

2.4.2 Icelandic cod in Division Va

State of the stock

Spawning biomass in relation to precautionary limits	Fishing mortality in relation to precautionary limits	Fishing mortality in relation to highest yield	Fishing mortality in relation to agreed target	Comment
Undefined	Undefined	Overexploited	The exploitation rate (30% of B4+) is above what is intended in the management plan (25%)	

Biological reference points have not been defined for this stock.

The assessment demonstrates that SSB has been at a low level since the mid-1980s and consists of relatively high proportions of younger fish. Recruitment has been well below the historical average in the same period. The six recent year classes are estimated to be below the long-term average, and year classes 2001, 2003, and 2004 are especially poor.

Management objectives

A formal Harvest Control Rule was implemented for this stock in 1995. The TAC for a fishing year was set as a fraction (25%) of the “available biomass”, computed as the biomass of age 4 and older fish B(4+) averaged over two adjacent (intermediate and projection year) calendar years. ICES evaluation of the harvest control rule was based on simulations that did not include implementation error. ICES considers the 1995 harvest control rule to be consistent with the precautionary approach provided the implementation error is minimal.

The harvest control rule has been modified since then with a constraint on year-to-year variation of the TAC. For the fishing years 2000/2001 through 2005/2006 the yearly constraint was a 30 kt buffer, but since 2006 the base of the rule is the average of the last year’s TAC and 25% of the estimated reference biomass B4+ in the assessment year (y):

$$TAC_{y/y+1} = \frac{0.25B_y + TAC_{y-1/y}}{2}$$

Using the biomass in the assessment year only and last year’s TAC was based on recommendations by a domestic expert group that met in 2004 to evaluate the performance of the assessment and the catch rule. The group showed that overestimations were carried forward into the prediction, leading to an amplification of the problem in the application of the “old” 25% catch rule.

ICES has not evaluated this revised harvest control rule.

Reference points

Precautionary reference points have not been defined for this stock.

Yield and spawning biomass per Recruit

F-reference points:

	Fish Mort Ages 5–10	Yield/R	SSB/R
Average last 3 years	0.60	1.74	1.62
F _{max}	0.33	1.79	3.37
F _{0.1}	0.14	1.61	7.84
F _{med}	0.66	1.73	1.41

Single-stock exploitation boundaries

Exploitation boundaries in relation to existing management plans

Following the present management plan would imply catches of 178 000 t in the fishing year 2007/2008.

Exploitation boundaries in relation to high long-term yield, low risk of depletion of production potential, and considering ecosystem effects

The current fishing mortality (0.59) is well above fishing mortalities that would lead to high long-term yields ($F_{0.1}=0.14$ and $F_{max}=0.33$). This indicates that the long-term yield will increase at F s well below historical values.

Exploitation boundaries in relation to precautionary limits

Applying the original plan, which was considered to be in accordance with the precautionary approach, would lead to a catch of 152 000 t.

Short-term implications

Outlook for 2008

Basis: $F(2007) = F_{sq} (0.61)$; $SSB(2008) = 186$; $B_{4+}(2008) = 570$; catch (2007) = 195.

Rationale	TAC (07/08)	Basis	F (2008)	B ₄₊ (2009)	SSB (2009)	%SSB change ¹⁾	% TAC change ²⁾
Zero catch	0	F=0	0	776	351	54	-100
<i>Status quo</i>	183	F_{sq}	0.61	588	165	-10	-5
High long-term yield	106	F(long-term yield)	0.32	675	230	24	-45
Agreed management plan	18	TAC(man. plan) * 0.1	0.05	755	333	48	-91
	45	TAC(man. plan) * 0.25	0.12	725	307	40	-77
	89	TAC(man. plan) * 0.50	0.26	674	263	26	-54
	134	TAC(man. plan) * 0.75	0.42	624	219	11	-31
	152	TAC(orig. man. plan)	0.49	602	201	5	-21
	178	TAC(man. plan)	0.59	573	179	-3	-8
	196	TAC(man. plan) * 1.1	0.67	553	160	-12	1
	223	TAC(man. plan) * 1.25	0.80	523	135	-22	15

Weights in '000 t.

Shaded scenarios are not considered consistent with the precautionary approach and the management plan.

¹⁾ SSB 2009 relative to SSB 2008.

²⁾ TAC 2008 relative to TAC 2007.

Management considerations

Catch quotas for the Icelandic cod stock have since 1994 been based on the 25% catch rule. This catch rule was based on extensive simulations and has been considered precautionary. Until 2000 the Icelandic government followed the catch rule with minimal deviations although it has turned out that the actual catches have exceeded what was intended with the 25% rule. In 2000 the Icelandic government changed the adopted 25% catch rule by limiting year-to-year changes in TAC to +/-30 000 t. The stabilizer was only effective in two fishing seasons. For the fishing year 2006/2007 onward the catch rule was based on the average of the last year's TAC and 25% of the estimated reference biomass $B(4+)$ in the assessment year.

Realised catches have exceeded the TAC (about 14% in 2001) and previous assessments have overestimated the stock. This has led to a higher exploitation rate than intended. It appears that the overshooting of the TAC has been reduced in recent years (4–8%).

Since 1995 fishing mortalities have been fluctuating in the range of 0.51–0.76, in the last three years about 0.6. With the application of the catch rule the expected long-term fishing mortality was 0.4. The spawning stock consists of very few ages, with age 9 and younger fish accounting for 98% of the fishable biomass (4+). This may have a negative effect on reproductive potential.

Given the relatively high proportions of younger fish in the fishable as well as in the spawning-stock biomass, the relatively weak incoming year classes, and a low capelin abundance, lower fishing mortalities than those obtained by the Harvest Control Rule should be considered. In order to ensure a high probability of the SSB increasing in the next 5 years, the exploitation rate must be reduced to no more than 20%.

The current fishing mortality is well above F_{\max} , indicating that candidate target fishing mortalities should be well below the current F .

Management plan evaluations

The management plan has been in effect for about 12 years. Given the recent revisions it is recommended that a full re-evaluation of the management plan is undertaken. ICES is prepared to contribute to this re-evaluation if requested to do so.

Factors affecting the fisheries and the stock

Regulations and their effects

A quick closure system has been in force since 1976, aimed at protecting juvenile fish. Fishing is prohibited, for at least two weeks, in areas where the number of small cod (< 55 cm) in the catches has been observed by inspectors to exceed 25%. A preliminary evaluation of the effectiveness of the system indicates that the relatively small areas closed for a short time do most likely not contribute much to the protection of juveniles. On the other hand, several consecutive quick closures often lead to closures of larger areas for a longer time and force the fleet to operate in other areas. The effect of these longer closures has not been evaluated.

Since 1995, spawning areas have been closed for 2–3 weeks during the spawning season for all fisheries. The intent of this measure was to protect spawning fish. In 2005, the maximum allowed mesh size in gillnets was decreased to 8 inches in order to protect the largest spawners.

The mesh size in the codend in the trawling fishery was increased from 120 mm to 155 mm in 1977. Since 1998 the minimum codend mesh size allowed is 135 mm, provided that a so-called “Polish cover” is not used. Numerous areas are closed temporarily or permanently for all fisheries or specific gears for protecting juveniles and habitat, or for socio-political reasons. The effects of these measures have not been evaluated.

The environment

An increased inflow of Atlantic water has been observed in Icelandic waters since 1997, resulting in higher temperature and higher salinity in the stock area. At present, however, no relationships have been demonstrated between these environmental indicators and cod recruitment, but the shift in distribution of capelin may be linked to these hydrographic changes.

In the past, weights-at-age of the cod have been clearly related to the biomass of capelin. The recent reduced mean weights-at-age are likely to be linked to the low abundance of capelin from the feeding areas for cod. These low weights were also used in forecasts, because the capelin biomass is expected to remain low.

In years of high recruitment a larval drift to Greenland is sometimes observed, resulting in a large year class at Greenland. In some other years an immigration of adult cod from Greenland has taken place, which has been taken into account in the assessment. Based on the present status of cod stocks in Greenland, no substantial immigration to Iceland can be expected in the near future. It is, however possible that the relatively big 2003 year class presently found in Greenland waters is of Icelandic origin.

Scientific basis

Data and methods

The data used in the assessment are catch-at-age and age-structured survey indices. The analytical assessment is based on catch and survey data using the AD-CAM (a statistical Catch-at-age Model using AD model builder) programme. Exploratory assessments using five different models gave consistent results. Catch-at-age data as well as survey indices are considered reliable. The modelling setup is the same as last year.

Information from the fishing industry

A liaison group was established between fishers and the MRI working group on cod in 2004. Active fishing captains representing various gears and fishing areas attend the annual meeting of the group. In a whole-day meeting the captains give a short presentation, for each gear and area, of the fishery in the current year compared to previous years and their perspective of the status of the cod stock. Similarly, the fisheries biologists and stock assessment scientists in the group present the latest available data on survey indices, cpue from the commercial fleet, preliminary data on catch-at-age, maturity, and mean weights-at-age, etc.

Results are discussed, and if discrepancies are identified they are further scrutinized. In general there was a good consensus between the perspectives of fishers and scientists concerning the perception of the cod stock in the last meeting of the group held at the end of November last year.

Uncertainties in assessment and forecast

The uncertainty in the biomass point estimate in the current year is estimated to be low.

Since 1985, recruitment has fluctuated around a lower level than previously. This may be related to an environmental change. Results of medium-term projections based on the current Harvest Control Rule indicate that the fishing mortality is expected to decrease, while the catchable biomass 4+ will remain stable. These projections cover only the short time span when the stock is dominated by year classes that have already been measured in surveys.

Assessments based on the more recently established autumn survey showed that the stock may be significantly higher than when using the spring survey series only. The reasons for the difference have not been evaluated.

Comparison with previous assessment and advice

In the present assessment the estimated reference biomass (B₄₊) at the beginning of 2007 is 649 000 t, compared to the 747 000 t predicted in last year's assessment. The reference biomass in 2006 is estimated at 675 000 t in the current assessment, compared to 756 000 t in last year's assessment. The retrospective pattern of recruitment estimates in recent years, both historical and analytical, indicates a minor but constantly downward revision (Figure 2.4.2.5). The advice is consistent with previous year's advice.

Source of information

ICES. 2007. Report of the North-Western Working Group, 24 April–3 May 2007. ICES CM 2007/ACFM:17.

Year	ICES Advice	Predicted catch corresp. To advice	Agreed TAC	ACFM Catch for the fishing year	ACFM Catch for the calendar year
1988 ¹	National advice	300	350		378
1989 ¹	National advice	300	325		356
1990 ¹	National advice	250	300		335
1991 ¹	National advice	240	245		309
1991/1992 ²	National advice	250	265	274	274
1992/1993 ²	Reduce F by 40%	154	205	241	241
1993/1994 ²	Reduce F by 40%	150	165	197	197
1994/1995 ²	Reduce F by 50%	130	155	165	169
1995/1996 ²	Apply catch rule	155	155	170	182
1996/1997 ²	Apply catch rule	186	186	202	203
1997/1998 ²	Apply catch rule	218	218	227	243
1998/1999 ²	Apply catch rule	250	250	254	260
1999/2000 ²	Apply catch rule	247	250	257	236
2000/2001 ²	Apply catch rule	203	220 ³	221	235
2001/2002 ²	Apply catch rule	164	190 ³	217	209
2002/2003 ²	Apply catch rule	183	179 ³	198	206
2003/2004 ²	Apply catch rule	210	209	225	226
2004/2005 ²	Apply catch rule	205	205	214	214
2005/2006	Apply catch rule	198	198	209	196
2006/2007	Apply catch rule	187	193 ⁴		
2007/2008	Apply catch rule	152			

Weights in '000 t.

¹Calendar year.

²National fishing year ending 31 August.

³Amended catch rule.

⁴Catch rule 2006.

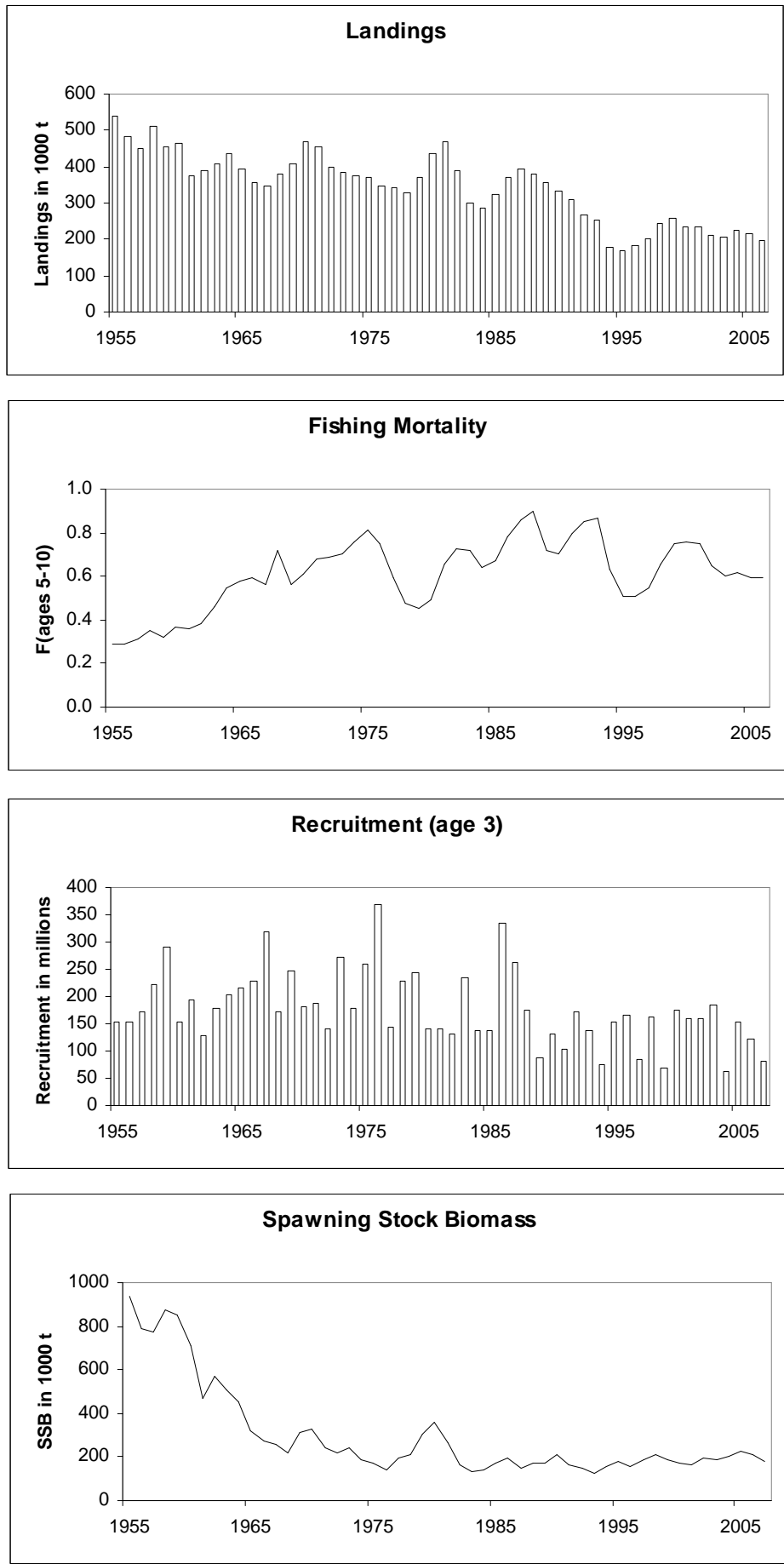


Figure 2.4.2.1 Icelandic cod in Division Va. Landings. Fishing mortality. Recruitment. Spawning stock biomass.

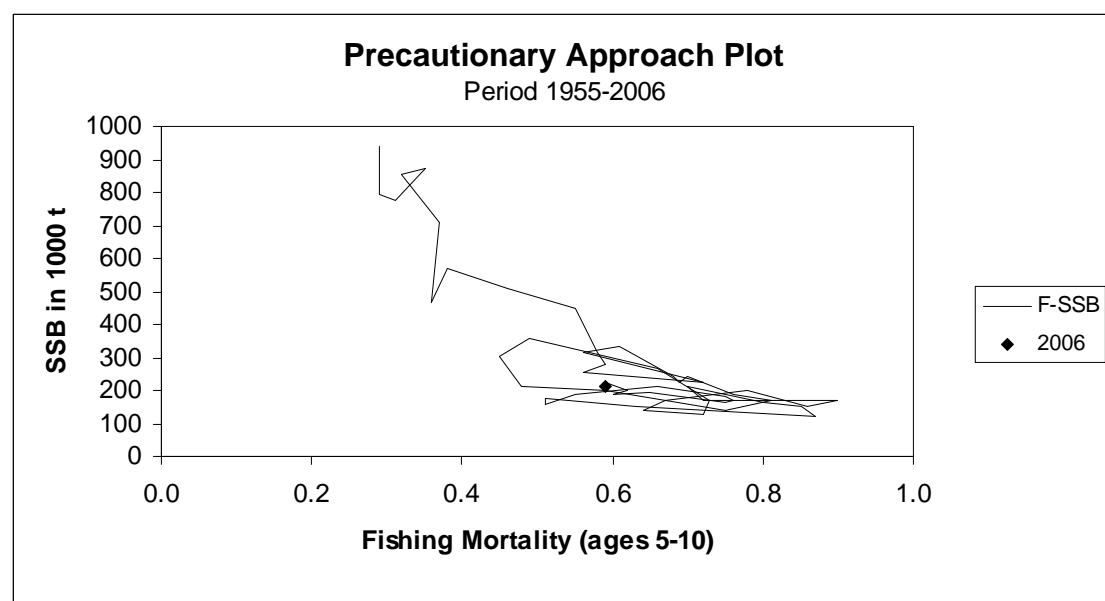
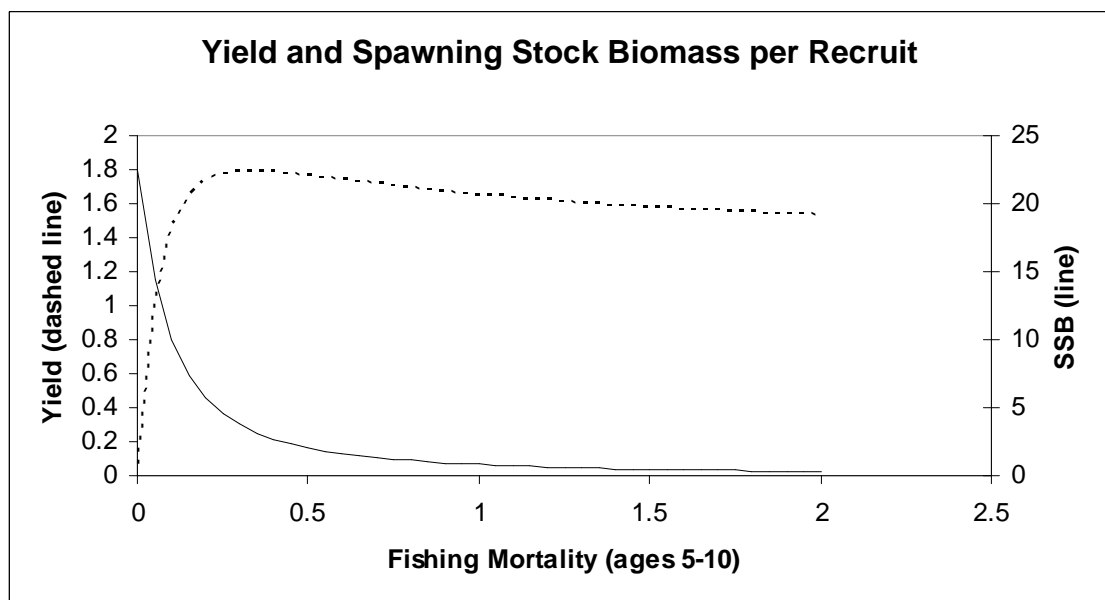
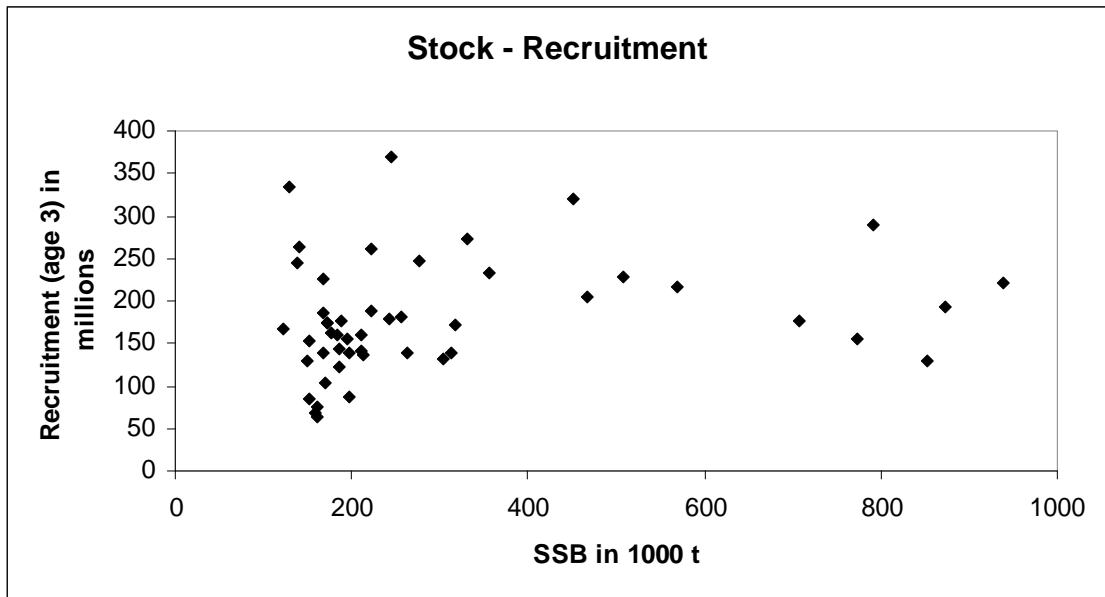


Figure 2.4.2.2 Icelandic cod in Division Va. Stock recruitment. Yield and spawning stock biomass per recruit. Precautionary approach plot.

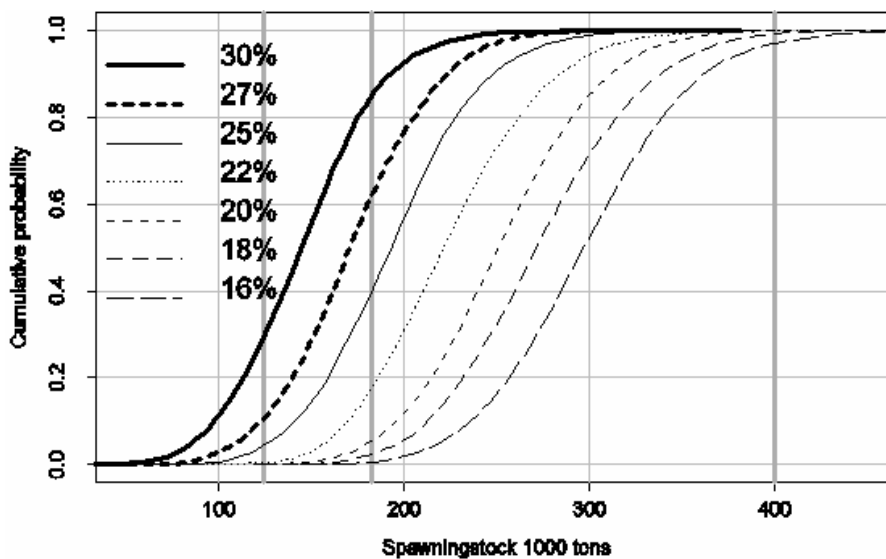


Figure 2.4.2.3 Cod in Division Va. Cumulative probability of the size of the spawning-stock biomass in 2011 according to different harvesting ratios (HCR).

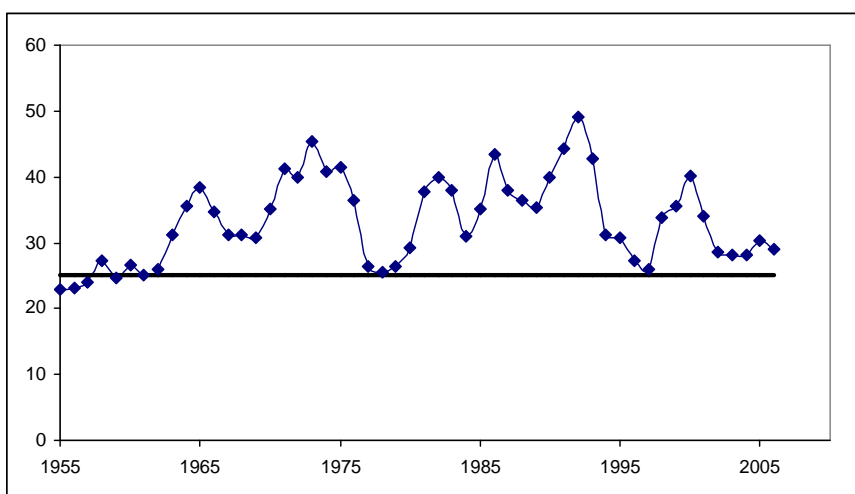


Figure 2.4.2.4 Icelandic cod (Division Va). Exploitation rate $100 \times (\text{landings} / B_{4+} \text{ biomass})$.

Icelandic cod (Division Va)

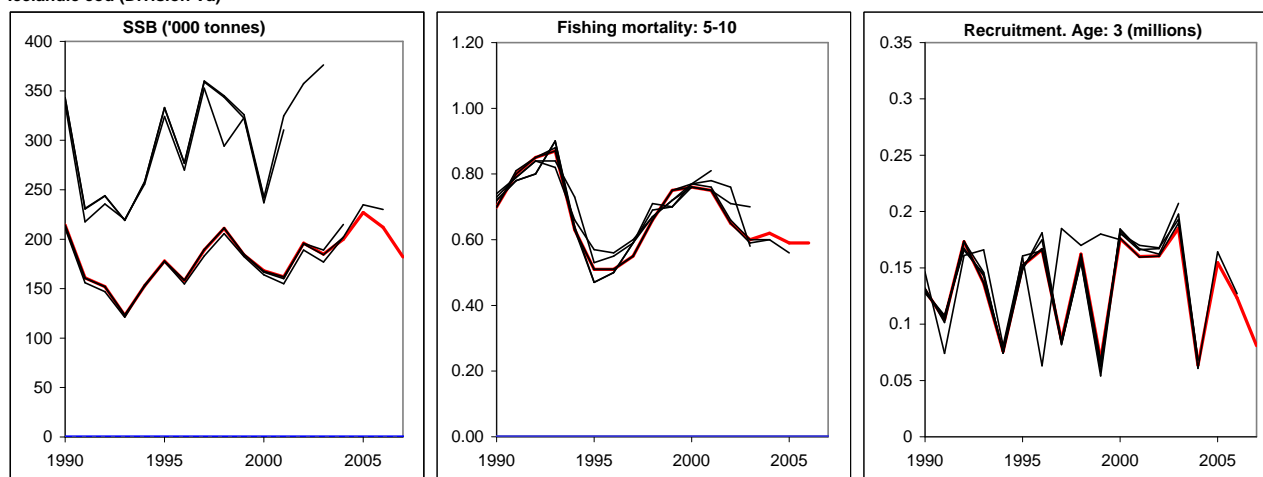


Figure 2.4.2.5 Icelandic cod (Division Va). Historical performance of the assessments. Note: the mean weight used to calculate SSB was changed from 2004 onwards. Recruitment was calculated differently in 2001.

Table 2.4.2.1

Icelandic cod, Division Va. Landings ('000 tonnes), average fishing mortality of age groups 5 to 10, recruitment to the fishery at age 3, total stock biomass (Bio4+) ('000 tonnes), spawning-stock biomass (SSB) at spawning time ('000 tonnes) and harvest ratio. The shaded rows are predictions.

Year	Landings	F5-10	SSB	N3	B4+	Hratio old
1955	538	0.29	1137	152	2357	0.24
1956	481	0.29	963	153	2081	0.24
1957	452	0.31	937	171	1878	0.24
1958	509	0.35	1071	221	1865	0.27
1959	453	0.32	1032	289	1828	0.25
1960	465	0.37	887	154	1753	0.27
1961	375	0.36	568	193	1496	0.25
1962	387	0.38	704	129	1492	0.26
1963	410	0.46	649	178	1315	0.31
1964	434	0.55	603	204	1219	0.36
1965	394	0.58	430	216	1023	0.38
1966	357	0.59	376	229	1032	0.35
1967	345	0.56	337	320	1103	0.31
1968	381	0.72	305	172	1223	0.31
1969	406	0.56	413	248	1326	0.31
1970	471	0.61	449	180	1337	0.35
1971	453	0.68	343	189	1098	0.41
1972	399	0.69	325	139	997	0.40
1973	383	0.70	345	273	843	0.45
1974	375	0.76	268	179	918	0.41
1975	371	0.81	238	261	895	0.41
1976	348	0.75	189	368	955	0.36
1977	340	0.59	257	143	1290	0.26
1978	330	0.48	269	227	1299	0.25
1979	368	0.45	379	244	1397	0.26
1980	434	0.49	464	140	1489	0.29
1981	469	0.66	385	141	1242	0.38
1982	388	0.73	251	132	970	0.40
1983	300	0.72	188	233	791	0.38
1984	284	0.64	194	139	914	0.31
1985	325	0.67	231	138	927	0.35
1986	369	0.78	274	333	850	0.43
1987	392	0.86	215	264	1031	0.38
1988	378	0.90	233	175	1038	0.36
1989	356	0.72	225	87	1007	0.35
1990	335	0.70	286	130	839	0.40
1991	309	0.80	231	104	696	0.44
1992	268	0.85	223	173	546	0.49
1993	252	0.87	174	136	589	0.43
1994	179	0.63	191	76	574	0.31
1995	169	0.51	217	152	553	0.31
1996	182	0.51	198	166	668	0.27
1997	203	0.55	241	86	783	0.26
1998	243	0.66	278	162	717	0.34
1999	260	0.75	251	68	730	0.36
2000	236	0.76	230	176	588	0.40
2001	235	0.75	219	160	693	0.34
2002	209	0.65	248	161	729	0.29
2003	208	0.60	234	185	740	0.28
2004	227	0.62	254	64	807	0.28
2005	214	0.59	288	155	703	0.30
2006	196	0.59	273	123	675	0.29
2007	193	0.60	241	81	649	0.30
2008	158	0.51	243	145	572	0.28
2009	159	0.50	252	135	617	0.26
2010			259	124	654	