

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

ICES advice on fishing opportunities

ICES advises that when the MSY approach is applied, catches should be no more than 943 tonnes in 2023. This applies to the sum of commercial and recreational catches.

Stock development over time

Fishing pressure on the stock is above F_{MSY} and between F_{pa} and F_{lim} ; spawning-stock size is below MSY $B_{trigger}$, B_{pa} , and B_{lim} .

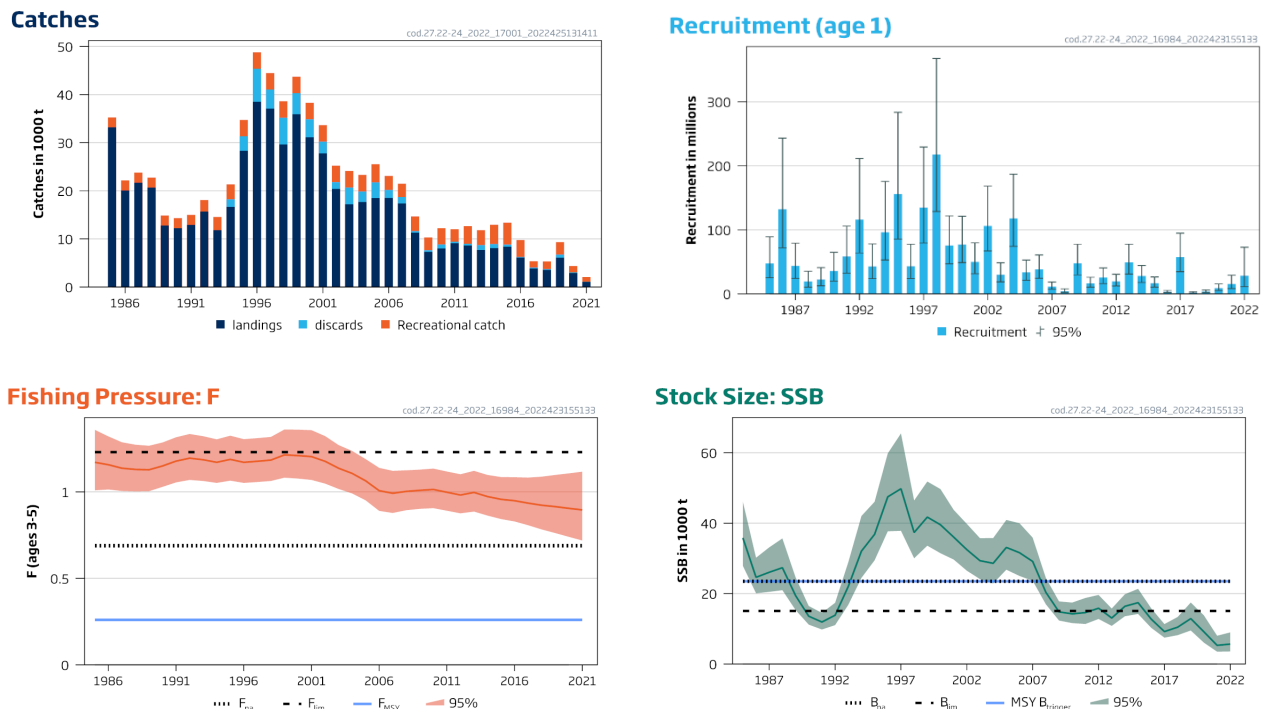


Figure 1 Cod in subdivisions 22–24, western Baltic stock. Summary of the stock assessment. Landings since 2017 include landings below minimum conservation reference size (BMS).

Catch scenarios

Table 1 Cod in subdivisions 22–24, western Baltic stock. Values in the forecast and for the interim year.

Variable	Value	Notes
$F_{ages\ 3-5}$ (2022)	0.90	Equal to F in 2021 (F_{sq})
SSB (2023)	9 299	Short-term forecast; tonnes
$R_{age\ 1}$ (2022)	28 966	From the assessment; thousands
$R_{age\ 1}$ (2023)	17 015	Sampled from the last ten years (2013–2022); thousands*
$R_{age\ 1}$ (2024)	17 187	Sampled from the last ten years (2013–2022); thousands*
Total catch (2022)	4 295	Based on F in 2021

* Recruitment is randomly resampled from the assessment estimates of the last ten years, and the median of these random draws is used. This will vary slightly every time this is carried out.

Table 2 Cod in subdivisions 22–24, western Baltic stock. Annual catch scenarios. All weights are in tonnes.

Basis	Total catch* (2023)	F_{total} (2023)	SSB (2024)	% SSB change***	% advice change^	% probability of SSB being below B_{lim} in 2024##
ICES advice basis						
MSY approach: $F_{\text{MSY}} \times \text{SSB (2023)}$ / $\text{MSY } B_{\text{trigger}}$	943	0.103	17 918	93	35	31
Other scenarios						
EU MAP**: $F_{\text{MSY}} \times \text{SSB (2023)}$ / $\text{MSY } B_{\text{trigger}}$	943	0.103	17 918	93	35	31
EU MAP**: MAP range F_{lower} SSB (2023)/ $\text{MSY } B_{\text{trigger}}$	621	0.067	18 240	96	34	29
Zero catch	0	0	18 859	103	–100	25
$F = F_{\text{pa}}$	5 277	0.69	13 581	46	656	60
$F = F_{\text{lim}}$	8 175	1.23	10 698	15	1071	76
$\text{SSB (2024)} = B_{\text{lim}}$	3 753	0.46	15 067	62	438	50
$\text{SSB (2024)} = B_{\text{pa}}^{\#}$	–	–	–	–	–	–
$\text{SSB (2024)} = \text{MSY } B_{\text{trigger}}^{\#}$	–	–	–	–	–	–
F_{sq} ($F = 2021$)	6 485	0.90	12 361	33	829	66
TAC_{2022} (489 t)+ estimated recreational catch 2022 (494 t)	983	0.108	17 872	92	41	32

* Includes commercial and recreational catch.

** EU Multiannual Plan for the Baltic Sea (EU, 2016, 2019).

*** SSB 2024 relative to SSB 2023.

^ Total catch in 2023 relative to total catch corresponding to the MAP F_{MSY} advice for 2022 (698 tonnes), including commercial and recreational catch.

The B_{pa} and $\text{MSY } B_{\text{trigger}}$ options were left blank because neither can be achieved in 2024 even with zero catch in 2023.

This probability relates to the short-term probability of $\text{SSB} < B_{\text{lim}}$ and is not comparable to the long-term probability of $\text{SSB} < B_{\text{lim}}$ tested in simulations when estimating fishing mortality reference points.

Recruitment in 2022 has been estimated to be slightly higher than in the previous year; this results in higher catch advice for 2023.

Basis of the advice

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

Advice basis	The EU Baltic multiannual plan could not be used because this plan does not provide guidance on catch scenarios for the present state of the stock. Therefore, the MSY approach was used as basis for the advice.
Management plan	The EU multiannual plan (MAP) in place for stocks in the Baltic Sea includes cod (EU, 2016, 2019). The advice, based on F_{MSY} ranges, is considered precautionary.

Quality of the assessment

In previous years' forecasts, the expected catch in the interim year predicted a substantial reduction in fishing mortality and a corresponding increase in SSB. However, although the assumptions made on catches in the interim year have turned out to be reasonable, the fishing mortality estimated from the assessment has remained high, with SSB subsequently considerably lower than was predicted. Such a pattern suggests that processes other than those captured by catch and assumed natural mortality data are influencing the SSB of the western Baltic cod stock. The sources for the presumably additional mortality are presently unclear but could involve e.g. increased natural mortality (due to increased predation, hypoxia, decreased condition, increased water temperatures) and unreported catches. However, the effects associated

with these drivers are presently not possible to identify and quantify and are therefore difficult to account for in the forecast. For this reason F_{sq} was used for the intermediate year, which produces a considerably higher assumed catch (total removal) than the present quota for 2022. It is not possible to account for this additional mortality in the advice year such that the estimated SSB in 2024 may be an overestimate. The probability of SSB being below B_{lim} in 2024 is likely to be higher than the 31% estimated in Table 2.

The SSB development from stock assessment is considered well estimated, but the trend in fishing mortality may represent a combination of other sources of mortality with those related to fishing.

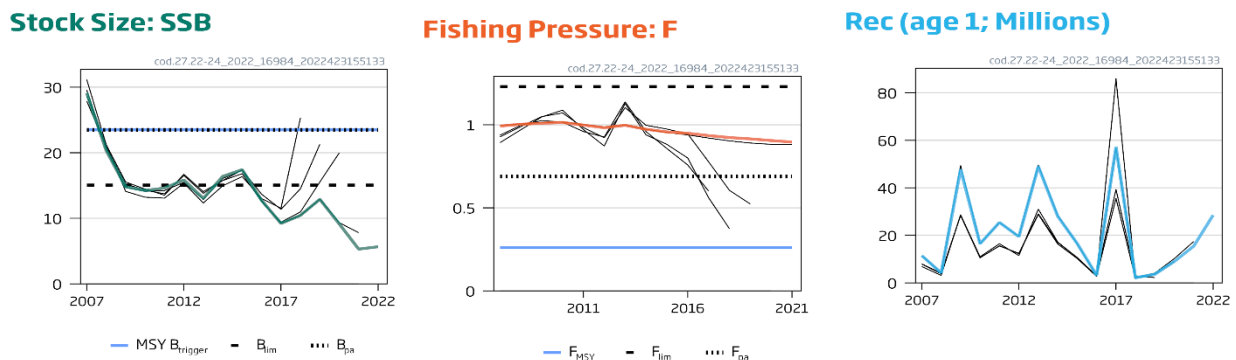


Figure 2 Cod in subdivisions 22–24, western Baltic stock. Historical assessment results (final-year recruitment estimates included). The stock was interbenchmarked in 2021, and only assessment results from the last two years should be compared to the reference points indicated.

Issues relevant to the advice

Cod is exploited by a mixed commercial–recreational fishery. In 2021, the recreational catches included in the stock assessment constituted 46% of the total catches. The current management includes trade-offs between commercial and recreational fisheries, but ICES is not in a position to provide catch options separately for commercial and recreational fisheries because the catch advice for the stock is so low that it is not possible to partition the 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 in the sea-based recreational fishery of 11.2%, while it is considered to be 100% in the land-based recreational fishery (ICES, 2020). The commercial fishery has changed from being a directed cod fishery towards a bycatch fishery. There are gears available that successfully reduce cod bycatches in the flatfish fisheries (Stepputtis *et al.*, 2020); however, these gears are not in use at present. Reducing the bycatch of cod in flatfish fisheries is necessary to enhance the recovery of the cod stocks.

There is high uncertainty in the short term forecast of this stock. The sum of fishing mortality and unaccounted natural mortality will probably be close to F_{sq} value in 2023, which would result in a probability of SSB being below B_{lim} of around 66% in 2024. Thus, the risk associated to the MSY advice is high.

Reference points

Table 5 Cod in subdivisions 22–24, western Baltic stock. Reference points, values, and their technical basis. Weights in tonnes.

Framework	Reference point	Value	Technical basis	Source
MSY approach	MSY $B_{trigger}$	23 492	B_{pa}	ICES (2021)
	F_{MSY}	0.26	Stochastic simulations with segmented regression stock–recruitment relationship	ICES (2021)
Precautionary approach	B_{lim}	15 067	Average of lowest SSB in years with above average recruitment (1990, 1991, 1993, 2016)	ICES (2021)
	B_{pa}	23 492	$B_{lim} \times \exp(1.645 \times 0.27)$	ICES (2021)
	F_{lim}	1.23	Equilibrium scenarios with stochastic recruitment: F value corresponding to 50% probability of ($SSB < B_{lim}$)	ICES (2021)
	F_{pa}	0.689	F_{pos} ; the F that leads to $SSB \geq B_{lim}$ with 95% probability	ICES (2021)
Management plan	MSY $B_{trigger}$	23 492	MSY $B_{trigger}$	ICES (2021)
	B_{lim}	15 067	B_{lim}	ICES (2021)
	MAP F_{MSY}	0.26	F_{MSY}	ICES (2021)
	MAP target range F_{upper}	0.26–0.44	Consistent with the ranges resulting in no more than 5% reduction in long-term yield compared with MSY	ICES (2021)
	MAP target range F_{lower}	0.17–0.26	Consistent with the ranges resulting in no more than 5% reduction in long-term yield compared with MSY	ICES (2021)

Basis of the assessment

Table 6 Cod in subdivisions 22–24, western Baltic stock. Basis of the assessment and advice.

ICES stock data category	1 (ICES, 2022a)
Assessment type	Age-based analytical assessment SAM (ICES, 2022b) that uses catches (landings, discards, and recreational catch) in the model and the forecast
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 20 of the 35 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 7 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

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)
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
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	13 418
2016	MSY approach (F = 0.23)	$\leq 7\,797$		12 720	10 629
2017	MSY approach (F = 0.15)	$\leq 3\,475$	≤ 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^

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)
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		489	
2023	MSY approach	≤ 943			

* 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 8 Cod in subdivisions 22–24, western Baltic stock. Catch distribution in 2021 as estimated by ICES.

Table 6 Cod in subdivisions 22–24, western Baltic stock: catch distribution in 2021 as estimated by ICES				
Catch (2021)	Commercial landings		Commercial discards	Recreational catch
2 084 tonnes	Active gears 45%	Passive gears 55%	51 tonnes	968 tonnes
	1 065 tonnes			

Table 9 Cod in subdivisions 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 Subdivision 24. All weights are in tonnes.

Year	Total for management area							
	Human consumption (HC) landings				BMS	Discards	Unalloc.	Total catch
	22	23	24	HC (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

Summary of the assessment

Table 10 Cod in subdivisions 22–24, western Baltic stock. Assessment summary. Weights are in tonnes. Recruitment in thousands. High and low refer to 95% confidence intervals.

Year	Recruitment			Stock size			Landings	Discards	Recreational catch	Fishing pressure		
	R (age 1)	High	Low	SSB	High	Low				F (ages 3–5)	High	Low
1985	47 412	89 065	25 239	35 840	46 095	27 866	33 188		2 075	1.17	1.36	1.01
1986	132 126	243 310	71 749	24 626	30 201	20 081	20 088		2 078	1.16	1.32	1.01
1987	43 683	79 116	24 119	26 063	33 142	20 497	21 692		2 081	1.14	1.29	1.00
1988	19 280	35 262	10 541	27 355	35 686	20 969	20 672		2 082	1.13	1.27	1.00
1989	22 649	41 039	12 500	19 435	24 642	15 328	12 795		2 083	1.13	1.27	1.00
1990	35 804	64 945	19 739	13 578	16 483	11 185	12 237		2 085	1.15	1.29	1.03
1991	58 495	105 900	32 310	11 928	14 533	9 790	12 931		2 087	1.18	1.32	1.05
1992	116 204	211 479	63 852	13 860	17 395	11 043	15 672		2 420	1.20	1.34	1.07
1993	42 902	77 999	23 597	22 016	28 876	16 786	11 815		2 752	1.19	1.32	1.06
1994	96 480	175 560	53 021	32 068	42 050	24 455	16 642	1 614	3 088	1.17	1.30	1.05
1995	155 746	283 426	85 585	36 840	46 099	29 441	28 310	3 016	3 417	1.19	1.32	1.06
1996	43 083	77 496	23 952	47 491	59 842	37 689	38 505	6 868	3 419	1.17	1.30	1.05
1997	134 857	229 263	79 325	49 784	65 511	37 833	37 077	3 981	3 420	1.18	1.31	1.06
1998	217 458	367 691	128 608	37 351	46 460	30 027	29 634	5 575	3 410	1.18	1.32	1.06
1999	75 488	121 670	46 835	41 734	51 841	33 598	35 934	4 378	3 416	1.21	1.36	1.08
2000	77 002	121 346	48 863	39 541	49 689	31 466	31 132	3 738	3 432	1.21	1.36	1.08
2001	50 016	79 549	31 447	36 051	43 801	29 672	27 781	2 449	3 427	1.20	1.36	1.07
2002	106 148	168 324	66 938	32 491	39 821	26 510	20 410	1 395	3 437	1.18	1.32	1.05
2003	30 176	48 500	18 775	29 344	35 742	24 092	17 205	3 473	3 448	1.14	1.27	1.02
2004	117 717	186 923	74 134	28 603	35 783	22 864	17 686	2 189	3 445	1.11	1.24	0.99
2005	33 530	52 857	21 270	33 112	40 928	26 789	18 493	3 265	3 771	1.06	1.19	0.95
2006	38 355	60 729	24 224	31 613	39 982	24 995	18 503	1 686	2 923	1.01	1.14	0.89
2007	11 458	18 428	7 124	29 126	35 899	23 631	17 384	1 325	2 782	0.99	1.12	0.88
2008	4 236	7 807	2 298	20 356	24 453	16 946	11 302	336	3 039	1.00	1.13	0.89
2009	47 789	77 487	29 473	14 812	17 783	12 337	7 313	351	2 648	1.01	1.13	0.90
2010	16 452	26 003	10 410	14 243	17 459	11 619	8 007	838	3 367	1.01	1.14	0.91
2011	25 450	40 587	15 958	14 612	18 773	11 373	9 107	299	2 595	1.00	1.12	0.89
2012	19 437	30 584	12 353	15 849	19 634	12 793	8 622	370	3 661	0.98	1.10	0.88
2013	48 989	77 547	30 947	13 060	15 764	10 821	7 697	1 007	3 106	1.00	1.12	0.89
2014	28 030	44 285	17 742	16 397	19 824	13 561	8 083	837	4 044	0.97	1.10	0.86
2015	16 605	26 239	10 508	17 420	21 361	14 206	8 390	432	4 568	0.96	1.09	0.84
2016	3 191	5 248	1 941	12 742	15 815	10 266	6 122	143	3 505	0.95	1.08	0.83
2017	57 165	94 684	34 513	9 209	11 347	7 474	3 861*	180	1 315	0.94	1.08	0.81
2018	2 182	3 551	1 341	10 456	13 358	8 185	3 555*	157	1 600	0.92	1.09	0.78
2019	3 590	5 984	2 154	12 896	17 478	9 515	6 103*	655	2 573	0.92	1.10	0.76
2020	8 972	15 571	5 170	9 133	13 799	6 045	2 900*	152	1 311	0.91	1.11	0.74
2021	15 456	29 242	8 169	5 303	8 038	3 498	1 065*	51	968	0.90	1.12	0.72
2022	28 524	72 770	11 180	5 661	8 986	3 566						

*Includes BMS.

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Recommended citation: ICES. 2022. Cod (*Gadus morhua*) in subdivisions 22–24, western Baltic stock (western Baltic Sea). In Report of the ICES Advisory Committee, 2022. ICES Advice 2022, cod.27.22–24, <https://doi.org/10.17895/ices.advice.19447868>