ICES
CIEM

EU request on emergency measures to prevent bycatch of common dolphin (*Delphinus delphis*) and Baltic Proper harbour porpoise (*Phocoena phocoena*) in the Northeast Atlantic

Advice summary

ICES concluded that the proposed measures by NGOs for both the common dolphin (*Delphinus delphis*) in the Bay of Biscay and the Baltic Proper harbour porpoise (*Phocoena phocoena*) are appropriate to reduce the bycatch. However, several spatio-temporal and technical amendments are recommended.

ICES advises, for the common dolphin in the Bay of Biscay, a combination of temporal closures of all métiers of concern and application of pingers on pair trawlers to mitigate bycatch outside of the period of closure. For the Baltic Proper harbour porpoise, ICES advises a combination of spatial-temporal closures and application of pingers in static nets (i.e. trammelnet, gillnet, and semi-driftnet) fisheries.

If the Baltic Proper harbour porpoise management unit is to meet the management objective of achieving bycatches below the potential biological removal (PBR) limit (< 0.7 individuals per year), all fisheries of concern should be closed. ICES notes that it remains uncertain whether this management unit constitutes a population or a subpopulation.

ICES notes ongoing issues with data availability and quality, contributing to high levels of uncertainty in the estimation of population abundance, distribution, bycatch, and other major threats for small cetaceans. Notably, observer coverage is well below 1% of the total effort in most fisheries. ICES recommends enhanced monitoring to assess the effectiveness of management measures and to augment precision in population abundance and bycatch mortality estimates of common dolphin in the Bay of Biscay and of the Baltic Proper harbour porpoise.

ICES further advises that protection measures, considering the life history of small cetaceans, can only be effective when applied for a longer period of time. ICES advice addresses not only the emergency measures, but also considers long-term measures.

ICES notes that conservation objectives set out under relevant EU legislation need to be defined more quantitatively. Furthermore, many EU Member States have not yet established baselines or reference levels for population abundance or pressures, such as bycatch, against which the status of the species can be assessed under the EU Habitats Directive and the Marine Strategy Framework Directive (MSFD). ICES therefore reiterates its previous advice that it is willing to assist competent authorities to establish limits for anthropogenic mortality, against which human impacts can be assessed.

Reporting for the Habitats Directive in 2019, Northeast Atlantic common dolphins were classified by EU Member States as either "unknown" or "unfavourable-inadequate" under Article 17, with only one EU Member State reporting its status as "favourable" within their national waters. All EU Member State assessments and the EU biogeographical assessment of conservation status of harbour porpoise in the Baltic Marine Region classified the status of the Baltic Proper porpoise as "unfavourable-bad" for the three consecutive assessments under Article 17.

Bycatch, anthropogenic pollution, and underwater noise are the major threats to the Baltic Proper harbour porpoise, and bycatch is the major threat to the common dolphin in the Northeast Atlantic. Potential impacts from resource/prey depletion on the population requires further assessment. The population-level consequences of some of the major threats on the species of concern, independently and in combination, are not fully understood. Thus, this level of uncertainty needs to be taken into consideration when applying anthropogenic mortality limits.

Request

DGMARE Special request to ICES:

Concerning common dolphin in the Bay of Biscay and harbour porpoise in the Baltic Sea, ICES is requested, on the basis of material provided in Annexes 1 and 2[*] and any other available relevant information, to:

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[*] Available as annexes 11 and 12 in ICES. 2020.

- *Step 1:*
  - *review the current conservation status and threats to the populations, including the threat due to commercial fisheries by-catches, taking account of any further relevant information, including the new material provided in Annexes 1 and 2.*
  - *evaluate whether the measures described in Sections 3.1, 3.1.1 and 3.1.2 of Annex 1 (for common dolphin the Bay of Biscay) and Sections 3.1, 3.1.1, and 3.1.2 of Annex 2 (for harbour porpoise in the Baltic Sea) are necessary and appropriate, in the context of EU law, in particular Articles 2 and 12 of Regulation (EU) 1380/2013; Article 3(2) of Regulation (EU) 1241/2019 and Article 1(i) of Council Directive 92/43/EEC.*

- *Step 2: if evaluated measures are deemed inappropriate, to advise on any alternative measure that could be used to ensure a satisfactory conservation status of these stocks, in the context of EU law as above.*

- *The latest ICES advice available on dolphins in the Bay of Biscay and to protect harbour porpoises in the Baltic Sea http://www.ices.dk/sites/pub/Publication%20Reports/Advice/2019/2019/byc.eu.pdf is limited to an analysis of data reported by Member States until 31.12.2017, while the Commission would require data until March 2019.*

Elaboration on the advice

Considering the life history of small cetaceans, any protection measures can only be effective when applied continuously for a long period of time. Emergency measures implemented under Article 12 of the Regulation (EU) 1380/2013 (EU, 2013) can be applied only for six months, with the possibility of extension for a further six months. Therefore, it is advised that emergency measures should be considered as a transition toward longer-term measures if any positive effects on small cetaceans are to be achieved. ICES considers the longer-term perspective of management measures in the current advice.

Common dolphin in the Bay of Biscay

Under Article 17 of the Habitats Directive (EU, 1992), EU Member States (MS) are required to report on the conservation status of listed species (and habitats). As the species is transboundary, assessments by MS should be undertaken at the population level rather than nationally, or at least at the range of the Marine Atlantic bioregion. The provisional overall assessment for 2019 reported the species in the Marine Atlantic bioregion as "unknown", although this may be subject to change based on recent consultation responses.

Little is known on the current conservation status of common dolphin in the Bay of Biscay as the abundance and the level of mortality are uncertain, and no anthropogenic mortality (or bycatch) limits have been defined for this species in the Northeast Atlantic. The results from several surveys suggest an increase in common dolphin abundance over recent years in the Northeast Atlantic. However, this increase is very likely the result of an influx of dolphins into the Bay of Biscay, potentially from oceanic/southern waters, rather than a population increase *per se*.

Despite the larger abundance estimates for the species in continental shelf and adjacent waters, many MS still classified the overall conservation status of the species as either "unknown" or "unfavourable-inadequate". Only one MS reported its status as "favourable" in the most recent Article 17 under the Habitats Directive. ICES notes that threats and pressures on the species are also reported by MS during this process, and that bycatch is cited as the main pressure on this species.

ICES has previously reviewed pressures and threats to marine mammal species on a regional basis (ICES, 2019a). Based on threat matrices developed for different marine mammal species in each ecoregion, ICES concluded that threat levels for common dolphin was high for bycatch in the Bay of Biscay. Polychlorinated biphenyls (PCBs) have been shown to negatively affect reproduction in common dolphins (Murphy *et al*., 2018), and cases of reproductive failure have been reported that may be linked to the exposure of these endocrine-disrupting chemicals.

The population-level consequences of some of the major threats on the Northeast Atlantic common dolphin are still not fully understood independently, let alone their combined effects. Thus, this level of uncertainty as well as the possible independent and cumulative effects of multiple stressors on the populations, it needs to be taken into consideration when applying anthropogenic mortality limits.

ICES has evaluated the measures proposed by NGOs, which can be found in Table 1 below.

Table 1   Measures proposed by NGOs for the common dolphin in the Bay of Biscay and ICES evaluation of those measures.

Measures proposed by NGOs		ICES evaluation
1.1	Close the responsible fisheries in the Northeast Atlantic between December 2019 and March 2020 (*ad minima* pair trawls and gillnet fisheries)	ICES considers that the closure of the fisheries of concern for the common dolphin bycatch in the Northeast Atlantic (from December to March) should significantly reduce bycatch of common dolphins; however, variants to the proposed measure were explored (Table 2). Fisheries of concern were identified as those with any bycatch of common dolphins, recorded by onboard observers from 2016 to 2018 in ICES subareas 6, 7, 8, and 9, and with gear types PTM, PTB, OTM, OTB, OTT, GNS, GTR, and PS*. ICES WKEMBYC (ICES, 2020) established that in the Northeast Atlantic most of the bycatch of common dolphins occurred in the Bay of Biscay and Iberian Coast ecoregion (subareas 8 and 9), rather than in the Celtic Seas ecoregion (subareas 6 and 7).
1.2	Monitoring + dynamic closures	ICES states that lack of information currently prevents assessment of the feasibility of the approach and its potential efficiency in terms of bycatch reduction. The implementation of adequate monitoring and allowing real-time decisions to be made is challenging; until this can be achieved, there is little feasibility of dynamic closures happening across all relevant métiers.
2.1	Technical measures: - daylight fishing - move-on procedure	ICES does not currently have sufficient information to evaluate the suitability of these proposed measures, due to limited scientific literature for the species concerned.
2.2	Dedicated bycatch observers and/or electronic monitoring should be undertaken on all fleets that may be involved in common dolphin bycatch in the region year-round. Fishing vessels should only fish in the region if they allow independent observations to be undertaken on board.	ICES agrees that dedicated marine mammal bycatch observers or remote electronic monitoring (REM) programmes should be prioritized in métiers with identified risk of bycatch of common dolphin. Such pilot projects should be established to compliment at-sea sampling programmes under EU-MAP. It was also suggested that participation in the monitoring programme should be compulsory under vessel licensing systems. However, ICES noted the requirement within EU-MAP for EU Member States to ensure that data collectors (e.g observers) have access to all vessels, and that the masters of EU fishing vessels must accept onboard scientific observers and cooperate with them. However, given the size of the fleets involved, ICES recognized that complete coverage by observers or REM presents logistical and financial challenges, and 100% coverage is not necessary to collect data for robust bycatch estimation.

*See https://vocab.ices.dk/?ref=1498 for a description of the gears.

Proposed alternative measures

Of the fifteen scenarios tested (see "Basis of the advice", Table 6, and results in Table 8), ICES identified emergency measures alternative to those proposed by the NGOs to meet the four tested management objectives proposed by ICES.

ICES used the potential biological removal (PBR) algorithm to estimate the level of anthropogenic mortality that should allow the population to be maintained at or above 50% of the carrying capacity 95% of the time. This was used as a quantitative interpretation ("a management objective") to ensure the "long-term viability" (EU, 2017) of the population and as a means to measure the limit to mortality that might threaten the conservation status of the species (EU, 2019). Given the uncertainties around the bycatch and common dolphin abundance data, ICES also used three alternative limits for anthropogenic mortality: less than 75% of PBR, less than 50% of PBR, and less than 10% of PBR. Reducing bycatch to less than 10% of PBR was used as a quantitative interpretation of what "minimise and where possible eliminate" (EU, 2019) might mean, while acknowledging that this may be insufficient to meet the requirements of strict protection under Council Directive 92/43/EEC (EU, 1992). The development of these management objectives was necessary to enable a quantitative interpretation of the EU legislation, but they may be legally insufficient to meet the legislative requirements. These management objectives may also not enable the ASCOBANS objective of maintaining small cetacean populations at 80% of carrying capacity (K). However, these management objectives are used to identify alternative measures for each objective (Table 2).

    a) to reduce annual common dolphin mortality to the potential biological removal (PBR) limit, the following measures should meet this objective (Table 8).
        1. (E) 4-week closure for all métiers (mid-Jan.–mid-Feb.)
        2. (B) Annual fishing effort reduction of 40% in métiers of concern

3. (J) Pinger PTM/PTB year round + 2-week closure (mid-Jan.–end of Jan.) all other fisheries

The main risk associated with this objective is that it may not take sufficient account of the uncertainty around bycatch estimates, i.e bycatch estimates are assumed accurate and the wide confidence intervals around estimates are not taken into account.

The success of the above measures is dependent on fishing effort being reduced and not redistributed and is sensitive to: the uncertainties around bycatch estimates (all scenarios); timing of the peak dolphin mortality (scenarios J, E); pingers in both PTM and PTB achieve at least 65% bycatch reduction; enforcement of correct pinger use is in place; pinger performance is validated (scenario J); and emergency measures can be extended to one year (scenario B).

   b)   to reduce annual common dolphin mortality to less than 75% of the PBR, the following measures should meet this objective (Table 8).
        1. (G) Pinger PTM / PTB all year and 6-week closure for all other métiers of concern (mid-Jan.–end of Feb.)
        2. (I) Pinger PTM/PTB year-round and 4-week closure of all other métiers of concern (mid-Jan.–mid-Feb.)
        3. (D) 6-week closure (mid-Jan.–end of Feb.) for all métiers of concern

The main risk associated with this objective is that it may not take sufficient account of the uncertainty around bycatch estimates, i.e bycatch estimates are assumed accurate and the wide confidence intervals around estimates are not taken into account.

The success of the above measures is dependent on fishing effort being reduced and not redistributed and is senstive to: uncertainties around bycatch estimates; timing of the peak dolphin mortality (all scenarios); pingers in both PTM and PTB achieve at least 65% bycatch reduction; enforcement of correct pinger use is in place; and pinger performance is validated (scenarios I, G).

   c)   to reduce annual common dolphin mortality to less than 50% of PBR the following measures should meet this objective:
        1)   (L) Two-month closure in the Bay of Biscay from mid-January until mid-March for all métiers of concern + pinger PTB / PTM rest of the year
        2)   (C) Two-month closure in the Bay of Biscay from mid-January until mid-March for all métiers of concern
        3)   (H) Six-week closure (mid-Jan.–end of Feb.) for all métiers of concern and pinger PTM / PTB the rest of the year

This management objective is more precautionary, allowing for large uncertainty evident around the bycatch estimates from strandings and at-sea monitoring data.

The success of the above measures is dependent on fishing effort being reduced and not redistributed and is sensitive to: pingers in both PTM and PTB achieve at least 65% bycatch reduction or more; enforcement of correct pinger use is in place; and pinger performance is validated (scenarios H, L). The measures under scenarios L and C are less sensitive to variation in the timing of the peak dolphin mortality due to longer closures.

   d)   to reduce the annual common dolphin mortality below 10% of the PBR, the following measures scenarios should meet this objective (Table 8).

        1. (M) 4-month closure (December–March) for all métiers + pinger PTM / PTB the rest of the year
        2. (N) 3-month (Jan.–Mar.) + 1-month (mid-July–mid-Aug.) closure of all métiers + pinger PTB / PTM the rest of the year
        3. (O) 3-month (Jan.–Mar.) + 1-month (mid-July–mid-Aug.) closure of all métiers

The success of the above measures is dependent on fishing effort being reduced and not redistributed and is senstive to: pingers in both PTM and PTB achieve at least 65% bycatch reduction; enforcement of correct pinger use is in place; and pinger performance is validated (scenarios M, N).

Table 2   Proposed scenarios for the four tested management objectives, and evaluation of associated risks, for the common dolphin in ICES Subarea 8. For further information on performance of scenarios, please see Table 8. Risk levels in relation to missing the peak in mortality – very high for 2-week closure, high for 4-week closure, medium for 6-week closure, and low for 2-month or longer closure.

(Scenario) measures that meet the objective	Expected outcome	Relative risk of not achieving the objective	Comments on the scenario risk
Management objective: PBR			
(J) – Pinger PTM/PTB year round + 2-week closure of all other fisheries	Bycatch reduction 36%. Efficiency score of 9.7 achieved.	Very high	Very short-term 2-week closure risks missing the peak in mortalities, which is shown to vary annualy in the strandings data. Timing is linked to the distribution of common dolphins. This approach enables the pinger trials already begun in the French PTM fleet to continue to verify effectiveness.
(E) – 4-week closure of all métiers (mid-Jan.–mid-Feb.)	Bycatch reduction 40%. Efficiency score of 5.2 achieved.	High	4-week closure is still relatively short and could miss the peak in mortalities. Does not rely on pinger deployment.Lost opportunity to continue the pinger trials already begun in the French PTM fleet to continue to verify effectiveness during peak winter months.
(B) – Annual fishing effort reduction of 40% in métiers of concern	Bycatch reduction 40%. Efficiency score of 1 achieved.	High	Does not rely on pinger deployment. Lost opportunity to continue the pinger trials already begun in the French PTM fleet to continue to verify effectiveness during peak winter months.
Management objective: <75% of PBR			
(I) – Pinger PTM/PTB year-round and 4-week closure of all other métiers of concern (mid-Jan.–mid-Feb.)	Bycatch reduction 48%. Efficiency score of 6.5 achieved.	High	Closure achieves the greatest proportion of the bycatch reduction, but 4-week closure is still relatively short and could miss the peak in mortalities. This approach enables the pinger trials already begun in the French PTM fleet to continue to verify effectiveness.
(G) – Pinger PTM / PTB all year and 6-week closure of all other métiers of concern (mid-Jan.–end of Feb.)	Bycatch reduction 60%. Efficiency score of 5.4 achieved	Medium	Closure achieves the greatest proportion of the bycatch reduction and a 6-week closure more likely to capture the peak in mortalities. This approach enables the pinger trials already begun in the French PTM fleet to continue to verify effectiveness.
(D) – 6-week closure (mid-Jan.–end of Feb.) of all métiers of concern	Bycatch reduction 58% Efficiency score of 5 achieved	Medium	Closure achieves the greatest proportion of the bycatch reduction and a 6-week closure more likely to capture the peak in mortalities. Does not rely on pinger deployment. Lost opportunity to continue the pinger trials already begun in the French PTM fleet to continue to verify effectiveness during peak winter months.
Management objective: <50% of PBR			
(H) – 6-week closure (mid-Jan.–end of Feb.) of all métiers and pingers on PTB and PTM gears for the rest of the year	Achieves 66% bycatch reduction. Efficiency score of 5.5 achieved.	Medium	Closure achieves the greatest proportion of the bycatch reduction and a 6-week closure more likely to capture the peak in mortalities. This approach enables the pinger trials already begun in the French PTM fleet to continue to verify effectiveness.
(L) – 2-month closure (mid-Jan.–mid-March) of all métiers and pingers on PTB and PTM gears for the rest of the year	Achieves 79% bycatch reduction. Efficiency score of 4.8 achieved.	Low	Longer-term closure that would cover the peak mortality. This approach enables the pinger trials already begun in the French PTM fleet to continue to verify effectiveness.
(C) – 2-month closure (mid-Jan.–mid-March) of all métiers	Achieves 74% bycatch reduction. Performance score of 4.4 achieved.	Low	Longer-term closure that would cover the peak mortality. Does not rely on pinger deployment. Lost opportunity to continue the pinger trials already begun in the French PTM fleet to continue to verify effectiveness during peak winter months.

Management objective: <10% of PBR			
(N) – 3-month (Jan.–March) and 1-month (mid-July–mid-Aug.) closure of all métiers and pingers on PTB and PTM gears for the rest of the year	Achieves 90% bycatch reduction. Efficiency score of 2.7 achieved.	Medium	Risk around the timing of the shorter second closure. This approach enables the pinger trials already begun in the French PTM fleet to continue to verify effectiveness. This scenario does not reduce the bycatch estimate based on strandings to 10% of PBR.
(O) – 3-month (Jan.–March) + 1-month (mid-July–mid-Aug.) closure of all métiers	Achieves 88% bycatch reduction. Efficiency score of 2.6 achieved.	Medium	Risk around the timing of the shorter second closure. Does not rely on pinger deployment. Lost opportunity to continue the pinger trials already begun in the French PTM fleet to continue to verify effectiveness during peak winter months. This scenario does not reduce the bycatch estimate based on strandings to 10% of PBR.
(M) – 4-month closure of all métiers and pingers on PTM / PTB gears for the rest of the year	Achieves 89% bycatch reduction Efficiency score of 2.7 achieved.	Low	Longer term closure that would cover the peak mortality. This approach enables the pinger trials already begun in the French PTM fleet to continue to verify effectiveness. This scenario does not reduce the bycatch estimate based on strandings to 10% of PBR.

It is important to note that in all proposed scenarios it is assumed that fishing effort in métiers of concern is not redistributed. Furthermore, all scenarios would imply large reductions in fishing effort for some fleets fishing in ICES Subarea 8. ICES has not evaluated the consequences of such reductions, neither in terms of potential effort redistribution towards other gears nor in terms of socio-economic impacts.

Harbour porpoise in the Baltic Sea

In the present advice, the term population is used to refer to the Baltic Proper harbour porpoise. ICES notes that it remains uncertain whether this group constitutes a population or a subpopulation; there are, however, significant genetic differences between the Belt Sea and the Baltic Proper harbour porpoises. Thus, the Baltic Proper harbour porpoise should be managed as a separate management unit (Wiemann *et al*., 2010; Lah *et al*., 2016; NAMMCO–IMR, 2019).

The Baltic Proper harbour porpoise is listed as Critically Endangered (CR) by IUCN and HELCOM (Hammond *et al*., 2008; HELCOM, 2013). All EU Member State assessments and the EU biogeographical assessment of the conservation status of the harbour porpoise in the Baltic Marine Region have been assessed as "unfavourable-bad" for the last three consecutive assessments under Article 17, reporting for the Habitats Directive (since 2001). ASCOBANS considers that "the Baltic subpopulation of the harbour porpoise is of particular concern". HELCOM is "deeply concerned about the population status of harbour porpoise in the Baltic Sea" and "convinced that the critical status of harbour porpoises in the Baltic Sea calls for immediate actions in order to safeguard their survival" (HELCOM, 2013).

In the latest threat matrix developed by ICES WGMME (ICES, 2019a), threat levels for the Baltic Proper harbour porpoise were considered high (evidence or strong likelihood of negative population effects, mediated through effects on individual mortality, health, and/or reproduction) for bycatch, contaminants, and three impulsive underwater noise sources.

ICES has evaluated measures proposed by NGOs (idependently but not in combination) which can be found in Table 3 below.

Table 3   Measures proposed by NGOs for the Baltic Proper harbour porpoise and ICES evaluation of those measures.

	Measures proposed by NGOs	ICES evaluation
1.a	Closure of the Northern Midsea Bank for all fisheries	ICES agrees that fisheries closure will ensure no bycatch in this area, which has the highest detection rates of Baltic Proper porpoise year-round, with peaks during the breeding season. An amendment is proposed that focuses on fisheries of concern (Table 4).
1.b	Closure of gillnet fisheries in the rest of the Natura 2000 area "Hoburgs bank och Midsjöbankarna" (SE0330308) as well as in all other Natura 2000 areas east of 13.5°E, where the harbour porpoise is listed as present, until site-specific assessments has been carried out for the impact of use of Acosutic Deterret Devices (ADDs)	ICES considers that these areas form a mosaic of often small and spatially disjointed sites with variable bycatch risk and detection rates of Baltic Proper porpoise at different times of the year. ICES concludes that the proposed measure may allow for large displacements of fishing effort and increased bycatch risk in neighbouring, unprotected waters. An amendment is proposed that refocuses the closure of gillnet fisheries in a single large cluster of sites, where detection rates of harbour porpoises are high (Table 4).
2.a	Mandatory use of ADDs in all commercial gillnet fisheries outside Natura 2000 areas	ICES considers that the bycatch in the Baltic will be reduced significantly since pingers have been shown to reduce bycatch rates in static nets by 50–80% in operational fisheries compared to nets without pingers (Orphanides and Palka, 2013).
2.b	Accurate recording of fishing effort and gear type used	ICES agrees that robust data on fishing effort and gear type are essential for estimating the bycatch risk and evaluating the effectiveness of any mitigation measures.
2.c	Dedicated electronic monitoring of all gillnet vessels in the region	ICES considers that 100% coverage of gillnet fishing effort is ambitious, and that given the small population size of Baltic Proper porpoise, the rarity of bycatch events, and important resources required to achieve monitoring on all gillnets, there may be other, more critical data gaps to address in the short term (see Suggestions and Table 5).
2.d	Monitoring and adaptive management/mitigation measures of gillnet fisheries	ICES considers that bycatch monitoring is not sufficient to support the development and timely implementation of appropriate adaptive mitigation measures (see Suggestions and Table 5).

To immediately reduce bycatch of harbour porpoise, a set of five measures are recommended (Table 4). Static nets (trammelnets, gillnets, and semi-driftnets) are gears with considerably higher bycatch risk for porpoise than other gear types (ICES, 2020). Therefore, only measures on static nets have been recommended.

Within the seasonal distribution range of the Baltic Proper harbour porpoise, it is recommended that pingers are used outside those Natura 2000 sites and including one unprotected area, where harbour porpoise is listed as present. It is also recommended to use pingers within two Natura 2000 sites, and part of one Natura 2000 site, that have low or potentially low occurrence of Baltic Proper harbour porpoise. In the remaining Natura 2000 sites and in an additional area, there is evidence of higher probability of detection of Baltic Proper porpoise. In these areas, closure of static-net fisheries is recommended rather than the use of pingers. The rationale for this is that pingers have been shown to reduce the bycatch rate of harbour porpoise by 50–80% in operational fisheries with static nets, in comparison to nets without pingers (Orphanides and Palka, 2013). There are also concerns about habituation over time, and a reduced foraging efficiency of deterred porpoises (Beest *et al.*, 2017; Dawson *et al.*, 2013; Kindt-Larsen *et al.*, 2019; Kyhn *et al.*, 2015).

For the Baltic Proper harbour porpoise management unit, to meet the management objective of achieving bycatches below PBR (< 0.7 individuals per year), all fisheries of concern should be closed..

ICES notes that enhanced monitoring is required to assess the effectiveness of management measures and to augment precision in population abundance and bycatch mortality estimates. Relevant recommendations are provided in Table 5.

Table 4 A set of five bycatch mitigation measures that, if implemented as a whole, is expected to reduce bycatch risk of Baltic Proper harbour porpoise. Note that where pingers are recommended as a bycatch reduction measure, the expectation is that only pingers which have been thoroughly tested and demonstrated to unambiguously reduce bycatch rates of harbour porpoise should be used.

	Measure	Rationale
1	Closure of the Northern Midsea Bank (Figure 1) to all fisheries, with the exception of passive gears proven not to bycatch harbour porpoise (this includes pots, traps, and longlines, but excludes static nets equipped with pingers or other acoustic devices). The Northern Midsea Bank is defined here as the area delimited within the following coordinates: NW: 56.241°N, 17.042°E SW: 56.022°N, 17.202°E NE: 56.380°N, 17.675°E SE: 56.145°N, 17.710°E	Core area for the Baltic Proper harbour porpoise during breeding season and also used to a high extent during winter.
2a	Closure of the Natura 2000 site "Hoburgs bank och Midsjöbankarna" (SE0330308, Figure 1) for fishing with static nets.	High-density area for Baltic Proper harbour porpoise and designated site for their protection. The site encompasses a large proportion of the population in summer (May–October) and is used to a high extent during winter (November–April). The measure is intended to ensure that fishing effort from métiers of concern is removed.
2b	Closure of the Southern Midsea Bank for fishing with static nets. The Southern Midsea Bank (Figure 1) is defined here as the Swedish part of the Southern Midsea Bank, covering all waters between the Natura 2000 site "Hoburgs bank och Midsjöbankarna" (SE0330308) and the Swedish–Polish border. Polish waters are delimited as the area within the following coordinates (Figure 1): SW: 55.377°N, 16.589°E SE: 55.466°N, 17.538°E NE: 55.797°N, 18.037°E	Important habitat to the Baltic Proper harbour porpoise in May–October, especially during the breeding season, and is used to a high extent during winter (November–April). The measure is intended to ensure that fishing effort from métiers of concern is removed.
3	Closure of the Natura 2000 sites Adlergrund (DE1251301), Westliche Rönnebank (DE1249301), Pommersche Bucht mit Oderbank (DE1652301), Greifswalder Boddenrandschwelle und Teile der Pommerschen Bucht (DE1749302), Ostoja na Zatoce Pomorskiej (PLH990002), Wolin i Uznam (PLH320019), and the SPA site Pommersche Bucht (DE1552401) (Figure 2) for fishing with static nets during November–January.	Together, these smaller sites form a larger cluster (approximately 5,000 km^2) of designated Natura 2000 site with Baltic Proper harbour porpoises being (occasionally) present during some winter months.
4	Obligatory use of pingers on static nets in the area west of the sandbank Ryf Mew within the Zatoka Pucka i Półwysep Helski Natura 2000 site (PLH220032), with the concurrent closure of static net fisheries in the area east of the sandbank Ryf Mew within the Zatoka Pucka i Półwysep Helski Natura 2000 site (Figure 3).	The area had 18 bycatches of harbour porpoise between 1990 and 1999. The area is only used by Baltic Proper harbour porpoise that are regulary present in the area. It is important that both measures are implemented simultaneously.
5	Prohibit the use of static nets without the simultaneous use of pingers during May–October in EU waters between the southwestern management border, proposed by Carlén *et al.* (2018) (a line drawn between the island of Hanö, Sweden, and Jarosławiec near Słupsk, Poland) and a line drawn between 60.5°N at the Swedish coast and 61°N at the Finnish coast; and during November–April in EU waters between a line drawn along east of longitude 13°E between the Swedish and German coasts, and a line drawn between 60.5°N at the Swedish coast and 61°N at the Finnish coast (Figure 1), with the exception of Natura 2000 sites and other areas, where static net fisheries have been closed.	The seasonal areas reflect the current best knowledge of the seasonal distribution of the Baltic Proper harbour porpoise. Static nets are the gear type with the highest bycatch numbers in these areas and represent a large proportion of the fleet.

Table 5 Monitoring measures recommended for the Baltic Porper harbour porpoise.

|	Measure	Rationale
1	Accurate spatio-temporal recording of fishing effort (in appropriate metrics on métiers used by all vessels)	Detailed information on fishing effort to estimate bycatch, evaluate the temporal and spatial distribution risk of bycatch for different métiers, and to evaluate the effectiveness of implemented bycatch mitigation measures.
2	Increased dedicated monitoring of bycatch of PETS	Ensure representative recording of bycatch events.
3	Monitoring of harbour porpoise occurrence	Ensure operational data availability on detection rates of harbour porpoise in key habitats in response to the implementation of pinger use.
4	Compliance control of mitigation measures (pinger use)	Ensure the use and functionality of acoustic deterrence devices.
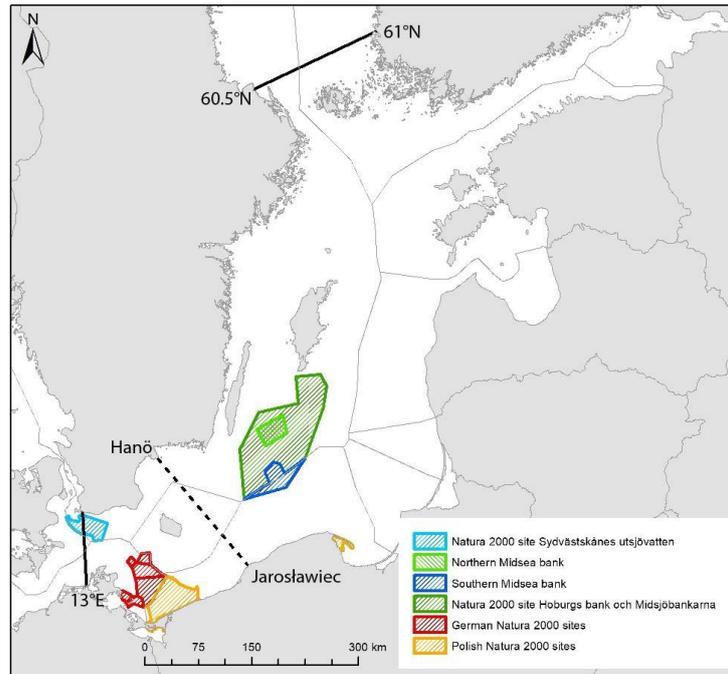
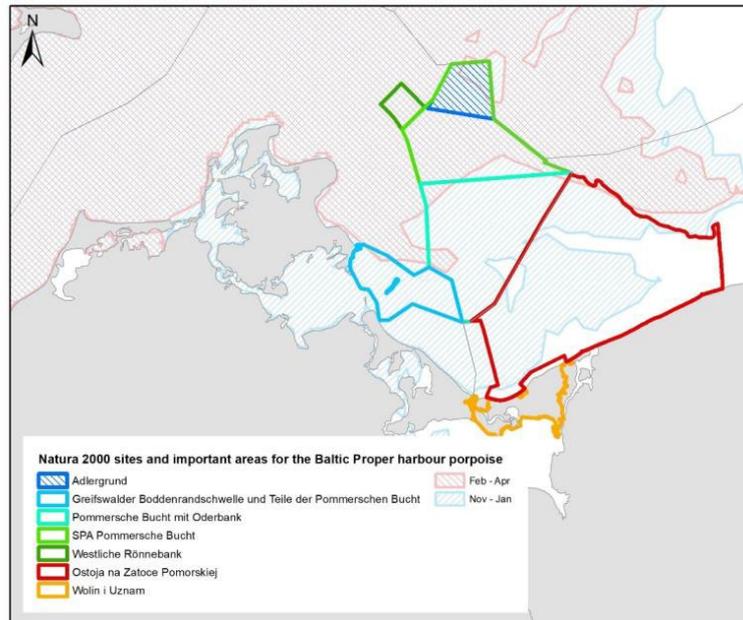**Figure 1** Map showing the Baltic Sea region with sites and areas referred to in the text.

Figure 2   Map showing the cluster of German and Polish Natura 2000 sites. The background layers show important areas for harbour porpoise in the period February–April and November–January. Source: ASCOBANS (2016).
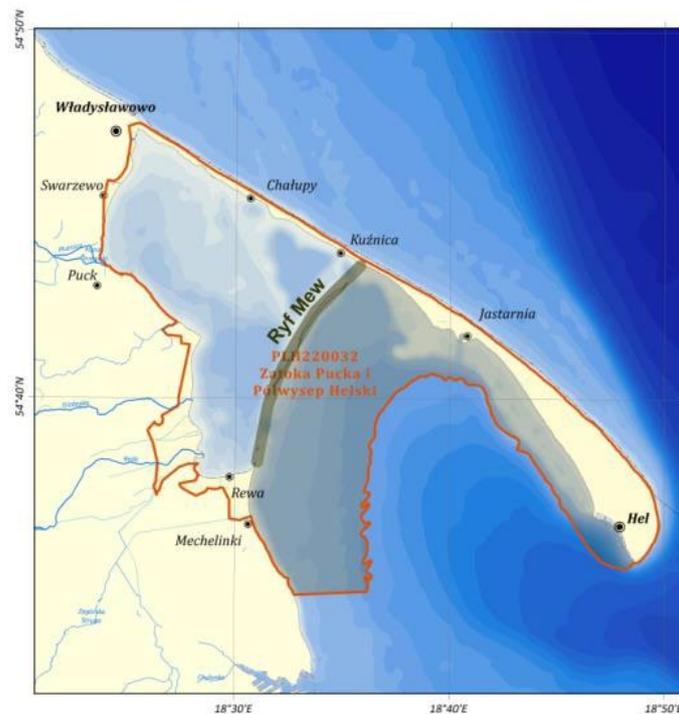

Figure 3   The Natura 2000 site Zatoka Pucka and Półwysep Helski Natura 2000 site (PLH220032; brown contour). The shaded area (light grey) indicates the proposed closure area for static nets east of the sandbank Ryf Mew (dark grey).

Suggestions

For marine mammals to attain a favourable or good conservation status, relevant EU legislation (e.g. EU, 2019) requires that bycatch of marine mammals should not exceed predetermined levels. ICES notes that robust methods for setting limits for bycatch of protected species already exist (ICES, 2013, 2014), but quantitative conservation objectives are not well-

defined. Therefore, ICES reiterates its previous advice that it is willing to assist EU competent authorities to establish quantitative conservation or management objectives, involving both managers and scientists.

Common dolphins in the Bay of Biscay

ICES recommends an adaptive management approach with enhanced monitoring of seasonal common dolphin abundance and bycatch in fisheries. Sequential implementation of progressively more constraining management measures (in terms of effort reduction) over a 5-year period could be used to achieve the management objectives proposed by ICES (e.g., bycatch reduction below 50% of PBR within a six-month period, and below 10% of PBR in 5 years from now)The proposed time period would allow for the development and implementation of fishing gears that have a low bycatch risk to cetaceans and other Protected, Endangered or Threatened Species (PETS). This would be akin to the approach taken for management of "strategic stocks" within the US Marine Mammal Protection Act (MMPA).

ICES considers that temporal closures in Subarea 8 in métiers of concern (PTM, PTB, OTM, GNS, GTR, and PS) are likely to be the most effective management measures for reducing bycatch mortality in the short term. ICES notes that the performance of the proposed technical management measures (i.e. pingers) is conditional upon the pingers performing optimally in both PTM and PTB gears. There is presently limited, but promising evidence of the effectiveness of pingers to mitigate common dolphin bycatch; preliminary trials carried out to assess the effectiveness of the Dolphin Deterrent Device (DDD) pinger in French PTM resulted in a 65% reduction in the bycatch rate (Rimaud *et al*., 2019). The DDD-03 pinger was reported to be highly effective at reducing common dolphin bycatch in UK bass pair-trawl fishery – though it was noted that a fully controlled experimental trial was not undertaken and pingers were used voluntarily by vessels (Northridge *et al*., 2011). ICES recommends ongoing data acquisition and field trials to reliably assess the efficiency of the proposed technical mitigation measures in reducing common dolphin bycatch.

Enhanced monitoring is required to assess the effectiveness of proposed management measures and augment precision in population abundance, seasonal distribution, and bycatch mortality estimates. Monitoring through dedicated observers or remote electronic monitoring (REM) should be implemented throughout the range of the species in the Northeast Atlantic (ICES subareas 6–9) to achieve representative coverage of the métiers of concern. Where technical measures are used, at-sea control systems should be implemented to check if pingers are adequately deployed and operational. The following measures are further recommended:

1) Large-scale surveys for estimating the abundance of common dolphins should be implemented more regularly than the current decadal interval of the SCANS surveys.
2) Encouragement or incentivising the use of REM on fishing vessels to ensure more complete monitoring and enable an efficient sampling strategy to be implemented.
3) Regional-scale (e.g. Bay of Biscay) abundance surveys should also be carried out on a seasonal basis to monitor short-term changes in distribution and density of common dolphins, which will also help assess the continued appropriateness of the proposed management measures in time.
4) Maintain or reinforce existing stranding networks in the Northeast Atlantic common dolphin range states, and encourage cooperation to fulfil analyses and data collection to further evaluate life history parameters and the impacts of other threats on the population, as well as tagging experiments of dolphin carcasses to refine key parameters for estimating bycatch mortality from stranding data.

Harbour porpoise in the Baltic Sea

ICES recommends the following monitoring of the Baltic Proper harbour porpoise:

1) *Long-term acoustic monitoring in key areas for the Baltic Proper harbour porpoise population.*
   Examples of monitoring areas are Hoburgs Bank and the northern and southern Midsea banks, Hanö Bight, Pomeranian Bay, and along the Polish coast the Gulf of Gdansk. Such monitoring would be indicative of changes in abundance and/or distribution on the population level.

2) *Repeated large-scale acoustic surveys of harbour porpoise.*
   These should be repeated at least every 12 years, contributing to the assessment of the MSFD and the Habitats Directive for estimating trends in abundance and detection of possible shifts in the distributional pattern of the population.

3) *Sample and necropsy for stranded and bycaught harbour porpoises.*
   Data from stranded and bycaught harbour porpoises (east of longitude 13°E) are indicative of population status, improve the scientific basis for robust estimates of anthropogenic mortality limits, and can improve knowledge on the spatio-temporal distribution range of the Baltic Proper harbour porpoise population. Genetic sampling should be carried out of all stranded and bycaught harbour porpoises east/south of the Darss and Limhamn ridges.

ICES notes that the development and implementation of fishing gears that have a low bycatch risk for harbour porpoises deserves a high priority.

Basis of the advice

General

The conservation status of cetaceans has been assessed recently as part of the assessment and reporting requirements of Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (the "Habitats Directive"; EU, 1992). EU Member States are required to assess and report on the conservation status of listed species (and habitats) every six years, and, for each species, it requires assessments of species-specific data collected through monitoring of population abundance, range, habitat, and future prospects. As part of this process, the current values of these parameters are compared with favourable reference values (FRVs). For cetaceans, setting FRVs is challenging, as there is a lack of information pertaining to historical abundance and pressures. The values that have been set so far have been at national level, while the setting of values at a biogeographic scale is possible and recommended for a transboundary species. In the context of this advice, this means that there is no target "population size" at which a species should be maintained or restored to achieve the favourable conservation status. Consequently, ICES decided that, in the context of emergency measures, the use of an anthropogenic mortality limit (identifying the maximum level of annual bycatch mortality, beyond which the population may decline) was more apprppriate.

ICES used the estimates of bycatch mortality to explore a range of emergency measures for the common dolphin in the Bay of Biscay and developed a set of spatial closures for Baltic Proper harbour porpoise to primarily fulfil the requirement of Article 12 of Regulation (EU) 1380/2013 (EU, 2013). ICES also considered that these measures may fulfil the requirements of other applicable EU law, in particular Article 12(4) of the Habitats Directive, requirements of the MSFD and Commission Decision 2017/848 (EU, 2017), and the requirements under Regulation 2019/1241 (EU, 2019). ICES further notes that the measures have not been designed to fulfil the requirements of Article 12(1) of the Habitats Directive, which requires preventive measures to avoid bycatch of these strictly protected species. ICES also notes that applicable anthropogenic mortality limits, as required by aforementioned provisions, have not yet been agreed upon by EU Member States.

In the absence of policy decisions at a European level, ICES has previously evaluated bycatch rates of small cetaceans against the ASCOBANS level, defining "unacceptable level" (e.g. ICES, 2018, 2019b); however, it has based the current advice on another approach (PBR, Wade 1998) as the only readily available measure to set anthropogenic mortality limits for the affected populations. ICES notes that the suggested approach is without prejudice to different approaches and methodologies that may be established under EU law in the future, and without prejudice to the requirements of EU law, such as those under Article 12(1) of the Habitats Directive that were not specifically considered by the present advice.

Methods

Parameters applied for the PBR bycatch-limit calculations

The management goal of the US Marine Mammal Protection Act (US Government, 2017) is to prevent populations from "depletion" and to maintain populations above the maximum net productivity level (MNPL), estimated to be between 50% and 85% of the carrying capacity (it is more likely to be in the lower portion of that range; Taylor and DeMaster, 1993). The US management procedure, the PBR framework, estimates limits for anthropogenic removals and is applied in the current

advice. Reducing levels of bycatch to the PBR should allow the population to either recover to, maintain at, or stay above 50% of its carrying capacity 95% of the time, within a time-frame of 100 years. This is without prejudice to the requirements of EU legislation, and in particular the favourable reference values under the Habitats Directive that need to be set in the future.

The PBR calculation requires an estimate of minimum population size (N_{min}, usually calculated as the 20th percentile of the log-normal distribution around the estimate of N), an estimate of the maximum rate of increase in population size (R_{max}, with a default value of 0.04 for cetaceans), and a recovery factor (F_R, between 0.1 and 1; where the status of the population/sub-population is unknown, 0.5 is applied) (Wade, 1998).

$$PBR = N_{min} \times \tfrac{1}{2} R_{max} \times F_R$$

Common dolphin in the Bay of Biscay

The estimates of R_{max} for the Northeast Atlantic common dolphin, ranging from 4% to 4.5% per year, have been calculated using life history data (Murphy *et al.*, 2007; Mannocci *et al.*, 2012). In other geographic regions, Gerrodette *et al.* (2008) reported a trend in common dolphin abundance of 5% in the eastern tropical Pacific (ETP) between 1986 and 2006 (Winship *et al.*, 2009). Though the life history traits of that population are not directly comparable to the Northeast Atlantic, as common dolphins in the ETP can calve year-round and have a higher pregnancy rate (47% vs 26%; Murphy *et al.*, 2009 and references therein). Thus, ca. 4% should be employed as the R_{max} for the common dolphin population in the Northeast Atlantic. A value of 0.5 for the recovery factor was proposed, based on the lack of genetic analysis for assessing population structure in recent years after the large-scale redistribution of dolphins in the Northeast Atlantic. Additionally, the observed large-scale anthropogenic mortality observed from strandings along the French Atlantic coast in recent years would suggest a precautionary approach to setting the recovery factor. The abundance estimate of 634 286 (CV = 0.307) common dolphins was obtained using data from the SCANS III survey and the ObSERVE project.

Testing of bycatch reduction scenarios

ICES used the estimates of common dolphin bycatch mortality from at-sea monitoring and strandings to explore a range of "emergency measures" scenarios. Different temporal fisheries closures for the metiers of concern (PTM_DEF, PTB_MPD, GTR_DEF, OTM_DEF, PS_SPF, GNS_DEF, PTM_LPF[†]), year-round total fishing effort reductions for the same metiers, technical mitigation approaches (in this case, pingers) and combinations of temporal closures and use of pingers were investigated. ICES considers that mitigation and/or closures applied to all fisheries of concern would be a more equitable and reliable method of achieving bycatch reduction.

Having established the current anthropogenic mortality limit as 4927 common dolphins for the North East Atlantic management unit using the PBR approach (N_{min} = 492 652 (corresponding to an abundance estimate of 634 286 (CV = 0.307)); R_{max} (%) = 0.04; F_R = 0.5) (ICES, 2020), and based on the considerations above and without prejudice to all applicable requirements under EU law and methodologies to be established in relation to those requirements, four quantitative management objectives were proposed, against which reduction in bycatch mortality achieved under each of the "emergency measures scenarios" could be tested. As both monitoring and strandings data were available for the ICES subarea 8, the scenarios were tested for subarea 8 only.

There is extensive interannual variation in the total common dolphin bycatch mortality estimated from strandings. The years 2016–2018 displayed lower bycatch levels, whereas 2019 (not included in the analysis) resulted in higher estimates (11 300 animals bycaught from January to April (95% CI: 7550–18 530]) (Peltier *et al.*, 2019). Therefore, the overall bycatch mortality obtained from strandings for 2016–2018 could be underestimated. Fishing effort has remained relatively stable. This further supports precautionary anthropogenic mortality limits below 75% of PBR and 50% of PBR as the tested management objectives 2 and 3.

[†] See https://vocab.ices.dk/?ref=1498 and https://vocab.ices.dk/?ref=1499 for a description of the metiers.

Tested management objective 1: Reduce bycatch to PBR

The objective is to reduce bycatch to PBR, which should ensure that the population is at 50% of carrying capacity (K) 95% of the time over the long term. This is one interpretation of "long-term viability" (EU, 2017) of the population and a means to measure the limit to mortality that might threaten the conservation status of the species (EU, 2019). This management objective results in an annual anthropogenic mortality limit of 4927 common dolphins for the Northeast Atlantic management unit. Whilst the at-sea monitoring point estimate of bycatch mortality is just below the PBR, the point estimate from strandings data exceeded it (Table 7).

Tested management objective 2: Reduce bycatch to < 75% of PBR

Given the high levels of uncertainty around the bycatch estimates and the abundance estimate used in the PBR, a "precautionary approach" was taken and the objective of achieving levels of bycatch that are below 75% of the PBR was tested. This management objective results in an annual anthropogenic mortality limit of 3695 common dolphins for the Northeast Atlantic management unit.

Tested management objective 3: Reduce bycatch to < 50% of PBR

This is the "precautionary approach option" taken, using the objective of achieving levels of bycatch that are below 50% of the PBR. This management objective results in an annual anthropogenic mortality limit of 2464 common dolphins for the Northeast Atlantic management unit.

Tested management objective 4: Reduce bycatch to < 10% of PBR

This quantitative objective aims to provide an interpretation of what "minimise and where possible eliminate" might mean in the context of bycatch reduction. This objective currently results in an annual anthropogenic mortality limit of 493 common dolphins for the Northeast Atlantic management unit.

Table 6   Scenarios used to assess possible bycatch reduction measures as alternatives to the 4-month closure proposed by NGOs (Scenario A) for the common dolphin in the Bay of Biscay. Métiers of concern are: PTM_DEF, PTB_MPD, GTR_DEF, OTM_DEF, PS_SPF, GNS_DEF, and PTM_LPF.

Scenario	Description	Explanation
A	NGO proposed 4-month closure (December–March) – all métiers	4-month closure from December to March of all métiers of concern as proposed in the NGO Emergency Measures request
B	Annual effort reduction of 40% – all métiers	Flat annual 40% reduction in total effort for métiers of concern, does not consider strandings patterns
C	2-month closure (mid-January to mid-March) – all métiers	2-month closure of all métiers of concern determined, using the % mortality in the peak period based on strandings
D	6-week closure (mid-January to end of February) – all métiers	6-week closure of all métiers of concern determined, using the % mortality in that peak period based on strandings
E	4-week closure (mid-January to mid-February) – all métiers	4-week closure of all métiers of concern determined, using the % mortality in that peak period based on strandings
F	2-week closure (mid-January to end of January) – all métiers	2-week closure of all métiers of concern determined, using the % mortality in that peak period based on strandings
G	Pinger all PTM/PTB all year and same 6-week closure all other métiers	PTM/PTB to use pingers all year + a 6-week closure of all other métiers of concern determined, using the % mortality in that peak period based on strandings
H	6-week closure (mid-January to end of February) all métiers (including PTM/PTB) and pinger PTM/PTB for the rest of the year	6-week closure of all métiers of concern determined, using the % mortality in that peak period based on strandings + PTM/PTB to use pingers during the rest of the year
I	Pinger all PTM/PTB all year and same 4-week closure all other métiers	PTM/PTB to use pingers all year + a 4-week closure of all other métiers of concern determined, using the % mortality in that peak period based on strandings

Scenario	Description	Explanation
J	Pinger all PTM/PTB all year and same 2-week closure all other métiers	PTM/PTB to use pingers all year + a 2-week closure of all other métiers of concern determined, using the % mortality in that peak period based on strandings
K	Pinger all PTM/PTB all year	PTM/PTB to use pingers all year, no other measures introduced
L	2-month closure all (mid-January to mid-March) + pingers	2-month closure for all fleets + pingers on PTM/PTB for the rest of the year
M	4-month closure all (mid-January to mid-March) + pingers	4-month closure for all fleets + pingers on PTM/PTB for the rest of the year
N	4-month closure (3 in winter + 1 in summer) + pingers	Closure for 3 months in winter (January–March) and 1 month in summer (mid-July–mid-August) for all fleets + pingers on PTB/PTM for the rest of the year
O	4-month closure (3 in winter + 1 in summer)	Closure for 3 months in winter (January–March) and 1 month in summer (mid-July–mid-August) for all fleets

Bycatch estimates derived from monitoring programmes and from strandings data correspond to consolidated datasets from the years 2016–2018. To determine bycatch levels associated with each scenario, fishing-effort data from ICES Regional Database (RDB) and bycatch rates from observer programmes were used to determine annual bycatch removal by the following métiers: PTM_DEF, PTB_MPD, GTR_DEF, OTM_DEF, PS_SPF, GNS_DEF, and PRM_LPF (in ICES subareas 8 and 9). Métier-specific bycatch rates (individuals/day-at-sea fished) were derived for the observer monitoring data, pooled over 2016–2018 and subareas 8 and 9. To estimate 95% confidence intervals around the bycatch rate, the Poisson distribution was assumed, and confidence intervals were estimated with bootstrapping. The bycatch rate was then raised, using an average of the available métier-specific fishing effort (days-at-sea) for 2016–2018. Due to the insufficient temporal resolution of the observer data from bycatch monitoring, the temporal pattern of bycatch mortality obtained from the strandings data along the French coast (ICES subarea 8) was used to allocate the total bycatch derived from monitoring programmes to fortnights. These fortnightly distributions of bycatch for each métier allowed the different closure scenarios to be associated with a specific bycatch level. A constant ratio of 1.66 (total bycatch based on strandings/total bycatch based on monitoring) was used to derive métier-specific bycatch levels for the strandings estimates. The two series of métier-specific bycatch estimates (Table 7) were seen as two views of the same phenomenon and were considered, within their uncertainty range, to contain the true bycatch level.

Although the bycatch was estimated within the current analysis for ICES subareas 8 and 9 represent the majority of the total (current) bycatch in the management unit, these rates are considered an underestimate of the total bycatch across the entire management unit (NE Atlantic). Choosing the management objectives < 75% of PBR and < 50% of PBR is an attempt to take these sources of bycatch underestimation into consideration.

The bycatch reduction rate was calculated for each scenario, as was the fishing effort reduction rate. An efficiency score for each scenario was obtained by dividing the bycatch reduction rate with the effort reduction rate. This efficiency score could be seen as a rough cost-effectiveness index for each scenario, considering that a reduction of effort would incur a cost for the industry (ICES, 2020).

Table 7 Summary of the bycatch rate and mortality of common dolphins for métiers of concern from monitoring (subareas 8 and 9; data pooled 2016–2018) and strandings (French coast, Subarea 8), raised using the annual mean of the available fishing effort data (RDB) for 2016–2018.

Métier 4[#]	Métier 5[^]	RDB fishing effort (DaS[^^])	Bycatch rate (animals/DaS fished)	At-sea monitoring estimate (95% CI)	Stranding estimate	% coverage of RDB fishing effort (DaS)
PTM	DEF	682	0.71	481 (408–555)	802	8.2
PTB	MPD	5195	0.149	775 (388–1163)	1292	0.43
GTR	DEF	58365	0.035	2061 (1203–3092)	3435	0.194
OTM	DEF	243	1.22[##]	297 (0–890)	495	0.112
PS	SPF	35564	0.0060	213 (0–532)	355	0.31
GNS	DEF	36836	0.0037	137 (0–343)	228	0.49
PTM	LPF	510	0.0153	8 (0–23)	13	4.3
TOTAL (95% Confidence Interval)				3973* (1998–6598)	6620 (4411-10827)	

* CIs too wide; not possible to calculate variance in bycatch rates and consequently CIs are summed métier mortality.

[#] See https://vocab.ices.dk/?ref=1498 for the description of gears.

[##] Based on ca. one day of monitoring effort.

[^] See https://vocab.ices.dk/?ref=1499 for the description of targeted species.

[^^] Days-at-sea (DaS).

Table 8 Information on the tested scenarios and synthesis of their performance. The key information for scenarios A to O is: scenario title, total bycatch mortality from monitoring programmes, total bycatch mortality from stranding data, bycatch reduction obtained, the implied effort reduction, and an efficiency score. The colour coding is explained in the box below the table. The efficiency score of each scenario is bycatch reduction rate divided by effort reduction rate. This efficiency could be seen as a rough cost effectiveness for each scenario, considering that a reduction of effort is a cost for the industry. Bycatch values are in number of individuals.

Scenario	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Description	NGO proposed 4 month closure (Dec–Mar) all métiers	Annual effort reduction of 40% all métiers	2-month closure (mid-Jan–mid-Mar) all métiers	6-week closure (mid-Jan–end Feb) all métiers	4-week closure (mid-Jan–mid-Feb) all métiers	2-week closure (mid-Jan–end Jan) all métiers	Pinger PTM / PTB all year & same 6-week closure all other métiers	6-week closure (mid-Jan–end Feb) all métiers and pinger PTM / PTB rest of the year	Pinger PTM / PTB all year and same 4-week closure all other métiers	Pinger PTM / PTB all year and same 2-week closure all other métiers	Pinger PTM / PTB all year	2-month closure all métiers + pinger PTB / PTM rest of the year	4-month closure all métiers + pinger PTM / PTB rest of the year	3-month (Jan–mid-Mar) + 1 month (mid-Jul–mid-Aug) closure all métiers + pinger PTB / PTM rest of the year	3-month (Jan–mid-Mar) + 1 month (mid-Jul–mid-Aug) closure all métiers
Total resulting bycatch: monitoring mortality	548	2384	1034	1685	2392	3087	1593	1340	2077	2551	3151	824	437	391	494
Total resulting bycatch: strandings mortality	913	3975	1725	2809	3989	5148	2657	2235	3463	4254	5254	1374	729	651	824
Bycatch reduction obtained	0.86	0.40	0.74	0.58	0.40	0.22	0.60	0.66	0.48	0.36	0.21	0.79	0.89	0.90	0.88
Effort reduction needed	0.3	0.4	0.2	0.1	0.1	0.0	0.1	0.1	0.1	0.0	0.0	0.2	0.3	0.3	0.3
Efficiency score	**2.6**	**1.0**	**4.4**	**5.0**	**5.2**	**5.8**	**5.4**	**5.5**	**6.5**	**9.7**	**N/A**	**4.8**	**2.7**	**2.7**	**2.6**

Colour coding used in table above for PBR levels:

% of PBR	< 10% PBR	< 50% PBR	< 75% PBR	< PBR	> PBR
Number of bycaught individuals	< 493	< 2464	< 3695	< 4927	> 4927

Harbour porpoise in the Baltic Sea

Identification of seasonal geographical areas for bycatch mitigation

During May–October, the southwestern management border for the Baltic Proper harbour porpoise has been proposed as a line drawn between the island of Hanö, Sweden, and Jarosławiec near Słupsk, Poland (Carlén *et al.*, 2018). This is the border used during May–October in the current advice, and not 13.5°E as stated in the NGO report (see Annex 12 in ICES, 2020). During November–April, Baltic Proper harbour porpoises migrate west of this border (Carlén *et al.*, 2018). The NGO report states that the waters east of 13.5°E host some Belt Sea porpoises during May–October and Baltic Proper harbour porpoises during November–April. However, the report provides no information on how far west Baltic Proper harbour porpoises migrate during November–April. In the advice, 13°E is considered the southwestern border during November–April. This is based on (i) seasonal patterns in acoustic detection rates and their correlations to environmental conditions in the southern Baltic; (ii) the morphological difference between the Belt Sea and Baltic Proper populations, indicating that Baltic Proper harbour porpoises are adapted to forage in deeper waters; and (iii) the bathymetry of the southern Baltic Sea, showing that deep waters of the Arkona Basin reach approximately to longitude 13°E (ICES, 2020). The NGO report has 60.5°N as the northern border. However, a cluster of opportunistic sightings of harbour porpoises during the 21st century, just below 60.5°N on the Swedish coast and 61°N on the Finnish coast (HELCOM Map and Data Service), led to a line between these points being used as northern border in the current advice.

Calculation of the PBR limit

The PBR for the Baltic Proper harbour porpoise was previously estimated by the Marine Mammal Commission and the Norwegian Institute of Marine Research Workshop on the Harbour Porpoise in the North Atlantic (NAMMCO–IMR, 2019). As outlined in that report, the anthropogenic mortality limit was estimated at 0.7 animals per year using the PBR approach; this is based on an abundance of 497 porpoises (CV = 0.42) for the years 2011–2013 (SAMBAH, 2016), an R_{max} of 4% (default value for small cetaceans), and a recovery factor of 0.1 (NAMMCO–IMR, 2019). An F_R of 0.1 is applied for critically endangered populations, which ensures a conservative estimate for the anthropogenic mortality limit. However, it was noted in the NAMMCO–IMR (2019) report that the R_{max} for the population could be lower than the assumed 4% due to high exposure to pollutants in the Baltic Sea.

Based on this PBR bycatch limit estimate, the management objective employed for the Baltic Proper harbour porpoise in the current advice is to reduce bycatch to 0.7 animals per year. Due to the low density of Baltic Proper porpoises in combination with the low monitoring effort within its distribution range, no reliable bycatch estimates per métier are available. Therefore, the number of bycatches of Baltic Proper harbour porpoises was estimated by adjusting data on bycatch rates, obtained by electronic monitoring systems and on-board observers in subdivisions 21, 22, and 23 and reported to ICES WGBYC during 2007–2016. A 95% confidence interval of the bycatch rate was calculated and its upper limit was first adjusted for the lower density of the Baltic Proper population, then mulitplied by the total gillnet fishing effort in ICES subdivisions 25–29 for each of the years from 2009 to 2017. The fishing effort was obtained from ICES Regional DataBase (RDB). This resulted in an annual bycatch estimate, declining from 12 in 2009 to 7 in 2017 (NAMMCO–IMR, 2019).

Identification of high-risk areas for bycatch

In the Baltic Proper, the majority of reported harbour porpoise bycatches have occurred in static nets (Berggren, 1994; Skóra and Kuklik, 2003; EC-DGMARE, 2014). Natura 2000 sites have been designated for the protection of the species. Therefore, the current advice focuses on the reduction of harbour porpoise bycatches in static net fisheries, with particular focus on Natura 2000 sites, within the seasonal distribution ranges of the Baltic Proper harbour porpoise population. High-risk areas for porpoise bycatch were primarily identified based on seasonal maps of high-density areas for Baltic Proper porpoises (ASCOBANS, 2016), and data on fishing effort (days-at-sea) per calendar quarter for gillnets and trammelnets from ICES Regional Database (ICES, 2020). For Swedish waters, quarterly bycatch risk maps were also available from the ongoing HELCOM Action project (Kindt-Larsen *et al.*, 2020). These maps were produced by multiplying detailed information on fishing effort (net length, soak time, and position) for Swedish static net fisheries (data from the Swedish Agency of Marine and Water Management) by seasonal maps of predicted detection rates of harbour porpoises (Carlén *et al.*, 2018). Finally, published literature and other available evidence were used for more site-specific information on porpoise occurrence and bycatches.

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