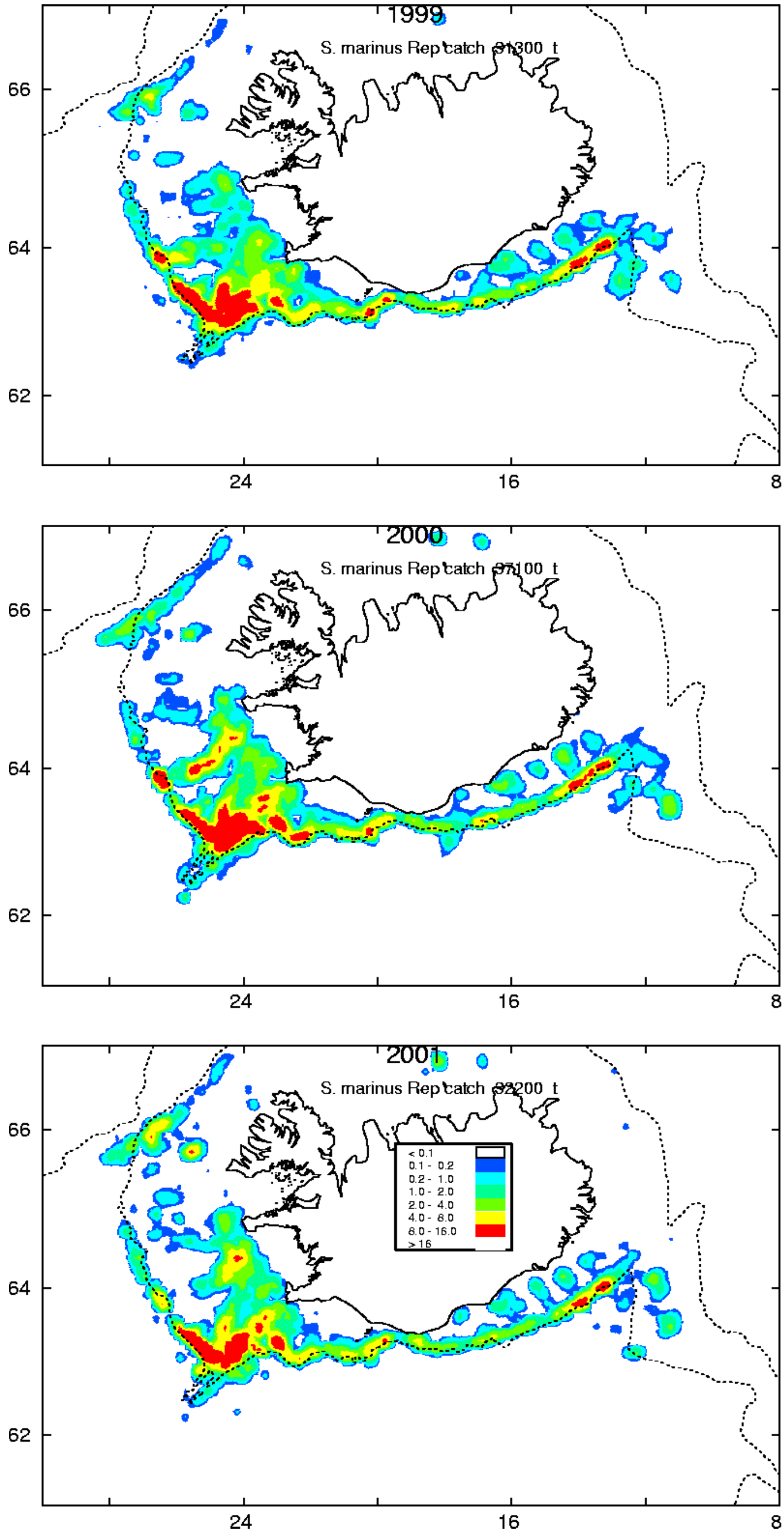


Figure 8.1.3. Distribution of S.marinus catches in division Va from 199-2001.

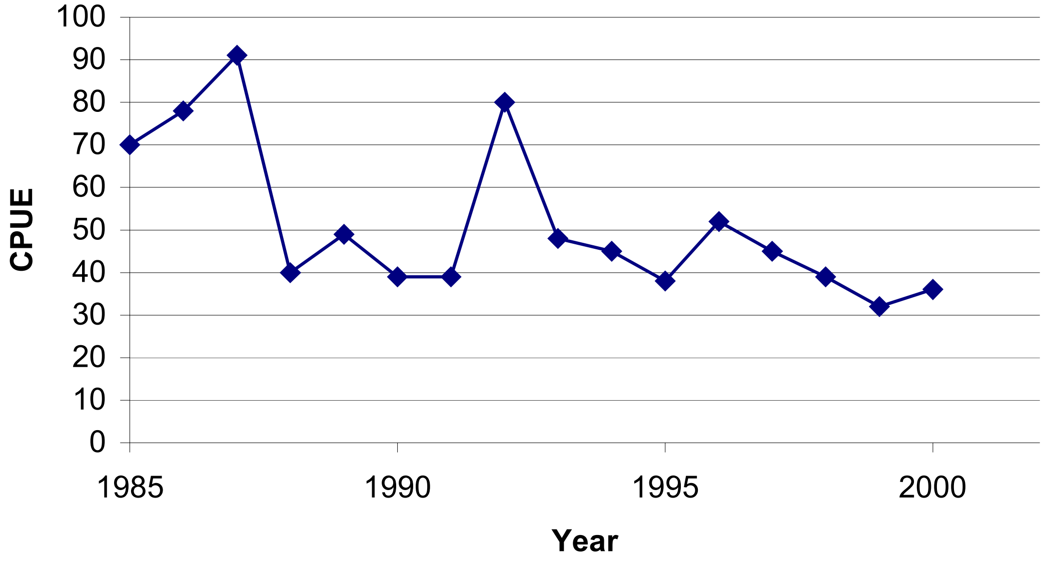


Figure 8.1.4. CPUE from the Faroese pair-trawlers in ICES division 1985-2000.

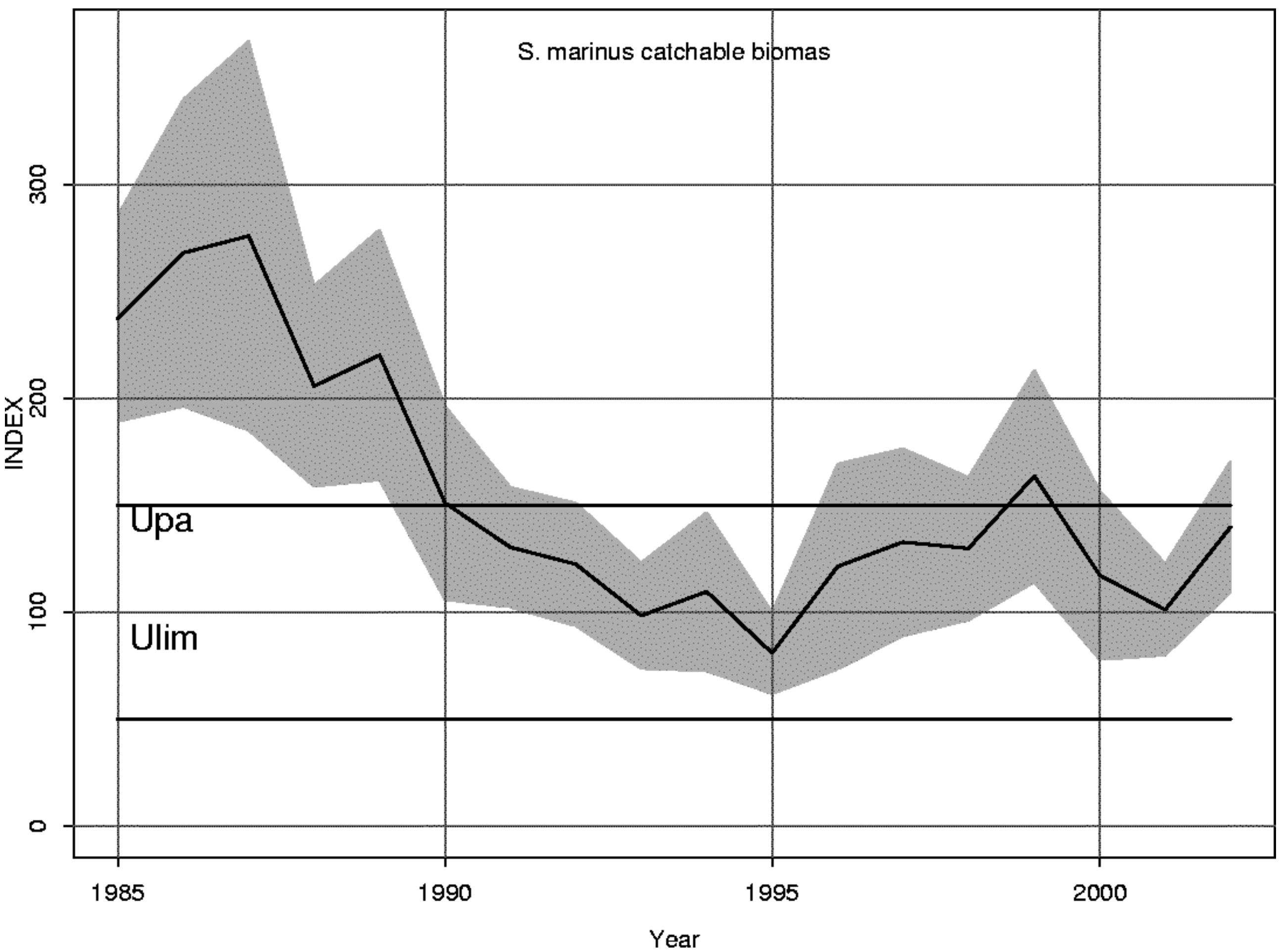


Figure 8.2.1. Index on fishale stock of *S. marinus* from Icelandic groundfish survey and 95% confidence intervals. The index is based on all strata at depths from 0-400 m.

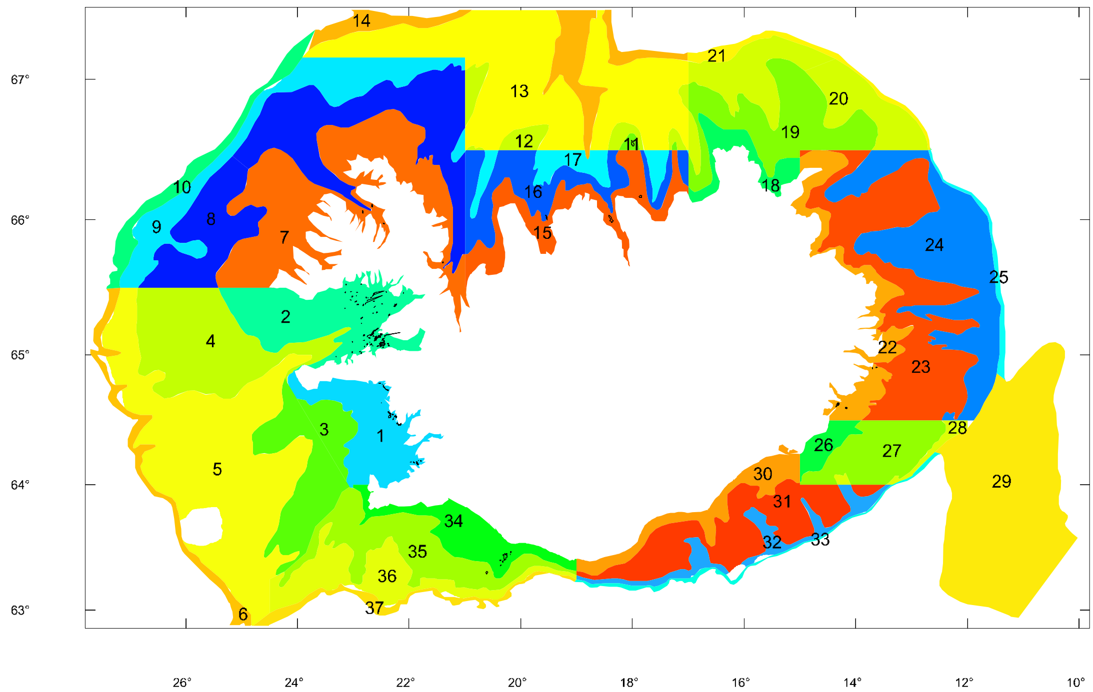


Figure 8.2.3. Stratification in the Icelandic groundfish survey by depth down to 500 m. The numbers show stratified index (Palsson *et al.* 1989). See also table 8.2.1.

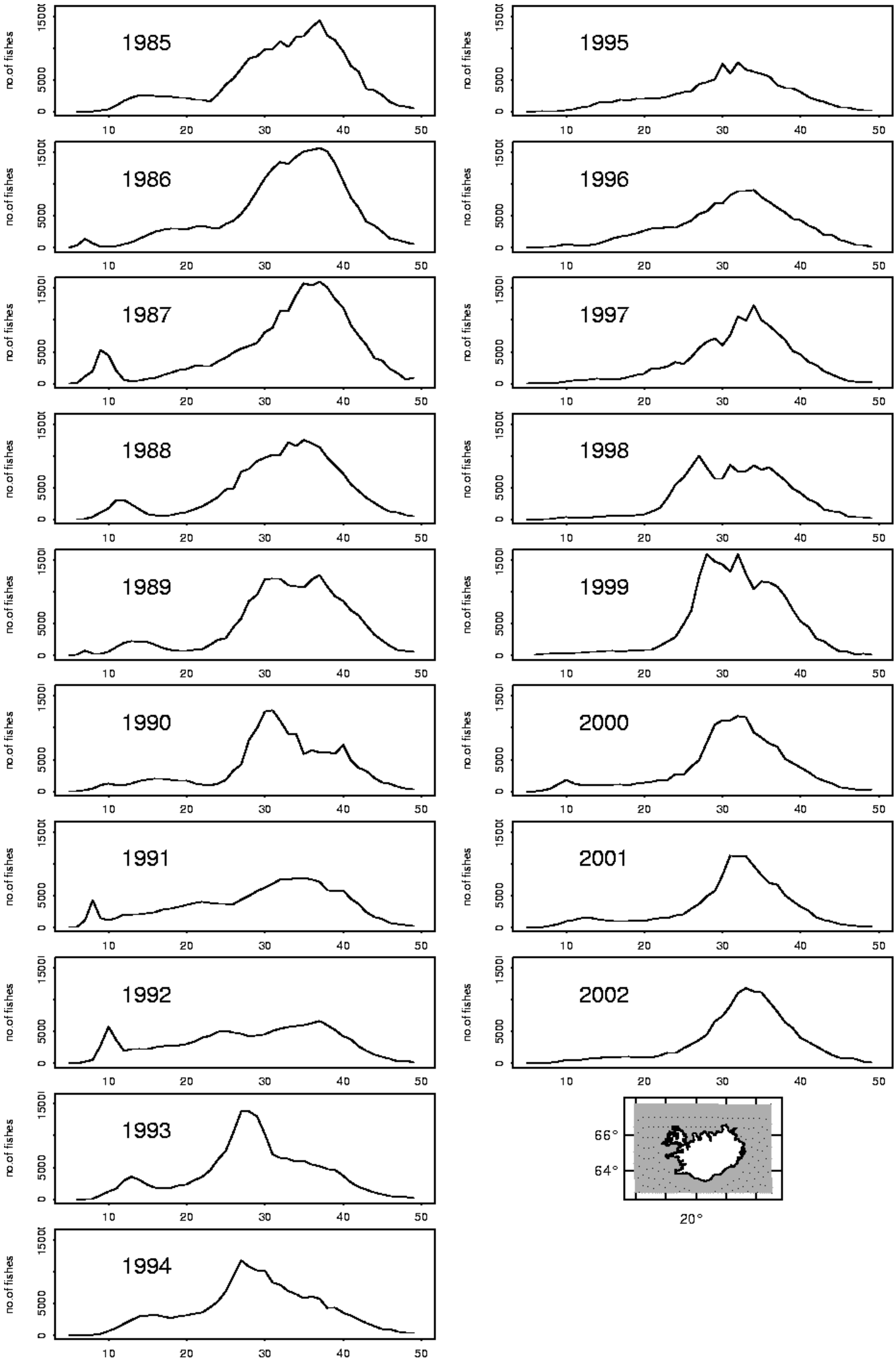


Figure 8.2.4. Length distribution of *S. marinus* in the Icelandic groundfish survey.

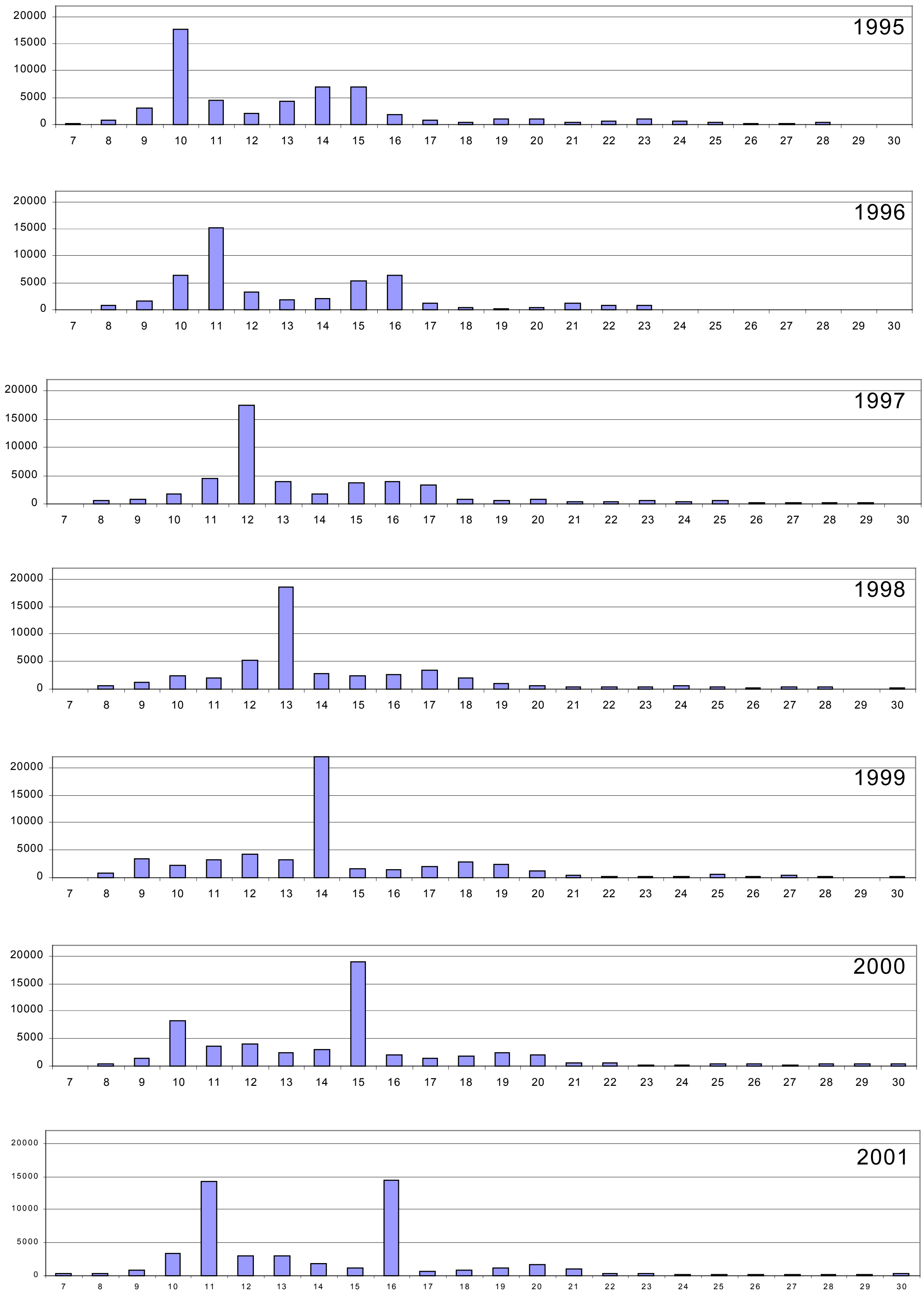
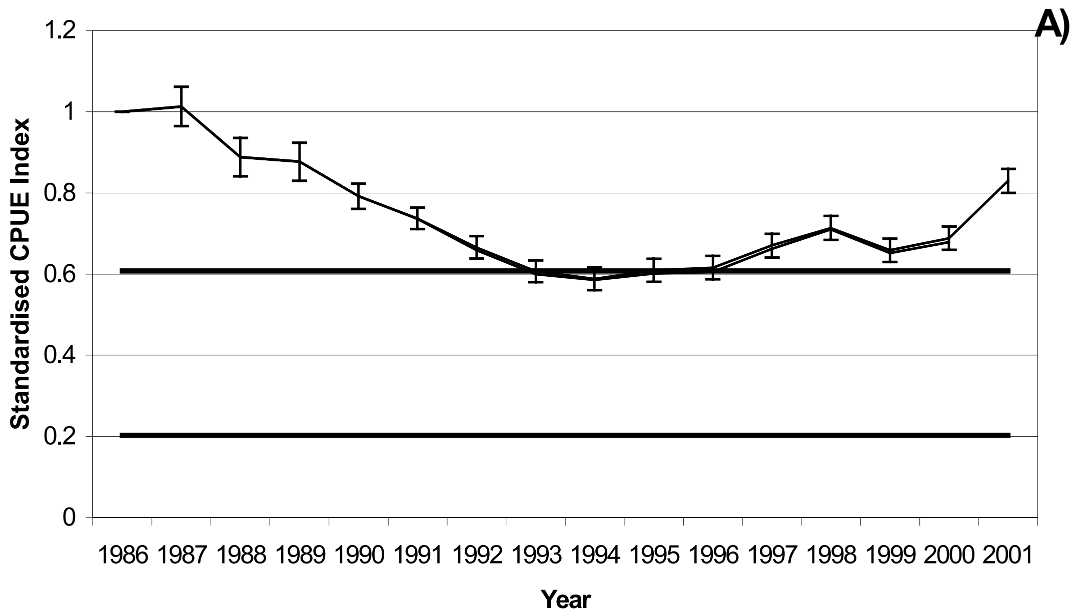


Figure 8.2.5. *S. marinus.* Catch in number by age in ICES Sub-division Va 1995-2001.



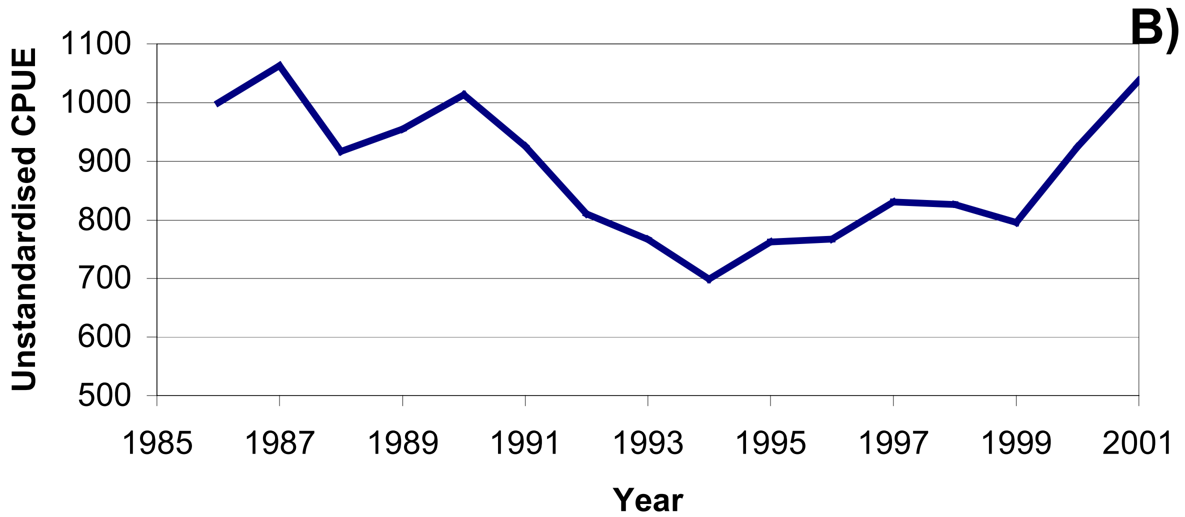


Figure 8.2.6. CPUE in *S. marinus* from Icelandic trawlers, both based on results from GLIM model 1985-2000 (A) with 95% CV) and based on simple mean of hauls where *S. marinus* catch compose 50% or more of the total catch in each haul (B).

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Figure 8.2.7. CPUE of *S. marinus* in the Faroes groundfish survey 1983-2000.

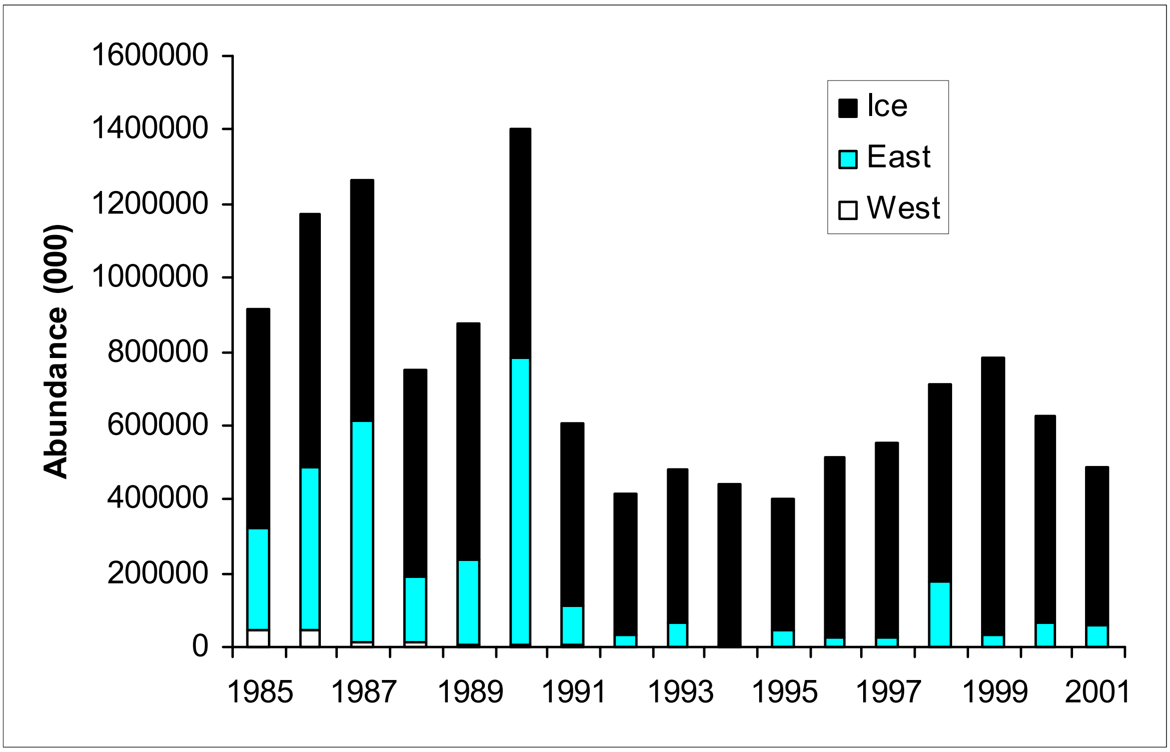

Figure 8.2.8 *S. marinus* (≥17 cm). Survey abundance indices for East, West Greenland and Iceland 1985-2001.

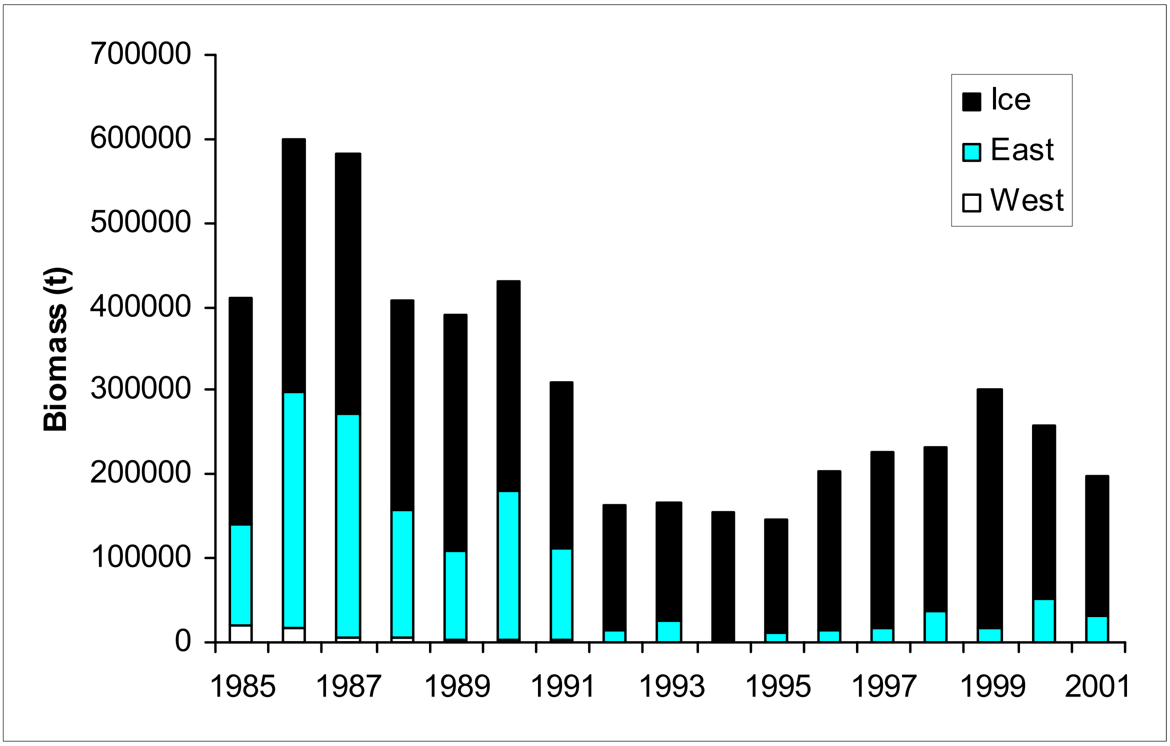

Figure 8.2.9. *S. marinus* (≥17 cm). Survey biomass indices for East and West Greenland and Iceland, 1985-2001.

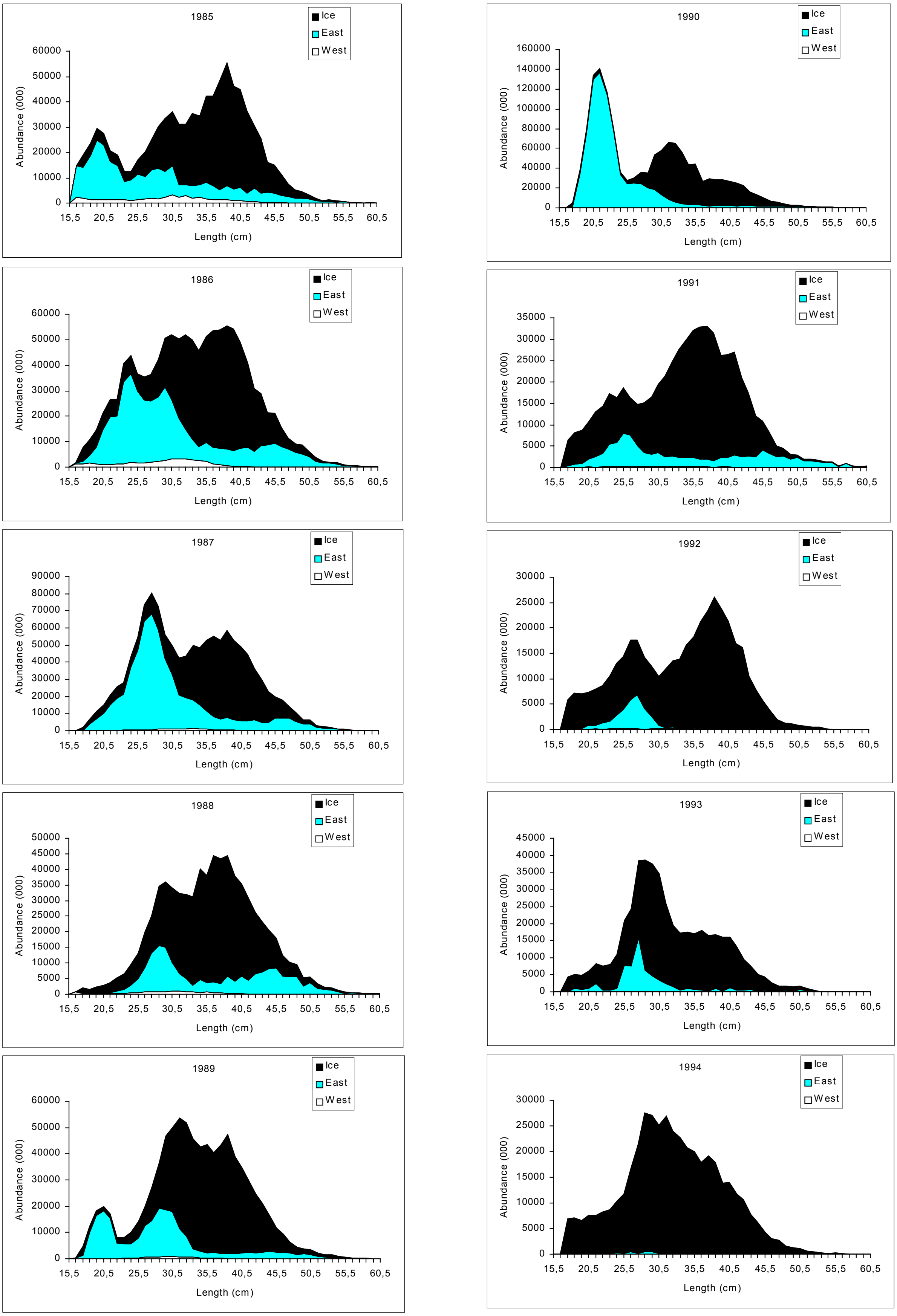

Figure 8.2.10 *S. marinus* (>17 cm). Length frequencies for East Greenland, West Greenland and Iceland, 1985-1994.

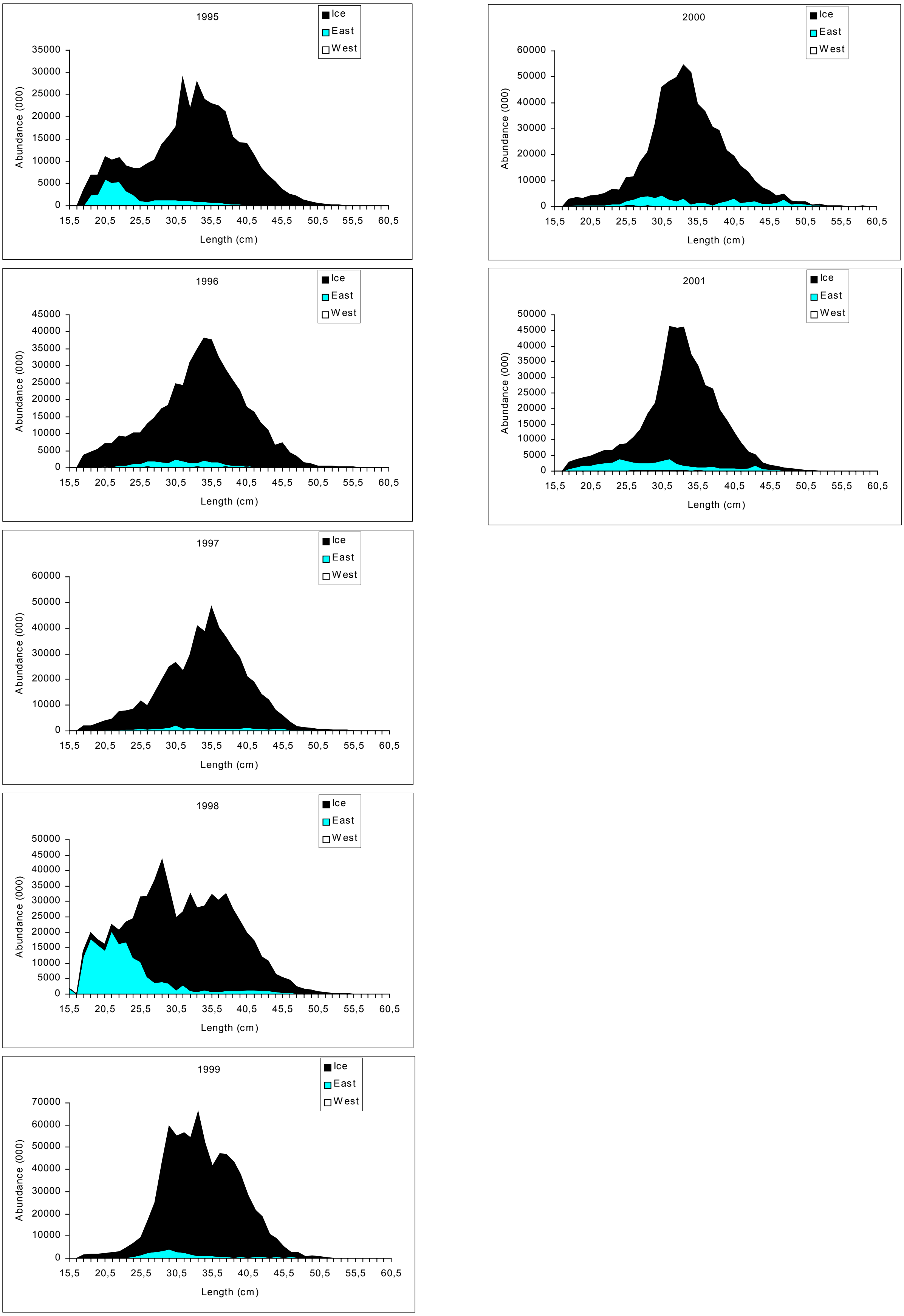

Figure 8.2.11 *S. marinus* (>17 cm). Length frequencies for East Greenland, West Greenland and Iceland, 1995-2001.

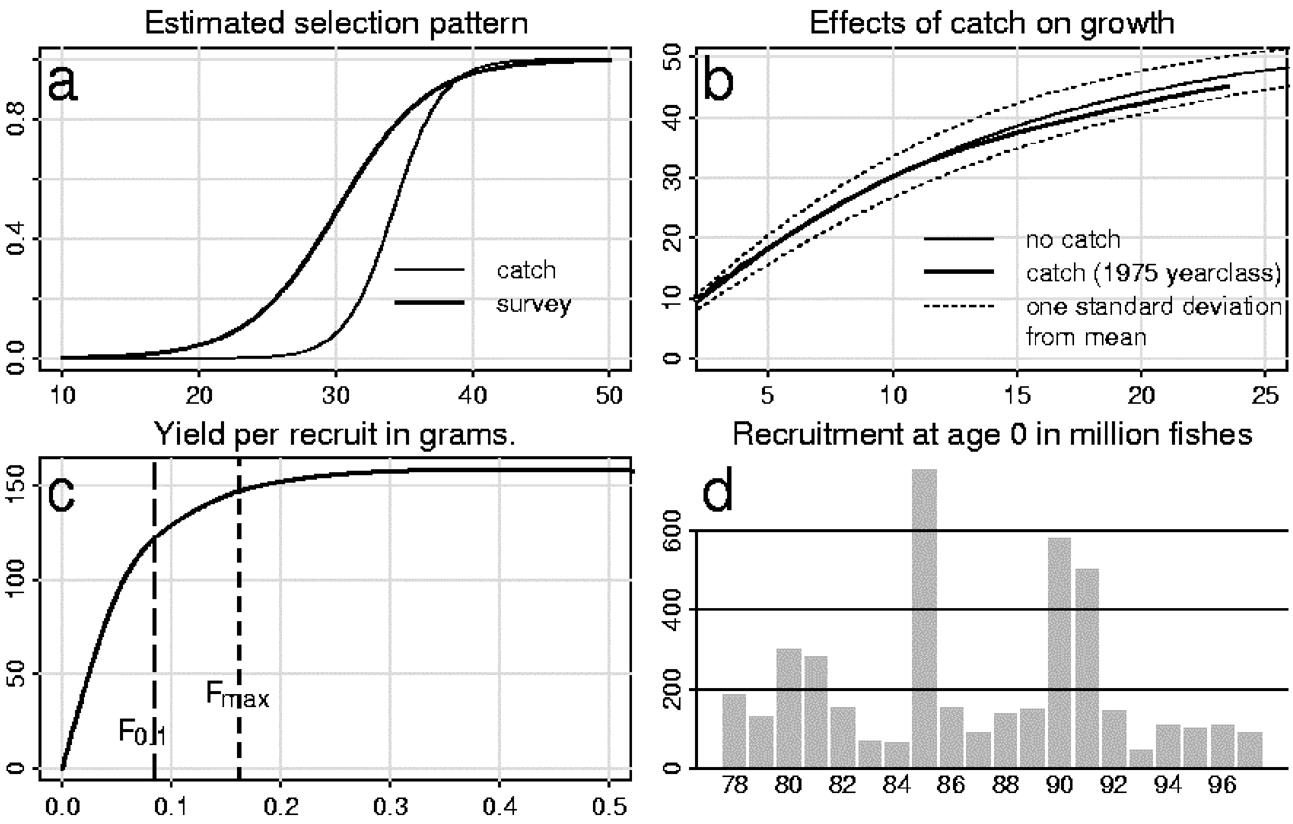

Figure 8.2.12. Results out of the BORMICON model-BASE CASE, using catch data from ICES Division Va only. a) .estimated selection pattern of the commercial fleet and the survey, b) Mean length (the figure also demonstrates the effect of catch on length at age), c) Yield per recruit and c) estimated recruitment at age 0.

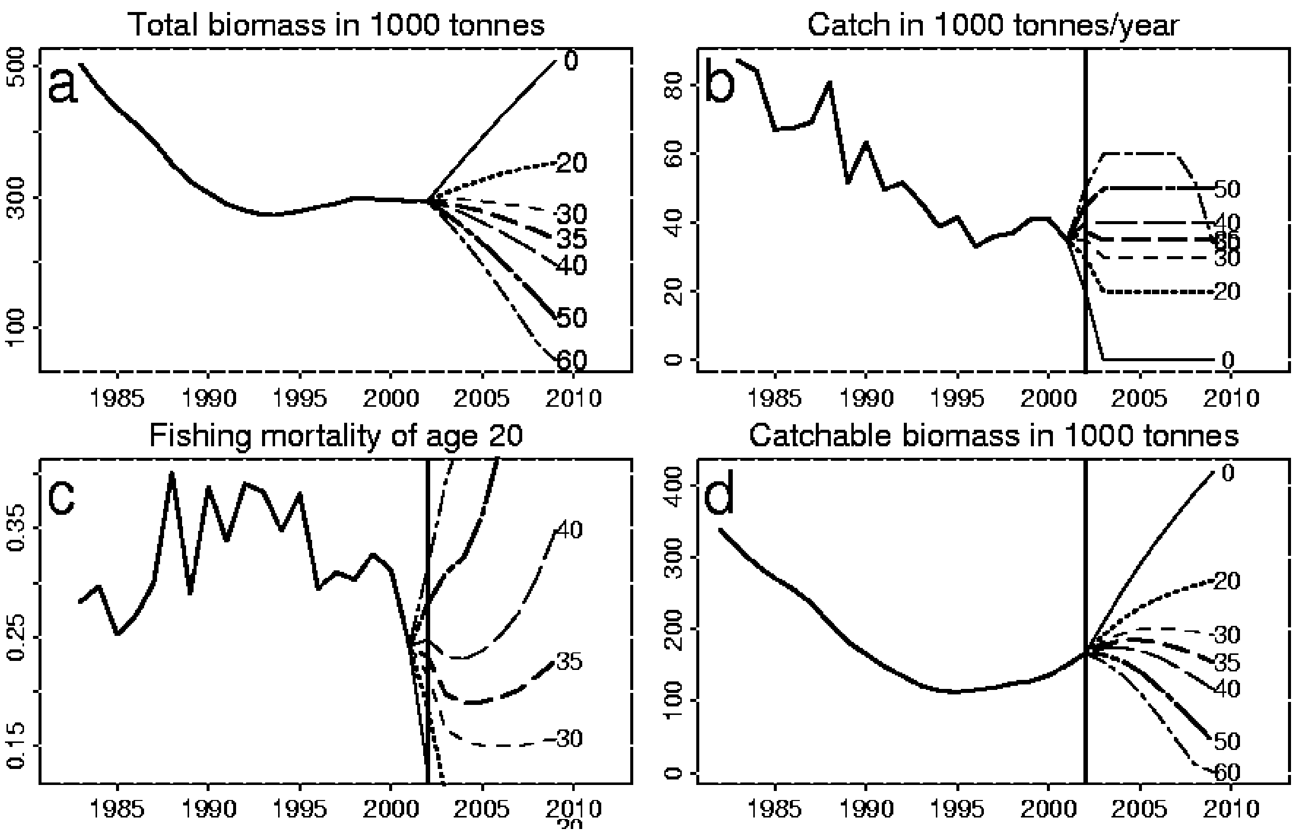

Figure 8.2.13. Results from BASE CASE run, using only catch in ICES Division Va. Fhe figures show development of biomass and F, using different catch options (0-60 000 t) after 2002.

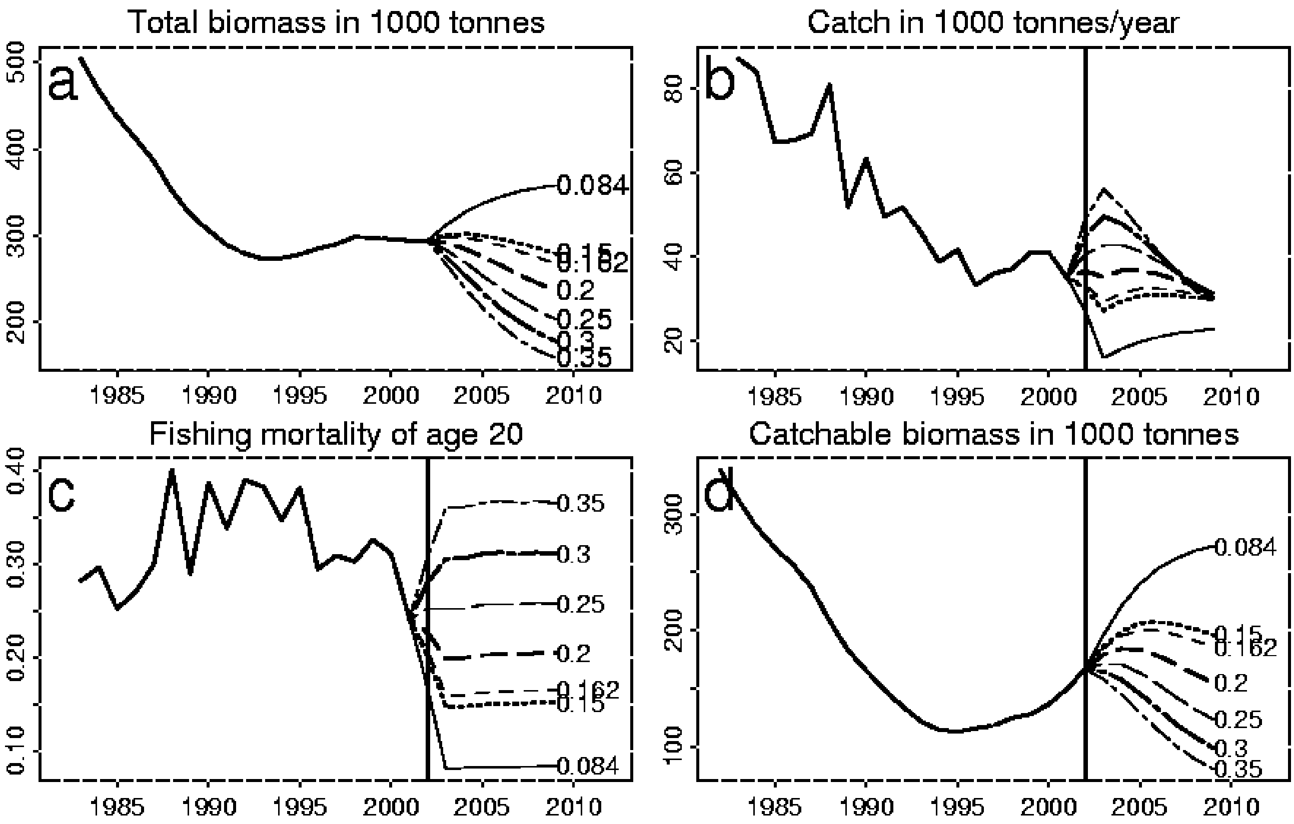

Figure 8.2.14. Results from BASE CASE run, using only catch in ICES Division Va. Fhe figures show development of biomass and F, using different effort after 2002.

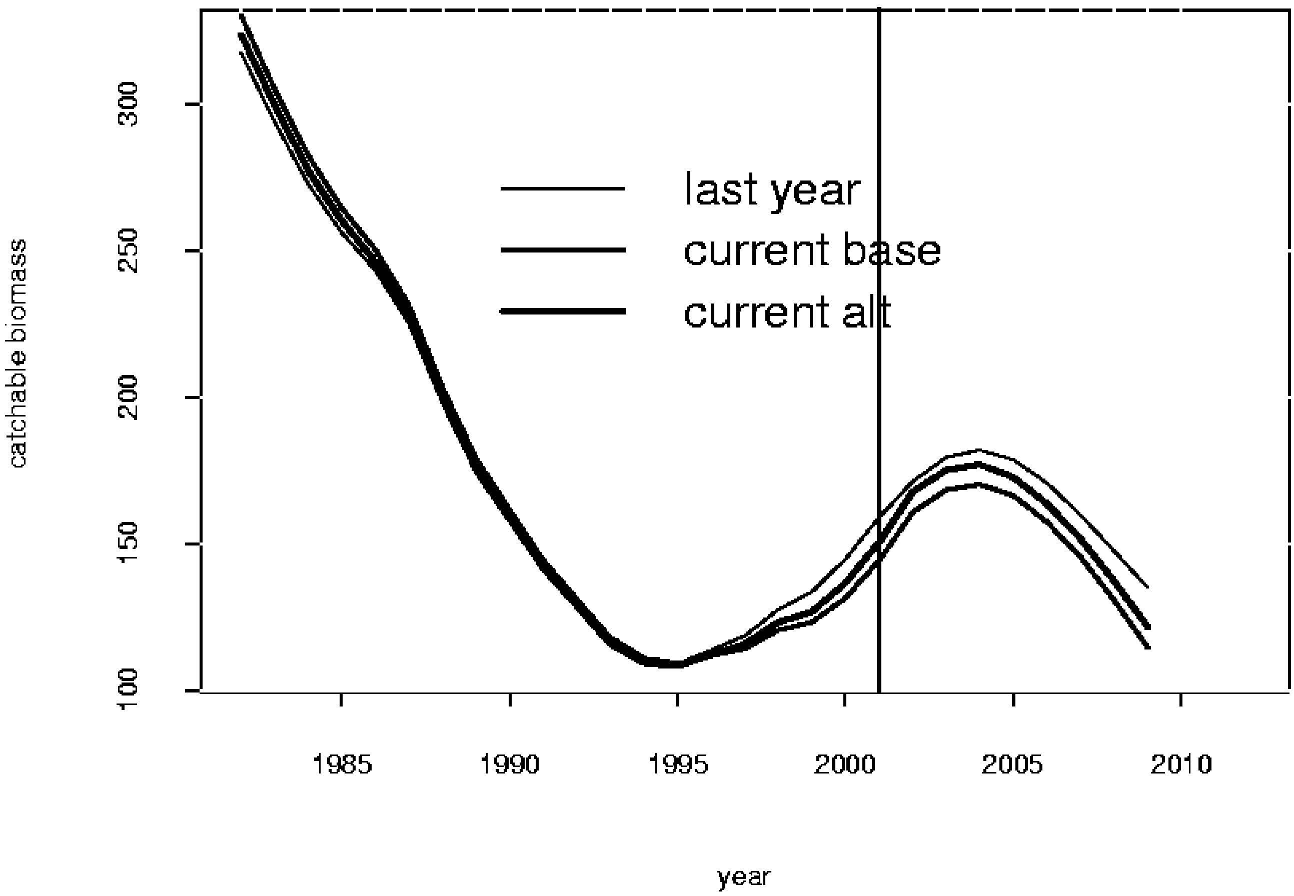

Figure 8.2.15. Comparison of catchable biomass using the data obtained now and last year, for same settings. Results are obtained using only the catch history from in ICES division Va.

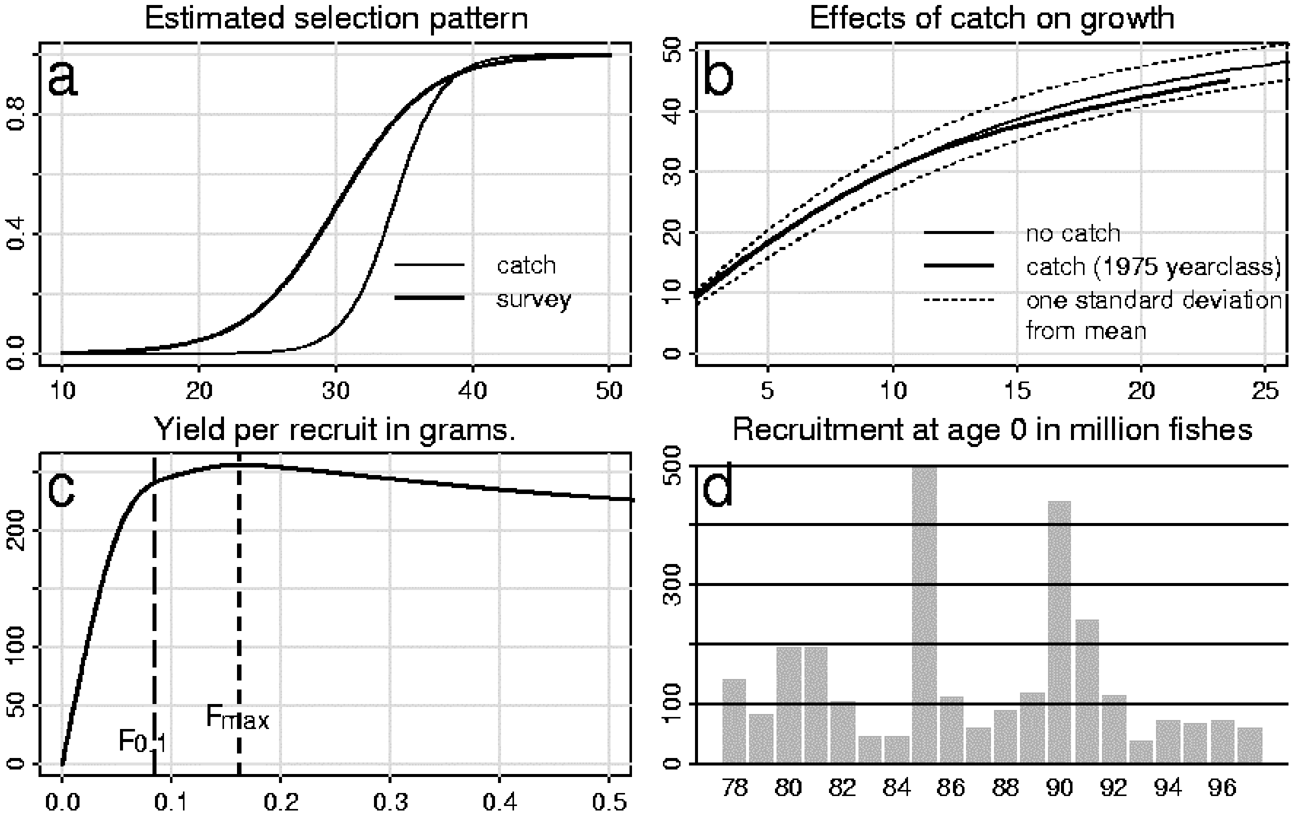

Figure 8.2.16. Results out of the BORMICON, allowing variable selection after 1997. The run is using catch data from ICES Division Va only. a) .estimated selection pattern of the commercial fleet and the survey, b) Mean length (the figure also demonstrates the effect of catch on length at age), c) Yield per recruit and c) estimated recruitment at age 0.

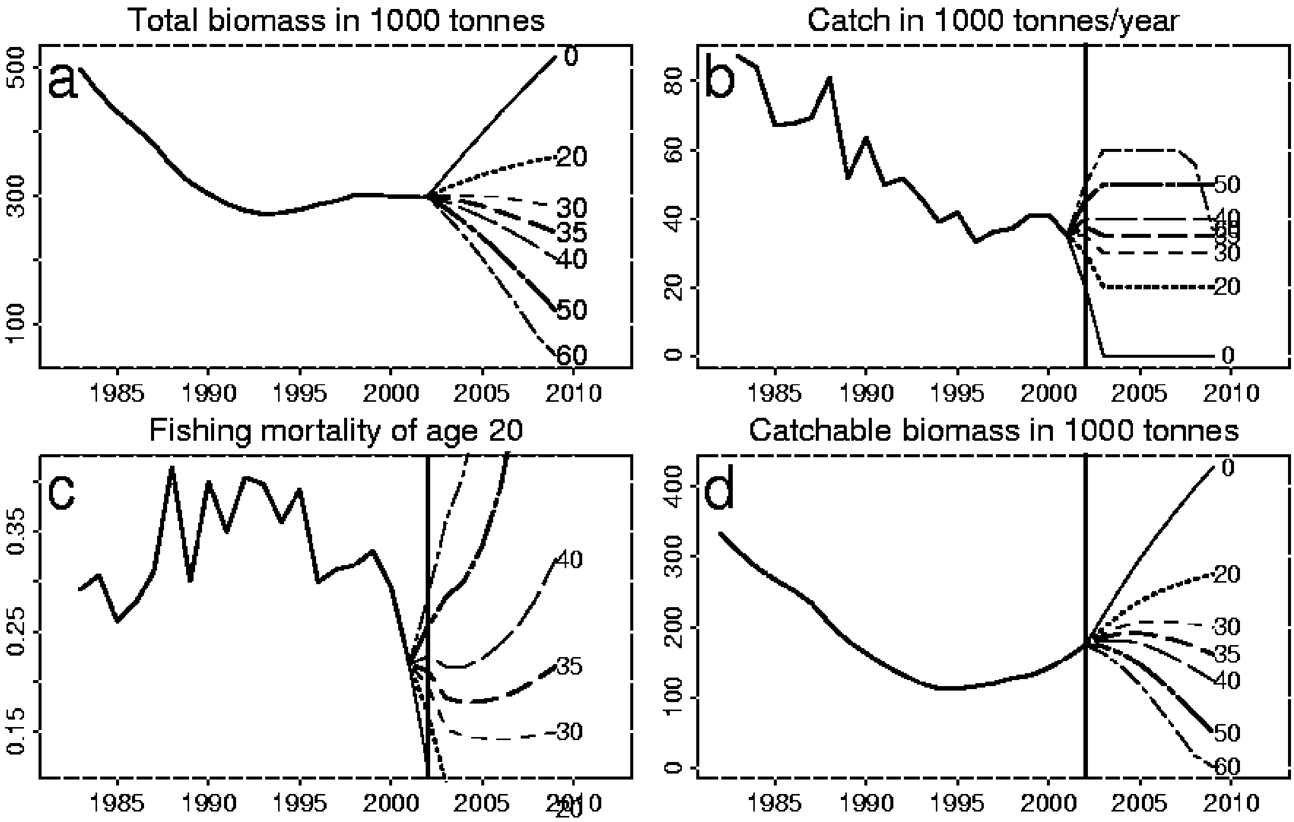

Figure 8.2.17. Results from model run where variable selection is allowed after 1997 The model is only using catch in ICES Division Va. The figures show development of biomass and F, using different catch options after 2002.

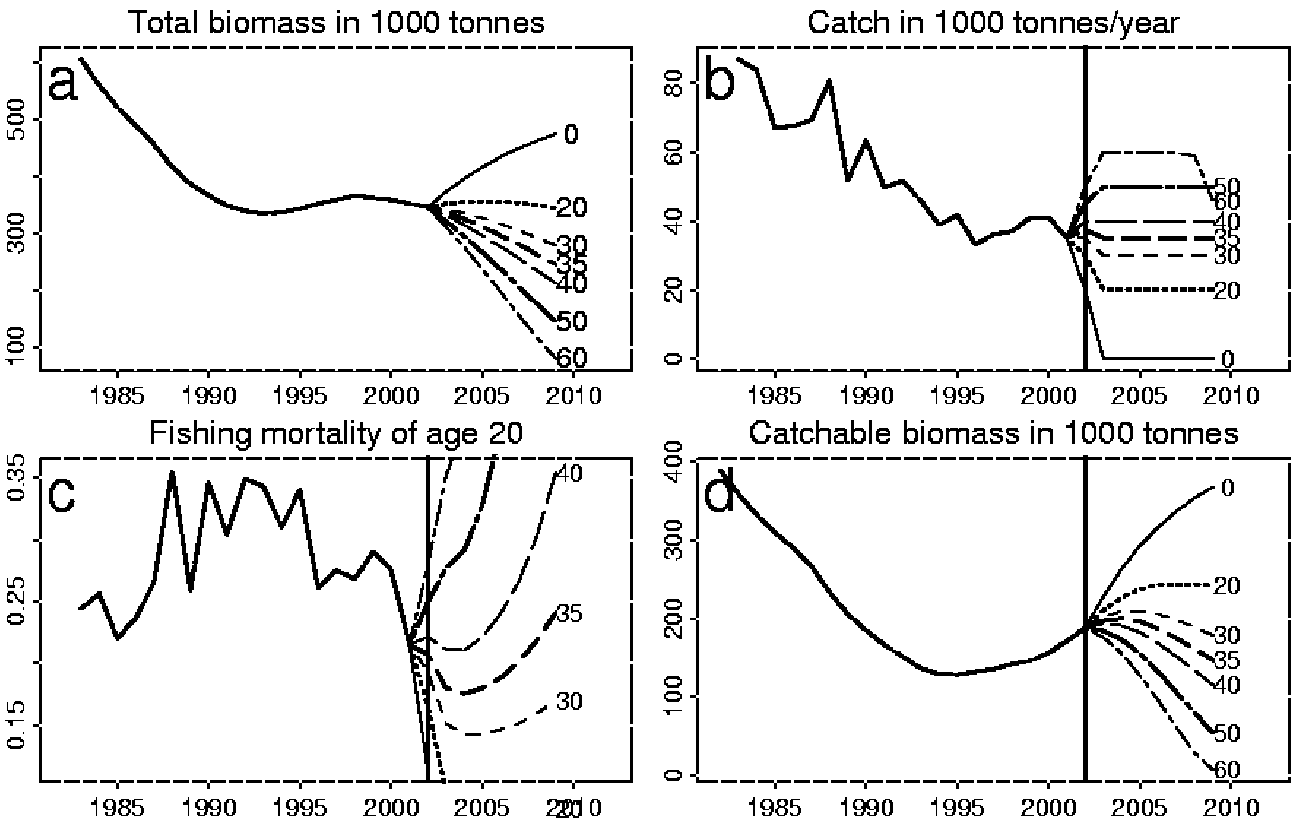

Figure 8.2.18 Results from model using M=0.1. The model is only using catch in ICES Division Va. The figures show development of biomass and F, using different catch options after 2002.