

ECOREGION North Sea
STOCK Cod in Division IIIa East (Kattegat)

Advice for 2011

Management Objective (s)	Landings in 2011
Transition to an MSY approach with caution at low stock size	n/a
Cautiously avoid impaired recruitment (Precautionary Approach)	No directed fisheries, minimise by-catches
Cautiously avoid impaired recruitment and achieve other objective(s) of a management plan (e.g., catch stability)	n/a

Stock status

Fishing mortality	2007	2008	2009
F_{MSY}	undefined	undefined	undefined
F_{PA}/F_{lim}	undefined	undefined	undefined
Spawning Stock Biomass (SSB)			
	2008	2009	2010
$MSY B_{trigger}$	undefined	undefined	undefined
B_{PA}/B_{lim}	below	below	below

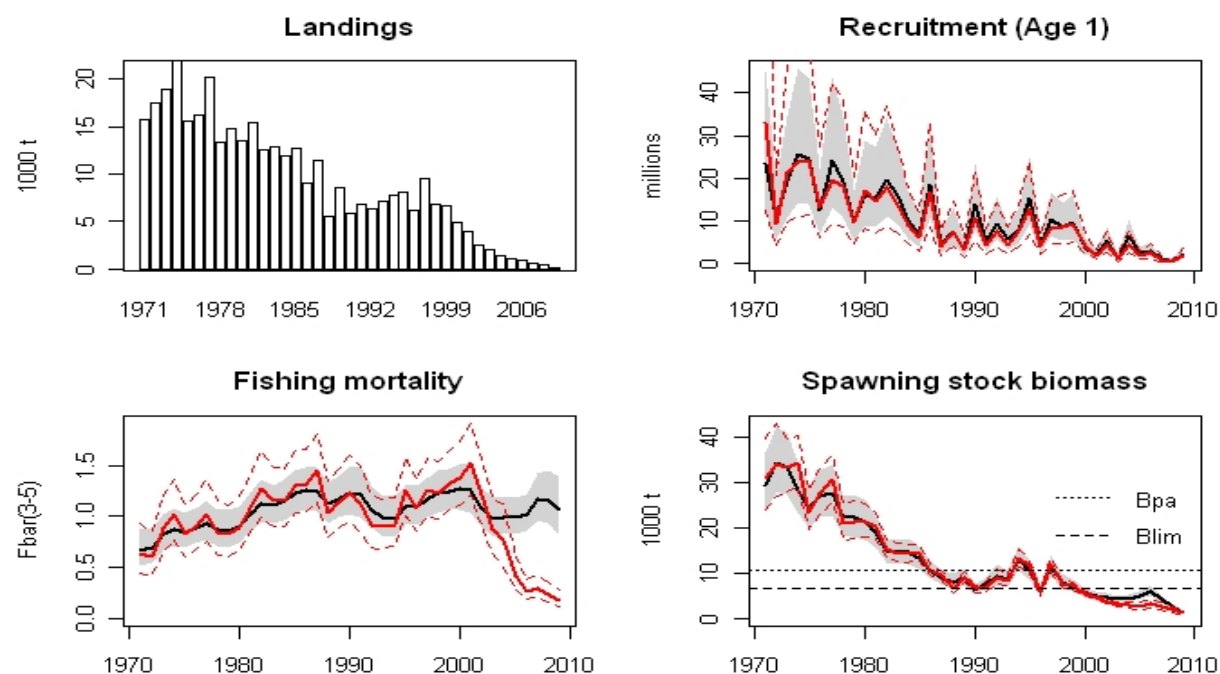


Figure 6.4.1.1 Cod in the Kattegat. Summary of stock assessment (weights in '000 tonnes) represented by two runs with (black line) and without (red line) estimating unallocated removals. Shaded area and broken lines represent 95% confidence intervals for the runs with and without estimating unallocated removals, respectively.

Spawning stock biomass has been at a historically lowest level since 2000. Recruitment in recent years has been the lowest in the time series. Current level of fishing mortality is unknown and is likely somewhere in between the estimates from the two runs, with and without estimating unallocated removals.

Management plans

A multi-annual plan has been agreed by the EU in 2008 ((EC) No [1342/2008](#)). According to Article 9 in the management plan, TAC should be reduced by 25 % in cases when it is advised that the catches of cod should be reduced to the lowest possible level. In a situation where unaccounted removals may be up to five times the TAC, ICES considers that a TAC constraint alone (under Article 9) is not precautionary.

Biology

Existence of separate stock units influences population dynamics in the Kattegat. In addition to local stocks, which are spawning in the Kattegat, there is a significant transportation of cod larvae/ juveniles from the North Sea and Öresund stocks into the Kattegat. Return migration to the North Sea/ Öresund occurs at ages 2- 3. An increasing proportion of fish originating from other stocks due to the decline of the Kattegat cod could thus seriously affect estimations of population parameters and bias the fishing mortality estimates.

Environmental influence on the stock

An analysis of the possible effect of environment and climate change on this stock has shown that fishing mortality has been the major driver of the long-term dynamics of the stock.

The fisheries

Kattegat cod are mainly taken by trawls, Danish seines and gill-nets, the former being the most important. In recent years cod is mainly caught as by-catch. Discarding of young cod and possibly also high-grading of marketable cod takes place. Further development and introduction of selective trawls with low catchability on cod is recommended. Potential changes in discarding of young cod in recent years due to introduction of new technical measures can not be evaluated with available data.

Catch by fleet	Total landings (2009) 197 kt (83% active and 17% passive gears), estimated unallocated removals due to fisheries and biological issues combined: 700 kt (95% confidence intervals 400–1200 kt)
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Effects of the fisheries on the ecosystem

The fish community in the Kattegat has changed profoundly over the last 100 yrs. Some species such as halibut, haddock, ling and pollock are no longer present or are now extremely rare, and the size composition of species such as cod, and plaice have all decreased during the 20th century.

Quality considerations

In recent years, reported landings appeared not to represent total removals from the stock; significant bias was estimated for 2003–2009. At present, the relative proportion of unallocated removals due to fishing and biology driven factors cannot be specified. Therefore, current level of fishing mortality cannot be reliably estimated. All available information consistently indicates that SSB is at historically lowest level in recent years. The level of SSB estimated from assessment is in line with the independent estimates of cod biomass based on data from the joint Swedish-Danish fishermen-scientist survey conducted in 2008–2009.

Scientific basis

Assessment type	Age based analytical assessment (stochastic state-space model SAM)
Input data	4 survey indices (IBTS 1Q; IBTS 3Q; Havfisker 1Q; Havfisker 4Q)
Discards and by-catch	Discards not included in the assessment
Indicators	Data from joint Swedish-Danish fishermen-scientists survey
Other information	benchmark done in 2009
Working group report	WGBFAS

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Reference points

	<i>Type</i>	<i>Value</i>	<i>Technical basis</i>
MSY Approach	MSY $B_{trigger}$	Not defined	
	F_{MSY}	Not defined	
Precautionary Approach	B_{lim}	6 400 t	lowest observed SSB before the late 1990s.
	B_{pa}	10 500 t	$B_{lim} * \exp(1.645 * 0.3)$.
	F_{lim}	Not defined	
	F_{pa}	Not defined	

(unchanged since: 2009)

Yield and spawning biomass per Recruit F-reference points (2009):

	Fish Mort	Yield/R	SSB/R
	Ages 3-5		
F_{max}	0.43	1.13	3.64
$F_{0.1}$	0.22	1.03	5.86
$F_{35\%SPR}$	0.26	1.08	5.16

Outlook for 2011

Due to uncertainty in the recent estimates, especially concerning fishing mortality, reliable predictions cannot be made.

MSY considerations

The state of the stock is unknown and given the low recruitment and the fact that spawning biomass is at historically lowest level in recent years it is not relevant to provide MSY based advice.

PA considerations

Due to the historical low recruitment and stock biomass the catches should be set to zero for 2011.

Management plan

According to the long-term management plan, the fishing mortality in 2011 shall be reduced by 25 % compared with the fishing mortality rate in 2010, unless the target 0.4 is reached. The current level of fishing mortality on cod in the Kattegat cannot be reliably estimated. According to Article 9 in the management plan, TAC should be reduced by 25 % in cases when it is advised that the catches of cod should be reduced to the lowest possible level. An exploratory evaluation (see section below) that assumed no bias in the TAC implementation shows that SSB will recover before 2015 to within precautionary limits; however, this evaluation is not expected to be realistic in a situation where unaccounted removals may be up to five times the TAC.

Additional considerations

Even though a management plan has been in place since 2005, the stock biomass has continued to decline. Total removals in the last 3 years have been estimated up to 5 times higher than the reported landings. No information is available on the nature of the unallocated removals but this information is essential to managers in order to take the appropriate management measures. Potential sources of unallocated removals are discarding of young ages and possibly also high-grading of marketable cod. Furthermore, migration of cod to other areas and unaccounted catches in recreational fisheries may contribute to the discrepancy between the reported landings and the estimates of total removals.

Management plan evaluations

ICES has conducted exploratory evaluation of the long-term management plan for cod in the Kattegat as specified by Council Regulation (EC) No 1342/2008 of 18 December 2008. The results showed that the present low TAC and the 20% TAC constraint in the long-term plan will allow a steep increase of SSB to above B_{pa} even though scenario

recruitment is assumed to be at a low level. This conclusion is based on no bias in the TAC implementation, which is not expected to be realistic. Due to uncertainties related to the historical and future bias in catch reporting and the extend of inflow of recruits from the North Sea stock and their homing at age 2-3 it is not possible to quantify the effect on the SSB of the local Kattegat stock spawning in the area.

Regulations and their effects

Since 2004, the use of trawls with codend mesh sizes below 90 mm in the *Nephrops* fisheries has only been permitted if the trawl was equipped with a separator grid. In 2007, Danish fishermen were allocated extra fishing days if using an exit-window with square-meshes at a minimum 120 mm; since 1st February 2008, the usage of the exit-window in trawls has been made mandatory. The Danish minimum landing size was reduced to 30 cm in February 2008. In 2008, due to effort restrictions imposed between 1 February and 30 April the usage of trawls equipped with species sorting grid (which allows most cod to escape from the trawl) increased considerably, as this type of trawl is not effort regulated. Since 2009, usage of selective trawls gives also a possibility to fish in the areas otherwise closed for fishery in order to protect cod. These changes can be expected to have reduced discard of undersized cod, the effect can however not be evaluated due to uncertain discard estimates. Recent changes in fishing pattern are believed to have reduced Swedish discards.

Spatial and temporal fishing area closures were implemented in the Kattegat in January 2009 in order to reduce fishing mortality on cod. The effects of the spatial restrictions on cod recovery will be evaluated in three years time after the implementation.

Data and methods

Reported landings and data from four scientific surveys were available for the assessment of this stock. Discard data were not used the assessment. The assessment is based on stochastic state-space model (SAM) that provides statistically sound estimates of uncertainty in the model results. The model allows estimating potential additional removals from the stock, not represented by reported landings. The stock estimates for these years consequently rely more on survey information.

The model estimates significant unallocated removals from the stock between 2003 and 2009. At present, the relative proportion of unallocated removals due to fishing and biology driven factors (migration patterns) cannot be specified. Therefore, both runs with and without estimating unallocated removals are presented (Figure 6.4.1.1). Estimates of F in either runs are not considered reliable and the fishing mortality is considered to be somewhere in between the estimates from the two runs.

Information from the fishing industry

In December 2008 and 2009, extensive joint Swedish-Danish cod surveys in Kattegat were conducted as a collaboration between the fishing industry and fisheries research institutes of Denmark and Sweden. The data from this survey were used to provide an independent estimate of biomass of adult cod in the Kattegat. The results were in line with the estimates from the assessment.

Uncertainties in assessment and forecast

In recent years, reported landings appeared not to represent total removals from the stock. Significant bias in removals was estimated for 2003–2009. At present, the relative proportion of unallocated removals due to fishing and biology driven factors cannot be specified. Recent tagging studies suggest that the Kattegat may function as a nursery area for North Sea cod, and that return migration to the North Sea are common (Svedäng *et al.*, 2007). There are some indications that the proportion of recruits of North Sea origin has increased in recent years. The migration of this stock component out of the area at an older age could contribute to the estimate of unallocated removals in the latest years. Because of these uncertainties, the current level of fishing mortality cannot be reliably estimated.

Concerning SSB, the estimates are considered imprecise, however both the assessment with and without estimating unallocated removals indicate historically lowest SSB in recent years (in the range of 750 and 1800 tonnes in 2009). The level of SSB estimated from assessment is in line with the independent estimates of cod biomass based on data from the joint Swedish-Danish fishermen-scientist survey conducted in 2009. In benchmark assessment 2009, the estimates of SSB showed also to be robust for uncertainties concerning natural mortality and discards of young fish. The assessment cannot be used as a basis for forecast.

Comparison with previous assessment and advice

The overall perception of the state of the stock is unchanged compared to last year. The basis for the advice is similar to last year, the precautionary principle, but extended by MSY considerations.

Sources

- ICES. 2009. Report of the Benchmark and Data Compilation Workshop for Roundfish (WKROUND), 16–23 January 2009, ICES Headquarters, Copenhagen. ICES CM 2009/ACOM:32.
- ICES. 2010. Report of the Baltic Fisheries Assessment Working Group, 15–22 April, ICES Headquarters, Copenhagen. 2010 ICES CM 2010/ACOM10.
- Cardinale, M., and Svedäng, H. 2004. Modelling recruitment and abundance of Atlantic cod, *Gadus morhua*, in the eastern Skagerrak–Kattegat (North Sea): evidence of severe depletion due to a prolonged period of high fishing pressure. *Fisheries Research*, 69: 263–282.
- Svedäng, H., Righton, D. and Jonsson, P. 2007. Migratory behaviour of Atlantic cod *Gadus morhua*: natal homing is the prime stock-separating mechanism. *Marine Ecology Progress Series*, 345: 1–12..
- Vitale, F., Börjesson, P., Svedäng, H. and Casini, M. 2008. The spatial distribution of cod (*Gadus morhua* L.) spawning grounds in the Kattegat, eastern North Sea. *Fisheries Research* 90: 36–44.

Table 6.4.1.1 Cod in the Kattegat. ICES advice, management and landings.

Year	ICES Advice / 2005 onwards: Single-stock exploitation boundaries	Predicted corresp. advice	catch to	Agreed TAC	ICES landings
1987	Reduction in F	< 13.0		15.5	11.5
1988	Reduction in F	< 15.0		15	5.5
1989	TAC	10		12.5	8.6
1990	TAC	7		8.5	5.9
1991	TAC	6.3		6.65	6.8
1992	30% reduction in fishing effort	-		6.65	6.3
1993	Limit fishing effort to 70% of 1991 effort	-		6.8	7.2
1994	Reduction in catch from 1991–1992	< 6.3–6.8		6.7	7.8
1995	Precautionary TAC based on recent catches	6–7		6.7	8.2
1996	30% Reduction in fishing effort from 1994 level	-		7.7	6.1
1997	Fishing effort should not exceed 70% of the 1994 level	-		8.5	9.5
1998	Fishing effort should not exceed 70% of the 1994 level	-		7.5	6.8
1999	F = 0.6	4.5		6.3	6.6
2000	At least 40% reduction in F	6.4		7	4.9
2001	F = Fpa = 0.6	4.7		6.2	3.9
2002	No fishery	0		2.8	2.3
2003	No fishery	0		2.3	2
2004	No fishery	0		1.363	1.4
2005	No fishery	0		1	1.1
2006	No fishery	0		0.85	0.9
2007	No fishery	0		0.731	0.6
2008	No catch	0		0.673	0.45
2009	No catch	0		0.505	0.197
2010	No catch	0		0.379	
2011	No directed fisheries, minimise by-catches	0			

Weights in '000 t.

Table 6.4.1.2 Cod in the Kattegat. Estimated scaling factors for landings to represent total removals from the stock (average and 95% confidence intervals, indicated as Low and High)

Year	Landings multiplier	Low	High
2003	1.61	1.13	2.30
2004	1.81	1.25	2.63
2005	3.77	2.59	5.50
2006	5.45	3.71	8.03
2007	4.85	3.23	7.28
2008	4.52	2.99	6.82
2009	4.54	2.99	6.90

Table 6.4.1.2 Cod in the Kattegat. Officially reported landings (in tonnes).

Year	Kattegat			Total
	Denmark	Sweden	Germany ¹	
1971	11748	3962	22	15732
1972	13451	3957	34	17442
1973	14913	3850	74	18837
1974	17043	4717	120	21880
1975	11749	3642	94	15485
1976	12986	3242	47	16275
1977	16668	3400	51	20119
1978	10293	2893	204	13390
1979	11045	3763	22	14830
1980	9265	4206	38	13509
1981	10693	4380	284	15337
1982	9320	3087	58	12465
1983	9149	3625	54	12828
1984	7590	4091	205	11886
1985	9052	3640	14	12706
1986	6930	2054	112	9096
1987	9396	2006	89	11491
1988	4054	1359	114	5527
1989	7056	1483	51	8590
1990	4715	1186	35	5936
1991	4664	2006	104	6834
1992	3406	2771	94	6271
1993	4464	2549	157	7170
1994	3968	2836	98	7802 ²
1995	3789	2704	71	8164 ³
1996	4028	2334	64	6126 ⁴
1997	6099	3303	58	9460 ⁵
1998	4207	2509	38	6835
1999	4029	2540	39	6608
2000	3285	1568	45	4897
2001	2752	1191	16	3960
2002	1726	744	3	2470
2003	1441	603 ⁷	1	2045
2004	827	575	1	1403
2005	608	336	10	1070 ⁶
2006	540	315	21	876
2007	390	247	7	645
2008	296	152	1	449
2009	134	62	0	197

¹ Landings statistics incompletely split on the Kattegat and Skagerrak.

² Including 900 t reported in Skagerrak.

³ Including 1.600 t misreported by area.

⁴ Excluding 300 t taken in Sub-divisions 22–24.

⁵ Including 1.700t reported in Sub-division 23.

⁶ Including 116 t reported as pollock

⁷ the catch reported to the EU exceeds the catch reported to the WG (shown in the table) by 40%