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Background

The document below provides a template filled by indicator leads to provide an overview of progress to STATE & CONSERVATION 15-2021. Key aspects such as methodologies, spatial extent changes, assessment scales and threshold values are presented, identifying ongoing work and other relevant issues towards HOLAS III. This process builds on the prior review of indicator development carried out under STATE & CONSERVATION 14-2021 (summarised in document 4J-16 Rev.1, and detailed within numerous documents under agenda item 4J). The focus of these development works is the completion of indicator development and adjustment work for HOLAS III by the end of 2021, as previously agreed under HOD 57-2019 (document 4-20, Outcomes paragraph 4.51).

The aspect of threshold values in particular is a key issue as threshold value approval will be carried out at HOD 61-2021, with these same templates being submitted to HOD at the same stage as submission to State and Conservation 15-2021 (to allow for the longer national processes required that culminate in approval at HOD).

The document below addresses a single indicator and as well as the generic 'action requests' relating to endorsement of the proposed application in HOLAS III (and the threshold values proposals, where relevant), specific additional requests or statements are also indicated within the separate sections of the document to help guide where further input/discussion/guidance may be needed.

This template aims to report the indicator development for HOLAS III, allowing for technical guidance and endorsement by STATE & CONSERVATION 15-2021 and also simultaneously to facilitate the threshold value approval process by HOD 61-2021.

Action requested

The Meeting is invited to:

- provide further technical guidance to the indicator leads and experts, including specific requests defined within the document;
- consider and endorse the proposed developments of the indicator for use in the HOLAS III assessment.
- take note of the summary about ongoing risk mapping work done via the HELCOM BLUES project, as provided in Annex 1

Numbers of drowned mammals and waterbirds in fishing gear

Indicator name
Numbers of drowned mammals and waterbirds in fishing gear
Scale of assessment for HOLAS III and rationale
The assessment for HOLAS III will be conducted on Assessment Unit Scale 2 – Baltic Sea sub-basins. There is no change compared to the explanation given for HOLAS II, when this core indicator remained without an assessment due to the lack of by-catch data. Assessment Unit Scale 2 is selected because it allows for the combination of data on the occurrence of mammals and waterbirds affected by by-catch with data on the occurrence of fisheries causing by-catch at a reasonable geographical scale. This is mainly based on the spatial resolution of fishing effort data, which are, in some fleet segments, only available on the scale of ICES rectangles.
Spatial coverage of the indicator for HOLAS III
Basic risk maps that support the indicator by demonstrating where waterbird and marine mammal distribution overlaps spatially and temporally with the application of fishing methods causing Protected, Endangered and Threatened Species (PETS) by-catch can be produced for almost the entire Baltic. For waterbird species, new results from a winter survey conducted in 2016 (ICES 2019) can be used as well as distribution data for marine mammal species (annual seal counts, SCANS or miniSCANS data and passive acoustic data for harbour porpoises). There is a deficit in fishing effort data, since fishing effort of small vessels does not provide necessary information for by-catch assessments and for the smallest vessels (<10) fishing effort may not be recorded at all. Depending on the data availability of by-catch rates and fishing effort, the assessment of PETS by-catch against the threshold that the long-term viability of a population is not threatened can be conducted for selected combinations of sub-basin and species.
Methodology to be applied for HOLAS III and rationale

Assessment protocol

The assessment is based on the number of by-caught mammals and waterbirds, which are calculated by extrapolating by-catch rates where available (number of individuals by-caught per fishing effort unit) to the total fishing effort including all fleet segments. This is carried out per métier. The number of by-caught individuals is compared to the threshold values defined below. Good status of a species is achieved if the number of by-caught animals (taking also other human-induced mortality such as hunting or oiling into account) of the species, within a given assessment unit, does not exceed the threshold value. If populations are distinguishable within a species, then the assessment is carried out at the population level.

The status of a species or population is assessed for all assessment units in which i) the species or population occurs and ii) fishing methods causing incidental by-catch in this species or population that overlap spatially and seasonally with the distribution of that species or population. If a species is by-caught in more than one fishing métier, then extrapolations of all relevant métiers have to be summed up and this total enters the assessment.

Data needs

The assessment of fishing-induced by-catch mortality in marine mammals and waterbirds is based on three components of data: i) data on fishing effort from the métiers producing by-catch, ii) by-catch rates (by-caught individuals per unit fishing effort) and iii) for birds and mammals, data on population size and demographic characteristics required for population modelling.

Fishing effort would ideally be addressed by considering gear-specific characteristics in the assessment. Appropriate units are the amount of gear and soak time (for example the product of net length and soak time for gillnets or number of hooks or pots for other passive gears. However, currently fishing effort is reported in days at sea as required by Appendix VIII of Commission Decision 2010/93/EU, which does not properly reflect the effort given that for example the number (and thus length) of gillnets used per individual vessel can vary considerably. Moreover, fishing effort is only reported on a monthly basis (e.g., sales records (e.g., DK) or monthly journals (e.g., SE) -if at all (e.g., DE)) for the vessels not using a logbook, i.e., vessels below 10 metres in overall length (EC 1224/2009), or below 8 m in the Baltic Sea if they are targeting cod (Regulation (EU) 2016/1139). Until fishing effort is reported in a more meaningful metric and by all vessels, days at sea or fishing days[1] have to be used as the standard unit for extrapolating by-catch rates.

Given the seasonality in the occurrence of marine mammals and waterbirds, monthly fishing effort needs to be included in analyses, or at the very least quarterly. Further, alignment with the spatial scale of the assessment units is needed. As currently data are mostly collected at a very coarse spatial resolution of ICES statistical rectangles[2] for vessels not carrying VMS, effort of those grid cells within an assessment unit needs to be summed up.

By-catch rates have to be derived from recorded by-catch events in monitoring schemes and case studies. The total number of by-caught individuals in one métier has to be related to the sampled effort. If fishing methods and patterns of occurrence of PETS are comparable, then by-catch rates from one assessment area may be applied to adjacent assessment areas.

Bird and mammal data required for assessments against the thresholds include population size (number of individuals), but also demographic data such as annual adult survival rate, reproductive rate, and age of first reproduction. Preferably, demographic data of the focal population are used, but if not available for a population, data from other populations of the same species, or from closely related species, may be used as long as this appears appropriate. Population sizes of birds are published and regularly updated by Wetlands International (2021). Demographic data for waterbirds were compiled by Horswill & Robinson (2015), Bird et al. (2020) and Evans (2021). Seals are annually counted at haul-out sites during their annual moult, and demographic data are also available. HELCOM Recommendation 27-28/2 defines specific management units for Baltic Sea seal populations. Harbour porpoises from the Belt Sea population have been counted infrequently during SCANS[3] and

miniSCANS surveys since 1994 (Hammond et al. 1994, 2002, 2016, Viquerat et al. 2014). Delineation between North Sea, Belt Sea and Baltic Proper populations have been made using genetic, morphological, acoustic, and satellite tagging data (Sveegaard et al. 2015). Some demographic data are available from the Belt Sea and Western Baltic (Lockyer 2003, Kesselring et al. 2017). However, some assumptions have to be made with respect to the maximum population growth rate on the basis of other populations (Taylor et al. 2007, Forney et al. 2020) or using age-frequency equations of other species with a similar demography (Woodley & Read 1991, Caswell *et al.* 1998).

Assessment scale

By-catch mortality is assessed at the population level. For most waterbird species, only one population occurs in the Baltic Sea, otherwise a separate assessment shall be made for each population as far as possible. Harbour porpoises and all three seal species are assessed within their respective management units. It must be investigated whether the by-catch mortality found threatens the long-term viability of a population (see threshold values).
The assessment of a population shall be broken down to the level of 17 Baltic Sea sub-basins (HELCOM assessment scale 2):

1. If the long-term viability of a population is not threatened by by-catch, the "good" assessment is applied to all sub-basins where the population occurs.
2. If the long-term viability of a population is threatened by by-catch, or a red-listed population could not be assessed due to insufficient by-catch data, the "poor" assessment is applied to those sub-basins in which the occurrence of the population overlaps in time and space with the exercise of fishery métiers in which by-catch events of the species occur. Such overlap can be identified from literature data and risk maps. A "poor" assessment is not applied to sub-basins where no fishing methods causing by-catch of the species are used.

The combination of by-catch assessments and risk maps allows for the localization of where measures are needed in order to safeguard population viability.

Species relevant for assessments of by-catch mortality in this indicator are listed in Table 1.

Table 1: Baltic Sea waterbird relevance for by-catch in different fishing gears and their status on the HELCOM Red List (HELCOM 2013). VU: vulnerable, EN: endangered, CR: critically endangered; x: recorded in the Baltic Sea, (x): recorded in other marine regions only.

Species	HELCOM Red list (breeding)	HELCOM Red list (winter)	trawls	gillnets	fyke nets	longlines	reference
waterbirds							
common pochard				x			A, I

[1] Fishing days is more appropriate than days at sea and relatively easy to calculate for all length classes for which effort data exists.
[2] Each ICES statistical rectangle is 30 min latitude by 1 degree longitude in size which is approximately 56 x 56 km. Some countries (e.g., PL) use Baltic Squares (about 20x20km).
[3] Small Cetacean Abundance in the North Sea (and adjacent waters), including mini-SCANS.

tufted duck				x			A, B, C, E, I, J
greater scaup	VU			x			A, B, C, I
Steller's eider		EN		x			D, J
common eider		EN		x			A, B, C, E, F, G, I, J, M
velvet scoter		EN		x		x	A, B, C, D, E, H, I, J
common scoter		EN		x		x	A, B, C, D, E, I, J, K
long-tailed duck		EN		x		x	A, B, C, D, E, H, I, J
common goldeneye				x			A, B, C, E, I, J
smew				x			A, C
goosander				x	x		A, C, I, J
red-breasted merganser		VU		x	x	x	A, C, E, I,J,K
Eurasian coot				x			A, B, C, I
red-necked grebe		EN		x			A, C, E, G, I
great crested grebe				x	x		A, C, D, G, I, J
Slavonian grebe	VU			x			A, C
black-legged kittiwake				(x)		(x)	K, L, M, N
black-headed gull	EN			x		(x)	A
common gull				x			I
great black-backed gull				x			A, I
herring gull				x		x	A, E, H, I, N
lesser black-backed gull	VU			x			A
common guillemot			(x)	x	x		A, C, E, F, G, I, K, M, N
razorbill			(x)	x			A, C, E, G, I, J, M, N
black guillemot		VU		x			A, C, E, I, J, M
red-throated diver		CR		x			A, C, D, E, I
black-throated diver		CR		x			A, C, D, I, J
northern fulmar				(x)		(x)	K, M, N
northern gannet			(x)	x		(x)	E, K, L, M, N
great cormorant			(x)	x	x	x	A, E, F, G, I, J, K, N
mammals							
ringed seal	VU		(x)	x	x		P, Q
grey seal			x	x	x		O,P
harbour seal	VU (Kalmarsund)		x	x	x		O
harbour porpoise	VU (Belt Sea)		x	x	x		O
	CR Baltic Proper		x	x	x		

References: A Schirmeister 2003, B Kirchhoff 1982, C Stempniewicz 1994, D Dagys & Žydelis 2002, E Oldén et al. 1988, F Lunneryd et al. 2004, G Glemarec et al. 2020, H Detloff & Koschinski 2015, I Bellebaum 2011, J Dagys et al. 2009, K ICES 2013, L Christensen-Dalsgaard et al. 2019, M Bærum et al. 2019, N Northridge et al. 2020, O Lunneryd 2004, P Vanhatalo et al. 2014., Q Perez 2006

Threshold value setting logic and rationale

Thresholds and status evaluation

The joint *OSPAR-HELCOM workshop to examine possibilities for developing indicators for incidental by-catch of birds and marine mammals* (September 2019, Copenhagen, OSPAR & HELCOM 2019) proposed the conservation objective '*Minimise and where possible eliminate incidental catches of all marine mammal and bird species such that they do not represent a threat to the conservation status of these species*' to be further considered by HELCOM in work on the Baltic Sea Action Plan. An interim management objective could be '*The mortality rate from incidental catches should be below levels which threaten any protected species, such that their long-term viability is ensured*'. A quite similar wording is provided by the EU Commission Decision 2017/848 which says "*The mortality rate per species from incidental by-catch is below levels which threaten the species, such that its long- term viability is ensured.*"

The threshold proposals outlined here are based on the outcome and recommendations of the workshop, i.e. they are built on the expertise of 52 experts representing 20 countries and several organizations.

Proposed threshold values

Thresholds represent the upper limit to anthropogenic mortality beyond which conservation objectives will not be met. The threshold values derived are entirely dependent on the conservation objective to be achieved. Available methods for threshold setting are e.g., Removal Limit Algorithm (RLA), Potential Biological Removal (PBR), Population Viability Analysis (PVA) or a rule-of-thumb (as a percentage of the best available abundance estimate), based on simple population models where data are scarce. Model-based threshold setting procedures (such as PVA, RLA and PBR) require a quantitative objective.

Threshold values for harbour porpoise

HELCOM has yet to agree on a conservation objective that is suitable for model-based threshold setting procedures for harbour porpoises. Within OSPAR a conservation objective proposed for the North Sea population is: *A population should be able to recover to or be maintained at 80% of carrying capacity (K), with 80% probability, within a 100-year period* (Authier 2021) and this could potentially also be used in the HELCOM area. This conservation objective is in line with the ASCOBANS sub-objective of restoring or maintaining stocks/populations to 80% or more of their carrying capacity (Res 3.3). In contrast, the conservation objective applied in the US Marine Mammal Protection Act (MMPA) is: A population should be able to recover to or be maintained at 50% of K with 95% probability within a 100-year period (Lonergan 2011). For data rich species such as the Belt Sea harbour porpoise population the joint *OSPAR-HELCOM workshop to examine possibilities for developing indicators for incidental by-catch of birds and marine mammals* (September 2019, Copenhagen) proposed a conservation objective based on 80 % of K, however, K still needs defining. In population models, K can be determined based on the levelling-off of the population growth curve when density dependence becomes more important.

Currently, in the PBR approach the conservation objective considers a stock to be depleted if their population size is less than the *Optimal Sustainable Population* which is 50% of K.
To separate a PBR threshold calculated using the US MMPA conservation objective from a PBR threshold calculated using the OSPAR conservation objective, the latter is termed mPBR for 'modified PBR'. Applying the US MMPA conservation objective, the **Baltic Proper population** is estimated to not sustain a by-catch of more than 0.7 animals per year (NAMMCO & IMR 2019). Therefore, the proposed threshold is zero, in order to reach that conservation objective. In absence of robust by-catch estimates the status is also "poor". No other modelled threshold (PVA or mPBR) has yet been calculated for the Baltic Proper or the Belt Sea population.

For the **Belt Sea population** in the Kattegat, Belt Sea and Western Baltic, an interim threshold of 1 % of the best available population estimate, taking into account the confidence interval, has previously been suggested. In order to improve this threshold for future assessments, a model-based approach threshold setting procedure has been proposed by the experts in the joint *OSPAR-HELCOM workshop*. If available in time for HOLAS III this could either be RLA or a modified PBR. For the Belt Sea population, a threshold calculated using the mPBR method is suggested. A run of the method using abundance data from the miniSCANS II survey in summer 2020 will be completed in time for HOLAS III. The conservation objective will be the same as the one applied in the RLA threshold calculation for the North Sea population by OSPAR (see above). Alternatively, RLA would require time-series data of both population size and by-catch numbers. NAMMCO & IMR (2009) used data from the ICES Regional Database to construct such a time series but due to data deficiencies described above derived by-catch data are not robust. By-catch numbers for the combined Danish and Swedish commercial gillnet fleets in ICES subdivisions IIIa21, IIIb23 and IIIc22 (HELCOM ACTION 2021) cannot be extrapolated to the whole population. Thus, it is unlikely that an RLA approach could be used for HOLAS III. In future assessments, the threshold setting procedure should be harmonised with the RLA approach taken by OSPAR for the North Sea population.

Threshold values for seals

The joint *OSPAR-HELCOM workshop to examine possibilities for developing indicators for incidental by-catch of birds and marine mammals* suggested a model-based threshold for data rich seal species. The RLA approach would require a time series for abundance and by-catch of which the latter is not available. By-catch numbers for the combined Danish and Swedish commercial gillnet fleets in ICES subdivisions IIIa21, IIIb23 and IIIc22 (HELCOM ACTION 2021) cannot be extrapolated to the whole management units. Therefore, PBR would be a practical threshold setting approach. PBR must however be modified (= ”mPBR”) if adapted to the conservation objective put forward by the joint *OSPAR-HELCOM workshop*. In contrast to the conservation objective of the US Marine Mammal Protection Act which the PBR approach is based on, the *threshold mortality rate from incidental catches should not exceed levels that would result in a reduction of the median population size below 70% of the carrying capacity (K) within a 100-year time period*. The *Optimal Sustainable Population* in the US approach is 50% of K (Lonergan 2011).

The following HELCOM seal management units (according to HELCOM Rec. 27-28/2) should be assessed separately:

- Harbour seals in the Kalmarsund region (Sweden)
- Southwestern Baltic and Kattegat harbour seals (Denmark, Germany, Poland, Sweden);
- Gulf of Bothnia ringed seals (Finland, Sweden);
- Southwestern Archipelago Sea, Gulf of Finland and Gulf of Riga ringed seals (Finland, Estonia, Latvia, Russia);
- Baltic Sea grey seals (all Contracting Parties to the Helsinki Convention).

OSPAR did not follow the recommendation from the joint *OSPAR-HELCOM workshop* and agreed on PBR with 50% of K as a threshold for the grey seal management unit in the North Sea. **Baltic grey seals** form a separate population. Provided that by-catch numbers will timely be available for HOLAS III, HELCOM has to agree on one of the two options of either using PBR (50% of K) harmonising threshold setting with OSPAR or mPBR (70% of K) following the advice from the workshop. It can be concluded from the General Management Principle stated in HELCOM Recommendation 27-28/2 of a „long-term objective to allow seal populations to recover towards carrying capacity levels“, that the conservation

objective should rather be 70% of K than 50% of K. An mPBR approach for grey seals has yet to be developed.

If a seal management unit/population is below its Limit Reference Level (LRL)[4], it can be assumed that the conservation objective is not met and in that case the threshold for by-catch is zero. However, since by-catch monitoring would require a very high monitoring effort, in absence of robust by-catch estimates the status is also "poor".

Threshold values for waterbirds

The joint *OSPAR-HELCOM workshop to examine possibilities for developing indicators for incidental by-catch of birds and marine mammals* proposed a threshold derived from the conservation objective to '*minimise and eliminate by-catch where possible'* (OSPAR & HELCOM 2019). This objective aligns with the prohibition of deliberate killing or capture of birds according to Article 5 of EU Directive 2009/147/EC (Birds Directive). It is also aligned with the conservation target of the EU *Action Plan for reducing incidental catches of seabirds in fishing gears* (COM(2012) 665), which requests Member States to *'minimize and, where possible, eliminate the incidental catches of seabirds'*.

Following the position of BirdLife International[5], the OSPAR-HELCOM workshop proposed a value of 1% of natural annual adult mortality as an approximation of 'zero by-catch', which acknowledges that small numbers of seabirds will probably still be caught even when the most effective mitigation measures are deployed. The 1% value is derived from legal interpretations in European Court of Justice of 'small numbers'[6] and EU Commission stemming from the EU Birds Directive and EU guide to sustainable hunting[7]. Since for most species it is extremely difficult to identify natural annual adult mortality in the presence of anthropogenic mortality, it is more feasible to use total annual adult mortality. Further, the workshop recommended testing the application of the threshold of 1% of annual adult mortality by conducting population modelling.

Based on this, the indicator assesses by-catch against the management objective *'The mortality rate from incidental catches should be below levels which threaten any protected species, such that their long-term viability is ensured'*. As by-catch mortality for most species is one out of several pressures, it can have negative impact on the population development especially for threatened species. Therefore, a precautionary approach is applied to species identified as vulnerable, endangered or critically endangered on the HELCOM Red List (HELCOM 2013). Therefore, the assessment of by-catch mortality includes the following three steps (see also Figure 1):

1. Wherever sufficient data are available, population modelling will be used to determine if the fishing-induced mortality threatens the long-term viability of seabird populations. In accordance with IUCN Red List criteria, 'long-term' is defined as three generations (Oliveira 2021). A percentage of maximum acceptable declines during this period is yet to be determined. If this species-specific value is exceeded for the specific population, the population failed in this indicator.
2. If population modelling is not possible in species classified as vulnerable, endangered or critically endangered on the HELCOM Red List, a precautionary threshold will be used instead. This corresponds to a reference value of 1% of the total annual adult mortality of the considered species. If the by-catch data are insufficient to even assess against this reference value, but the species is known to be by-

[4] Defined in HELCOM Recommendation 27-28/2 (ringed seal, grey seal) and HOD 51-2016 (harbour seal Kattegat and SW Baltic). No LRL has been defined for the Kalmarsund management unit.

[5] BirdLife International 2019. BirdLife position on Good Environmental Status threshold criteria for Descriptor 1: seabird bycatch and population abundance. https://portal.helcom.fi/meetings/Incidental%20bycatch%20WS%201-2019-647/MeetingDocuments/BirdLife%20position%20D1criteria_02092019_FINAL.pdf.

[6] See the following judgements: judgment of 9 December 2004, Commission/Spain, case C-79/03, ECR 2004, p.11619, paragraphs 36 and 41; judgment of 15 December 2005, Commission/Finland, case C-344/03, ECR 2005, p.11033, paragraphs 53-54; judgment of 8 June 2006, WWF Italia and others, case C-60/05, ECR 2006, p.5083, paragraphs 25-27.

[7] EC (European Commission), 2008. Guidance document on hunting under Council Directive 79/409/EEC on the conservation of wild birds "The Birds Directive". Available at: https://ec.europa.eu/environment/nature/conservation/wildbirds/hunting/docs/hunting_guide_en.pdf

caught in fisheries, the species failed in this indicator. In this case the by-catch monitoring needs to be intensified to provide evidence that by-catch of a species from the HELCOM Red List is below this threshold. This procedure implements the precautionary approach.
3. For data-poor species which are not classified as vulnerable, endangered or critically endangered on the HELCOM Red List, no status assessment for by-catch mortality enters the indicator, if specific model-based threshold values cannot be assessed due to a shortage in demographic and/or by-catch data. Contracting parties must strive to improve monitoring of population and/or by-catch mortality, and to reduce by-catch rates aiming to reach values close to zero, as committed to in the Baltic Sea Action Plan.
The threshold setting is identical to the OSPAR candidate indicator B5 Marine Bird By-catch. It should be noted that other assessment methods mentioned above for birds have either not yet been explored (RLA) or have at most limited applicability (PBR: O'Brien et al. 2017, Marchowski et al. 2020).

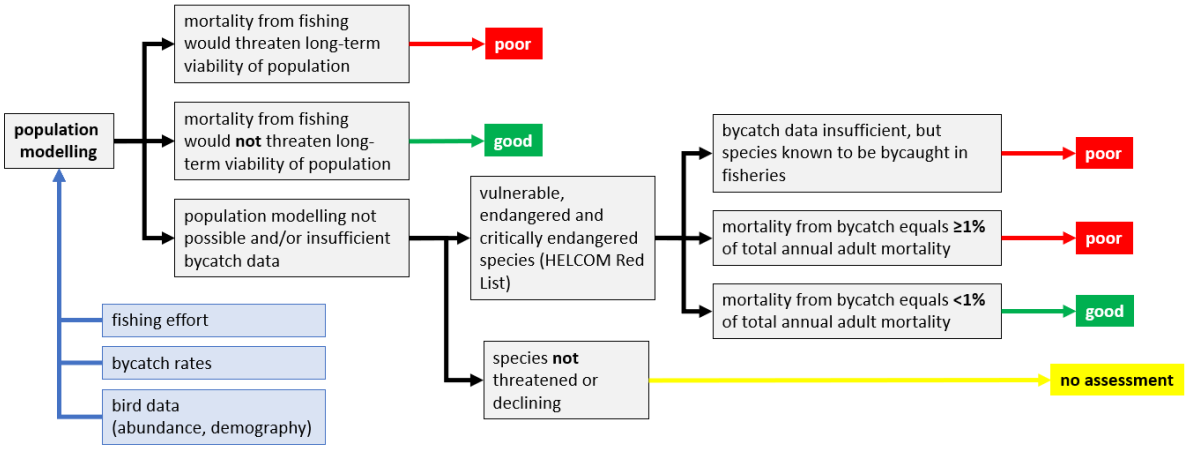

Figure 1: Schematic of the assessment of waterbird by-catch in fishing gear in the Baltic Sea.

Relevance of the core indicator

The level of pressures affecting the status of biodiversity is assessed using several core indicators. Each indicator focuses on one important aspect of the complex issue. This indicator provides an indicator-based evaluation of the numbers of drowned mammals and waterbirds in fishing gear. This information should be considered together with other biodiversity core indicator evaluations at species level, which are then integrated to species group and ecosystem component (Dierschke et al. 2021) in order to achieve an overall assessment of the status of biodiversity.
The populations of marine mammals and diving waterbirds evaluated in the indicator represent highly mobile animals in the Baltic Sea that are sensitive to additional mortality caused by fishing gear due to their characteristic slow reproduction rate. The indicator is an important tool for detecting the impact of mortality due to fishing activities in key populations of these species.
The distribution and abundance of marine mammal populations is closely linked to healthy fish stocks and influenced by many human activities. For harbour porpoises, incidental by-catch has been identified as the main known cause of human-related mortality and it is likely to inhibit population recovery towards conservation targets.
Drowning due to incidental by-catch in fishing gear is a significant pressure on population trends and demography of waterbirds, as for vulnerable species the number of drowned birds may represent a relatively large proportion of the total population size.
The HELCOM Red List of 2013 considers by-catch as a main threat for waterbirds and marine mammals in the Baltic Sea.

Policy relevance

The core indicator on number of drowned mammals and waterbirds in fishing gear addresses the Baltic Sea Action Plan's (BSAP) biodiversity and nature conservation segment's ecological objectives *'Viable populations of species'* and *'Thriving and balanced communities of plants and animals'* as well as the Eutrophication segment's ecological objective *'Natural distribution and occurrence of plants and animals'*. It also addresses the following specific target:
'By 2015 by-catch of harbour porpoise, seals, waterbirds and non-target fish species has been significantly reduced with the aim to reach by-catch rates close to zero'.
In the BSAP, it was further agreed to set up a reporting system and database for harbour porpoise incidental by-catch, and competent fisheries authorities were urged to minimize the incidental by-catch of harbour porpoises.
The core indicator also addresses the following qualitative descriptors of the MSFD for determining Good Environmental Status (European Commission 2008a):
Descriptor 1: *'Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions'* and
Descriptor 4: *'All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity'*,
including the following criteria of the Commission Decision (European Commission 2010):
• Criterion D1C1 (mortality rate from by-catch)
• Criterion D1C2 (population abundance)
• Criterion D1C3 (population demographic characteristics)
• Criterion D1C4 (species distribution)
• Criterion D4C1 (diversity of trophic guild)
• Criterion D4C2 (balance of total abundance between trophic guilds)
• Criterion D4C4 (productivity)
For the three seal species occurring in the Baltic Sea, the HELCOM Recommendation (27-28/2) adopted in 2006 relating to seals recommends:
• '*to take effective measures for all populations in order to prevent illegal killing, and to reduce incidental by-catches to a minimum level and if possible, to a level close to zero'*;
• '*to develop and to apply where possible non-lethal mitigation measures for seals to reduce by-catch and damage to fishing gear, as well as to support and coordinate the development of efficient mitigation measures'*.
Presently, management objectives for all protected species are unclear at the EU level (ICES 2013a). While broad commitments have been made to achieve Good Environmental Status (GES) under the EU Marine Strategy Framework Directive (MSFD), and to Favourable Conservation Status (FCS) under the Habitats Directive, translating these goals into specific targets on incidental by-catch limits is as yet unspecified by the EU.
The EU Habitats Directive lists harbour porpoise as a strictly protected species (Annex IV). The harbour porpoise and the three seal species are listed in Annex II, meaning that they should be protected by the Natura 2000 network. Article 12, paragraph 4 of the Habitats Directive states that Member States shall establish a system to monitor the incidental capture and killing of the animal species listed in Annex IV (a) (European Commission 1992) , which includes all species of cetaceans. In the light of the information gathered, Member States shall take further research or conservation measures as required to ensure that incidental capture and killing does not have a significant negative impact on the species concerned. Member States of the EU are further obliged to develop national programmes for monitoring fisheries, including on board monitoring, under Articles 4 and 5 of Parliament and Council Regulation 2017/1004, Parliament and Council Regulation 2019/1241 annex XIII, part A, 2, Commission Regulation 665/2008 and the Commission Delegated Decision 2019/910 and collection of effort data, under Commission Decision 2010/93/EU. These plans include detailed information for

which species by-catch data shall be collected as well as detailed data on fleet capacity and fishing effort by métier and fishing area.
The EU Birds Directive aims to protect, inter alia, habitats of endangered and migratory birds to ensure their conservation in the Europe (European Commission 2009b). This not only refers to birds needing special conservation measures (Article 4 (1)) and listed in Annex I (black-throated diver, red-throated diver, Slavonian grebe, Steller's eider, smew), but also to all migratory species (Article 4 (2)). Therefore, all waterbird species breeding, wintering and staging during migration in the Baltic Sea are covered by this Directive.
EU legislation clearly requires Member States to take measures prohibiting deliberate killing or capture of birds by any method (Article 5 Birds Directive; Article 12 Habitats Directive) which also includes the mere acceptance of the possibility of killing or capture (Case C-221/04 Commission v Spain [2006] ECR I-4515, paragraph 71).
As a voluntary instrument within the framework of EU and international environmental and fishery legislation and conventions, the EU Commission has adopted an *'Action Plan for reducing incidental by-catches of seabirds in fishing gears*' (European Commission 2012). It aspires to provide a management framework to minimise incidental by-catch as much as possible in line with the objectives of the reformed EU Common Fisheries Policy (Parliament and Council Regulation 1380/2013, CFP), i.e. to cover all components of the ecosystem. Among others, proposed action includes the monitoring of seabird incidental by-catch with a minimum coverage of 10% of the fisheries and mitigation measures.
The Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS) aims to achieve and maintain a favourable conservation status of small cetaceans. Six of the nine Baltic Sea countries are Parties to the Convention (Denmark, Germany, Sweden, Poland, Lithuania and Finland).
All waterbird species occurring in the Baltic Sea are subject of the Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA).
The core indicator is relevant for the United Nations Sustainable Development Goals, particularly SDG 14 'Life below water', which aims to "*Conserve and sustainably use the oceans, seas and marine resources for sustainable development*".

Threshold value(s)

The threshold values are species-specific and to be generated through population modelling. The numerical values will be produced in the frame of the HELCOM BLUES project and by Contracting Parties. Thus, the numerical values for the threshold will change over time. They differ on every occasion an analysis is run, depending on the data input.

The mechanism for generating these specific values is set out above.

Other significant issues that need to be addressed or presented to State and Conservation

An ongoing and significant lack of data is preventing an extensive assessment of PETS by-catch in the Baltic Sea. Most HELCOM Contracting Parties are currently not conducting by-catch monitoring in the relevant métiers (especially gillnet fishing) to a sufficient degree, and case studies and projects addressing by-catch are scarce and cannot provide data on a regular basis. Further, for small vessels (<12 m) which represent the majority of vessels in the Baltic Sea, the temporal and spatial resolution of recording the fishing effort is not sufficient to serve the by-catch assessment, including also the lack of appropriate recording of effort. This data deficiency has been repeatedly addressed (i.a. in the HELCOM Roadmap on Fisheries Data) is responsible for allowing only partial (pilot) assessments for selected populations in selected sub-basins.
As assessments will not be possible for a number of species and gear combinations in HOLAS III, risk maps to be developed in HELCOM BLUES can support the indicator by highlighting where measures would be required. The risk maps will not be part of the assessment.

Monitoring for harbour porpoise by-catch rates in some areas like the Baltic Proper or in the northern Baltic is not likely to give any reliable data that can be used in statistical analysis. Thus, it must be carefully considered where to put monitoring effort in order to get the best results with the monitoring effort possible.

This template was circulated among all experts of the OSPAR/HELCOM/ICES Joint Working Group on Marine Birds (JWGBIRD) and of HELCOM EG MAMA for reviewing and commenting. Comments have been received from experts in HELCOM Contracting Parties (DK, PL, SE, DE) and have been taken into account in the preparation of the final version.

Latest indicator report or (for new indicators) initially completed indicator template

HELCOM 2018. Numbers of drowned mammals and waterbirds in fishing gear. HELCOM Core Indicator Report. https://helcom.fi/media/core%20indicators/Number-of-drowned-mammals-and-waterbirds-HELCOM-core-indicator-2018.pdf

References

Authier M 2021. Annex I in Update on development of an RLA for Harbour Porpoises in the North Sea. Annex II to OSPAR 2021 Meeting of the Biodiversity Committee BDC 21/4/7 Add3 Proposal for a threshold for common indicator M6

Bærum KM, Anker-Nilssen T, Christensen-Dalsgaard S, Fangel K, Williams T & Vølstad JH 2019: Spatial and temporal variations in seabird bycatch: Incidental bycatch in the Norwegian coastal gillnet-fishery. PLoS ONE 14(3): e0212786.

Bellebaum J 2011.: Untersuchung und Bewertung des Beifangs von Seevögeln durch die passive Meeresfischerei in der Ostsee. BfN-Skripten 295: 1-79.

Bird JP, Martin R, Akçakaya HR, Gilroy J, Burfield IJ, Garnett ST, Symes A, Taylor J, Şekercioğlu ÇH & Butchart SHM 2020. Generation lengths of the world's birds and their implications for extinction risk. Conservation Biology 34: 1252-1261. https://doi.org/10.1111/cobi.13486

Caswell H, Brault S, Read AJ & Smith TD 1998. Harbor porpoise and fisheries: an uncertainty analysis of incidental mortality. Ecological Applications, 8(4): 1226-1238.

Christensen-Dalsgaard S, Anker-Nilssen T, Crawford R, Bond A, Sigurðsson GM, Glemarec G, Hansen ES, Kadin M, Kindt-Larsen L, Mallory M, Merkel FR, Petersen A, Provencher J & Bærum KM 2019. What's the catch with lumpsuckers? A North Atlantic study of seabird bycatch in lumpsucker gillnet fisheries. Biological Conservation 240: 108278.

Dagys M, Ložys L, Žydelis R, Stipniece A, Minde A & Vetemaa M 2009. Action C1 – Assessing and reducing impact of fishery by-catch on species of community interest. Final Report LIFE Nature project "Marine Protected Areas in the Eastern Baltic Sea" Reference number: LIFE 05 NAT/LV/000100.

Dagys M & Žydelis R 2002. Bird bycatch in fishing nets in Lithuanian coastal waters in wintering season 2001-2002. Acta Zool. Lituanica 12: 276-282.

Detloff KC & Koschinski S 2015. Wissenschaftliche Grundlagen für ein ökosystemgerechtes Fischereimanagement in der deutschen AWZ. Erprobung und Weiterentwicklung alternativer, ökosystemgerechter Fanggeräte zur Vermeidung von Beifängen von Seevögeln und Schweinswalen in der Ostsee. Bundesamt für Naturschutz, Bonn-Bad Godesberg. 61 pp.

Dierschke V, Kreutle A, Häubner N, Magliozzi C, Bennecke S, Bergström L, Borja A, Boschetti ST, Cheilari A, Connor D, Haas F, Hauswirth M, Koschinski S, Liquete C, Olsson J, Schönberg-Alm D, Somma F, Wennhage H & Palialexis A 2021. Integration methods for Marine Strategy Framework Directive's biodiversity assessments. EUR 30656 EN, Publications Office of the European Union, Luxembourg.

Erdmann F, Bellebaum J, Kube J & Schulz A 2005. Verluste von See- und Wasservögeln durch die Fischerei unter besonderer Berücksichtigung der international bedeutsamen Rast-, Mauser- und Überwinterungsgebiete in den Küstengewässern Mecklenburg-Vorpommerns. ILN Greifswald, IfAÖ Neu Broderstorf.

Evans PGH 2021. Population Parameters necessary for developing indicators for incidental by-catch of birds and marine mammals. Annex to Technical Report of OSPAR-HELCOM Workshop to examine possibilities for developing indicators for incidental by-catch of birds and marine mammals. In prep.
Glemarec G, Kindt-Larsen L, Lundgaard LS & Larsen F 2020. Assessing seabird bycatch in gillnet fisheries using electronic monitoring. Biol. Conserv. 243: 108461.
Hammond PS, Benke H, Berggren P, Borchers DL, Buckland ST, Collet A, Heide-Jørgensen MP, Heimlich-Boran S, Hiby AR, Leopold MF & Øien N 1995. Distribution & abundance of the harbour porpoise & other small Cetaceans in the North Sea & adjacent waters. 1-240 S.
Hammond PS, Berggren P, Benke H, Borchers DL, Collet A, Heide-Jørgensen MP, Heimlich S, Hiby AR, Leopold MF & Øien N 2002. Abundance of harbour porpoise and other cetaceans in the North Sea and adjacent waters. Journal of Applied Ecology 39: 361-376.
Hammond PS, Lacey C, Gilles A, Viquerat S, Börjesson P, Herr H, Macleod K, Ridoux V, Santos MB, Scheidat M, Teilmann J, Vingada J & Øien N 2017. Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys. Sea Mammal Research Unit, University of St Andrews, St Andrews, Scotland, UK, 39 S.
HELCOM 2013. HELCOM Red List of Baltic Sea species in danger of becoming extinct. Baltic Sea Environment Proceedings No. 140, 106 pp.
HELCOM ACTION 2021. Bycatch in Baltic Sea commercial fisheries: High-risk areas and evaluation of measures to reduce bycatch.
Horswill C & Robinson RA 2015. Review of seabird demographic rates and density dependence. JNCC Report No. 552, 115 pp. https://data.jncc.gov.uk/data/897c2037-56d0-42c8-b828-02c0c9c12d13/JNCC-Report-552-REVISED-WEB.pdf
ICES 2013. Report of the Workshop to Review and Advise on Seabird Bycatch (WKBYCS), 14–18 October 2013, Copenhagen, Denmark. ICES CM 2013/ACOM:77. 79pp.
Kesselring T, Viquerat S, Brehm R & Siebert U 2017. Coming of age: - Do female harbour porpoises (*Phocoena phocoena*) from the North Sea and Baltic Sea have sufficient time to reproduce in a human influenced environment? PLOSone 12(10): e0186951. https://doi.org/10.1371/journal.pone.0186951
Kirchhoff K 1982. Wasservogelverluste durch die Fischerei an der schleswig-holsteinischen Ostseeküste. Vogelwelt 103: 81-89.
Lockyer C 2003. Harbour porpoises (*Phocoena phocoena*) in the North Atlantic: Biological parameters. NAMMCO Scientific Publications, 5: 71-89. https://doi.org/10.7557/3.2740
Lonergan M 2011. Potential biological removal and other currently used management rules for marine mammal populations: A comparison. Mar. Policy 35, 584–589. https://doi.org/10.1016/j.marpol.2011.01.020
Lunneryd SG, Königson S & Sjöberg NB 2004. Bifångst av säl, tumlare och fåglar i det svenska yrkesfisket. Fiskeriverkets kustlaboratorium, Öregrund.
Northridge S, Kingston A & Coram A 2020. Preliminary estimates of seabird bycatch by UK vessels in UK and adjacent waters. DEFRA Report ME6024. Scottish Ocean Institute, University of St Andrews.
Marchowski D, Jankowiak Ł, Ławicki Ł, Wysocki D & Chylarecki P 2020. Fishery bycatch is among the most important threats to the European population of Greater Scaup *Aythya marila*. Bird Conservation International 29: 1-18.
North Atlantic Marine Mammal Commission (NAMMCO) & Norwegian Institute of Marine Research (IMR), 2019. Report of the Joint IMR/NAMMCO International Workshop on the Status of Harbour Porpoises in the North Atlantic. Tromsø Nor. 236
O'Brien SH, Cook ASCP & Robinson RA 2017. Implicit assumptions underlying simple harvest models of marine bird populations can mislead, environmental management decisions. Journal of Environmental Management 201: 163-171
Oldén B, Peterz, M & Kollberg B 1988. Sjöfågeldöd i fisknät i nordvästra Skåne. Naturvårdsverket Rapport 3414. Solna, Sweden: 51 pp.
Oliveira N 2021. Preparatory work to assist in the delivery of a pilot OSPAR indicator: B5 Marine Bird Bycatch. Draft Report to JNCC.

OSPAR & HELCOM 2019. Outcome of the OSPAR-HELCOM workshop to examine possibilities for developing indicators for incidental by-catch of birds and marine mammals. https://portal.helcom.fi/meetings/Incidental%20bycatch%20WS%201-2019-647/MeetingDocuments/Outcome%20OSPAR-HELCOM%20incidental%20by-catch%20indicator%20workshop_final.pdf

Perez, M. A. 2006. Analysis of marine mammal bycatch data from the trawl, longline, and pot groundfish fisheries of Alaska,1998-2004, defined by geographic area, gear type, and catch target groundfish species. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-AFSC-167,194 p.

Schirmeister B 2003. Verluste von Wasservögeln in Stellnetzen der Küstenfischerei - das Beispiel der Insel Usedom. Meer und Museum 17: 160-166.

Stempniewicz L 1994. Marine birds drowning in fishing nets in the Gulf of Gdańsk (southern Baltic): numbers, species composition, age and sex structure. Ornis Svecica 4: 123-132.

Sveegaard S, Galatius A, Dietz R, Kyhn L, Koblitz JC, Amundin M, Nabe-Nielsen J, Sinding MHS, Andersen LW & Teilmann J 2015. Defining management units for cetaceans by combining genetics, morphology, acoustics and satellite tracking. Global Ecology and Conservation 3: 839–850

Taylor BL, Chivers SJ, Larese J, Perrin WF 2007. Generation length and percent mature estimates for IUCN assessments of cetaceans. NOAA NMFS Southwest Fish. Sci. Cent. Adm. Rep. LJ-07–01 21

Vanhatalo J, Vetemaa M, Herrero A, Aho T & Tiilikainen R 2014. By-Catch of Grey Seals (Halichoerus grypus) in Baltic Fisheries—A Bayesian Analysis of Interview Survey. PLOS one 9(11): e113836.: doi:10.1371/journal.pone.0113836.

Viquerat S, Herr H, Gilles A, Peschko V, Siebert U, Sveegaard S, & Teilmann J 2014. Abundance of harbour porpoises (Phocoena phocoena) in the western Baltic, Belt Seas and Kattegat. Marine Biology, 161(4), 745-754

Woodley TH & Read AJ 1991 Potential rates of increase of a harbour porpoise (*Phocoena phocoena*) population subjected to incidental mortality in commercial fisheries. Canadian Journal of Fisheries and Aquatic Sciences, 48: 2429-2435.

Annex 1: Summary about ongoing risk mapping work done via the HELCOM BLUES project

Methods Bycatch risk maps HELCOM B

Mapping the risk of bycatch of marine mammals and birds in the Baltic

Bycatch of marine mammals and seabirds in gillnets have been documented in many different fisheries worldwide and are regarded as one of the most important source of mortality for a large number of species (Read, Drinker and Northridge, 2006; Lewison *et al.*, 2014; Dias *et al.*, 2019).

There are many protected marine mammals and birds which are abundant in the Baltic. The harbour porpoise *Phocoena phocoena* is the only stationary cetacean and three species of seals are present year long, the grey seal *Halichoerus grypus*, the harbour seal *Phoca vitulina* and the ringed seal *Pusa hispida*. The Baltic Sea is also a major migratory route for millions of Palearctic birds and an essential breeding and wintering ground for numerous seabird species.

Bycatch in Baltic fisheries has been reported for all four species of marine mammals cited above, as well as dozens of species of seabirds (Vinther, 1999; Žydelis *et al.*, 2009; Degel *et al.*, 2010; Kindt-Larsen *et al.*, 2012; Sonntag *et al.*, 2012; Bellebaum *et al.*, 2013; Žydelis, HELCOM, 2018a, 2018b; Field *et al.*, 2019; ICES, 2019; Glemarec *et al.*, 2020; Marchowski *et al.*, 2020). However bycatch rates do differ depending on many factors such as spatial distribution of the species and fishing effort as well as the characteristics of the fisheries.

Identification of high-risk areas for bycatch estimates can be used to evaluate the level of pressure on non-target populations from the fishing industry and identify areas where monitoring of bycatch needs to be intensified. The possibility to identify areas and fisheries with high risk of bycatch is dependent on whether data on bycatch rates in different fisheries of the species of concern and information on fishing effort are available. Information on population size and distribution is also useful when creating bycatch risk maps.

Overlaying information on harbour porpoise densities and gillnet fishing effort were used to identify high-risk areas for bycatch in gillnet fisheries (Kindt-Larsen *et al.*, 2016). In that study, harbour porpoise density data, together with gillnet fishing effort data, were used to model porpoise bycatch risk in the area. In other studies (HELCOM, 2020) there has also been a focus on Harbour porpoise bycatch in gillnet fisheries in the Baltic. In this study we hope to create bycatch risk maps for other species such as grey seals, harbour seals, ringed seals, red-throated and black-throated diver, common eider, great cormorant, common scoter, velvet scoter, common guillemot, and long-tailed duck for all fisheries of concern.

There are many challenges that needs to be taken into account when working with bycatch in fisheries. The main concern is the limited data on bycatch rates and fishing effort in different fisheries. If we want to get an overall view of bycatch risk in all areas and all fisheries it is important to first evaluate which fisheries that have a high risk of bycatch for which species. Birds and porpoises for example do not get bycaught in pots and traps at the same extent as seals. One of the projects major challenge will be to evaluate, existing data from ICES WGBYC and other data sources, if we can relate bycatch rates of selected species in different fisheries.

We also need to collate the spatial distribution and abundance of the selected species along with the distribution of the fishing effort for fisheries of concern. Thereafter we will overlay the species distribution of the selected species with the fishing effort from fisheries of concern to get bycatch risk maps in the Baltic. There will also be evaluations if it is possible to pool fishing effort from

different métiers, depending on their relative bycatch rates, to be used in the bycatch risk maps. Even if we do not have bycatch rates in all areas and fisheries, overlaying fishing effort with species distribution can give us indications on areas and fisheries which are problematic with regard to bycatch.

References

Bellebaum, J. *et al.* (2013) 'Decreasing but still high: bycatch of seabirds in gillnet fisheries along the German Baltic coast', *Aquatic Conservation: Marine and Freshwater Ecosystems*, 23(2), pp. 210–221. doi: 10/f4wfmn.

Degel, H. *et al.* (2010) *Fugle som bifangst i garnfiskeriet. Estimat af utilsigtet bifangst af havfugle igarnfiskeriet i området omkring Ærø*. DTU Aqua-rapport nr. 227-2010. Charlottenlund: DTU Aqua. Institut for Akvatiske Ressourcer, p. 65. Available at: https://backend.orbit.dtu.dk/ws/portalfiles/portal/6581125/227-2010_Fugle-som-bifangst-i-garnfiskeriet.pdf (Accessed: 19 February 2020).

Dias, M. P. *et al.* (2019) 'Threats to seabirds: A global assessment', *Biological Conservation*, 237, pp. 525–537. doi: 10.1016/j.biocon.2019.06.033.

Field, R. *et al.* (2019) 'High contrast panels and lights do not reduce bird bycatch in Baltic Sea gillnet fisheries', *Global Ecology and Conservation*, 18, p. e00602. doi: 10.1016/j.gecco.2019.e00602.

Glemarec, G. *et al.* (2020) 'Assessing seabird bycatch in gillnet fisheries using electronic monitoring', *Biological Conservation*, 243, p. 108461. doi: 10/ggmrwr.

HELCOM (2018a) *Number of drowned mammals and waterbirds in fishing gear*. HELCOM core indicator report. Online. Available at: https://helcom.fi/wp-content/uploads/2019/08/Number-of-drowned-mammals-and-waterbirds-HELCOM-core-indicator-2018.pdf (Accessed: 3 April 2020).

HELCOM (2018b) 'State of the Baltic Sea–Second HELCOM holistic assessment 2011-2016', in *Baltic Sea Environment Proceedings*, p. 155.

HELCOM (2020) *Bycatch in commercial fisheries; high-risk areas and evaluation of measures to reduce bycatch.* Report WP1 Helcom Action project

ICES (2019) *Working Group on Bycatch of Protected Species (WGBYC)*. International Council for the Exploration of the Sea (ICES).

Kindt-Larsen, L. *et al.* (2012) 'Observing incidental harbour porpoise Phocoena phocoena bycatch by remote electronic monitoring', *Endangered Species Research*, 19(1), pp. 75–83. doi: 10/ggk2cp.

Kindt-Larsen, L. *et al.* (2016) 'Identification of high-risk areas for harbour porpoise Phocoena phocoena bycatch using remote electronic monitoring and satellite telemetry data', *Marine Ecology Progress Series*, 555, pp. 261–271. doi: 10/f849c3.

Lewison, R. L. *et al.* (2014) 'Global patterns of marine mammal, seabird, and sea turtle bycatch reveal taxa-specific and cumulative megafauna hotspots', *Proceedings of the National Academy of Sciences*, 111(14), pp. 5271–5276. doi: 10.1073/pnas.1318960111.

Marchowski, D. *et al.* (2020) ‘Fishery bycatch is among the most important threats to the European population of Greater Scaup Aythya marila’, *Bird Conservation International*, pp. 1–18. doi: 10/ggkz8p.

Read, A. J., Drinker, P. and Northridge, S. (2006) ‘Bycatch of Marine Mammals in U.S. and Global Fisheries: Bycatch of Marine Mammals’, *Conservation Biology*, 20(1), pp. 163–169. doi: 10/c73v88.

Sonntag, N. *et al.* (2012) ‘Seabirds, set-nets, and conservation management: assessment of conflict potential and vulnerability of birds to bycatch in gillnets’, *ICES Journal of Marine Science*, 69(4), pp. 578–589. doi: 10/ggkz8z.

Vinther, M. (1999) ‘Bycatches of harbour porpoises (Phocoena phocoena, L.) in Danish set-net fisheries’, *Journal of Cetacean Research and Management*, (2).

Žydelis, R. *et al.* (2009) ‘Bycatch in gillnet fisheries – An overlooked threat to waterbird populations’, *Biological Conservation*, 142(7), pp. 1269–1281. doi: 10/fwdfxp