Cod (*Gadus morhua*) in subdivisions 22–24, western Baltic stock (western Baltic Sea)

ICES advice on fishing opportunities

ICES advises that when the precautionary approach is applied, catches should be no more than 24 tonnes in each of the years 2024 and 2025. This applies to the sum of the commercial and recreational catches.

ICES advice on conservation aspects

ICES advises that western Baltic cod conservation should be considered within the context of degradation of ecosystem status resulting from cumulative anthropogenic pressures and climate change. Habitat restoration efforts, focusing on the reduction of eutrophication to improve bottom oxygen content, are recommended.

Stock development over time

Spawning-stock size is below MSY $B_{trigger}$, B_{pa}, and B_{lim}. No reference points for fishing pressure have been defined for this stock.

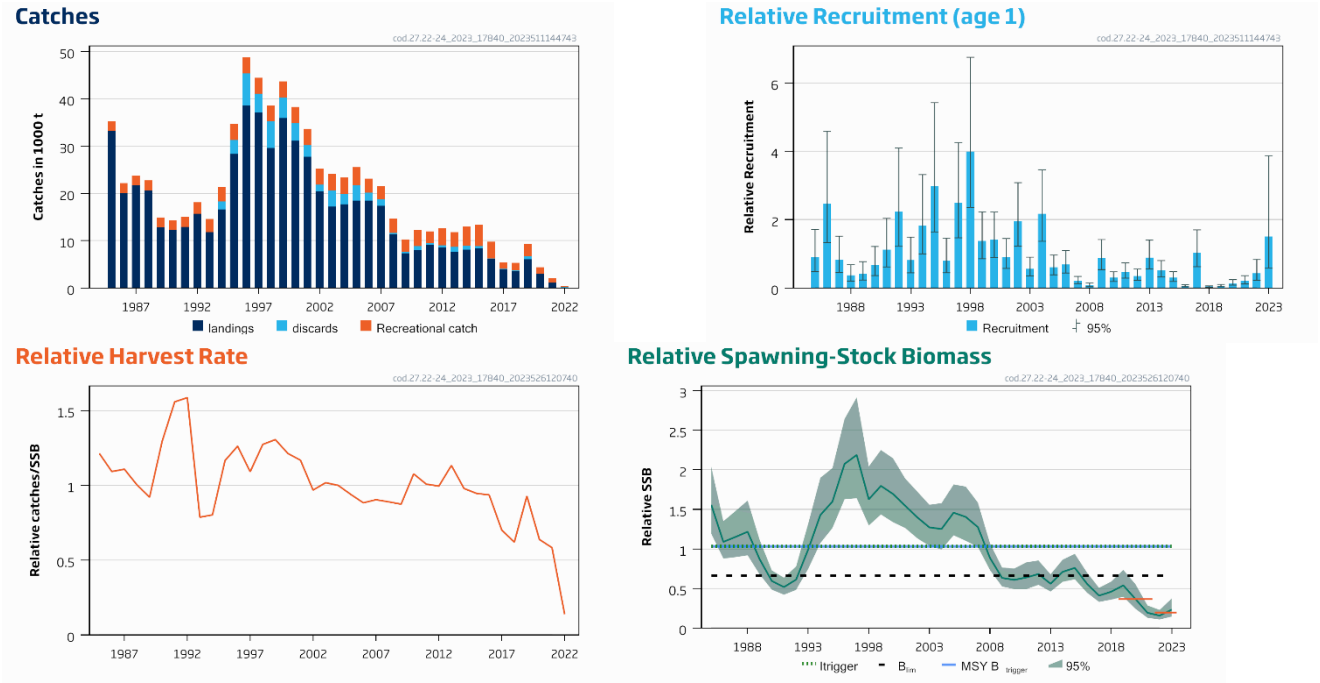

Figure 1 Cod in subdivisions 22–24, western Baltic stock. Summary of the stock assessment. Recruitment, harvest rate, and SSB are relative to the average of the time-series. Landings since 2017 include landings below minimum conservation reference size (BMS). The horizontal orange lines indicate the average of the relative SSB for 2022–2023 and for 2019–2021.

Conservation status

Cod was categorized as Vulnerable on the HELCOM Red List for the Baltic Sea and Kattegat (2013).

Catch scenarios

The ICES framework for category 3 stocks was applied (ICES, 2022). The advice is based on the rb rule (method 2.3) to provide precautionary advice. The relative spawning-stock biomass (SSB) index was used as an indicator of stock development. The advice is based on the last year's catch, multiplied by the ratio of the mean of the last two index values (index A) and the mean of the three preceding values (index B), a biomass safeguard, and a precautionary multiplier. Recent catch was used instead of advised catch, since catches have been declining in recent years, and the previous advice was

based on an estimate of fishing mortality that is now considered unreliable. The stability clause was not applied, as b was < 1.

Table 1 Cod in subdivisions 22–24 (western Baltic cod). The basis for the catch scenarios.*

Cy: total catch including commercial and recreational (2022)	403 tonnes
Biomass index	
Index A (2022–2023)	0.193
Index B (2019–2021)	0.367
r: Stock biomass trend (index ratio A/B)	0.525
Biomass safeguard	
Last index value (I_{2023})	0.230
Index trigger value ($I_{trigger}$)	1.03
b: index relative to trigger value, min{$I_{2023}/I_{trigger}$, 1}	0.223
Precautionary multiplier to maintain long-term biomass above B_{lim} with 95% probability	
m: multiplier (generic multiplier based on life history)	0.5
RB calculation**	24 tonnes
Stability clause (+20%/−30% compared to Cy, only considered if b = 1)	Not Applied
Catch advice for 2024 and 2025**	24 tonnes
% advice change***	−97%

* The figures in the table are rounded. Calculations were done with unrounded inputs, and computed values may not match exactly when calculated using the rounded figures in the table.
** Formula: Ay + 1 = Cy × r × b × m, limited by stability clause if applicable.
*** Advice value for 2024 and 2025 relative to the advice value for 2023 (the advice for 2023 was based on an analytical assessment; category 1 stock).

The 97% decrease in catch advised for 2024 and 2025 is due to the application of an empirical harvest control rule (HCR). Because SSB is well below B_{lim} and the SSB index shows a decreasing trend, the new HCR results in a substantial reduction in catch advice.

Basis of the advice

On the fishing opportunities

Table 2 Cod in subdivisions 22–24, western Baltic stock. The basis of the advice.

Advice basis	Precautionary approach
Management plan	The EU multiannual plan (MAP) in place for stocks in the Baltic Sea includes cod (EU, 2016, 2019, 2020). The MAP can only be applied if information on fishing mortality is available; therefore, the MAP is not applied as basis for the advice.

On the conservation aspects

Table 3 Cod in subdivisions 22–24, western Baltic stock. The basis of the advice.

Advice basis	Ecosystem-based management (EBM) considerations
Existing conservation measures	To achieve the management objective of ensuring healthy status of populations of all commercially exploited fish stocks (as mandated by the MSFD [EU, 2008]), the Baltic Sea Action Plan of the Baltic Marine Environment Protection Commission (HELCOM) requires identification of necessary complementary measures by 2024 in relevant policy areas to improve the size/age structure for cod (HELCOM, 2021).

Quality of the assessment

There are conflicting signals for stock development between the survey index and the catches. Survey data show unchanged high total mortality, while recent catches indicate a significant reduction in F, as indicated by the harvest rate time-series (Figure 1). This means that the total sources of mortality could not be reliably partitioned into fishing mortality and natural mortality. This discrepancy seems to be due to high unaccounted natural mortality that cannot be quantified,

rather than to potentially unreported catches. ICES has downgraded the assessment to a category 3 because of an unreliable F estimate. Trends in SSB are still considered reliable, and these are used as basis for the advice.

Issues relevant to the advice

On the fishing opportunities

Cod is exploited by a mixed commercial–recreational fishery. In 2022, the recreational catches included in the stock assessment constituted 68% of the total catches. Catch and release in the recreational fishery is one potential measure to reduce the exploitation rate on western Baltic cod. The assessment uses estimates of post-release mortality of 11.2% in the sea-based recreational fishery and 100% in the land-based recreational fishery (ICES, 2020).

The commercial fishery has evolved from being a directed cod fishery to a bycatch fishery; as a result, the sampling level has decreased. There are gears available that successfully reduce cod bycatches in the flatfish fisheries; however, these gears are not currently in use. Reducing the bycatch of cod in flatfish fisheries may enhance the recovery of the cod stocks.

On the conservation aspects

The Western Baltic cod stock has experienced a decrease in body condition due to such changes in the ecosystem as seasonally poor oxygen conditions in the bottom water, which can adversely affect the habitat, benthic food supply, and metabolism of cod. During summer, poor oxygen conditions build up below the halocline in the western Baltic Sea due to eutrophication as well as to rising temperatures linked to climate change. At the same time, warmed surface waters restrict cod habitat use during summer and autumn.

Reference points

Table 4 Cod in subdivisions 22–24, western Baltic stock. Reference points, values, and their technical basis. The biomass reference points are relative to the average of the time-series (1985–2023).

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	1.03	$B_{pa} = B_{lim} * \exp(1.645*0.27)$	ICES (2023a)
	F_{MSY}	Not defined		
Precautionary approach	B_{lim}	0.66	Average SSB in the years 1990, 1991, 1993, and 2016. These are the years with low SSB and above-average recrutiment.	ICES (2023a)
	$I_{trigger}$	1.03	MSY $B_{trigger}$	ICES (2023a)
	F_{lim}	Not defined		
	F_{pa}	Not defined		
Management plan	MSY $B_{trigger}$	Not defined		
	B_{lim}	Not defined		
	MAP F_{MSY}	Not defined		
	MAP target range F_{upper}	Not defined		
	MAP target range F_{lower}	Not defined		

Basis of the assessment

Table 5 Cod in subdivisions 22–24, western Baltic stock. Basis of the assessment and advice.

ICES stock data category	3 (ICES, 2023b)
Assessment type	Relative SSB trends from an age-based analytical assessment SAM (ICES, 2023a)
Input data	Commercial catches (landings, age distributions from catch sampling) and recreational catch (Germany, Sweden, and Denmark). Annual stock separation key (from commercial catches) to split catches in Subdivision 24 into eastern and western Baltic cod, derived from otolith shape analyses combined with genetics (this key is available for 21 of the 36 years in the present time-series). The allocation of catches to stock for the remaining years was performed by interpolation. Three survey indices: FEJUCS ([N2828], age 0), BITS-Q1 ([G2916], ages 1–4+), and BITS-Q4 ([G8863]; ages 0–4+); constant maturity data as an average from BITS-Q1 surveys for the whole time period. Natural mortalities estimated from life history parameters, constant for the whole time period.
Discards and bycatch	Included in the assessment since 1994, data series from the main fleets
Indicators	None
Other information	Interbenchmarked in 2021 (ICES, 2021)
Working group	Baltic Fisheries Assessment Working Group (WGBFAS)

History of the advice, catch, and management

Table 6 Cod in subdivisions 22–24, western Baltic stock. ICES advice and official landings. All weights are in tonnes.

Year	ICES advice	Total catch from the stock corresponding to the advice	Commercial catch corresponding to the advice*	Agreed TAC**	ICES estimated total commercial landings subdivisions 22–24 (eastern and western Baltic cod stocks)
1987	TAC		9 000		28 566
1988	TAC		16 000		29 159
1989	TAC		14 000	220 000	18 516
1990	TAC		8 000	210 000	17 780
1991	TAC		11 000	171 000	16 693
1992	Substantial reduction in F		-	100 000	17 996
1993	F at lowest possible level		-	40 000	21 228
1994	TAC		22 000	60 000	30 695
1995	30% reduction in fishing effort from 1994 level		-	120 000	33 895
1996	30% reduction in fishing effort from 1994 level		-	165 000	50 845
1997	Fishing effort should not be allowed to increase above the level of recent years		-	180 000	43 624
1998	20% reduction in F from 1996		35 000	136 950	34 216
1999	At or below F_{sq} with 50% probability		38 000	126 000	42 155
2000	Reduce F by 20%		44 600	105 000	38 347
2001	Reduce F by 20%		48 600	105 000	34 244
2002	Reduce F to below 1.0		36 300	76 000	24 158
2003	Reduce F to below 1.0		***22 600 or 28 800	75 000	24 624
2004	Reduce F to below 1.0		< 29 600	29 600	20 854

Year	ICES advice	Total catch from the stock corresponding to the advice	Commercial catch corresponding to the advice*	Agreed TAC**	ICES estimated total commercial landings subdivisions 22–24 (eastern and western Baltic cod stocks)
2005	Reduce F to below 0.92		< 23 400	24 700	22 045
2006	Management plan		< 28 400	28 400	22 751
2007	Keep SSB at B_{pa}		< 20 500	26 700	23 736
2008	Rebuild SSB to B_{pa}		< 13 500	19 200	20 082
2009	Rebuild SSB to B_{pa}		< 13 700	16 300	15 549
2010	Management plan		< 17 700	17 700	14 120
2011	See scenarios		-	18 800	16 332
2012	Management plan		21 300	21 300	17 072
2013	Management plan		20 800	20 000	12 968
2014	Management plan		17 037	17 000	13 538
2015	MSY approach		8 793	15 900	13418
2016	MSY approach (F = 0.23)	≤ 7 797		12 720	10 629
2017	MSY approach (F = 0.15)	≤ 3 475	≤ 917	5 597	5 865^
2018	MAP F ranges: F_{lower} to F_{MSY} adjusted by SSB_{2018}/ MSY $B_{trigger}$ (F = 0.11–0.188)	3 130–5 295	1 376–3 541	5 597	5 850^
2019	MAP range: F_{MSY} F_{lower} to F_{upper} (F = 0.15–0.45)	9 094–23 992	5 867–22 238	9 515	7 701^
2020	MAP range: F_{MSY} F_{lower} to F_{upper} (F = 0.18–0.43)	5 205–11 006	3 065–8 866	3 806	3 329^
2021	Management plan	5 950 (range 4 275–9 039)	4 635 (range 2 960–7 724)	4 000	1 329^
2022	MSY approach	≤ 698	No split provided	489	136
2023	MSY approach	≤ 943	No split provided	489	
2024	Precautionary approach	≤ 24	No split provided		
2025	Precautionary approach	≤ 24	No split provided		

* Values since 2016 are for the western Baltic cod stock only, whereas, in earlier years, they are for the area of subdivisions 22–24 and include a fraction of the eastern Baltic cod stock.
** Included in TAC for total Baltic until and including 2003.
*** Two options based on implementation of the adopted mesh regulation.
^ Including BMS.

History of the catch and landings

Table 7 Cod in subdivisions 22–24, western Baltic stock. Catch distribution in 2022 as estimated by ICES.

Catch (2022)	Commercial landings		Commercial discards	Recreational catch
403 tonnes	Active gears 59%	Passive gears 41%	27 tonnes	288 tonnes
	88 tonnes			

Table 8 Cod in subdivisions (SDs) 22–24, western Baltic management area. History of commercial catch; both the official and ICES estimated values are presented by area. The table includes landings of the western Baltic cod stock as well as of the eastern Baltic cod stock in SD 24. All weights are in tonnes.

Year	Total for managment area							
	Human consumption (HC) landings				BMS	Discards	Unalloc.	Total catch
	SD 22	SD 23	SD 24	SDs 22–24				
1992	9 887	2 739	5 370	17 996				17 996
1993	7 296	1 275	7 129	15 700			5 528	21 228
1994	8 229	1 628	13 336	23 193		2 235	7 502	32 930
1995	16 936	3 158	13 801	33 895		3 684		37 579
1996	21 417	4 031	23 097	48 545		7 984	2 300	58 829
1997	21 966	2 663	18 995	43 624		4 623		48 247
1998	15 093	3 074	16 049	34 216		6 207		40 423
1999	20 409	3 521	18 225	42 155		4 978		47 133
2000	18 934	3 149	16 264	38 347		4 947		43 294
2001	14 976	2 817	16 451	34 244		2 839		37 083
2002	11 968	2 409	9 781	24 158		1 958		26 116
2003	9 573	1 925	13 127	24 624		4 336		28 960
2004	9 091	2 320	9 430	20 841		2 377	13	23 231
2005	8 729	2 621	10 686	22 036		4 994	9	27 039
2006	9 979	1 914	10 858	22 751		1 831		24 582
2007	7 840	2 713	13 183	23 736		2 199		25 935
2008	5 687	2 139	12 256	20 082		1 123		21 205
2009	3 451	839	11 259	15 549		815		16 364
2010	3 925	1 179	9 016	14 120		1 371		15 491
2011	5 493	1 198	9 641	16 332		780		17 112
2012	4 896	1 123	11 053	17 072		905		17 977
2013	4 675	960	7 333	12 968		2 250		15 218
2014	4 316	1 361	7 862	13 538		2 135		15 673
2015	4 994	1 232	7 193	13 419		1 361		14 780
2016	3 193	1 123	6 313	10 629	34	449		11 112
2017	2 195	941	2 697	5 833	32	421		6 286
2018	2 014	870	2 942	5 826	24	476		6 326
2019	3 728	1 167	2 783	7 679	22	1 292		8 993
2020	2 147	508	671	3 326	3	205		3 534
2021	624	345	357	1 326	3	80		1 409
2022	43	21	72	136	< 1	42		177

Summary of the assessment

Table 9 Cod in subdivisions 22–24, western Baltic stock. Assessment summary. Weights are in tonnes. Recruitment, SSB, and harvest rate are relative to the average of the time-series. High and Low refer to 95% confidence intervals.

Year	Relative Recruitment			Relative Stock size			Landings*	Discards	Recreational catch	Relative Harvest rate		
	Relative R (age 1)	High	Low	Relative SSB	High	Low				Catch/SSB		
1985	0.90	1.71	0.48	1.56	2.0	1.19	33188		2075	1.21		
1986	2.5	4.6	1.33	1.09	1.35	0.88	20088		2078	1.09		
1987	0.83	1.51	0.46	1.15	1.48	0.90	21692		2081	1.11		
1988	0.37	0.68	0.20	1.22	1.61	0.92	20672		2082	1.00		
1989	0.42	0.77	0.23	0.87	1.11	0.68	12795		2083	0.92		
1990	0.66	1.21	0.36	0.59	0.73	0.48	12237		2085	1.29		
1991	1.12	2.0	0.61	0.52	0.64	0.42	12931		2087	1.56		
1992	2.2	4.1	1.22	0.61	0.78	0.48	15672		2420	1.59		
1993	0.81	1.48	0.44	0.99	1.32	0.75	11815		2752	0.79		
1994	1.82	3.3	0.99	1.43	1.90	1.07	16642	1614	3088	0.80		
1995	3.0	5.4	1.64	1.60	2.0	1.26	28310	3016	3417	1.17		
1996	0.81	1.45	0.45	2.1	2.6	1.63	38505	6868	3419	1.26		
1997	2.5	4.3	1.47	2.2	2.9	1.64	37077	3981	3420	1.09		
1998	4.0	6.7	2.4	1.63	2.0	1.29	29634	5575	3410	1.27		
1999	1.38	2.2	0.86	1.80	2.3	1.43	35934	4378	3416	1.31		
2000	1.41	2.2	0.89	1.69	2.1	1.34	31132	3738	3432	1.21		
2001	0.91	1.45	0.57	1.55	1.89	1.26	27781	2449	3427	1.17		
2002	1.94	3.1	1.22	1.40	1.73	1.13	20410	1395	3437	0.97		
2003	0.56	0.90	0.35	1.27	1.56	1.04	17205	3473	3448	1.02		
2004	2.2	3.5	1.37	1.25	1.58	0.99	17686	2189	3445	1.00		
2005	0.61	0.96	0.39	1.46	1.82	1.17	18493	3265	3771	0.94		
2006	0.69	1.09	0.44	1.40	1.79	1.10	18503	1686	2923	0.88		
2007	0.21	0.34	0.129	1.27	1.59	1.02	17384	1325	2782	0.90		
2008	0.076	0.142	0.040	0.89	1.07	0.73	11302	336	3039	0.89		
2009	0.87	1.42	0.54	0.63	0.77	0.52	7313	351	2648	0.87		
2010	0.30	0.48	0.190	0.61	0.75	0.49	8007	838	3367	1.08		
2011	0.46	0.73	0.29	0.64	0.83	0.49	9107	299	2595	1.01		
2012	0.35	0.55	0.22	0.68	0.85	0.55	8622	370	3661	0.99		
2013	0.88	1.40	0.56	0.56	0.68	0.46	7697	1007	3106	1.13		
2014	0.51	0.80	0.32	0.71	0.86	0.58	8083	837	4044	0.98		
2015	0.30	0.48	0.191	0.76	0.94	0.62	8390	432	4568	0.95		
2016	0.057	0.094	0.034	0.56	0.70	0.45	6122	143	3505	0.94		
2017	1.03	1.70	0.62	0.41	0.51	0.33	3861	180	1315	0.70		
2018	0.040	0.064	0.024	0.46	0.59	0.36	3555	157	1600	0.62		
2019	0.061	0.102	0.037	0.54	0.74	0.40	6103	655	2573	0.93		
2020	0.142	0.24	0.083	0.37	0.56	0.24	2900	152	1311	0.64		
2021	0.20	0.36	0.114	0.192	0.29	0.128	1065	51	968	0.58		
2022	0.43	0.83	0.22	0.156	0.23	0.107	88	27	288	0.138		
2023	1.50	3.9	0.58	0.23	0.38	0.143						

*Includes BMS.

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