

8.4.2 **Advice May 2013**
ECOREGION Baltic Sea
STOCK Cod in Subdivisions 22–24 (Western Baltic Sea)

Advice for 2014

ICES advises on the basis of the EU management plan (EC 1098/2007) that the TAC (commercial landings) should be set at 17 037 tonnes in 2014, assuming that discard and recreational fisheries rates do not change from 2012.

Measures should be implemented to protect the local spawners in Subdivision 22.

Stock status

F (Fishing Mortality)			
	2010	2011	2012
MSY (F _{MSY})	✗	✗	✗ Above target
Precautionary approach (F _{pa} , F _{lim})	?	?	? Undefined
Management plan (F _{MGT})	✗	✗	✗ Above target
SSB (Spawning Stock Biomass)			
	2011	2012	2013
MSY (B _{trigger})	✗	✓	✓ Above trigger
Precautionary approach (B _{pa} , B _{lim})	○	✓	✓ Full reproductive capacity
Management plan (SSB _{MGT})	?	?	? Undefined

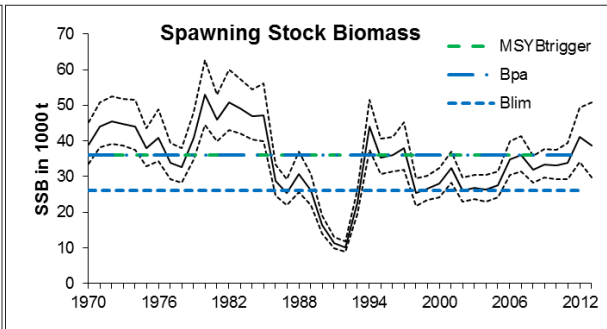
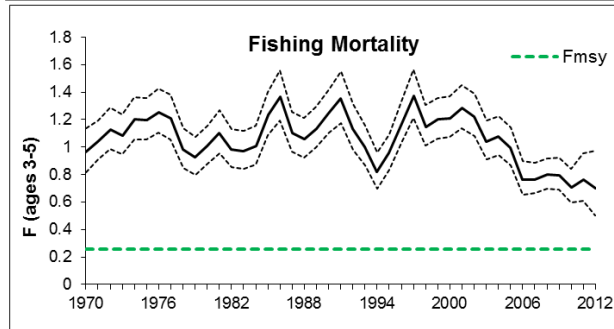
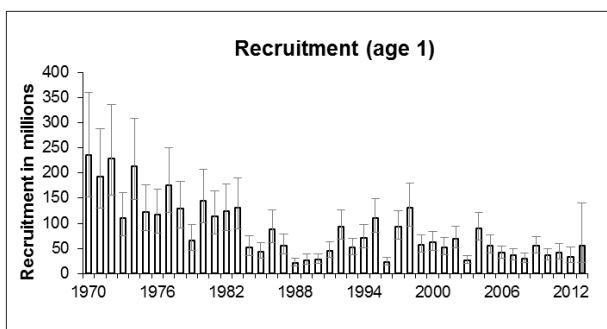
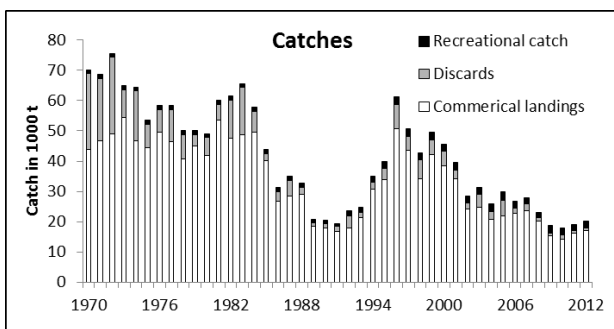
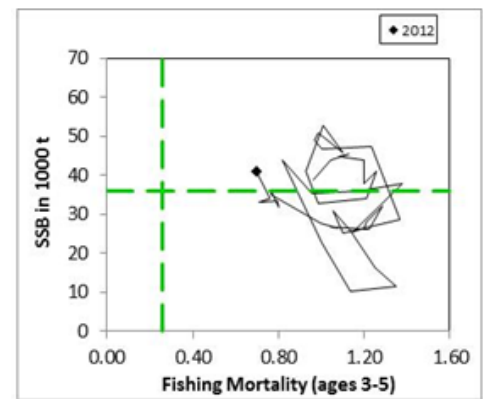


Figure 8.4.2.1 Cod in Subdivisions 22–24. Summary of stock assessment (weights in thousand tonnes). Recruitment, F, and SSB have uncertainty boundaries (95%) in the plot. Top right: SSB/F for the time-series used in the assessment. Management target fishing mortality cannot be displayed due to the difference in reference F age range compared to the current assessment.

SSB has increased since 2000, and the 2012 value is estimated above B_{pa}. F (ages 3–5) in 2012 is estimated at 0.7; although values were estimated with high uncertainty this estimate is well above F_{MSY}. Recruitment has been low since 2004.

Management plans

A management plan for cod in the western Baltic Sea was agreed in September 2007 by the EU (EC 1098/2007). This plan aims for a reduction in F by 10% each year until the target F is reached. ICES has evaluated the management plan in 2009 and 2011 and considered it to be in accordance with the precautionary approach. Recent changes (the inclusion of recreational catches) have not changed

the perception of the stock dynamics.

With the observed annual upwards revision of F a re-evaluation of the management plan is needed. Continued use of the 10% reduction of the most recent F in the presence of the upwards revision of F is not considered precautionary. ICES considers that using the target F of the management plan as basis for the advice is precautionary.

The management plan is currently under revision. It should be noted that there is a large difference between the F_{MSY} and the target F in the management plan, regardless of the difference in reference age range.

Biology

At present three main spawning sites are considered for this stock: the Sound (Subdivision 23), the Belt Sea (Subdivision 22), and the Arkona Basin (Subdivision 24). A recent study indicates that the cod in the Sound might constitute a separate resident stock. There is a mixture of eastern and western Baltic cod, especially in Subdivision 24. There are indications of juvenile cod migrating from the western Baltic to the east. Furthermore, there is evidence that the spill-over of adult eastern Baltic cod to Subdivision 24 has increased. The mixing has not been quantified. The cod abundance in Subdivision 24 is currently substantially higher compared to that in Subdivision 22.

The fisheries

The main part of the catch is taken by trawls and gillnets. Western Baltic cod is usually taken in mixed demersal fisheries. In Subdivision 22, different flatfish species (flounder, plaice, dab, and turbot) are caught together with cod; in Subdivision 24, flounder is the main bycatch species, at least in some periods.

Catch distribution

Total catch (2012) is 20.1 kt, where 17.1 kt are commercial landings (65% trawlers, 35% gillnetters), 0.9 kt discards, and 2.1 kt partial recreational catch.

Quality considerations

Mixing of the eastern and western Baltic cod stocks in recent years is considered an increasing problem for the quality of the assessment. A large part of the commercial fleet targets cod in Subdivision 24, in the area bordering Subdivision 25, where a significant proportion of cod catches is likely to originate from the eastern Baltic. This results in high abundance of older (4+) cod in catches and commercial tuning indices. There are inconsistencies with the surveys with wider spatial coverage; however, these have low and variable occurrence of older age groups. Consequently, the estimates of F for older ages are highly uncertain. Data are needed to quantify the amount of mixing of cod between eastern and western the Baltic Sea areas. Stock identification studies are required.

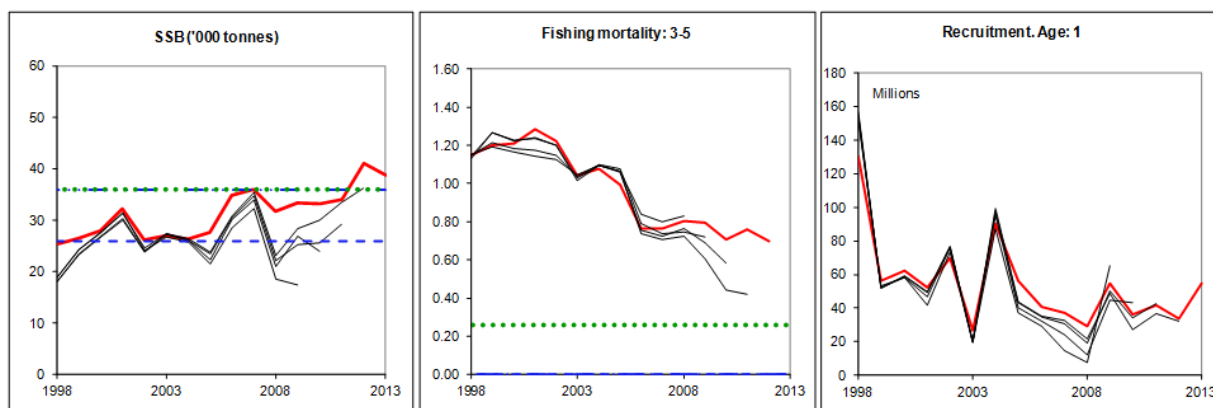


Figure 8.4.2.2 Cod in Subdivisions 22–24. Historical assessment results (final-year recruitment estimates included). The stock was benchmarked in 2013, with a revision in data input. The reference F age range changed from 3–6 to 3–5 between the current and the previous years' assessments.

Scientific Basis

Assessment type	Age analytical assessment (SAM).
Stock data category	Category 1
Input data	Commercial catches (international landings, ages and length frequencies from catch sampling); recreational catch (only German data included); two survey indices (BITS–Q1 and BITS–Q4); one commercial index (cpue from Danish trawlers); annual maturity data from BITS–Q1 surveys; natural mortalities from multispecies assessment, unchanged since 1996.
Discards and bycatch	Discards included in the assessment, from both active and passive gears.
Indicators	None.
Other information	Last benchmarked in 2013 (WKBALT 2013; ICES, 2013a).
Expert Group report	WGBFAS

8.4.2 **Supporting information May 2013**
ECOREGION **Baltic Sea**
STOCK **Cod in Subdivisions 22–24 (Western Baltic Sea)**

Reference points

	<i>Type</i>	<i>Value</i>	<i>Technical basis</i>
MSY Approach	MSY B _{trigger}	36 400 t	B _{pa} .
	F _{MSY}	0.26	F _{MSY} from stochastic simulations (age range 3–5).
Precautionary Approach	B _{lim}	26 000 t	Break point of the stock–recruitment relationship.
	B _{pa}	36 400 t	1.4*B _{lim} .
	F _{lim}	Not defined.	
	F _{pa}	Not defined.	
Management Plan	SSB _{MGT}	Not defined.	
	F _{MGT}	0.60	EU management plan based on stochastic simulations(reference F age range 3–6).

(Changed in 2013, WKBALT (ICES, 2013a)).

Outlook for 2014

Basis: F = F_{sq} (2013) = 0.7 (F range 3–5) = 0.79 (F range 3–6); SSB (2014) = 42.0; R age 1 (2013) = 54.7 million; R age 0 (2014) = 83.0 million (random sampled from last 7 years in model); R age 1 (2014) = 53.9; R age 1 (2015) = 39.3; Commercial landings (2013) = 18.8; Discards (2013) = 0.8; Recreational catch (2013) = 2.4.

Rational	Total catch 2014	Comm. catch 2014	Comm. Landings 2014	Discards ¹⁾ 2014	Recr. Catch ¹⁾ 2014	Basis	F _{total} 2014	F _{Comm.} Landings 2014	F _{discard} 2014	F _{Recr.} Catch 2014	SSB 2015	%SSB change ²⁾	% TAC change ³⁾
Management plan	20.0	17.8	17.0	0.7	2.2	-15% TAC change (F3–6)	0.65 ⁴⁾	0.59 ⁴⁾	0.02 ⁴⁾	0.04 ⁴⁾	49.0	17%	-15%
MSY approach	10.2	9.1	8.8	0.3	1.1	F _{MSY}	0.26	0.23	0.02	0.01	58.7	40%	-56%
MSY transition	13.2	11.7	11.3	0.4	1.5	0.2 × F ₂₀₁₀ + 0.8 × F _{MSY}	0.35	0.31	0.02	0.02	55.6	32%	-44%
Zero catch	0	0	0	0	0	F = 0	0	0	0	0	69.1	65%	-100%
Other options	15.5	13.8	13.3	0.5	1.7	F ₂₀₁₃ × 0.6	0.42	0.38	0.02	0.02	53.3	27%	-34%
	18.8	18.1	16.0	0.7	2.1	F _{total} = 0.6 (F3–6)	0.6 ⁴⁾	0.54 ⁴⁾	0.03 ⁴⁾	0.03 ⁴⁾	50.2	20%	-20%
	19.6	17.4	16.7	0.7	2.2	F ₂₀₁₃ × 0.8	0.56	0.5	0.03	0.03	49.3	17%	-16%
	21.3	18.9	18.1	0.8	2.4	90% F ₂₀₁₃ (F3–6)	0.71 ⁴⁾	0.64 ⁴⁾	0.03 ⁴⁾	0.04 ⁴⁾	47.7	14%	-9%
	21.5	19.1	18.3	0.8	2.4	F ₂₀₁₃ × 0.9	0.63	0.57	0.03	0.03	47.5	13%	-9%
	23.2	20.6	19.8	0.8	2.6	F ₂₀₁₃ × 1.0	0.7	0.63	0.03	0.04	45.8	9%	-1%
	23.6	20.9	20.0	0.9	2.7	0% TAC change (F3–6)	0.81 ⁴⁾	0.73 ⁴⁾	0.03 ⁴⁾	0.05 ⁴⁾	45.6	9%	0%
	25	22.2	21.2	1	2.8	F ₂₀₁₃ × 1.1	0.78	0.69	0.05	0.04	44.2	5%	6%
	27.2	24.1	23.0	1.1	3.1	+15% TAC change (F3–6)	0.99 ⁴⁾	0.89 ⁴⁾	0.04 ⁴⁾	0.06 ⁴⁾	42.2	1%	+15%
	29.6	26.3	25	1.2	3.3	F ₂₀₁₂ × 1.4	0.99	0.88	0.06	0.05	40.2	-4%	25%
	33.5	29.7	28.3	1.4	3.8	F ₂₀₁₂ × 1.7	1.2	1.07	0.07	0.06	36.7	-12%	41%

Weights in thousand tonnes.

- 1) Recreational catch and discards are calculated assuming the same proportion of recreational catch and discards in total catch as observed in 2012.
- 2) SSB 2015 relative to SSB 2014.
- 3) Commercial landings 2014 relative to TAC 2013.
- 4) The fishing mortality provided for a reference F age range of 3–6.

Management plan

Following the agreed EU management plan implies a total fishing mortality of 0.6, which in combination with the 15% TAC constraint corresponds to a TAC (commercial landings) of 17 037 tonnes in 2014. This is conditional on the discard and recreational fisheries rates remaining unchanged from 2012. This is expected to lead to an SSB of 49 000 tonnes in 2015.

MSY approach

Following the ICES MSY approach implies the fishing mortality being reduced to 0.26, resulting in total catches of no more than 10 212 tonnes in 2014. This is expected to lead to an SSB of 58 735 tonnes in 2015. If discard and recreational fisheries rates do not change from 2012, this implies commercial landings of no more than 8800 tonnes.

Following the transition scheme towards the ICES MSY approach implies the fishing mortality being reduced to 0.35, resulting in total catches of no more than 13 245 tonnes in 2014. This is expected to lead to an SSB of 55 589 tonnes in 2015. If discard and recreational fisheries rates do not change from 2012, this implies commercial landings of no more than 11 300 tonnes.

Precautionary approach

As there is no F_{pa} defined for this stock, the catch corresponding to the precautionary approach cannot be calculated. B_{pa} is 36 400 tonnes, and all options in the outlook will result in an SSB above B_{pa} in 2015.

Additional considerations

Management considerations

ICES considers that maintaining the target $F_{2014} = \text{target } F_{2013} = 0.6$ subject to the interannual restriction on change in TAC is precautionary and is an appropriate interpretation of the plan, and advises accordingly. In the original evaluations of the plan it was expected that, once the target F had been reached, following the management plan would not imply upward revision of the target (ICES, 2009). In 2012 ICES advised a target of 0.6 to comply with the management plan.

The wording of the management plan envisages stepwise reductions in F to a target value of 0.6. The plan uses reductions in F from the previous year's estimate by 10% to achieve this. In its evaluations of the proposed plan in 2005 ICES (ICES, 2005) tested the sensitivity to various types of error. It was noted that "errors above 10–20% disrupt achievement of low risk to reproduction and high long-term yield". Errors greater than 10% associated with upward revision of the F in the assessment are of particular critical concern as these errors cause next year's target F to rise. This type of error was not explicitly tested in the evaluation of the plan and in general an increasing F target could not be regarded as precautionary. ICES also noted in its 2005 review of the proposed plans that "the management plan is only in accordance with the precautionary approach if effectively implemented". Increasing the F target is not considered effective implementation of the plan, and thus it would not be precautionary. One interpretation of the wording of the plan suggests that following an upward revision of F in the assessment, and including the 10% reduction, the target F in 2014 is 0.71, which is higher than the $F_{MP} = 0.6$ used as basis for the advice under the management plan last year. Although ICES provides the option at $F = 0.71$ in the catch option table, ICES does not consider this option as appropriate for its advice.

The F target in the management plan of 0.6 is precautionary but well above F_{MSY} of 0.26.

The adult cod abundance in Subdivision 22 is presently low, while the abundance of adult cod in Subdivision 24 is at a historical high. Cod spawning in Subdivision 22 likely represents the western Baltic subpopulation, while the adult cod in Subdivision 24 is considered to be a mixture of populations originating from the eastern and western Baltic Sea. To protect the western Baltic cod spawners, ICES recommends reducing the catches in Subdivision 22, specifically at spawning time. The present targeted fishery on spawning cod in Subdivision 22 in the 1st quarter of the year takes about 17% (in 2012) of the annual catch of cod in Subdivisions 22–24. There are several possible approaches to achieving a protection of these spawners:

- 1) a temporal and spatial spawning closure in Subdivision 22, with the appropriate timing (i.e. February–April), area, and depth (deeper than 20 m);
- 2) a separate (sub-)TAC for Subdivision 22 (as for the Downs component in North Sea herring);
- 3) additional effort restrictions and/or divergence in Subdivision 22.

The benchmark in 2013 (ICES, 2013a) included historical catches from the German recreational fishery that had not previously been included in the assessment or the evaluation of the management plan. The overall stock dynamics are not affected in a major way although catch and stock biomass have increased to reflect this change. The reference points have been modified to account for these changes. Future inclusion of further recreational catches from other countries is expected to have a similar minor effect on dynamics, but with some revisions in catch and stock biomass. The advice provided in the option table has been adapted to account for the additional recreational catch. Having the target F based on the total F and commercial catches and landings under the management plan or MSY approach thus conforms to the method that would have been used to give advice had the recreational fishery not been included in the assessment.

The Baltic cod management plan (EC Regulation 1098/2007) *inter alia* called for a reduction in fishing effort (10% annually in terms of number of fishing days per year), if F is higher than the target F . The maximum number of fishing days for Subdivisions 22–24 was fixed at 163 in 2010, and has been kept at that number since. From 2012, Member States may allocate additional days absent from port to vessels if an equal amount of days absent from port is withdrawn from other vessels. The number of receiving vessels may not exceed 10% of the total number of vessels. For 2014, the provisions of the plan call for a reduction in F (as $F_{3-6\ 2013} \geq 1.1 \times F_{MP}$) and thus a 10% reduction in days-at-sea, corresponding to 147 days-at-sea in 2014 (days-at-sea current year \times 0.9).

It should be noted that the plan would have allowed for an increase in the number of days-at-sea in the last 2 years (EC 1098/2007, Art 8 Para 5), when the perceived F was below F_{MP} . This was, however, not implemented.

Regulations and their effects

The fishery is managed through TAC, effort, seasonal fisheries restrictions, and technical measures. Only 80% of the TAC was utilized in 2012.

The cod fisheries in the western Baltic have also been regulated since 2009 by a seasonal closure from 1 April to 30 April to protect spawning aggregations of cod. The spawning time of cod presently differs between Subdivisions 22 and 24. In Subdivision 22, targeted cod fishery on spawning grounds takes place in the 1st quarter of a year, with cod peak spawning in March–April (Bleil *et al.*, 2009). Given the presently poor stock status in Subdivision 22, a spawning closure in the first quarter of a year in Subdivision 22 would benefit the "true" western Baltic cod. The spawning aggregations in Subdivision 22 (usually deeper than 20 m water depth) are mainly targeted by trawlers. Gillnetters fish in shallower waters. In Subdivision 24, spawning takes place during summer (peak spawning June–July) (Bleil and Oeberst, 2012).

To decrease discards, a "Bacoma" codend with a 120 mm mesh was introduced by the International Baltic Sea Fisheries Commission (IBSFC) in 2001 in parallel to an increase in diamond mesh size to 130 mm in traditional codends. The expected effect of introducing the "Bacoma" 120 mm exit window was nullified by compensatory measures in the industry. This was to some extent explained by the mismatch between the selectivity of the 120 mm "Bacoma" trawl and the minimum landing size. In October 2003, the regulation was changed to a 110 mm "Bacoma" window. This was expected to enhance compliance and to be in better accordance with the minimum landing size, which was changed from 35 to 38 cm in the same year. As of 1 January 2010 the "Bacoma" 120 mm was re-introduced along with an extended "Bacoma" window (5.5 m) to further decrease discarding, and the minimum landing size was kept at 38 cm. The increase in minimum landing size from 35 to 38 cm has increased discard rates (Feeckings *et al.*, 2013).

Information from the fishing industry

The recent increase in flatfish abundance interferes with the selectivity of the "Bacoma" codend, and discarding of unwanted flatfishes and undersized cod (due to clogging of the net by flatfishes) may have increased in 2011 and 2012 (cases reported for Sweden and Germany). However, the official discard rates do not indicate an overall increase in discards by trawlers.

Data and methods

The assessment includes catch data, supplemented with one commercial cpue index and two survey indices. The assessment is based on the stochastic state–space model (SAM) that provides statistically sound estimates of uncertainty in the model results.

Discard data have been available since 1996 and are used in the assessment as yearly proportions discarded per age group. Thus, for 1970 to 1996 an average proportion discarded per age group, estimated for 1996–2003, is applied. The season and area coverage of discard sampling requires improvement.

Recreational catch was included in the assessment for the first time. At present only German recreational catch is included, where data are available from 2005 onwards. The data for earlier years are extrapolated.

Uncertainties in the assessment and forecast

The information for older age groups (4+) in recent years is inconsistent between years and data sources. This is likely due to movement of adult cod from the eastern to the western Baltic Sea and strong spatial heterogeneity in cod and fishery distribution (Figure 8.4.2.4). Also, some bias in the assessment may be introduced by insufficient sampling of commercial catches for older ages.

Furthermore, in the 2013 assessment, F for ages 5+ substantially deviated from the trends in F for younger ages (Figure 8.4.2.5a) showing increasing values for the recent years while the F for younger ages are declining, which is in accordance with the decrease in fishing effort (Figure 8.4.2.5d). This pattern emerged after adding the 2012 data points to the time-series (Figure 8.4.2.5b).

The high F for age 5+ estimated in this year's assessment is given by the BITS surveys (Figure 8.4.2.5c). However, this survey shows inconsistencies and strong year effects for older ages in most recent years (Figure 8.4.2.6).

This deteriorates the quality of the assessment, especially concerning estimation of fishing mortality for older ages.

The reference F age range (ages 3–5) derived from this assessment shows stable fishing mortality since 2006, whereas the harvest rate (catch in weight divided by SSB) from the same assessment indicates a ca. 35% reduction in exploitation rate since 2006 (Figure 8.4.2.5d). This is in line with the ca. 40% reduction in otter trawls (main segment catching cod) fishing effort in the western Baltic Sea from 2006 to 2011 (STECF, 2012).

Comparison with previous assessment and advice

The stock was benchmarked this year with major revision in input data. The SSB estimates for 2012 have been revised upwards by 13% compared to last year's assessment, and the recruitment of the 2011 year class has been revised upwards by 5%. The 2011 fishing mortality was revised upwards by 48% (for the same age range), due to a much higher F at age 5+ from this year's assessment compared to last year's assessment. Change in SSB is partly due to adding recreational catch to the assessment.

In this year's assessment the reference age range of fishing mortality was changed from 3–6 to 3–5 to better reflect the age group that is mainly targeted by the fishery.

Sources

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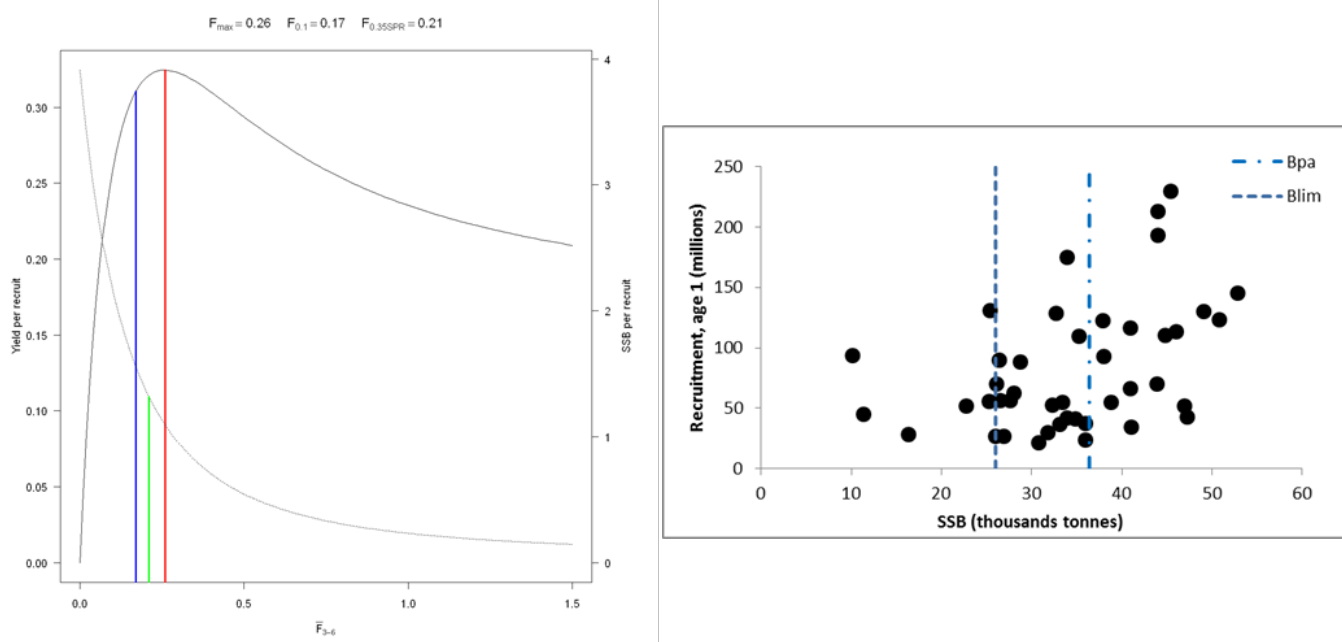


Figure 8.4.2.3 Cod in Subdivisions 22–24. Left: Yield- and SSB-per-recruit plots. The vertical lines represent biological reference points (blue: F_{0.1}, green: F_{0.35 SpR}, and red: F_{max}) based on long-term average data, not updated the last few years. Right: Stock and recruitment plot.

Table 8.4.2.1 Cod in Subdivisions 22–24. ICES advice, management, and commercial landings, discards, and recreational catch.

Year	ICES Advice	Predicted landings corresp. to advice	Agreed TAC ¹	ICES Commercial landings (22–24)	ICES Commercial landings (22–32)	Discards (22–24)	Recreational catch (22–24)
1987	TAC	9		29	236	5	1.3
1988	TAC	16		29	223	2.2	1.3
1989	TAC	14	220	19	198	1.0	1.3
1990	TAC	8	210	18	171	1.5	1.3
1991	TAC	11	171	17	140	1.7	1.1
1992	Substantial reduction in F	-	100	18	73 ²	3.9	1.6
1993	F at lowest possible level	-	40	21	66 ²	1.8	1.8
1994	TAC	22	60	31	124 ²	2.2	2.1
1995	30% reduction in fishing effort - from 1994 level		120	34	142 ²	3.7	2.3
1996	30% reduction in fishing effort - from 1994 level		165	51	173	8.0	2.3
1997	Fishing effort should not be - allowed to increase above the level of recent years		180	44	132	4.6	2.5
1998	20% reduction in F from 35 1996		160	34	102	6.2	2.3
1999	At or below F_{sq} with 50% probability	38	126	42	115	5.0	2.4
2000	Reduce F by 20%	44.6	105	38	128	5.0	2.4
2001	Reduce F by 20%	48.6	105	34	126	2.8	2.4
2002	Reduce F to below 1.0	36.3	76	24	92	2.0	2.3
2003	Reduce F to below 1.0	22.6–28.8 ³	75	25	94	4.3	2.3
2004	Reduce F to below 1.0	< 29.6	29.6	21	*	2.4	2.6
2005	Reduce F to below 0.92	< 23.4	24.7	22	*	5.0	3.1
2006	Management plan	< 28.4	28.4	23	*	1.8	2.1
2007	Keep SSB at B_{pa}	< 20.5	26.7	24	*	2.2	2.0
2008	Rebuild SSB to B_{pa}	< 13.5	19.2	20	*	1.1	1.8
2009	Rebuild SSB to B_{pa}	< 13.7	16.3	15.3		0.8	2.6
2010	Management plan	< 17.7	17.7	14.1		1.4	2.5
2011	See scenarios	-	18.8	16.3		0.8	1.8
2012	Management plan	21.3	21.3	17.1		0.9	2.2
2013	Management plan	20.8	20.0				
2014	Management plan	17.0					

Weights in thousand tonnes.

¹ Included in TAC for total Baltic, until and including 2003.² The reported landings in 1992–1995 are known to be incorrect due to incomplete reporting.³ Two options based on implementation of the adopted mesh regulation.

* Separate management for western and eastern Baltic cod since 2004.

Table 8.4.2.2 Cod in Subdivisions 22–24. Official and ICES landings (tonnes) by country and area.

	Denmark		Finland	German Dem.Rep. ¹	Germany, FRG	Estonia		Lithuania	Latvia	Poland	Sweden		Total				
	23	22+24	24	22+24	22+24	22	24	24	24	24	23	22+24	22	23	24	Unalloc	Grand total
1965		19457		9705	13350							2182	27867		17007		44874
1966		20500		8393	11448							2110	27864		14587		42451
1967		19181		10007	12884							1996	28875		15193		44068
1968		22593		12360	14815							2113	32911		18970		51881
1969		20602		7519	12717							1413	29082		13169		42251
1970		20085		7996	14589							1289	31363		12596		43959
1971		23715		8007	13482							1419	32119		14504		46623
1972		25645		9665	12313							1277	32808		16092		48900
1973		30595		8374	13733							1655	38237		16120		54357
1974		25782		8459	10393							1937	31326		15245		46571
1975		23481		6042	12912							1932	31867		12500		44367
1976	712	29446		4582	12893							1800	33368	712	15353		49433
1977	1166	27939		3448	11686						550	1516	29510	1716	15079		46305
1978	1177	19168		7085	10852						600	1730	24232	1777	14603		40612
1979	2029	23325		7594	9598						700	1800	26027	2729	16290		45046
1980	2425	23400		5580	6657						1300	2610	22881	3725	15366		41972
1981	1473	22654		11659	11260						900	5700	26340	2373	24933		53646
1982	1638	19138		10615	8060						140	7933	20971	1778	24775		47524
1983	1257	21961		9097	9260						120	6910	24478	1377	22750		48605
1984	1703	21909		8093	11548						228	6014	27058	1931	20506		49495
1985	1076	23024		5378	5523						263	4895	22063	1339	16757		40159
1986	748	16195		2998	2902						227	3622	11975	975	13742		26692
1987	1503	13460		4896	4256						137	4314	12105	1640	14821		28566
1988	1121	13185		4632	4217						155	5849	9680	1276	18203		29159
1989	636	8059		2144	2498						192	4987	5738	828	11950		18516
1990	722	8584		1629	3054						120	3671	5361	842	11577		17780
1991	1431	9383			2879						232	2768	7184	1663	7846		16693
1992	2449	9946			3656						290	1655	9887	2739	5370		17996
1993	1001	8666			4084						274	1675	7296	1275	7129	5528	21228
1994	1073	13831			4023						555	3711	8229	1628	13336	7502	30695
1995	2547	18762	132		9196				15		611	2632	16936	3158	13801		33895

1996	2999	27946	50		12018		50		32		1032	4418	21417	4031	23097	2300	50845	
1997	1886	28887	11		9269		6			263	777	2525	21966	2663	18995		43624	
1998	2467	19192	13		9722		8		13	623	607	1571	15093	3074	16049		34216	
1999	2839	23074	116		13224		10		25	660	682	1525	20409	3521	18225		42155	
2000	2451	19876	171		11572		5		84	926	698	2564	18934	3149	16264		38347	
2001	2124	17446	191		10579		40		46	646	693	2479	14976	2817	16451		34244	
2002	2055	11657	191		7322				71	782	354	1727	11968	2409	9781		24158	
2003	1373	13275	59		6775				124	568	551	1899	9573	1925	13127		24624	
2004	1927	11386			4651				221	538	393	1727	9091	2320	9430	13	20854	
2005	1902	9867	2		7002	72	67		476	1093	720	835	8729	2621	10686	9	22045	
2006	1899	9761	242		7516		91		586	801		1855	9979	1914	10858		22751	
2007	2169	8975	220		6802		69		273	2371	534	2322	7840	2713	13183		23736	
							13											
2008	1612	8582	159		5489		4		30	1361	525	2189	5687	2139	12256		20082	
							19											
2009	567	7871	259		4020		4		23	529	269	1817	3451	839	11259		15549	
2010	689	6849	203		4250			9	159	319	490	1151	3925	1179	9016		14120	
2011	783	7799	149		4521				24	487	414	2153	5493	1198	9641		16332	
2012	733	8381	260		4522		3		11	818	390	1955	4896	1123	11053		17072	

¹ Includes landings from October to December 1990 of Fed. rep. Germany.

Table 8.4.2.3 Cod in Subdivisions 22–24. Summary of stock assessment (weights in tonnes). Recruits (age 1, in thousand ind.), Low = 2.5% confidence limit, High = 97.5% confidence limit. F3–5 = Fbar 3–5. F3–6 is presented as this is the reference age range used in the management plan.

Year	Recruits (age 1)	R boundaries		TSB	TSB boundaries		SSB	SSB boundaries		F3–5	F boundaries		F3–6
		Low	High		Low	High		Low	High		Low	High	
1970	234920	153016	360663	107689	90402	128280	38910	33544	45134	0.964	0.818	1.137	0.913
1971	193300	129635	288232	116192	99007	136359	44046	38115	50901	1.041	0.908	1.193	1.017
1972	229578	156636	336489	113550	97349	132448	45388	39156	52612	1.127	0.988	1.286	1.123
1973	109974	75490	160210	109645	93481	128603	44846	38793	51844	1.084	0.948	1.239	1.042
1974	212777	146714	308587	100007	85951	116363	44046	37592	51609	1.2	1.054	1.365	1.166
1975	122149	84616	176331	97441	82530	115045	37873	32921	43570	1.197	1.053	1.36	1.174
1976	116541	81008	167661	95035	80440	112277	40946	34275	48914	1.256	1.106	1.426	1.24
1977	174905	121886	250988	83200	71692	96555	33928	29185	39443	1.208	1.055	1.383	1.179
1978	128541	89786	184024	90129	76206	106596	32728	28260	37903	0.983	0.849	1.137	0.925
1979	66503	45767	96633	92226	78476	108385	40946	34774	48213	0.926	0.799	1.073	0.869
1980	145074	101237	207893	85819	74207	99249	52892	44608	62714	1.006	0.877	1.153	0.959
1981	113437	78150	164657	89680	77064	104361	45982	39865	53037	1.1	0.956	1.266	1.071
1982	123500	85574	178235	91583	78873	106340	50767	42969	59980	0.983	0.856	1.13	0.967
1983	130353	89277	190327	88787	76824	102614	49119	42101	57306	0.971	0.844	1.117	0.949
1984	51483	35644	74359	80822	69407	94114	46911	40418	54446	1.005	0.874	1.155	0.989
1985	42873	29708	61873	72766	62687	84465	47287	39842	56125	1.235	1.087	1.404	1.229
1986	88521	61514	127386	47099	40846	54308	28739	24676	33470	1.365	1.194	1.56	1.376
1987	55216	38475	79240	55659	46749	66267	25311	21889	29268	1.102	0.965	1.259	1.082
1988	20946	14572	30107	49119	41557	58057	30761	25642	36902	1.057	0.923	1.21	1.025
1989	26582	18384	38437	39222	33861	45433	25978	21940	30758	1.134	0.996	1.292	1.099
1990	27723	19404	39606	32794	28483	37758	16357	14095	18981	1.25	1.104	1.417	1.234
1991	44757	31646	63299	21908	19207	24989	11398	9949	13059	1.351	1.175	1.554	1.304
1992	93714	68938	127394	26450	22995	30423	10190	8808	11790	1.135	0.98	1.314	1.102
1993	51689	38164	70008	40135	34709	46409	22720	19676	26235	1.003	0.869	1.158	0.983
1994	70263	50828	97129	65973	57059	76280	43915	37501	51425	0.82	0.699	0.963	0.799
1995	109754	81227	148301	51896	45769	58843	35277	30637	40620	0.956	0.833	1.096	0.947
1996	23179	16250	33062	68460	59061	79354	35954	31352	41232	1.171	1.032	1.329	1.15
1997	92596	68327	125485	57469	48761	67731	37987	31874	45272	1.375	1.21	1.563	1.374
1998	130483	94754	179685	56557	49412	64734	25387	21851	29496	1.149	1.011	1.306	1.128
1999	56500	41700	76553	57297	49739	66003	26556	23338	30218	1.201	1.062	1.358	1.203
2000	62442	46279	84251	52365	45838	59822	28029	24230	32424	1.211	1.071	1.369	1.18
2001	52208	37630	72435	47763	42022	54287	32306	28242	36954	1.283	1.134	1.451	1.238
2002	69703	51484	94370	41564	36648	47140	26134	22949	29761	1.222	1.078	1.386	1.198
2003	26635	19623	36155	44936	39402	51248	26930	23761	30522	1.042	0.909	1.194	1.01
2004	90129	67001	121242	44135	38728	50296	26397	22884	30448	1.076	0.943	1.227	1.078
2005	56050	41273	76118	48874	42813	55793	27667	24278	31530	0.995	0.864	1.146	1.039
2006	40946	30316	55303	52997	46483	60425	34892	30547	39854	0.766	0.656	0.895	0.77
2007	37235	27827	49822	50716	44903	57282	35990	31367	41294	0.765	0.663	0.884	0.77
2008	29407	21173	40845	41648	37158	46680	31793	28158	35897	0.802	0.699	0.92	0.869
2009	54776	40589	73920	51689	45924	58177	33423	29670	37651	0.797	0.688	0.923	0.872
2010	36388	26538	49895	46444	40908	52729	33157	29298	37524	0.709	0.599	0.839	0.787
2011	41564	29178	59210	48194	41631	55793	33962	29309	39354	0.761	0.608	0.952	0.874
2012	33827	21691	52752	58454	48910	69860	41028	34163	49271	0.698	0.499	0.976	0.788
2013	54721	21250	140913	54014	41360	70540	38793	29610	50825				

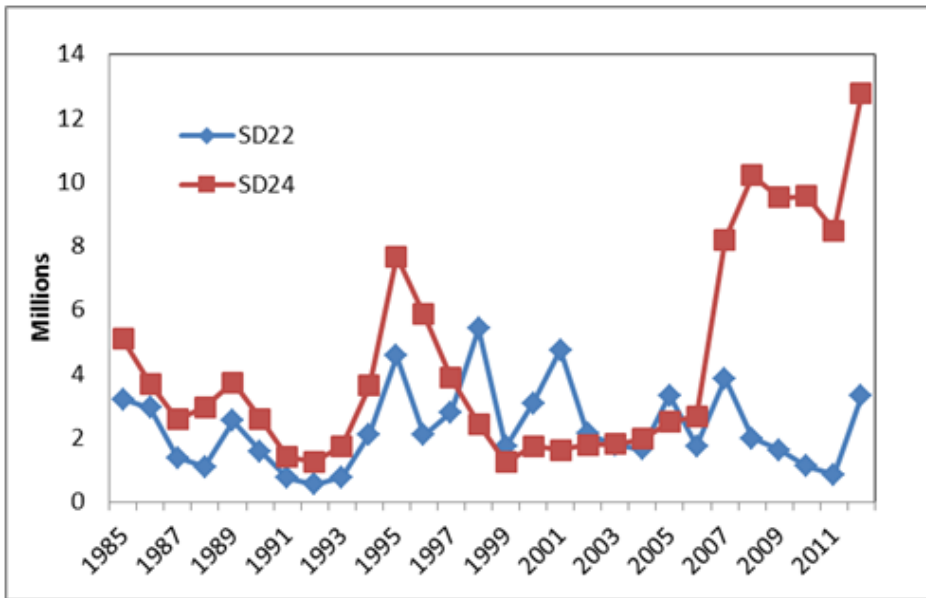


Figure 8.4.2.4 Cod in Subdivisions 22–24. Stock numbers of older cod (4+) in SD 22 compared to SD 24, based on separate assessments for the two Subdivisions (ICES, 2013a).

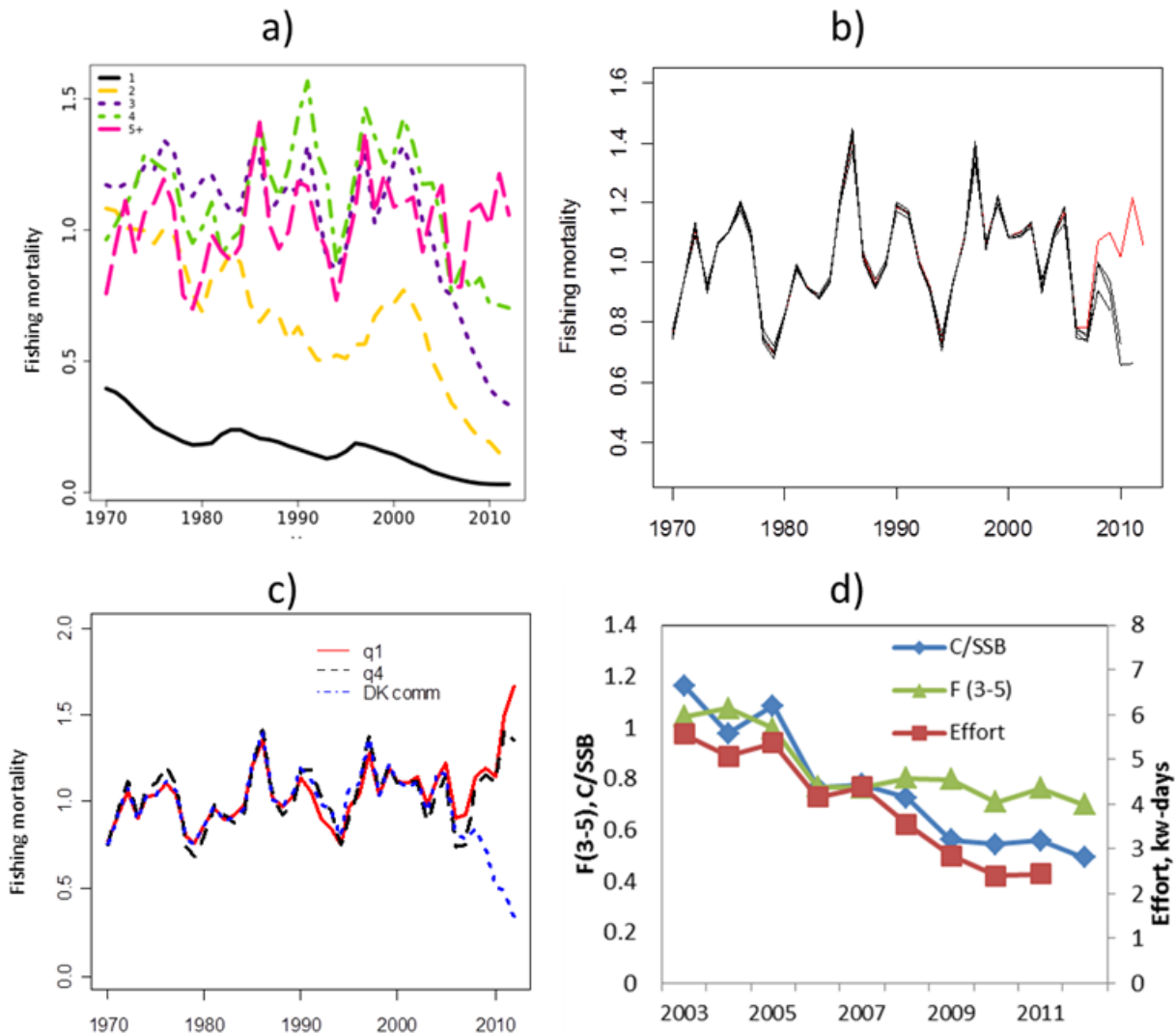


Figure 8.4.2.5 Cod in Subdivisions 22–24. a) Fishing mortality by age from the final assessment, b) Retrospective analyses of fishing mortality at age 5+; c) Fishing mortality at age 5+ from exploratory runs in SAM using one tuning series at a time (BITS q1, BITS Q4 or DK commercial cpue); d) F(3-5) from the final assessment compared to exploitation rate (C/SSB) and development in fishing effort by otter trawls.

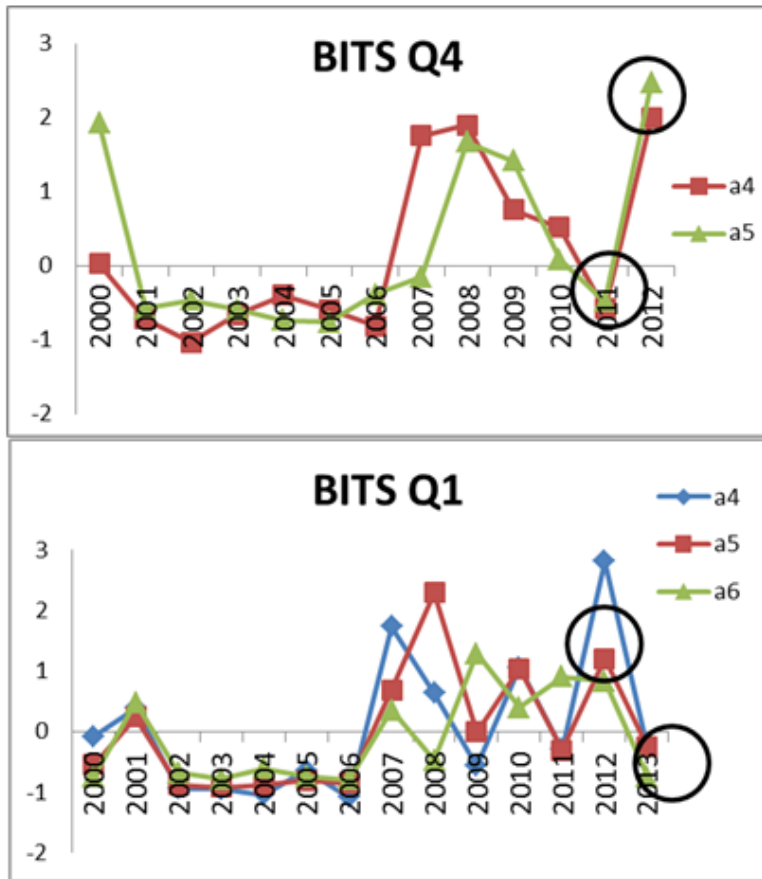


Figure 8.4.2.6 Cod in Subdivisions 22–24. Standardized catch per unit of effort from BITS-Q4 (upper panel) and BITS-Q1 (lower panel) surveys, for ages 4-6 (i.e. a4, a5 and a6, respectively). The circles point to large year effects in survey time series, with low numbers in 2011 for all ages, high values in 2012 and low values again in 2013.