ICES Special Request Advice
Baltic Sea ecoregion
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EU request for further information on the distribution and unavoidable bycatches of eastern Baltic cod

Advice summary

1. Bycatch of eastern Baltic cod in non-targeted fisheries

ICES is not in a position to quantify the amount of unavoidable bycatch of cod in non-targeted fisheries in 2020. Total EU cod bycatch in 2018 was in the range of 66–417 tonnes in Subdivision 24 (eastern and western stocks combined) and 360–1306 tonnes in subdivisions 25–32 (eastern stock). The ranges correspond to different definitions of bycatch thresholds, from 10% to 50% cod in the landings per fishing trip. ICES is not in a position to provide advice on a specific threshold for unavoidable bycatch. In 2018 these cod bycatch amounts contributed less than 11% and 15%, respectively, to the total cod landings in those areas, corresponding to fishing patterns when cod was a target species. The biomass then was higher than that predicted for 2020, and there was no incentive for fishers to avoid catching cod.

ICES is not in a position to predict future fishing patterns or the uptake of more selective gears. Bycatch of cod in demersal trawl fisheries for flatfish could be substantially reduced when applying selectivity devices in fishing gear. Three selectivity strategies are possible: i) species-specific size selection, ii) selection by behavioral differences of the species, and iii) a strategy that combines i and ii. Strategy i can be efficient in reducing bycatch of small cod (though not large), while strategies ii and iii can be applied to minimize bycatches of cod at all sizes in targeted flatfish fisheries.

Cod and flounder overlap in the entire distribution area of the eastern Baltic cod (EBC) stock; plaice and eastern Baltic cod overlap in subdivisions 24–25. Thus there are no areas or months where flatfish fisheries with non-selective gears could be conducted in subdivisions 24–26 without a risk of bycatch of cod. Only a small fraction of EU flatfish landings have been taken in Subdivision 26 in recent years (6% of flounder landings in 2018). A potential closure of Subdivision 26 for demersal fisheries would therefore have limited implications for EU flatfish fisheries, while protecting a substantial part of the eastern Baltic cod stock; around half of the catches of EBC have been taken in Subdivision 26 in recent years.

2. Mixing of eastern and western Baltic cod in Subdivision 24

ICES advises that bycatch of EBC in fisheries targeting western Baltic cod (WBC) in Subdivision 24 can be reduced by closing demersal fisheries in deeper offshore areas east of 13˚E.

EBC occurs throughout Subdivision 24 and in all seasons. In the area west of 13°E, EBC has accounted for an average of 47% of the cod catches in the past 11 years; east of 13°E this increases to an average of 78%. The EBC accounts for a lower percentage of the cod catches at water depths 0–10 m or 10–20 m (on average 27% or 39% EBC, respectively). It is assumed this does not to apply for the coastal waters around Bornholm. The proportion of EBC is also lower in fisheries by passive gears, due to their use in mostly shallow areas.

Bycatch of EBC in fisheries targeting WBC can be calculated by multiplying the TAC for the management area with the proportion of the TAC taken in Subdivision 24 (0.53 of the catch in the last three years), and the proportion of cod in Subdivision 24 that belongs to the eastern stock (0.74 in the last three years). This implies that 1493 tonnes of EBC could be taken in Subdivision 24 in 2020. However, the additional fishing restrictions to be applied in 2020 in Subdivision 24 are expected to reduce the proportion of the WBC cod TAC taken in that subdivision; this would also reduce the bycatch of EBC.

A closure of the whole of Subdivision 24 could result in up to 22% loss of WBC commercial landings, based on the fishing patterns observed in recent years (2016–2018). It is not possible to quantify the extent of effort reallocation to subdivisions 22–23 for different fleets. The cod TAC set for the western Baltic management area (3806 tonnes for 2020) is close to the amount taken in subdivisions 22–23 in recent years. It seems possible, therefore, that the 3806 tonnes TAC could be taken in subdivisions 22–23.

3. Cod in subdivisions 27–32

ICES advises that the impact of continued fishing and potential effort reallocation from other areas to subdivisions 27–32 would lead to a maximum of 3% reduction in total biomass of EBC. EBC annual catches in subdivisions 27–32 were between 150 and 400 tonnes in 2010–2018, with the exception of 2017 (883 tonnes). This corresponds to less than 1% of the total catch from the EBC stock in these years, with the exception of 2017 where it was 3%. Most catches within this area were taken in subdivisions 27–29, both by active (trawls) and passive (gillnets) gears.

Fishing at *status quo* effort in subdivisions 27–32, corresponding to a total cod catch of 168 tonnes in 2020, is estimated to result in 0.08% lower SSB in 2021 compared to the scenario of zero catch.

Request

Request to ICES:

1) *ICES is requested to estimate the levels of unavoidable by-catches of eastern Baltic cod in fisheries not targeting eastern Baltic cod (such as e.g. pelagic fisheries, flatfish fisheries, small-scale coastal fisheries when not targeting cod, and fisheries targeting western Baltic cod in subdivision 24), where possible broken down by fishery and Member State, respectively in subdivisions 25-32 and subdivision 24. In that respect, ICES is requested to establish different scenarios and estimate their respective effect on the level of unavoidable by-catches: a baseline scenario which assumes unchanged fishing patterns in terms of effort and behaviour in fisheries not targeting eastern Baltic cod; at least one, but preferably several, other scenarios in which by-catches are reduced by e.g. using more selective gears and/or closures. Such scenarios would be particularly important for demersal flatfish fisheries, which traditionally have been mixed fisheries of flatfish and cod.*

2) *ICES is requested to provide more details on the geographical distribution within subdivision 24 of the western and the eastern Baltic cod stock. For example:*
    - *Are there areas or time periods where eastern Baltic cod stock are more abundant which might be suitable for closure to minimise catches. What would be the impact of such closures on the western Baltic cod catches.*

3) *ICES is requested to*
    - *provide data about eastern Baltic cod catches in subdivisions 27-32, where possible by subdivision and fishery.*
    - *quantify the effect on the biomass of the eastern Baltic cod stock if the fishing effort in subdivisions 27-32, ideally broken down by subdivision, remained at status quo levels.*
    - *quantify the impact on the biomass of the eastern stock of a potential effort reallocation to subdivisions 27-32 in case fisheries for the eastern Baltic cod were closed in subdivisions 24-26 but remained open in subdivisions 27-32.*

Elaboration on the advice

Request part 1)

The main challenge for calculating bycatch of cod in “non-targeted fisheries” is to define precisely what “non-cod targeting fisheries” are. In some cases, the target species group can be defined based on gear and mesh size, e.g. the pelagic fisheries for sprat and herring. However, flatfish species are usually caught with the same gears and mesh sizes that are used for targeting cod. This is particularly the case for the demersal trawl fishery, where cod and flatfish were frequently targeted together in a mixed fishery in 2018. In the absence of a bycatch definition, ICES (2019a) investigated the total landings of cod accounted for by trips, where cod made up for different thresholds between 0% and 50% of the landings by trip.

Reported landings data for 2018 were used to investigate the bycatch of EBC in fisheries not targeting cod. Discards are not included in the analysis, because information on discards is not available for all relevant fisheries. Results presented are contingent on the accuracy of the reported landings data.

It is also important to state that the results presented reflect the fishing patterns of 2018, when cod was still a target species, and the fishers had no need to avoid cod in their catches. Limitations imposed on cod fishing may affect the

amount of cod bycatch in mixed fisheries, since targeting cod is no longer allowed. Vessels that used to target cod will likely shift to other targets instead, e.g. flatfish. This may lead to increased cod bycatches in some fisheries compared to 2018, but the magnitude of that increase will depend on which allowed-percentage limit is chosen for cod bycatches in these fisheries and whether additional technical measures are introduced.

The future choice of the allowed threshold level for cod bycatch could create incentives for changing fishing patterns, and as a result, for cod bycatches. For example if the threshold is set high, i.e. allowing for a higher bycatch percentage of cod, this may cause higher total cod bycatches compared to if the threshold was set at a lower level.

In addition, the EBC stock size would likely affect the level of bycatch. It is predicted that the biomass of EBC will decline further in 2020 from the level estimated for 2018 (ICES, 2019b), and this will impact future catches in non-target fisheries in 2020. Up to now, most of the gear trials in the Baltic have focused on selecting for cod. Recent trials have shown that it is possible to reduce catches of cod while maintaining catches of flatfish. It is difficult to predict future uptake of different selective gears in fisheries targeting flatfish in the Baltic.

Request part 2)

There is a significant overlap between cod and flatfish species in the Baltic. Based on 2018 data, it is not possible at present to point out areas within subdivisions 24–26 or months where cod bycatch in flatfish fisheries would be consistently lower, compared to other areas or months when using the same fishing gears.

Information on mixing proportions of eastern and western Baltic cod in Subdivision 24 is based on Danish and German samples, originating from commercial and survey catches. Part of this information is used in the annual stock assessments carried out by ICES.

The analysis of the stock mixing gradient from coastal to offshore waters is based solely on data from Germany. It is assumed that similar proportions of EBC occur in Danish and Swedish coastal waters. It is also assumed that this does not to apply to the coastal waters around Bornholm, due to the proximity of deeper waters; these are dominated by EBC.

The impact of a closure of Subdivision 24 is based on fishing patterns observed in recent years. If there is a reallocation of effort to subdivisions 22–23, this may negatively affect the spawning success of WBC due to disturbance (though the effects on recruitment cannot be quantified).

Request part 3)

The time-series of EBC catches in subdivisions 27–32 were used to show the distribution of catches by subarea. Short-term forecasts were carried out; the latest assessment results were used to investigate the possible effect on the biomass of the EBC stock if the fishing effort in subdivisions 27–32 either remained at *status quo* levels, or was increased in 2020.

Basis of the advice

The EU Commission provided the following background in its request:

Following a special Commission request earlier this year ICES issued special advice 2019.11 on eastern Baltic cod on 29 May 2019. The Commission had notably asked about the level of a possible by-catch TAC for eastern Baltic cod in 2019 but ICES was not in a position to provide a reply given that the relevant catch data was not readily available.

Furthermore, the situation of subdivision 24 where the western and eastern stock mix is of particular interest for the best tailored management measures for 2020 in the context of the annual stock advice issued by ICES on 29 May 2019 for eastern Baltic cod in the areas 24-32.

Finally, in its special advice on eastern Baltic cod ICES stated that eastern Baltic cod abundance and catches in subdivisions 27-32 are very low. It would be very useful to have some further information about eastern Baltic cod abundance and catches, and the effect of a potential effort reallocation in order to well design management measures for 2020.

Results and conclusions

Volume of cod bycaught at different bycatch definitions

Results are presented for five different bycatch definitions (or thresholds), from 10% to 50% of cod in the landings by trip. The results are shown separately for Subdivision 24 (Table 1) and subdivisions 25–32 (Table 2).

In "Active pelagic" trawl fishery targeting small pelagics, as well as in some métiers included in the category "Other", all cod landings could be considered as bycatch. For consistency, the results for these fisheries are also presented for the five different bycatch thresholds, where it is evident that most cod landings in pelagic fisheries fall below the 10% cod threshold.

In Subdivision 24, total cod bycatch for thresholds between 10% and 50% was in the range of 66–417 tonnes. Most of the cod bycatch occurred in Active demersal fishery (30–286 tonnes). In Active pelagic fishery cod bycatch was 18 tonnes, while in the small-scale coastal fishery it was in the range of 11–55 tonnes. Note that the cod landings presented for Subdivision 24 combine the eastern and western Baltic stocks.

In subdivisions 25–32, total cod bycatch for thresholds between 10–50% was in the range of 360–1306 tonnes. As in Subdivision 24, most of the cod bycatch occurred in Active demersal fishery (186–973 tonnes). In Active pelagic fishery the cod bycatch was 175 tonnes, and in the small-scale coastal fishery it was in the range of 7–50 tonnes.

These results show that 14% of cod landings in Subdivision 24 and 10% of cod landings in subdivisions 25–32 were taken in trips having a maximum of 50% cod bycatch in their landings. This implies that most of the cod landings (86% and 90% in Subdivision 24 and subdivisions 25–32) were taken in trips with more than 50% cod in their landings.

Table 1 Bycatch landings (tonnes) of cod in Subdivision 24 in 2018, corresponding to the different thresholds for bycatch definition (0–10%, 0–20%, 0–30%, 0–40%, and 0–50% cod in the landings). The last column shows the total amount of cod landed by the fishery (i.e. including landings with more than 50% cod bycatch).

Area	Fishery	Country	Bycatch threshold of cod landings in trips					
			Max. 10%	Max. 20%	Max. 30%	Max. 40%	Max. 50%	All cod landings
24	Active demersal	DEU	11.2	26.8	43.0	53.4	63.6	181
		DNK	7.3	31.1	55.4	83.3	99.4	996
		FIN	0.5	0.5	0.5	0.5	0.5	0.5
		POL	10.6	22.2	38.6	72.5	121.9	734
		SWE	0	0	0.1	0.3	0.9	237
	Total Active demersal (t)		29.6	80.5	137.5	210.0	286.4	2148
	Coastal small scale	DEU	4.9	9.7	14.6	20.8	28.3	110
		DNK	2.2	4.8	8.4	10.0	14.2	151
		POL	4.2	8.3	10.6	11.3	11.3	14
		SWE	0.1	0.2	0.3	0.4	0.9	43
	Total Coastal small scale (t)		11.3	23.1	33.9	42.5	54.8	318
	Passive, non-coastal	DEU	0.5	2.4	5.5	6.7	9.0	76
		DNK	0	0	0.2	0.4	1.1	59
		POL	5.9	14.7	26.7	39.0	42.8	132
		SWE	0.3	0.6	0.9	1.2	2.1	187
	Total Passive non-coastal (t)		6.7	17.8	33.3	47.3	55.0	454
	Active pelagic	DEU	12.6	12.6	12.7	12.7	12.7	12.7
		DNK	0.3	0.3	0.3	0.3	0.3	0.3
		POL	3.0	3.2	3.3	3.6	3.6	3.6
		SWE	1.0	1.0	1.0	1.0	1.0	1.0
	Total Active pelagic (t)		17.0	17.1	17.3	17.6	17.6	17.6
	Other	DEU	0.5	0.7	0.7	0.8	0.8	0.8
		DNK	0.6	0.7	0.7	0.7	0.7	0.7
		POL	0.0	0.4	2.0	2.2	2.2	6.4

Area	Fishery	Country	Bycatch threshold of cod landings in trips					
			Max. 10%	Max. 20%	Max. 30%	Max. 40%	Max. 50%	All cod landings
	Total Other (t)		1.1	1.8	3.4	3.6	3.7	7.8
	Total cod bycatch (t)		65.6	140.3	225.4	321.0	417.4	2946
	% of total cod landings in 2018		2.2	4.8	7.7	10.9	14.2	100

Table 2 Bycatch landings (tonnes) of cod in subdivisions 25–32 in 2018, corresponding to the different thresholds for bycatch definition (0–10%, 0–20%, 0–30%, 0–40%, and 0–50% cod in the landings). The last column shows the total amount of cod landed by the fishery (i.e. including landings with more than 50% cod bycatch).

Area	Fishery	Country	Bycatch threshold of cod landings in trips					
			Max. 10%	Max. 20%	Max. 30%	Max. 40%	Max. 50%	All cod landings
25–32	Active demersal	DEU	6.3	13.4	37.3	60.9	61.4	245.1
		DNK	20.1	34.0	44.6	72.2	84.3	2569.4
		FIN	4.2	4.2	4.2	4.2	4.2	4.2
		LVA	3.5	17.9	30.4	37.6	51.4	970.5
		LTU	3.6	14.2	36.4	51.4	55.0	590.4
		POL	148.4	287.0	397.1	534.3	716.1	3876.5
		SWE	0.1	0.1	0.1	0.1	0.8	1652.9
	Total Active demersal (t)		186.2	370.8	550.1	760.8	973.2	9909
	Coastal small scale	DEU	0	0.1	0.1	0.2	0.2	0.2
		DNK	0.6	0.9	1.0	1.2	1.6	35.2
		EST	0.4	0.5	0.5	0.5	0.6	0.8
		FIN	0	0	0	0	0	9.8
		LVA	0.1	0.3	0.7	1.2	1.8	39.0
		LTU	0.8	1.1	1.4	1.5	2.8	42.1
		POL	3.9	10.7	16.7	23.0	29.6	462.9
		SWE	1.1	3.2	6.0	7.1	13.2	117.5
	Total Coastal small scale (t)		6.9	16.6	26.5	34.7	49.7	707
	Passive, non-coastal	DNK	0	0	0	0	0	4.9
		FIN	0	0	0	0	0	39.2
		LVA	0	0	0.1	0.1	0.1	54.6
		LTU	0	0	0	0.2	0.2	126.4
		POL	15.9	38.1	58.5	79.7	105.2	1346.1
		SWE	0.4	0.7	0.8	1.1	1.3	131.9
	Total Passive non-coastal (t)		16.4	38.8	59.4	81.0	106.7	1703
	Active pelagic	DEU	1.3	1.3	1.3	1.3	1.3	1.3
		DNK	0.3	0.3	0.3	0.3	0.3	0.3
		FIN	0.4	0.4	0.4	0.4	0.4	0.4
		LVA	8.9	8.9	8.9	8.9	8.9	14.8
		LTU	9.8	9.8	9.8	9.8	9.8	9.8
		POL	120.5	138.2	144.5	144.5	144.5	144.5
		SWE	9.6	9.6	9.6	9.6	9.6	9.6
	Total Active pelagic (t)		151	169	175	175	175	181
	Other	DNK	0	0	0	0	0	8
		POL	0.1	0.1	0.2	1.3	1.3	6
		SWE	0	0	0	0	0	0
	Total Other (t)		0.1	0.1	0.2	1.3	1.3	13.6
	Total cod bycatch (t)		360.4	594.9	811.1	1052.6	1305.8	12513.8
	% of total cod landings in 2018		2.9	4.8	6.5	8.4	10.4	100

Technical strategies to avoid cod catches in Baltic Sea trawl fisheries

Three different strategies to reduce cod bycatches in Baltic flatfish trawl fisheries were examined.

i) Strategy 1: Mechanical size selectivity devices based on morphological differences

The results show that T90 codends of 140 mm mesh size are expected to achieve ~80% and ~100% bycatch reduction of cod; this is above and below MCRS, respectively. This strategy, however, has limitations; it will not, for example, reduce catches of large cod. Undersized plaice is also expected to be reduced by ~80%, while not compromising catches of marketable plaice.

ii) Strategy 2: Selectivity devices based on behavioural differences between flatfish and cod

Two selective devices (STIPED and CODEX) could reduce the catches of cod using behavioural differences between cod and flatfish. Experimental trials showed that the "STIPED" can prevent +90% of cod from entering the codend, while losses of flounder were less than 10%. The larger reduction in catches of plaice (> 50%), however, indicates a potential for further improvement of the device. CODEX is a very recent concept that has not been fully tested to date.

iii) Strategy 3: Selectivity devices that combine strategies 1 and 2

To improve the escapement of cod further, codend selectivity (Strategy 1) and species separation (Strategy 2) could be combined to form Strategy 3. Experimental trials demonstrated that these devices effectively separated cod from flatfish catches, though further investigations are still required.

Effects of spatio-temporal closures on reducing cod bycatch

Cod is caught together with flatfishes in demersal fisheries. In the area of subdivisions 24–32, the main target flatfish species are plaice and flounder. Within this area, plaice is most abundant in Subdivision 24, where close to 70% of the plaice landings were taken in 2018; it also occurs in Subdivision 25. Flounder is distributed in the entire area covered by the bottom trawl survey (subdivisions 24–28). Cod and flounder therefore overlap in the entire distribution area of the EBC stock, whereas plaice and EBC predominantly overlap in subdivisions 24–25.

A large part of the plaice and flounder landings in 2018 were taken with a relatively low bycatch of cod (< 10% cod in landings per trip; ICES, 2019a). At present it is not possible to point out larger areas within subdivisions 24–26, or months, where cod bycatch in flatfish fisheries, when using the same fishing gears, would be consistently lower in comparison to other areas or months. This would require comprehensive analyses, including several years' data, to investigate whether there are spatio-temporal patterns in cod bycatch (when using the same gears) that would be stable between years. There may be areas and months where cod bycatch would be consistently relatively lower, but this has not been thoroughly investigated at present. Considering the spatial overlap between the flatfish and EBC stock, there are no areas within subdivisions 24–26 where flatfish fisheries with non-selective gears could be conducted without a risk of bycatch of cod. It would not be possible, therefore, to design spatio-temporal closures that would avoid any bycatch of cod.

In terms of the spatial distribution of EU flatfish landings, Subdivision 26 has been of relatively little importance in recent years (6% of the EU flounder landings in subdivisions 24–32 were taken in Subdivision 26 in 2018). However, in recent years a large fraction (50% in 2018) of the cod landings in subdivisions 24–32 have been taken in Subdivision 26. Survey information also supports the statement that a substantial part of the EBC stock is distributed in Subdivision 26. A potential closure of Subdivision 26 for demersal fisheries would thus protect a substantial part of the EBC stock, while having limited implications for EU flatfish fisheries.

Possibilities to reduce bycatch of EBC in fisheries targeting WBC in SD24

It is possible to lessen the EBC bycatch in fisheries targeting WBC by reducing the proportion of WBC catches taken in Subdivision 24. EBC occurs throughout Subdivision 24 and in all seasons. Furthermore, a reduction in the fisheries in the eastern and offshore areas (at water depths deeper than 20 m) within Subdivision 24 would lead to reduced bycatch of EBC. There is an east–west gradient in stock mixing, however, with a lower proportion of EBC in the area west of 13°E (on

average 47% EBC in the past 11 years), compared to the area east of 13°E (on average 78% EBC). The proportion of EBC is also lower (on average 27% EBC in waters < 10 m depth) in coastal shallow areas. In terms of gear types, the proportion of EBC is lower in fisheries by passive gears (e.g. gillnets) and higher in active gears (trawls). The latter have taken most of the cod landings (65–75%) in Subdivision 24 in recent years. This is due to passive gears fishing mostly in shallower coastal areas, where the proportion of EBC is lower.

Most (88% on average in the last three years) of the commercial cod landings in Subdivision 24 (EBC + WBC) have historically been taken in the area between 13˚ and 15˚E, i.e. in the area with higher proportions of EBC. Consequently, only 1% of the total landings of EBC in the last ~10 years have been taken in the area between 12˚ and 13˚E (Table 3). Fishing in the area west of 13˚E, therefore, has had limited impacts on the eastern Baltic cod stock.

Table 3 Amount of eastern Baltic cod landings taken in the area west of 13°E, compared to total landings from the EBC stock.

Year	Amount(t) of eastern cod landings in Subdivision 24	Amount (t) of eastern Baltic cod landings west of 13°E	Total landings of eastern Baltic cod (t) in subdivisions 24–32	% of eastern Baltic cod landings taken in the area west of 13°E
2009	8284	677	56722	1.2
2010	6049	647	56325	1.1
2011	7545	668	57913	1.2
2012	8469	527	59694	0.9
2013	5359	430	36714	1.2
2014	5455	618	34364	1.8
2015	5029	552	43108	1.3
2016	4541	289	33854	0.9
2017	2004	111	27500	0.4
2018	2295	224	18202	1.2

Impact of a potential closure of Subdivision 24 for western Baltic cod landings

Approximately half of the total cod landings (EBC + WBC) taken in the management area of Subdivision 22–24 have come from Subdivision 24 in the last three years (ICES, 2019b). Cod landings in Subdivision 24 mainly originated from Denmark and Poland, followed by Sweden and Germany (Figure 1). Most of the total cod landings in Subdivision 24 were taken by demersal trawls in 2018. Cod landings in Subdivision 24 were distributed throughout the year, but landings in August–September and in February–March were relatively lower due to a spawning closure.

A closure of the whole of Subdivision 24 could result in up to 25% loss of WBC commercial landings, with the fishing patterns observed in later years. It is difficult to foresee to what extent effort reallocation to subdivisions 22–23 would be possible for different fleets. The cod TAC at 3806 tonnes for subdivisions 22–24 in 2020 is close to the amount that has been taken in subdivisions 22–23 in later years. It would likely be possible to take the entire TAC of 3806 tonnes in subdivisions 22–23.

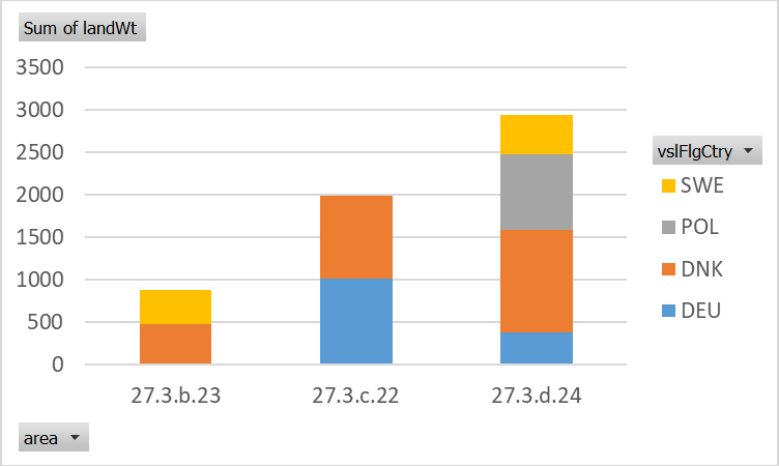

Figure 1 Cod landings (tonnes) in the WBC management area by country and subdivision, in 2018. Data provided to ICES in response to a data call in 2019.

Eastern Baltic cod catches in subdivisions 27–32

EU catches taken in subdivisions 27–32 have contributed less than 1% to the total catch from the EBC stock in 2010–2018, with the exception of 2017, when these areas contributed close to 3% of the total cod catches (Table 4). EBC catches in subdivisions 27–32 have been between 150 and 400 tonnes in recent years (2010–2018), with the exception of 2017 when 883 tonnes were taken in this area. Most of the cod catch within subdivisions 27–32 was taken in subdivisions 27–29. Active and passive gears have contributed to cod landings in varying proportions. In 2018, most of the cod landings in subdivisions 27–32 were taken by gillnets with 110–156 mm mesh size, targeting demersal species.

Table 4 Contribution of catches in subdivisions 27–32 (in %) relative to the total catch of eastern Baltic cod (in subdivisions 24–32).

Year	BAL27	BAL28	BAL29	BAL30	BAL31	BAL32	Total
2010	0.08	0.10	0.08	0.00	0.00	0.00	0.27
2011	0.07	0.15	0.11	0.00	0.00	0.00	0.33
2012	0.04	0.30	0.11	0.00	0.00	0.00	0.45
2013	0.07	0.49	0.16	0.00	0.00	0.01	0.72
2014	0.06	0.56	0.27	0.00	0.00	0.01	0.90
2015	0.07	0.23	0.23	0.00	0.00	0.00	0.54
2016	0.18	0.31	0.40	0.00	0.00	0.00	0.89
2017	0.33	2.21	0.32	0.00	0.00	0.00	2.86
2018	0.20	0.18	0.40	0.00	0.00	0.00	0.78

Effect on the biomass of eastern Baltic cod of fishing at *status quo* level in subdivisions 27–32

The results show little difference in the estimated SSB in 2021 between the two investigated scenarios (Table 5). Applying zero catch in 2020 for the entire EBC stock (Scenario 0) resulted in a 0.08% higher SSB in 2021 compared to *status quo* fishing in subdivisions 27–32 (Scenario 1). The very small difference is due to a very low cod catch amount recorded in subdivisions 27–32 in 2018 (168 tonnes), applied in Scenario 1.

Table 5 Results of the short-term forecast scenarios. Weights are in tonnes.

Scenario	Total catch (2019)	F (2019)	Total catch (2020)	F (2020)	SSB (2019)	SSB (2020)	SSB (2021)
Scenario 0	12754	0.13	0	0	66353	71578	79122
Scenario 1	12754	0.13	168	0.002	66353	71514	79055

Potential impact on the biomass of eastern Baltic cod of increased fisheries in subdivisions 27–32

Survey data can provide a rough proxy for stock distribution, and is in line with the spatial distribution of commercial catch observed in later years, where less than 3% of the total catch of the stock was taken in subdivisions 27–32. Even at the scenario of extreme high fishing effort in subdivisions 27–32, less than 3% of the total biomass of EBC would be removed.

Methods

1) Bycatch of eastern Baltic cod in fisheries not targeting cod

The analyses presented here are based on landings, not on total catches. This is because discards estimates were not available at the aggregation level needed for the analyses presented in this advice. It should also be noted that the amount of cod landings reported for Subdivision 24 are a combination of the eastern and western Baltic stocks; it is not possible to separate these landings by stock at the scale presented in these analyses. The analyses were conducted at trip level for all countries, with the exception of the vessels without logbooks; for these a combination of vessel, month, ICES rectangle, landing location, and métier had to be used instead.

Métiers were grouped into five fisheries; Active pelagic, Active demersal, Passive gears (not included in coastal small-scale), Coastal/small-scale fisheries, and Other.

Table 6 Definitions of fisheries.

Fishery	Definition
Active pelagic	Defined by gear and mesh size. Includes all active gears (trawls and purse seines) targeting pelagic species (sprat and herring).
Active demersal	Demersal trawls targeting cod and flatfish.
Passive gears (not included in coastal small-scale)	Demersal nets and longlines for vessels ≥ 10 m LOA.
Coastal/small-scale fisheries	Demersal nets and lines for vessels < 10 m and all other passive gears regardless of vessel length.
Other *	Gears not included in other categories above, mostly trawls for freshwater species and sandeel.

* Though some of these métiers can also be considered coastal, they were kept separate since the coastal small-scale group was restricted to passive gears.

The cod bycatch in pelagic fisheries as estimated from logbooks compared with samples from the control agency showed an average of 0.10% cod in pelagic fisheries landings. This is, on average, in line with the logbook information.

Information regarding the potential species-selection concepts to avoid/reduce the catch of cod was collected from different national sources and synthesized.

The following were produced to investigate the spatial and temporal patterns in landing and catch: maps with EU landings of cod, flounder, and plaice, by months and rectangle in 2018; catches of cod, flounder, and plaice on the BITS surveys for Q4 in 2017 and Q1 in 2018.

2) Geographical distribution of eastern and western Baltic cod stocks in Subdivision 24

Analyses of both commercial and survey samples show that there is an east–west gradient in the proportion of EBC within Subdivision 24, with the proportion of EBC increasing towards the east. Genetic analyses have shown that the proportion of EBC increases in the area around 13°E (Hemmer-Hansen *et al*., 2019; Weist *et al*., 2019).

This was confirmed by otolith shape analyses that showed a higher proportion of EBC in areas east of 13°E within Subdivision 24, compared to the area between 12° and 13°E (Figure 2). For simplicity, when calculating mixing proportions in commercial catches of EBC and WBC, ICES uses two subareas (Area 1 and 2) within Subdivision 24 that are separated at 13°E (Figure 2).

Based on the otolith shape analyses of commercial catch samples, used in ICES stock assessment, most cod caught in the area east of 13°E (Area 2 in Figure 2) were assigned to the EBC stock (78% on average in the last 11 years). In the area between 12° and 13°E (Area 1), slightly less than half of the cod, on average, were assigned to the EBC stock (47% in the last 11 years). The proportion of eastern Baltic cod may be lower close to the border of Subdivision 22; the data available, however, do not allow mixing proportions to be quantified at a finer spatial scale at present.

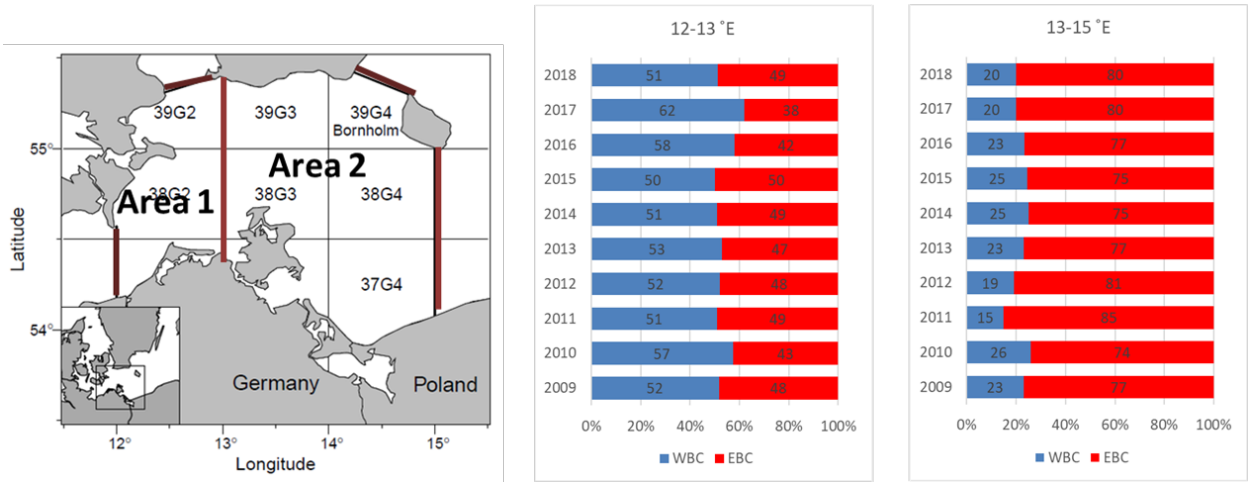

Figure 2 Proportion (%) of EBC (in red) and WBC (in blue) in Subdivision 24 from commercial samples, shown separately for two subareas, i.e. west (Area 1, 12–13°E) and east (Area 2, 13–15°E) (from ICES, 2019b). Stock assignment is based on otolith shape analysis.

The estimated mixing proportions based on survey samples in Subdivision 24 are generally in line with the presented estimates based on commercial catch samples. This is despite some differences in size distribution of cod between commercial catch and surveys, as the survey catches generally contain smaller individuals.

Seasonal and spatial variation in stock mixing

Seasonal variations in mixing proportions have been investigated based on data from Danish commercial samples (Hüssy *et al*., 2016), and from scientific survey samples from the German BITS. In the commercial samples, stock mixing proportions varied over the seasons for all analyzed years, but no consistent seasonal pattern was evident. Consequently, samples from all quarters were pooled in the analyses of mixing proportions for stock assessment purposes.

The comparison of mixing proportions based on samples from BITS in the 1st and 4th quarter from selected years, between 1995 and 2016, did not show significant differences (1% to 10% deviation between quarters within the same year).

The proportion of EBC also decreased towards the (German) coast, and towards shallower waters. This may also be the case for other coastal areas of Subdivision 24, however probably not around Bornholm.

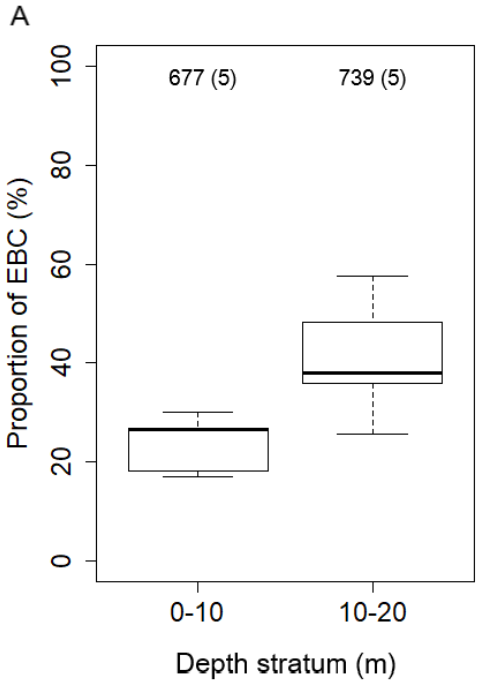

Figure 3 Proportion of EBC in Subdivision 24, based on commercial samples from passive gear fisheries in German waters, grouped by different depth strata. The box represents the interquartile range (IQR) with the median and the 1st and 3rd quantiles at the bottom and top of the box, respectively. Lower and upper whiskers are restricted to 1.5 × IQR. Numbers on top of each box plot correspond to the numbers of analysed otoliths and in brackets the numbers of sampled hauls. Stock assignment is based on otolith shape analysis.

To calculate the bycatch of EBC in fisheries targeting WBC, the TAC for the management area was multiplied by the proportion of that taken in Subdivision 24 (0.53 in the last three years) and the proportion of cod in Subdivision 24 that belongs to the EBC stock (0.74 in the last three years).

3) Eastern Baltic cod catches in subdivisions 27–32

The time-series of catches in subdivisions 27–32 shown in this document are based on the data provided to the ICES Baltic Fisheries Assessment Working Group (WGBFAS). This information is available by Active (e.g. trawls) and Passive (e.g. gillnets) gears. More specific information on the métiers contributing to the landings in subdivisions 27–32 was available for 2018, from ICES Regional Database (RDB) https://www.ices.dk/marine-data/data-portals/Pages/RDB-FishFrame.aspx.

To quantify the impact on cod biomass of continued fishing in subdivisions 27–32 at *status quo* level, two short-term forecast scenarios were run. The two scenarios differed in terms of the catch amount applied for 2020. In the baseline scenario (Scenario 0), catch from the entire eastern Baltic cod stock was set to zero in 2020. The results from Scenario 0 were compared to the scenario of *status quo* fishing effort in subdivisions 27–32 in 2020 (Scenario 1).

It is not possible to reliably quantify how much the cod catches in subdivisions 27–32 could potentially increase as a result of effort reallocation to these areas. For this reason, maximum possible impact on the eastern Baltic cod biomass was evaluated, under an extreme scenario of fishing effort. The maximum impact on the cod stock that is theoretically possible would be eradication of the fraction of the stock distributed in subdivisions 27–32. It is unrealistic that a commercial fishery could remove all cod present in this area. Thus, the total impact on the stock biomass would likely correspond to less than the fraction of the stock that is present in this area.

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