WORKING GROUP ON BYCATCH OF PROTECTED SPECIES (WGBYC)

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Contents

i Executive summary

The Working Group on Bycatch of Protected Species (WGBYC) was established in 2007 and collates and analyses information from across the Northeast Atlantic and adjacent sea areas (Baltic, Mediterranean, and Black Seas) related to the bycatch in commercial fishing operations of protected and sensitive species including marine mammals, seabirds, turtles, and sensitive fish species.

WGBYC seeks to describe and improve understanding of the likely impacts of fishing activities on affected populations, to inform on the suitability of existing at-sea monitoring programmes for assessing sensitive species bycatch, and to collate information on bycatch mitigation efforts.

The report provides an overview of data collection activities during 2023 including details of reported monitoring and fishing effort data, and bycatch records that were submitted to the WGBYC database in 2024 following a formal data call (ToR A). Data were requested from 17 of the 20 ICES countries, six EU Mediterranean countries and two EU Black Sea countries. 23 of the 25 contacted countries submitted data. WGBYC considers that the quantity and quality of the information provided by the ICES WGBYC datacall have been steadily improving since the first data call in 2018 (ToR A and ToR G).

WGBYC conducted a literature review on mitigation solutions for ETP species published in 2023 and summarised information about ongoing projects to mitigate bycatch of ETP species within the group. Furthermore, all WGFTFB national reports were reviewed and relevant projects were summarised (ToR B).

WGBYC further expanded the BEAM approach which was first developed in 2022 and is designed for evaluating and quantitatively assessing population impacts of bycatch across the full range of relevant taxa (ToR C). The method considers various criteria, including data availability, quality, and representativity, within group expertise and the existence of bycatch management/conservation thresholds or reference points. Estimated bycatch mortality ranges, by ecoregion and gear type, were produced for several mammal, seabird, turtle, and fish species listed on the EU priority species list and the ICES Roadmap for Bycatch Advice ecoregion species lists. This year, WGBYC was able to provide total bycatch estimate at the ecoregion scale for more species, however, population impact assessments continue to be limited by a lack of species abundance estimates at the ecoregion scale and Bycatch Reference Points.

The semi-quantitative methodology for evaluating bycatch risk for high priority data limited species was further developed in 2024. This methodology is for species for which reliable quantitative assessments cannot currently be carried out using the BEAM approach (ToR D). WGBYC made recommendations on how to further progress the development of the methodology.

A risk-based approach to highlight potential monitoring gaps and inform coordinated sampling designs was further expanded to include all ecoregions, including the Mediterranean, and provides useful insights into which métiers may currently be under-sampled by existing at-sea data collection programmes with respect to PET species bycatch (ToR E).

A new ToR (ToR F) was established for WGBYC in 2024 to examine data deficient species and to propose measures to obtain the required information to improve the data situation in these cases. This work highlighted the barriers to achieving BPUE and total bycatch estimates and identified where clarification on data collections protocols and improved data reporting would be beneficial.

ii Expert group information

Expert group name	Working Group on Bycatch of Protected Species (WGBYC)
Expert group cycle	Annual
Year cycle started	2024
Reporting year in cycle	1/1
Chair(s)	Ailbe Kavanagh, Ireland
	Guðjón Sigurðsson, Iceland
	Lotte Kindt-Larsen, Denmark
Meeting venue(s) and dates	16-20 September 2024, Bayeux, France (35 participants)

Section 1 (ToR A) contents

1 ToR A: Review and summarize information submitted through the annual bycatch data call and other means for assessment of protected/sensitive species bycatch (ToR A)

Link to the figures and tables :

https://github.com/ices-eg/wg_WGBYC/tree/master/2024/WGBYC2TAF/output

1.1 Legislation concerning the bycatch of endangered, threatened, and protected (ETP) species

The work of WGBYC from 2021 onwards is primarily driven by the current agreement between ICES and DG-Mare. Following this agreement ICES *"**will provide**, on the basis of data provided by Member States and any other relevant data sources, **annual estimates of the numbers of specimens of sensitive species** (as defined in Article 6(8) of Regulation (EU)2019/1241) **caught incidentally in fishing activities**, disaggregated **by sea area and type of fishing gear**. These estimates shall be accompanied with evaluations or estimates of their **accuracy where possible**. They shall be provided by December each year and shall cover incidental catches made until 31 December of the previous year. ICES shall progressively accompany these estimates with calculated values of potential biological removal (PBR), or alternative markers of sustainability where appropriate"*. In addition, ICES is asked to *"provide **warnings** of any **serious threats** (i.e., if there is at this moment, **a threat to the abundance posing a risk so serious that it would be unwise to postpone action**) from fishing activities alone or in conjunction with any other relevant activity to local ecosystems or species **as soon as ICES is aware of such threats**"*.

Regulation 812/2004 was repealed and replaced by Regulation (EU) 2019/1241 (hereafter referred to as Reg.2019/1241) of the European Parliament and of the Council *on the conservation of fisheries resources and the protection of marine ecosystems through technical measures (Technical Conservation Measures Regulation)*. The objectives of the new Regulation are:

(a) to minimise, and where possible eliminate, incidental catches of sensitive species so that fishery-related mortality does not represent a threat to their conservation status,

(b) to minimise negative impacts of fishing on marine habitats and

(c) to put in place management measures for the purposes of complying with the Habitats, Birds, Water Framework and Marine Strategy Framework Directives.

These measures shall ensure that bycatches of sensitive species do not exceed levels in Union legislation and international agreements. Member States are required to take the necessary steps to collect data on the relevant species. Provisions on vessel sizes, areas and fishing gears for mitigation and monitoring measures contained in Regulation 812/2004 are retained. Measures to monitor, manage, and mitigate bycatches of sensitive species (including but not limited to cetaceans, seabirds, and turtles) are subject to regional management through Joint Recommendations to the European Commission prepared by Member States.

Technical descriptions of Acoustic Deterrent Devices (ADDs) carried over from Regulation 812/2004 are contained in the Commission Implementing Regulation (EU) 2020/967 of 3 July 2020 *laying down the detailed rules on the signal and implementation characteristics of acoustic deterrent* *devices as referred to in Part A of Annex XIII of Regulation (EU) 2019/1241 of the European Parliament and of the Council on the conservation of fisheries resources and the protection of marine ecosystems through technical measures.* This Implementing Regulation mandates that ADDs be functional during the whole duration of the fishing operation, not only at the time when nets are set. It also allows Member States '*to authorize the use of acoustic deterrent devices that do not fulfil the technical specifications or conditions of use defined in the Annex, provided that such devices are at least equally effective in the reduction of incidental catches of cetaceans as the acoustic deterrent devices with the technical specifications or conditions defined in the Annex, and this has been duly documented*'.

There are several other legislative instruments in ICES Member Countries, Regional Fisheries Management Organisations (RFMOs), and other European Union law concerning bycatch of ETP species. For an overview of the main pieces of legislation see the section "Introduction to legislative background" of the *Roadmap for ICES bycatch advice on ETP species*.

ICES obtains data on ETP species bycatch through an annual data call. These data are mainly collected during at-sea observations carried out for the purposes of fisheries monitoring in accordance with the EU Data Collection Framework Regulation 2017/1004 (DCF). While the collection of protected species bycatch data through the DCF as part of the Multiannual Plan (DC-/EU-MAP) may facilitate targeted sampling of métiers of concern, inadequate data collection protocols may lead to downward bias in the number of recorded events (see ICES 2015).

There are many other obligations to monitor and introduce measures to reduce protected species bycatch within legislation specific to fisheries and the Common Fisheries Policy. As examples, MS have obligations under Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (the Habitats Directive) and Council Directive 2009/147/EC of 30 November 2009 (The Birds Directive).The revised Commission Decision 2017/848 relating to the implementation of the MSFD specifies a primary criterion for the assessment of Good Environmental Status (GES) linked to the assessment of bycatch, Primary criterion: D1C1, through the estimation of mortality rate per species due to incidental fisheries bycatch. Specific to seabirds is the European Commission's 'Action Plan for reducing incidental catches of seabirds in fishing gears' (EU-POA) which was published in 2012. It seeks to provide a management framework to minimise seabird bycatch to as low levels as are practically possible. Robust data pertaining to fishing effort and bycatch monitoring data are required by MS to assess the impact of bycatch and work towards meeting the various legislative requirements and commitments.

1.2 Monitoring data submitted - Overview

ICES/WGBYC requested data from 25 countries through the 2024 data call. 23 countries responded and submitted data on fishing and monitoring effort, and 22 for bycatch observations, for 2023. Malta and Romania did not report any data. All other countries reported fishing effort and monitoring effort data for 2023. Slovenia was the only country that did not report bycatch records for 2023. A data submission was considered achieved if at least a single value was reported in the fishing effort and/or monitoring effort tables. For bycatch events, only the presence of data was considered, as zero values (e.g., absence of bycatch events) is not clearly defined in the data call. The submission status for 2017-2024 by country are summarized in Table 1.

The quality and scope of the information provided in the ICES WGBYC data call is variable but has steadily improved over the last six years since annual data calls have been issued. Consistent with the content of WGBYC reports from previous years the most recent data call has been reviewed for:

- Implementation of monitoring of ETP species bycatch and observation schemes;

- Information on ETP species bycatch, including records of individual bycatch events and levels of monitoring coverage provided;
- Other relevant issues emanating from the data call (e.g. exploration of monitoring methods and monitoring programmes reported).

1.3 Monitoring, observed ETP specimens, and total and observed effort obtained from the ICES WGBYC data call by ecoregion.

Prior to the WGBYC 2024 meeting, an ICES WGBYC data call (https://ices-library.figshare.com/articles/report/WGBYC_Data_call_2024_Bycatch_of_protected_species_for_ICES_advisory_work/26124430) requesting 2023 ETP species bycatch data from dedicated (e.g. pilot projects or dedicated monitoring programmes) and non-dedicated/multi-purpose (e.g. DCF) monitoring programmes was issued to EU Member States and non-EU ICES Member States with coastal areas in the European Atlantic (e.g., Iceland, Norway, and the UK), and EU Member States from the Mediterranean Sea and Black Sea.

The data call requested information on fishing effort, monitoring effort and bycatch of marine mammals, birds, turtles and fish species. For ICES waters, species reference lists for each taxa and ecoregion were provided to data submitters. For GFCM waters, data on all marine mammals, seabirds, and sea turtles were requested. For both regions (ICES & GFCM) the EU priority list of species was also provided to data submitters.

This section summarizes all data obtained through the 2024 data call (i.e., 2023 data) which have been extracted from the WGBYC database (see Section 7 ToR G). Any issues or inconsistencies associated with submitted data are discussed in the data summary sections below as necessary and in further detail in Section 7 (ToR G).

The total number of specimens and/or number of bycatch incidents of marine mammal, seabird, fish, and marine turtles, total fishing effort and observed effort aggregated by gear type (métier level 3), monitoring method, ecoregion and ICES Division or GFCM Geographic Sub-Area (GSA) for 2023 are summarized in Annex 3 (https://github.com/ices-eg/wg_WGBYC/blob/master/2024/WGBYC2TAF/output/TOR_A_long_table.xlsx). Information for strata with monitoring effort but no reported bycatch incidents are provided. Data were aggregated by ICES Division/GFCM GSA and Ecoregion for consistency across taxa and to improve the accessibility or transferability of these data to other ICES Working Groups (WGs).

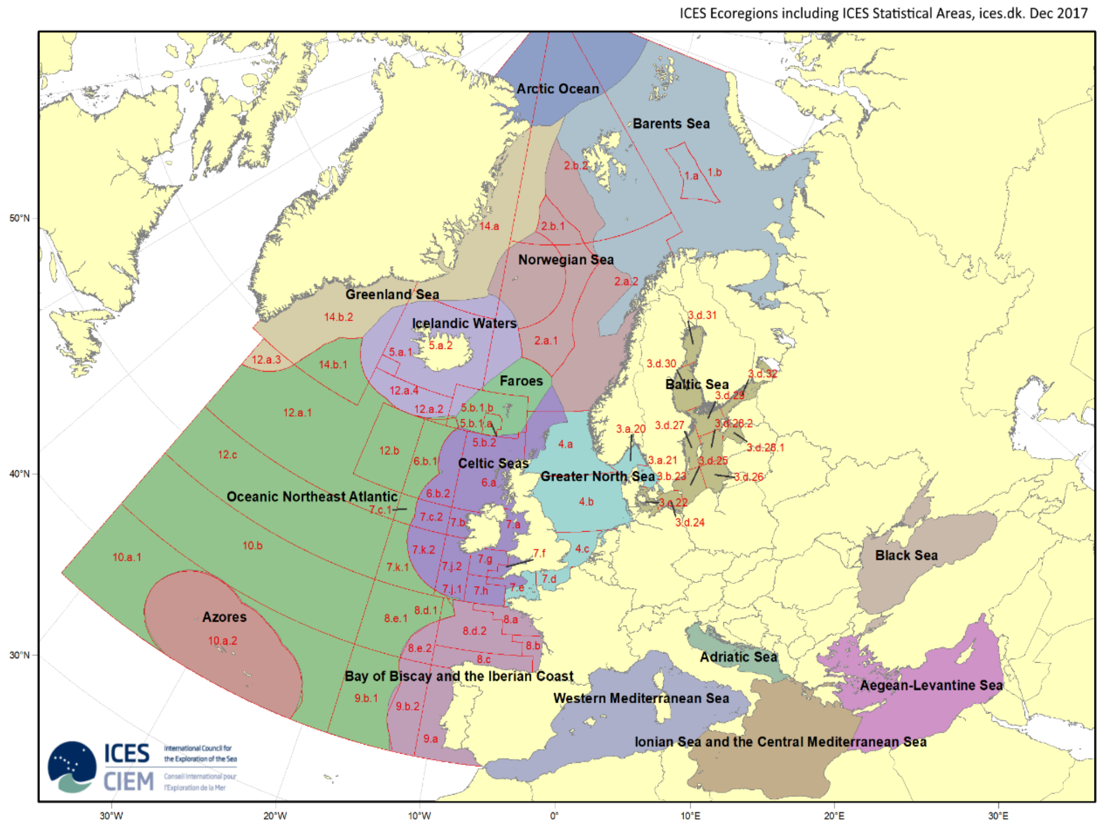

Figure 1.1 Map of ICES and Mediterranean Ecoregions including ICES Statistical Areas, ices.dk.

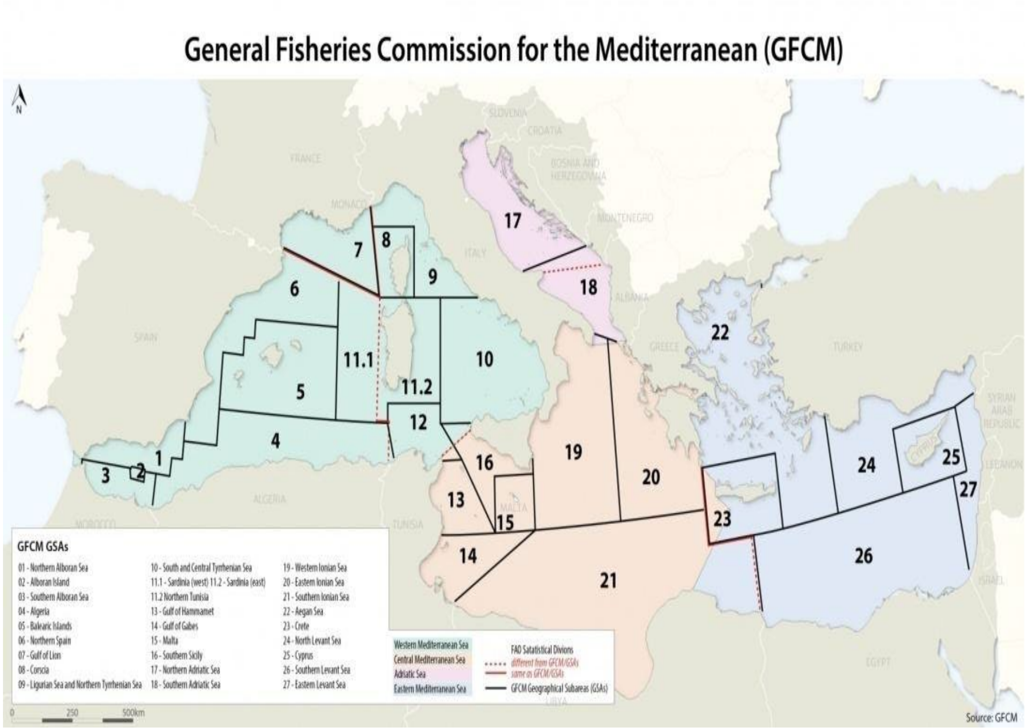

Figure 1.2 Map of Mediterranean Ecoregions including GFCM Statistical Areas

It should be noted that some issues with data submitted were flagged during the Quality Control (QC) of the data submitted by countries; please see ToR G for details of data issues.

Aggregated data are presented by ecoregion in Table 1.2 and Annex 3, and a brief summary is provided below.

Please note that the 'species' category includes not only individuals identified to species level, but also those for which only identification to 'genus' or groups of species has been transmitted (e.g. phocidae).

Data summaries include all monitoring methods:

In the **Adriatic Sea** ecoregion, 1 mammal, 3 birds (1 species), 136 turtles (1 species), and 497 elasmobranchs (6 species) were reported from 7727 days monitored at sea (Table 1.2).

In the **Aegean-Levantine Sea** ecoregion, 5 birds (3 species), 11 turtles (3 species), 2622 elasmobranchs (18 species), and 301 holocephalians (1 species) were reported from at total of 1700 days monitored at sea (Table 1.2).

In the **Azores** ecoregion, 11 birds (1 species), 2 turtles (2 species), 1110 elasmobranchs (8 species) and 3023 teleost individuals (15 species) were recorded from 687 days monitored at sea (Table 1.2).

In the **Baltic Sea** ecoregion, 218 marine mammals (7 species), 390 birds (21 species), 3 elasmobranchs (1 species), 79530 teleost individuals (3 species), 23 chondrosteians (2 species) and 40 lamprey (1 species) were recorded from 129904 days monitored at sea (Table 1.2).

In the **Barents Sea** ecoregion, 863 elasmobranchs (1 species), 1751 teleost individuals (6 species) were recorded from 745 days monitored at sea (Table 1.2).

In the **Bay of Biscay and the Iberian Coast** ecoregion, 260 marine mammals (4 species), 260 birds (12 species), 8 turtles (1 species), 5586 elasmobranchs (24 species), 100001 teleosts (24 species), and 2295 deep sea holocephalians (1 species) were recorded from 2162 days monitored at sea (Table 1.2).

In the **Black Sea** ecoregion, 10 chondrosteians (1 species) were recorded from 100 days monitored at sea (Table 1.2).

In the **Celtic Seas** ecoregion, 14 marine mammals (3 species), 15 birds (3 species), 5553 elasmobranchs (29 species), 29310 teleosts (14 species) and 575 deep sea holocephalians (1 species) were reported from 1454 days monitored at sea (Table 1.2).

In the **Faroes ecoregion**, 1 elasmobranch and 97 teleosts (1 species) were recorded from 3 days monitored at sea (Table 1.2).

In the **Greater North Sea** ecoregion, 304 marine mammals (6 species), 129 birds (13 species), 8780 elasmobranchs (21 species), 9767 teleosts (21 species), 18 lamprey (2 species) and 1655 deep sea holocephalians (1 species) were reported from 3071 days monitored at sea (Table 1.2).

In the **Greenland Sea** ecoregion, 2257 elasmobranchs (7 species), 4541 teleosts (9 species) and 10 deep sea holocephalians (2 species) were reported from 104 days monitored at sea (Table 1.2).

In the **Icelandic Waters** ecoregion, 88 marine mammals (4 species), 194 birds (9 species), 2870 elasmobranchs (13 species), 8973 telosts (4 species), 2070 holocephalians (2 species) and 1 lamprey were reported from 573 days monitored at sea (Table 1.2).

In the **Ionian Sea and the Central Mediterran Sea** ecoregion, 1147 elasmobranchs (19 species) and 12 holocephalians (1 species) were reported from 557 days monitored at sea (Table 1.2).

In the **North West Atlantic** ecoregion, 3 marine mammals (2 species) were reported from 474 days monitored at sea (Table 1.2).

In the **Norwegian Sea** ecoregion, 63 mammals (3 species), 61 birds (5 species), 798 elasmobranchs (9 species), 265 teleosts (9 species) and 24 deep sea holocephalians (1 species) were reported from 1237 days monitored at sea (Table 1.2).

In the **Oceanic Northeast Atlantic** ecoregion, 1 turtle and 3 elasmobranchs (2 species) were reported from 49 days monitored at sea (Table 1.2).

In the **Western Mediterranean Sea** ecoregion, 1 marine mammal, 170 birds (6 species), 28 turtles (1 species) and 227 elasmobranchs (15 species) were reported from 1641 days monitored at sea (Table 1.2).

In total (all ecoregions combined), 952 marine mammals (11 species), 1238 seabirds (33 species) and 186 marine turtles (3 species) were recorded as bycatch during 2023. Records of 43 fish species from the ICES fish bycatch reference list were also reported, totalling over 230 thousand specimens.

In this section, WGBYC has not calculated bycatch rates or bycatch estimates due to uncertainties associated with data reported from some monitoring methods, incomplete spatial/temporal monitoring coverage, and total fishing effort data as reported to WGBYC. However, detailed bycatch assessments are carried out by WGBYC under ToR C (see Section 3 of report).

There is insufficient detail in the submitted data to provide separate and robust information on observed cetacean bycatch according to Acoustic Deterrent Devices (ADD) functionality and/or presence/absence. Consequently, all observed bycaught cetacean specimens are combined (fishing operations with or without ADD) to provide overall numbers of reported bycatch..

Table 1.1 Summary table of countries providing data submissions to ICES WGBYC with data on fishing effort, observer effort (either days at sea or other measurement, e.g. effort per haul or set), and bycatch records. Green = Data submission received, White = no data received. The year of submission is also provided.

	Fishing Effort (D1 table)							Monitoring Effort (D2 table)							Bycatch Events (D3 table)						
Year of data	2017	2018	2019	2020	2021	2022	2023	2017	2018	2019	2020	2021	2022	2023	2017	2018	2019	2020	2021	2022	2023
Belgium	2019	2021	2021	2021	2022	2023	2024	2019	2020	2021	2021	2022	2023	2024	2019	2020			2022	2023	2024
Bulgaria			2024	2024	2024	2024	2024			2024	2024	2024	2024	2024			2024			2024	2024
Croatia	2019				2022	2023	2024	2019	2019			2022	2023	2024	2019	2019			2022	2023	2024
Cyprus		2020	2021	2021	2022	2023	2024		2020	2021	2021	2022	2023	2024		2020	2021	2021	2022	2023	2024
Denmark	2019	2020	2021	2021	2022	2023	2024	2019	2020	2021	2021	2022	2023	2024	2019	2020	2021	2021	2022	2023	2024
Estonia	2019	2020	2021	2021	2022	2023	2024	2019	2020	2021	2021	2022	2023	2024			2021	2021	2022	2023	2024
Finland	2019	2020	2021	2021	2022	2023	2024	2019	2020	2021	2021	2022	2023	2024	2019	2020	2021	2021	2022	2023	2024
France	2023	2023	2023	2023	2023	2023	2024	2023	2023	2023	2023	2023	2023	2024	2023	2023	2023	2023	2023	2023	2024
Germany	2019	2020	2021	2021	2022	2023	2024	2019	2020	2021	2021	2022	2023	2024	2019	2020	2021		2022	2023	2024
Greece	2019	2020	2021	2021	2022	2023	2024	2019	2020	2021	2021	2022	2023	2024	2019	2020	2021	2021	2022	2023	2024
Iceland	2019	2020	2021	2021	2022	2023	2024	2019	2020	2021	2021	2022	2023	2024	2019	2020	2021	2021	2022	2023	2024
Ireland	2019	2020	2021	2021	2022	2023	2024	2019	2020	2021	2021	2022	2023	2024	2019	2020	2021	2021	2022	2023	2024
Italy	2019	2020	2021	2021	2022	2023	2024	2019	2020	2021	2021	2022	2023	2024	2019	2020	2021	2021	2022	2023	2024

	Fishing Effort (D1 table)							Monitoring Effort (D2 table)							Bycatch Events (D3 table)						
Latvia	2019	2020	2021	2021	2022	2023	2024	2019	2020	2021	2021	2022	2023	2024	2019	2020	2021	2021	2022	2023	2024
Lithuania	2019	2019	2022	2021	2022	2023	2024	2019	2019	2022	2021	2022	2023	2024						2023	2024
Malta			2021	2021	2022	2023				2021	2021	2022	2023				2021				
Netherlands	2019	2020	2021	2021	2022	2023	2024	2019	2020	2021	2021	2022	2023	2024	2019	2020	2021	2021	2022	2023	2024
Norway	2021	2021	2021	2021	2022	2023	2024	2021	2021	2021	2021	2022	2023	2024	2021	2021	2021	2021	2022	2023	2024
Poland	2019	2020	2021	2021	2022	2023	2024	2019	2020	2021	2021	2022	2023	2024	2019	2020	2021		2022	2023	2024
Portugal	2019	2020	2021	2021	2022	2023	2024	2019	2020	2021	2021	2022	2023	2024	2019	2020	2021	2021	2022	2023	2024
Slovenia	2019	2020	2021	2021	2022		2024	2019	2020	2021	2021	2022		2024	2019	2020	2021	2021			
Spain	2019	2020	2021	2021	2022	2023	2024	2019	2020	2021	2021	2022	2023	2024	2019	2020	2021	2021	2022	2023	2024
Sweden	2019	2020	2021	2021	2022	2023	2024	2019	2020	2021	2021	2022	2023	2024	2019	2020	2021	2021	2022	2023	2024
United Kingdom		2020	2021	2021	2022	2023	2024	2019	2020	2021	2021	2022	2023	2024	2019	2020	2021	2021	2022	2023	2024

Table 1.2 Summary of reported fishing effort, monitoring days (for métiers with reported bycatch only, all métiers combined), number of bycaught specimens, and incidents in 2023 per ecoregion, provided through the ICES WGBYC 2024 data call. Extended summary of reported data is provided in Annex 3. Please note that the 'species' category includes not only individuals identified to species level, but also those for which only identification to 'genus' or groups of species has been transmitted (e.g. *phocidae*).

Ecoregion	Fishing Effort (das)	Total Observed Effort (das)	Monitoring Coverage (%)	variable	Aves	Elasmobranchii	Holocephali	Mammalia	Reptiles	Teleostei	Chondrostei	Petromyzonti
Adriatic Sea	613,746	7,727	1.26	Species	2	6	1	1	1			
				Individuals	3	497	1	1	136			
				Incidents	3	482	1	1	126			
Aegean-Levantine Sea	1,025,702	1,700	0.17	Species	3	18	1		3			
				Individuals	5	2,622	301		11			
				Incidents	3	583	10		9			
Azores	41,546	687	1.65	Species	1	8			2	15		
				Individuals	11	1,110			2	3,023		
				Incidents	4	66			2	187		
Baltic Sea	239,735	129,904	54.19	Species	21	1		7		3	2	1
				Individuals	390	3		218		79,530	23	40
				Incidents	247	3		180		437	15	7

Ecoregion	Fishing Effort (das)	Total Observed Effort (das)	Monitoring Coverage (%)	variable	Aves	Elasmobranchii	Holocephali	Mammalia	Reptiles	Teleostei	Chondrostei	Petromyzonti
Barents Sea	8,762	745	8.50	Species		1				6		
				Individuals		863				1,751		
				Incidents		54				215		
Bay of Biscay and the Iberian Coast	747,617	2,162	0.29	Species	12	24	1	4	1	24		
				Individuals	260	5,586	2,295	260	8	100,001		
				Incidents	105	258	90	159	6	1,102		
Black Sea	15,304	100	0.65	Species							1	
				Individuals							10	
				Incidents							9	
Celtic Seas	191,405	1,454	0.76	Species	3	29	1	3		14		
				Individuals	15	5,553	575	14		29,310		
				Incidents	12	566	258	12		3,948		
Faroes	355	3	0.84	Species		1				1		
				Individuals		1				97		

Ecoregion	Fishing Effort (das)	Total Observed Effort (das)	Monitoring Coverage (%)	variable	Aves	Elasmobranchii	Holocephali	Mammalia	Reptiles	Teleostei	Chondrostei	Petromyzonti
				Incidents		1				1		
Greater North Sea	479,246	3,071	0.64	Species	13	21	1	6		21		2
				Individuals	129	8,780	1,655	304		9,766		18
				Incidents	76	1,287	71	148		1,589		2
Greenland Sea	761	104	13.67	Species		7	2			9		
				Individuals		2,257	10			4,541		
				Incidents		222	8			467		
Icelandic Waters	1,535,522	573	0.04	Species	9	13	2	4		4		1
				Individuals	194	2,870	2,070	88		8,973		1
				Incidents	99	411	221	69		304		1
Ionian Sea and the Central Mediterranean Sea	583,316	557	0.10	Species		19	1					
				Individuals		1,147	12					
				Incidents		90	1					
	4,239	474	11.18	Species				2				

Ecoregion	Fishing Effort (das)	Total Observed Effort (das)	Monitoring Coverage (%)	variable	Aves	Elasmobranchii	Holocephali	Mammalia	Reptiles	Teleostei	Chondrostei	Petromyzonti
North West Atlantic				Individuals				3				
				Incidents				6				
Norwegian Sea	59,278	1,237	2.09	Species	5	9	1	3		6		
				Individuals	61	798	24	63		265		
				Incidents	36	235	3	48		46		
Oceanic Northeast Atlantic	5,486	49	0.89	Species		2			1			
				Individuals		3			1			
				Incidents		2			1			
Western Mediterranean Sea	767,969	1,641	0.21	Species	6	15		1	1			
				Individuals	170	227		1	28			
				Incidents	33	79		1	23			

Data for 2024 consisted of monitoring information collected by several different methods (at-sea-observers, electronic monitoring, port observers, vessel crew observers, and logbooks) (Figure 1.3). Overall, there has been a temporal change in the proportions of ‘monitoring method’ data reported to WGBYC, from primarily at-sea-observers in 2017, to vessel crew observers in 2019, and to logbook data in 2021, 2022, and 2023 (Figure 1.3). This change in monitoring methods reported is country-specific (Figure 1.4) and may in part be linked to covid restrictions on sampling (see ICES 2022), or to changes in available technologies such as electronic monitoring which was reported by 3 countries in 2023.

In 2024 (2023 data), most submitted data (DaS monitoring effort) was reported as logbook data followed by port-observers and at-sea-observers (Figure 1.3). In 2023, 4 countries submitted logbook data (Figure 1.4), a specific ‘Monitoring Methods’ category was included in the data call to enable countries to correctly identify data obtained from logbooks in that year. The inclusion of logbook data has resulted in very high “observed” effort days for a number of Ecoregions (including the Baltic and Barents Seas Ecoregions) and fisheries (Table 1.2, Annex 3). Therefore, as in 2023, caution is needed when interpreting observed effort in these ecoregions and metiers and monitoring coverage for most ecoregions/metiers remains low (Table 1.2, Figure 1.3).

Although logbooks represent the greatest proportion of monitored data in 2023, the majority of bycatch incidents for all species groups, except turtles, were recorded by at-sea-observers or electronic monitoring. Turtle species were recorded most often by port and at-sea observers in 2023 (Figure 1.5). A small proportion of marine mammal and seabird bycatch incidents were reported from logbooks in 2023 data (Figure 1.5). Consistently between 2017 and 2023, the majority of elasmobranch and other fish species bycatch incidents were reported by at-sea-observers. Marine mammal and seabird bycatch records have come from a variety of sources over the years but are increasingly primarily coming from at-sea-observers and electronic monitoring programmes (Figure 1.5). Although turtle bycatch is consistently reported by at-sea-observers between 2017 and 2023, these incidents are increasingly being reported by other observation methods (Figure 1.5).

Definitions of the different monitoring methods are provided in Table 1.3 along with each data type’s suitability for inclusion in detailed bycatch analyses as currently considered by WGBYC.

Data from 2023 submitted through the 2024 WGBYC data call consisted of information from multiple monitoring programmes (DCF, Reg 812, DCF/Reg 812, EU-MAP, Research Programmes, and other) (Figure 1.6). 16 countries reported data from DCF or DCF/Reg 812, and 5 countries reported data from research programmes in 2023 (Figure 1.6). 10 countries reported data from more than one monitoring programme type (Figure 1.6).

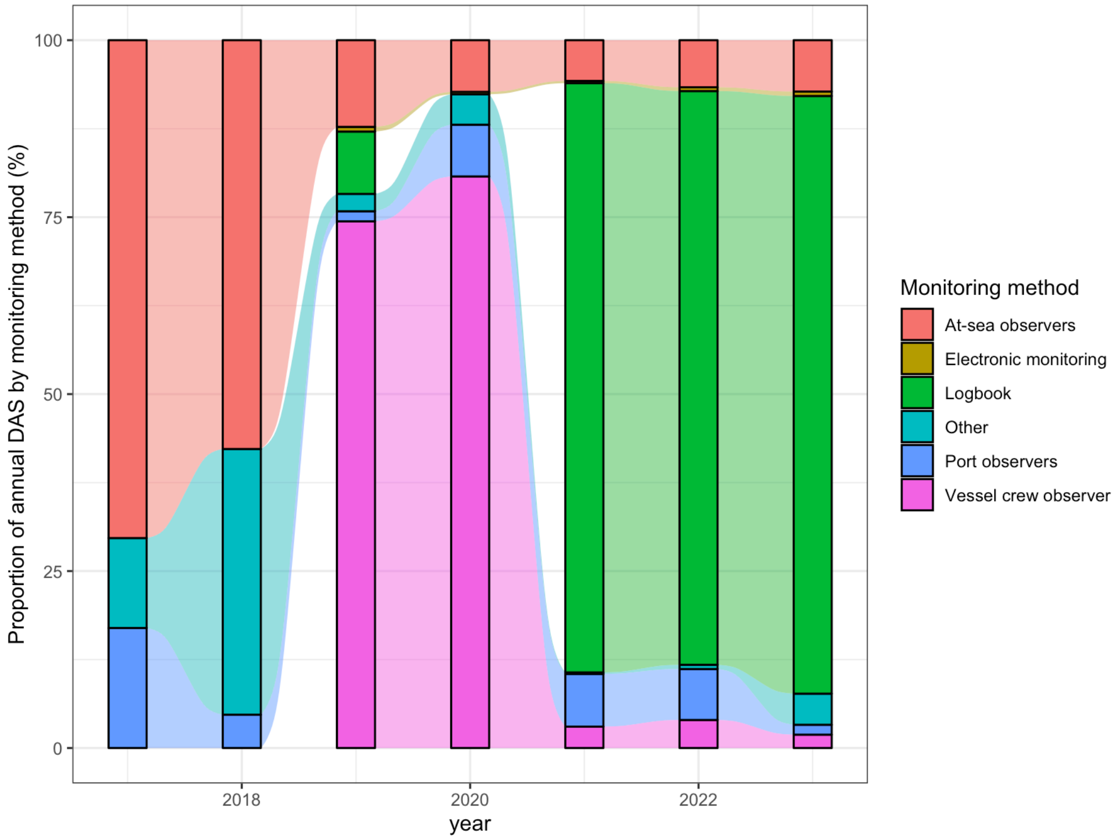

Figure 1.3 Total monitored (observed) days at sea reported per monitoring method (2017-2023)

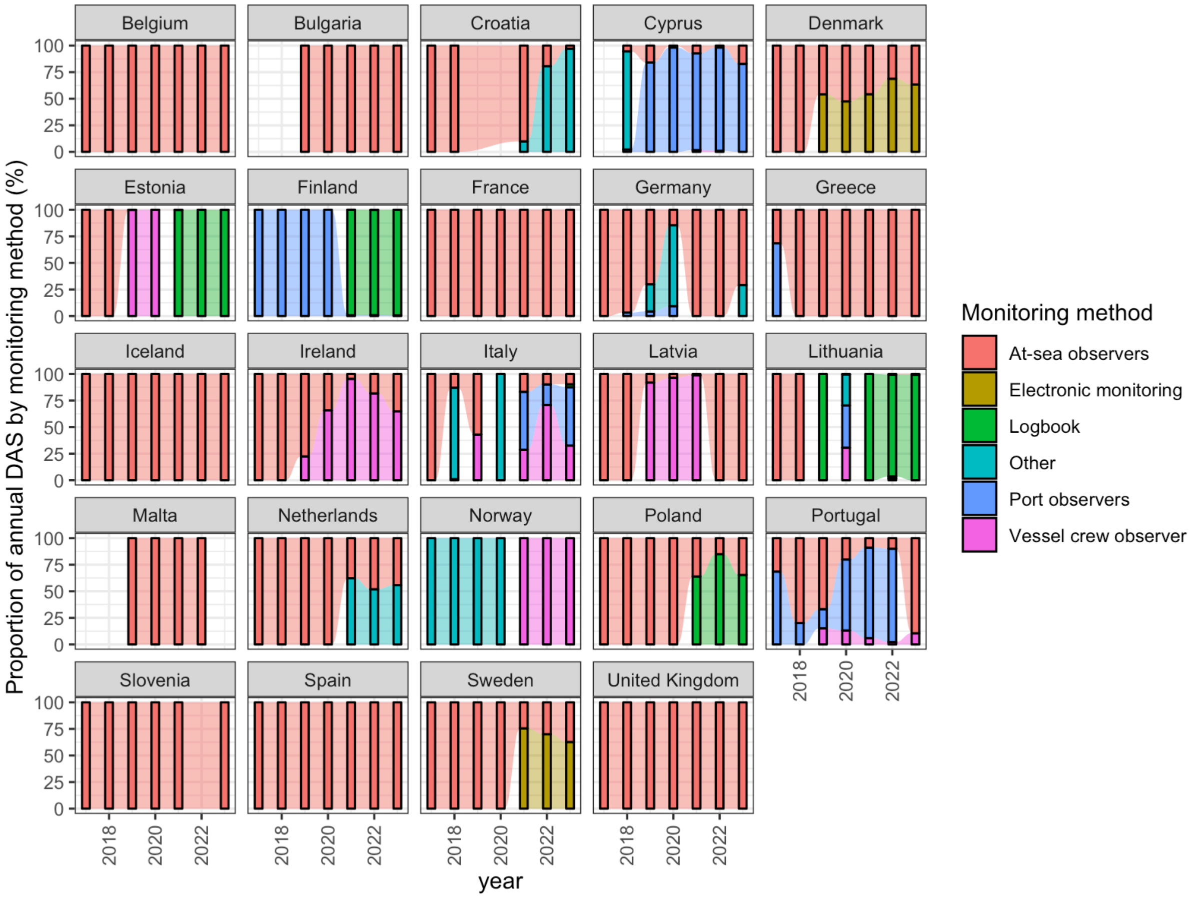

Figure 1.4 Total monitored (observed) days at sea reported by each country for each monitoring method (2017-2023)

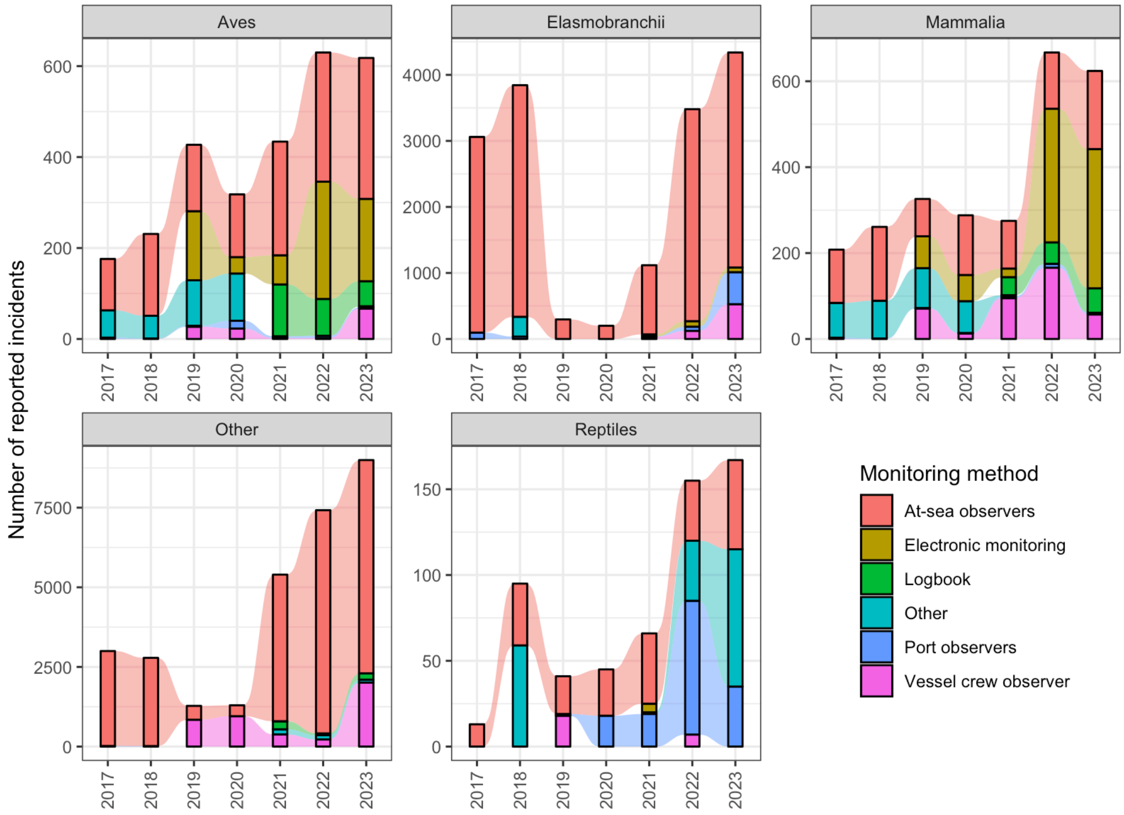

Figure 1.5 Total number of bycatch incidents for each taxa (birds, elasmobranchs, mammals, other fish species, and reptiles) reported by each monitoring method (2017-2023).

Table 1.3 Monitoring methods provided in the 2024 datacall template and their suitability for bycatch estimations.

	Monitoring Method	Summary
SO	At-Sea Observer	Data collected by independent observers using appropriate protocols for quantifying bycatch are currently considered by WGBYC to be the most reliable source of data for the calculation of bycatch rates across the full range of sensitive taxa for inclusion in detailed bycatch assessments.
PO	Port Observer	Data collected by independent observers in port are not currently considered reliable enough by WGBYC for the calculation of bycatch rates for inclusion in detailed bycatch assessments, though they may have value for highlighting bycatch occurrence in fisheries with no other monitoring.
EM	Electronic Monitoring	Data collected with electronic monitoring systems with appropriately placed cameras and suitable species identification methods are currently considered by WGBYC to be reliable for calculating bycatch rates for inclusion in detailed bycatch assessments.
VO	Vessel Crew Observer	Data collected by fishers following specific sampling protocols are currently considered by WGBYC to be moderately reliable for calculation of bycatch rates, particularly if data accuracy can be validated against independent monitoring data from the same fishery.
LB	Logbooks	Data recorded by fishers as part of mandatory bycatch reporting in official logbooks are currently considered by WGBYC to be unreliable for calculation of bycatch rates and inclusion in detailed bycatch assessments (see Basran & Már Sigurðsson 2021). Logbook data may have value for highlighting bycatch occurrence in fisheries with no other monitoring and/or for sensitive fish species that are permitted for sale.
OTH	Other	Other unspecified monitoring methods, e.g., interviews with fishers, are currently considered by WGBYC to be generally unsuitable for the calculation of bycatch rates for inclusion in detailed bycatch assessments as underlying biases are difficult to evaluate and estimate.

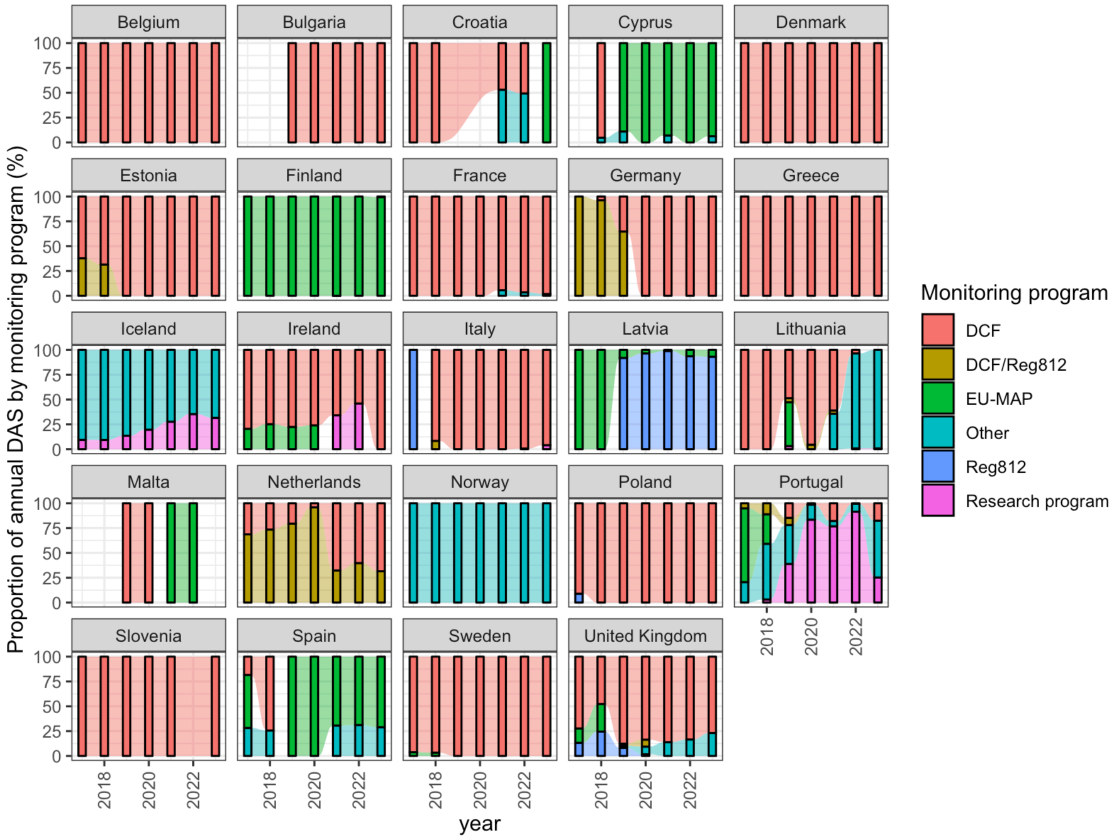

Figure 1.6 Total monitored (observed) days at sea reported by each country for each monitoring programme (2017-2023)

1.4 Electronic monitoring

Among the variety of monitoring methods that are reported annually to ICES as part of the data-call, electronic monitoring (EM) is currently considered by WGBYC to be one of the most reliable sources of data for the estimation of bycatch rates across a range of sensitive taxa.

Some countries are deploying EM efforts to estimate ETP species bycatch (Figure 1.7). Denmark, France, and Sweden submitted EM data from 2023 through the 2024 WGBYC data call. Spain also deployed efforts through EM programs but data were not included in the WGBYC data calls.

However, in relation to EM some challenges are still to be addressed (Dubroca *et al.* ICES poster). For instance, taxonomic identification can be problematic in some regions with EM. Sweden has stopped recording elasmobranch bycatch with EM in 2022 and onwards due to difficulties in taxonomic identification (Figure 1.8).

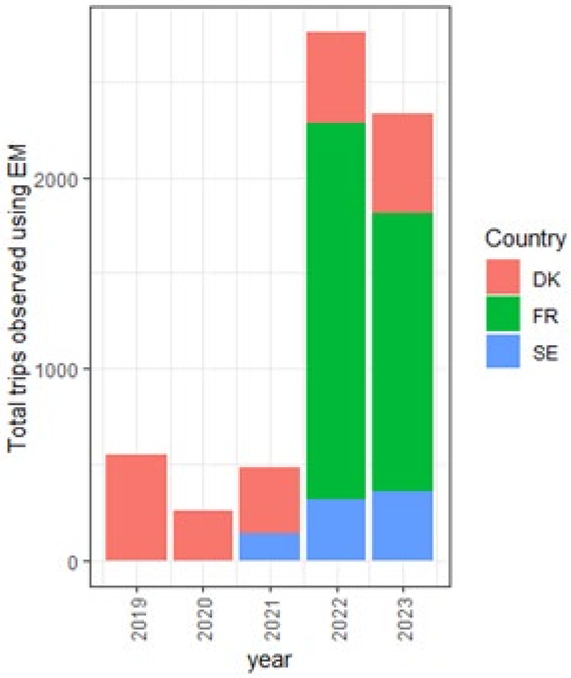

Figure 1.7 ***Total monitored (observed) number of fishing trips reported by each country with electronic monitoring.***

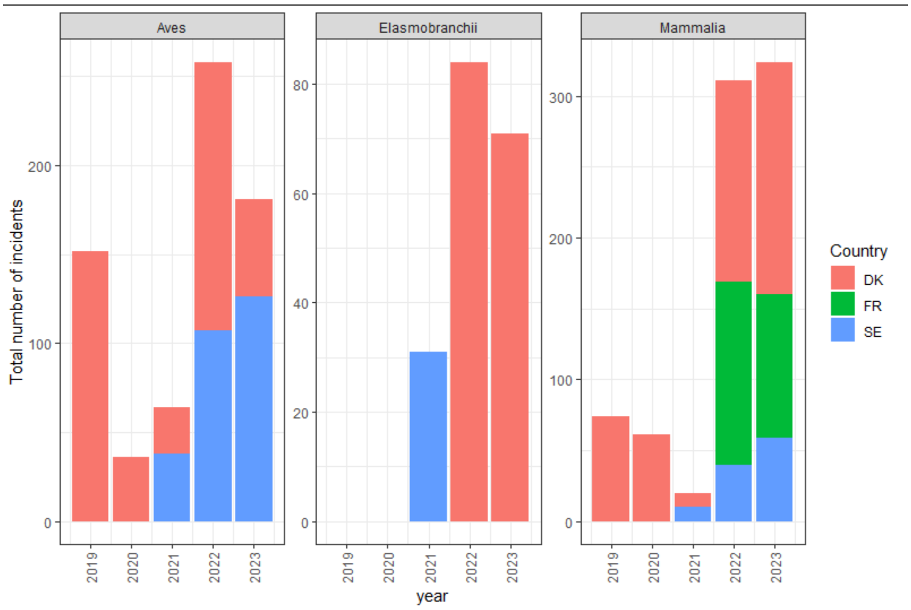

Figure 1.8 Total number of bycatch incidents reported by each country through the WGBYC data calls, observed with electronic monitoring. Sweden did not report elasmobranchs bycatch in 2022 and 2023 due to difficulties in taxonomic identification. France did not report bycatch of seabirds and elasmobranchs due to the necessity to obtain approval of vessel crews for analysis. Spain has ongoing EM research programs but did not submit EM data through the WGBYC data calls.

In some countries (e.g. France), EM data can only be analyzed with respect to cetaceans as no agreements with the vessels are in place for other ETP Species (Figure 1.8). Along with at-sea observers, EM is the source of a majority of bycatch records reported (Figure 1.5), with 52% of reported mammal and 29% of seabird bycatch incidents recorded by EM in 2023. This method allows continuous monitoring (unless malfunctions or interruption of the device), providing high survey coverage, and reducing the issues monitoring rare events such as ETP species bycatch.

When compared to at-sea observers, EM may be more efficient as it can monitor the hauling process all the time. In addition, if observers have other tasks and/or are not looking over the side of the vessel during hauling bycatches may be missed (e.g. 21% of bycatch for marine mammals on a preliminary estimation in gillnet fisheries on voluntary vessels in the Bay of Biscay, Vignard, Tachoires, 2023[1]). One of the ways to reduce the cost of EM analysis is the use of artificial intelligence algorithms (AI). AI efforts are currently being deployed through different research projects to improve EM:

Marine Beacon, https://marinebeacon.eu/ (2024-2027), focuses on next generation monitoring of ETP species bycatch through AI, with the aim to approach real-time monitoring and to reduce costly manual analysis of all the footage by pinpointing bycatch events.

DEV-OBSCAMe+ (2023-2025) linked to the OBSCAMe+ project on gillnetters, also aims to detect and classify bycatch events through AI, while looking to improve anonymization algorithms.

OPTIFISH, https://optifish.eu/, (2024-2026) EM video footage will be used to create training data sets for the developing deep neural networks for species identification, counts and measurement.

The OBSDEV, (2025 - 2027) and will focus on AI with the aim to adapt the algorithms to detect and classify bycatch for trawlers.

These are a few of the many examples of projects focusing on AI use in EM for ETP species. Collaborative efforts on AI training for monitoring of different fisheries should be deployed in the future.

1.5 Other monitoring programmes or additional projects to monitor bycatch of ETP species and associated bycatch estimates

In addition to direct DCF reporting to ICES, several countries have additional monitoring programmes and/or projects reporting on bycatch of ETP species in their waters. Below are details of ongoing programmes and/or projects, as reported by ICES representatives of member states. Programmes reported here are limited to those employing onboard monitoring through either fishers/log-books, observers, or EM-systems (other sources, e.g. strandings, are detailed in section 2.5). Details of known published reports and papers reporting bycatch estimates and/or rates, as highlighted by ICES representatives of member states, are summarized in Table 1.4. As no representatives from Canada, Latvia, and Russia were present in the group, no additional ongoing monitoring programmes or bycatch estimates/rates were reported for these countries.

1.5.1 Additional ongoing monitoring programmes

Finland, Germany, Lithuania, The Netherlands, Poland, and Sweden, had no additional programmes to report. While Bulgaria and Norway provided information for Table 1.4, no additional text was provided for section 2.4.1.

Belgium: Yearly marine mammal reports are published at www.marinemammals.be/reports (in French and Dutch, with English summaries). These contain an overview of marine mammal monitoring in Belgium waters. No data from onboard bycatch monitoring is reported.

[1] Sentence edited after the Advice Drafting Group in November 2024 following reviewers' comments

Estonia: One study (the Estonian Baltic Sea fishing vessels' CCTV system pilot project), with CCTV monitoring herring/sprat trawlers, is ongoing with data still to be analysed. These data are not considered in WGBYC assessments.

France: OBSCAMe is a French scientific program based on EM observation with the following objectives: (1) to reinforce the observation of incidental bycatch of marine mammals, especially for small cetaceans, while diversifying the methods of data collection, (2) to evaluate the scientific contributions of EM observation to better understand the interactions between gillnetters and marine mammals in the Bay of Biscay, and (3) to evaluate the cost/benefit ratio of these devices for the monitoring of marine mammal bycatches. This project is coordinated by the French Biodiversity Agency (OFB), in scientific partnership with IFREMER, Observatoire Pelagis La Rochelle University-CNRS and the Museum National d'Histoire naturelle (MNHN) under political supervision of the Ministries in charge of the environment and fisheries. Data are submitted separately from the DCF for inclusion in WGBYC assessments.

After a first phase in 2021 that validated the feasibility of the system on French gillnetters in the Bay of Biscay (with 5 voluntary vessels), and a second phase with 20 vessels, the OBSCAMe project ended in summer 2023 and was followed by OBCAMe+. As of December 2023, 32 gillnetters were equipped with onboard cameras. In 2023, 2002 days at sea and 6 655 fishing operations were observed with EM systems (the involvement and the fishing activity of the vessels fluctuated during the project) with 140 marine mammal bycatch identified for the year 2023. As this is a voluntary program (i.e. vessel participation is voluntary), the data may not be representative of the diversity of the Bay of Biscay gillnet fleet. The coverage in 2023 represented around 3.5% of the fishing effort of French gillnetters in the Bay of Biscay.

EM system can be used on gillnetters to provide information on marine mammal bycatch, as well as on the fishing effort of gillnetters (number of fishing operations, soak time, net length, etc.). More than 340 marine mammals have been identified in nets from 2021 to January 2024 (common dolphin – 66% and harbour porpoise – 19%: a relatively high proportion for this species compared to stranding data or at-sea observations data).

The project OBSCAMe+ is planned as part of the French action plan to reduce cetacean bycatch in the Bay of Biscay. It will integrate the analysis of other marine protected species (for volunteer vessels) such as seabirds, turtles, and European sturgeon, and will also contribute to assessing the efficiency of bycatch reduction devices (BRD). The legal decree making the use of cameras and acoustic deterrent devices mandatory on gillnetters fishing in areas 27.8.a and 27.8.b is still pending.

Iceland: Bycatch is monitored by onboard inspectors from the Directorate of Fisheries. All fisheries are monitored as part of this national monitoring program, and coverage varies between 1 and 5% of total fishing effort. In addition to that monitoring programme, bycatch is recorded in annual trawl and gillnet surveys conducted by the Marine and Freshwater Research Institute. These data are submitted for inclusion in WGBYC assessments.

Ireland: Sample monitoring of bycatch in the tangle-net crayfish fishery (South West Ireland) is carried out by the Marine Institute, under financing from the Irish Government and the European Maritime, Fisheries and Aquaculture Fund as part of the EMFAF Operational Programme for 2021-2027. These data are submitted separately from the DCF for WGBYC assessments.

Portugal: In 2023, significant observer effort was provided by several dedicated projects. Monitoring effort from the southern coast (Algarve) led by the Centre of Marine Sciences of the Algarve (CCMAR), was reported under the scope of Life Ilhas Barreira (2019-2024) and Carefish-Catch (2021-2025). Effort from the western coast led by the Society for the Study of Birds (SPEA), was reported from work within projects Anzol + and Life+ PanPuffinus. All projects use the same sampling methodology, such as onboard observations and vessel crew paper logbooks filled by trained fishers. The contribution of these dedicated projects, especially with at sea observers and vessel crew entries, significantly increased the observation effort with hundreds of trips being monitored, allowing the report of incidental catches of different ETP taxa (cetaceans, reptiles, marine birds and fish). In 2023, both institutions (CCMAR and SPEA) reported 17 day-trips with pots and traps, 17 day-trips of purse seining, 19 day-trips of set gillnet (GNS), and 26 day-trips in trammel nets (GTR) with onboard observers in vessels at different length ranges. Bycatches were reported for cetaceans and marine birds. All cetaceans (3 common dolphins) were reported in the purse seine fishery, 182 marine birds (153 *Morus bassanus*, 4 *Alca torda*, 16 *Larus sps*, 2 *Melanitta nigra*, 4 *Puffinus mautitanicus* and 4 *Uria aalge*) were observed dead when hauled mostly in GTR (1 *Alca torda* reported only for GNS). These data are submitted for inclusion in WGBYC assessments.

Spain: A sampling program related to monitoring and evaluation of cetacean bycatch using EM in the Cantabrian and Northwest trawl fleet (southern Bay of Biscay) equipped with acoustic active cetacean deterrent devices (pingers) is carried out by AZTI and supported by the Spanish General Secretariat for Fisheries of the Ministry of Agriculture, Fisheries and Food (SGP-MAPA). Bottom trawlers from ICES 8c and longliners from ICES 5b, 6 and 7 were equipped with EM from march to July and although the primary objective was the cetacean monitoring, birds, and elasmobranchs were also recorded. The vessels involved in the programme were presented voluntarily and the sampling period was not randomly selected. The objective was to quantitatively evaluate the bycatch of cetaceans in the Cantabrian and Northwest trawl fleet equipped with active acoustic cetacean deterrent devices (pingers) through EM. The programme is ongoing and started in October 2020. The data collected in this program were not included in the WGBYC data call or submitted directly to WGBYC for inclusion in assessments as the vessel selection and period was not randomly selected and could lead to some bias when estimating bycatch rates from this data.

Also in Spain, since October 2020, an ongoing onboard sampling program (at-sea observers) for monitoring the bycatch of marine mammals and other ETP species is carried out by the Spanish Ministry of Fisheries focused on the Spanish métiers in waters of the Cantabrian-Northwest national fishing ground (ICES divisions 27.8.c and 27.9.a) and French waters of the Bay of Biscay (ICES Division 27.8.a.b.d). The first annual pilot program was extended and continued to the present incorporating different improvements such as the inclusion of new métiers, increases in monitoring coverage (by 50%), and the observation of the ICES 2024 recommendations. Data for all sampling years of this program (2020 - 2023) are included in submissions to the annual WGBYC data call. Data from the first year of this programme (October 2020-September 2021) were analyzed to check the representativeness of the sampling design and estimate BPUEs for marine mammals caught by the Spanish bottom gillnet and pair trawl bottom fleets (Castro et al 2024).

In addition to the projects described above, a pilot program was carried out to study the feasibility of installing onboard cameras in the artisanal set gillnet and trammel net fleets (vessels less than 12 m). These fleets operate in the Spanish Cantabrian-Northwest fishing grounds (ICES Divisions 27.8.c and 27.9.a North) to monitor the incidental catch of marine mammals. This action was developed within the framework of the Spanish Government's Recovery, Transformation and Resilience Plan, the main instrument for the development of the Next Generation EU recovery funds. Within this an agreement was signed between the Ministry of Fisheries and the State Agency of the Spanish National Research Council (CSIC) to promote fisheries research as a basis for sustainable fisheries management. Two vessels have been monitored for a year (March 2023-February 2024), a total of 95 trips. No bycatch of marine mammals has been reported. The pilot program found that logistically the use of EM methodology in this fleet segment is feasible: no instrumental problems were detected, however, the cooperation of the fishing sector was particularly limited. Although no bycatch was recorded, EM methodology seems to be appropriate for recording mammal specimens and their taxonomic identification, and with the appropriate calibration also the recording of biometrics. The study proposed to adopt a mixed programme maintaining the Spanish at-sea dedicated programme described in the previous section on vessels over 12 m in length and implementing the EM methodology on vessels less than 12 m in length. In this way, a 5% coverage of the artisanal fleet could realistically be achieved. To improve collaboration with the fishing sector, it could be effective to draw up a regulation at European level establishing a general obligation for Member States to use EM technology as a control tool, whose images could later be reused for scientific purposes.

United Kingdom: In the UK, Clean Catch (https://www.cleancatchuk.com/) is a collaborative research programme formed of fishers, scientists, conservationists, policy makers, and others working to develop fisher-led approaches to monitor and mitigate sensitive species bycatch. Mitigation work from Clean Catch is detailed under Tor B.

Clean Catch is developing and testing tools for monitoring bycatches, including a smartphone application (the Clean Catch app) and the use of EM. In 2024, the programme released a self-reporting app to collect data on bycatches of sensitive species for use by multiple gear types following development and testing by fishers. Clean Catch uses EM on a subset of vessels where skippers are self-reporting bycatch events to assess the quality of these data types. Due to the high resource requirements to analyse the EM data, the project continues to collate images and contribute to collaborative databases required for training AI, in collaboration with the UK's Bycatch Monitoring Programme. Clean Catch has also deployed an acoustic array in the southwest of England which is being used to examine localised spatial and seasonal patterns of cetacean density in an area of higher bycatch risk. Approximately 1,733 days of data have been collected as of April 2024. These data are not included in WGBYC assessments.

The Insight360 project is developing a cetacean bycatch EM system. This project began in 2021 and is due to be delivered in 2024. Five vessels have EMinstalled to collect image and voice records. Research is continuing to improve software and hardware features such as automatic haul detection and speech to text tools.

In addition to work under Clean Catch, a Scottish Government funded study aimed to improve knowledge and understanding of bycatch in offshore longline hake fisheries (in UK and EU waters), using a combination of data analysis (collected in collaboration with industry partners) and literature review, focusing on several seabird species (details at www.gov.scot/publications/improving-understanding-seabird-bycatch-scottish-longline-fisheries-exploring-potential-solutions/). Post 2018 data are submitted for WGBYC assessments.

United States of America: Northeastern USA bycatch estimates are collected through fisheries observer coverage (see Table 1.4 for details and www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessment-reports-region). This information is submitted for WGBYC assessments.

NAMMCO: The NAMMCO Scientific Committee (SC21) established a Bycatch Working Group in 2014 with members from four countries: Faroe Islands (FO), Iceland (IS), Norway (NO), and Greenland (GL). The WG has met 9 times and will meet next in October 2024. The Terms of Reference (ToR) of the working group (WG) as defined by SC21 are:

1. Identify all fisheries with potential bycatch of marine mammals

2. Review and evaluate current bycatch estimates for marine mammals in NAMMCO countries

3. If necessary, provide advice on improved data collection and estimation methods to obtain best estimates of total bycatch over time

The NAMMCO WG has reviewed bycatch estimates provided by its members. It has endorsed estimates of marine mammal bycatch for the Icelandic lumpsucker fishery for the period 2014-2018 (BCWG 2020), estimates of harbour seal (*Phoca vitulina*) and grey seal (*Halichoerus grypus*) bycatch in Norwegian commercial coastal gillnet fisheries for the period 2006-2020 (BCWG 2021), and estimates of harbour porpoise (*Phocoena phocoena*) bycatch in Norwegian commercial coastal gill-net fisheries 2006-2018 (BYCWG 2021). As reliable data on by-catch is lacking for other fisheries, the WG is currently progressing with assessing bycatch exposure, by mapping the overlap of fishing effort (both national and foreign) and marine mammal distribution in the NAMMCO area. The WG sent out a data call to the fishery departments of the NAMMCO Parties, requesting monthly fishing effort data for all métiers, at a spatial resolution of ICES Rectangle (or comparable), for the years 2019–2023. The aim of the WG is to begin analysis and visualisation of these data at its next meeting, in October 2024, following which it will be able to identify fishing gears and areas where increased bycatch monitoring may be needed.

1.6 Published bycatch estimates/rates

Table 1.4 Details bycatch estimates highlighted by ICES representatives of member states.

Country	Year	Fishery	Species	Rate	Estimate	Source
Bulgaria	2019-2024	Gillnets	Harbour porpoise	-	282	Green Balkans NGO
	2019-2024	Gillnets	Bottlenose dolphin	-	21	Green Balkans NGO
Denmark	2020	All DK and SE gillnet fisheries	Harbour porpoise	-	2089 (666-6798)	https://royalsocietypublishing.org/doi/pdf/10.1098/rspb.2022.2570
Iceland	2020-2023	Lumpsucker gillnets	Harbour porpoise	-	108 (95% CI 41-175)	https://www.hafogvatn.is/static/extras/images/taekniskyrsla-medafli-fugla-og-spendyra-i-grasleppuveidum-20231429811.pdf
	2020-2023	Lumpsucker gillnets	Harbour seal	-	501 (95% CI 296-716)	https://www.hafogvatn.is/static/extras/images/taekniskyrsla-medafli-fugla-og-spendyra-i-grasleppuveidum-20231429811.pdf
	2020-2023	Lumpsucker gillnets	Grey seal	-	159 (95% CI 27-291)	https://www.hafogvatn.is/static/extras/images/taekniskyrsla-medafli-fugla-og-spendyra-i-grasleppuveidum-20231429811.pdf
	2020-2023	Lumpsucker gillnets	Common guillemot	-	890 (95% CI 392-1388)	https://www.hafogvatn.is/static/extras/images/taekniskyrsla-medafli-fugla-og-spendyra-i-grasleppuveidum-20231429811.pdf
	2020-2023	Lumpsucker gillnets	Brünnich's guillemot	-	54 (95% CI 16-92)	https://www.hafogvatn.is/static/extras/images/taekniskyrsla-medafli-fugla-og-spendyra-i-grasleppuveidum-20231429811.pdf
	2020-2023	Lumpsucker gillnets	Black guillemot	-	1485 (95% CI 698-2272)	https://www.hafogvatn.is/static/extras/images/taekniskyrsla-medafli-fugla-og-spendyra-i-grasleppuveidum-20231429811.pdf
	2020-2023	Lumpsucker gillnets	Cormorants	-	333 (95% CI 120-546)	https://www.hafogvatn.is/static/extras/images/taekniskyrsla-medafli-fugla-og-spendyra-i-grasleppuveidum-20231429811.pdf
	2020-2023	Lumpsucker gillnets	Eider duck	-	2245 (95% CI 1280-3210)	https://www.hafogvatn.is/static/extras/images/taekniskyrsla-medafli-fugla-og-spendyra-i-grasleppuveidum-20231429811.pdf
	2020-2023	Lumpsucker gillnets	Puffin	-	10 (95% CI 1-20)	https://www.hafogvatn.is/static/extras/images/taekniskyrsla-medafli-fugla-og-spendyra-i-grasleppuveidum-20231429811.pdf
	2020-2023	Lumpsucker gillnets	Long-tailed duck	-	50 (95% CI 5-90)	https://www.hafogvatn.is/static/extras/images/taekniskyrsla-medafli-fugla-og-spendyra-i-grasleppuveidum-20231429811.pdf
	2020-2023	Lumpsucker gillnets	Black-legged kittiwake	-	10 (95% CI 1-20)	https://www.hafogvatn.is/static/extras/images/taekniskyrsla-medafli-fugla-og-spendyra-i-grasleppuveidum-20231429811.pdf

	2020-2023	Lumpsucker gillnets	Razorbill	-	28 (95% CI 3-52)	https://www.hafogvatn.is/static/extras/images/taekniskyrsla-medafli-fugla-og-spendyra-i-grasleppuveidum-20231429811.pdf
	2020-2023	Lumpsucker gillnets	Northern gannet	-	10 (95% CI 1-20)	https://www.hafogvatn.is/static/extras/images/taekniskyrsla-medafli-fugla-og-spendyra-i-grasleppuveidum-20231429811.pdf
	2020-2023	Lumpsucker gillnets	Common loon	-	11 (95% CI 1-22)	https://www.hafogvatn.is/static/extras/images/taekniskyrsla-medafli-fugla-og-spendyra-i-grasleppuveidum-20231429811.pdf
	2020-2023	Lumpsucker gillnets	Fulmar	-	41 (95% CI 14-66)	https://www.hafogvatn.is/static/extras/images/taekniskyrsla-medafli-fugla-og-spendyra-i-grasleppuveidum-20231429811.pdf
	2020	Cod gillnets	Harbour porpoise	-	2100 (cv 0.3)	https://cdnsciencepub.com/doi/full/10.1139/cjfas-2019-0386
	2020	Cod gillnets	Harbour seal	-	50 (cv 1.0)	https://cdnsciencepub.com/doi/full/10.1139/cjfas-2019-0386
	2020	Cod gillnets	Grey seal	-	15 (cv 1.0)	https://cdnsciencepub.com/doi/full/10.1139/cjfas-2019-0386
Ireland	2011 to 2016	Static-net (misc species)	Grey seal	-	202 (90% CI: 2-433) to 349 (90% CI: 6-833) annually (2011-2016)	https://www.sciencedirect.com/science/article/pii/S235198942030754X
Norway	2018-2021	Purse seine, NSS herring	*Laurs spp.*	-	0.356 (95% CI = 0.133–0.949)	https://doi.org/10.1016/j.marenres.2022.105625
	2006-2015	gillnet-fishery	Bird species	-	Per trip: 0.06 (SE = 0.02)	https://doi.org/10.1371/journal.pone.0212786
Portugal	2018-2022	GNS - red mullet, 27.9a	Tursiops truncatus	0.009	-	https://www.sciencedirect.com/science/article/pii/S0165783624001644?via%3Dihub
	2018-2022	GNS - monkfish, 27. 9 a	Delphinus delphis	0.008	-	https://www.sciencedirect.com/science/article/pii/S0165783624001644?via%3Dihub
	2018-2022	GNS - monkfish, 27. 9 a	Tursiops truncatus	0.008	-	https://www.sciencedirect.com/science/article/pii/S0165783624001644?via%3Dihub
	2018-2022	GTR	Tursiops truncatus	0.006	-	https://www.sciencedirect.com/science/article/pii/S0165783624001644?via%3Dihub
Spain	2020-2021	GNS, 27.8.c	*Delphinus delphis*	0.012	-	https://doi.org/10.1093/icesjms/fsad197
	2020-2021	PTB, 27.8.b	*Delphinus delphis*	0.865	-	https://doi.org/10.1093/icesjms/fsad197
	2020-2021	PTB, 27.8.c	*Globicephala melas*	0.054	-	https://doi.org/10.1093/icesjms/fsad197
	2020-2021	PTB, 27.8.c	*Delphinus delphis*	0.012	-	https://doi.org/10.1093/icesjms/fsad197
	2020-2021	PTB, 27.8.c	*Tursiops truncatus*	0.054	-	https://doi.org/10.1093/icesjms/fsad197
UK	2010-2018	Long-line hake fisheries (UK/EU)	Great Shearwaters	-	~10-20 per year	https://www.gov.scot/publications/improving-understanding-seabird-bycatch-scottish-longline-fisheries-exploring-potential-solutions/

	2010-2018	Long-line hake fisheries (UK/EU)	Great Skuas	-	~10-20 per year	https://www.gov.scot/publications/improving-understanding-seabird-bycatch-scottish-longline-fisheries-exploring-potential-solutions/
	2010-2018	Long-line hake fisheries (UK/EU)	Northern Gannets	-	~100 per year	https://www.gov.scot/publications/improving-understanding-seabird-bycatch-scottish-longline-fisheries-exploring-potential-solutions/
	2010-2018	Long-line hake fisheries (UK/EU)	Northern Fulmars	-	~1000 per year	https://www.gov.scot/publications/improving-understanding-seabird-bycatch-scottish-longline-fisheries-exploring-potential-solutions/
USA	2018-2022	New England Gillnet	*Tursiops truncatus*	-	1 (CV=1.78)	https://repository.library.noaa.gov/view/noaa/56564
	2018-2022	New England Gillnet	*Delphinus delphis*	-	42 (CV=0.22)	https://repository.library.noaa.gov/view/noaa/56564
	2018-2022	New England Gillnet	*Halichoerus grypus*	-	1210 (CV=0.09)	https://repository.library.noaa.gov/view/noaa/56564
	2018-2022	New England Gillnet	*Phocoena phocoena*	-	125 (CV=0.12)	https://repository.library.noaa.gov/view/noaa/56564
	2018-2022	New England Gillnet	*Phoca vitulina*	-	237 (CV=0.09)	https://repository.library.noaa.gov/view/noaa/56564
	2018-2022	New England Gillnet	*Pagophilus groenlandicus*	-	63 (CV=0.16)	https://repository.library.noaa.gov/view/noaa/56564
	2018-2022	New England Gillnet	*Grampus griseus*	-	3 (0.57)	https://repository.library.noaa.gov/view/noaa/56564
	2018-2022	New England Gillnet	*Lagenorhynchus acutus*	-	1 (1.17)	https://repository.library.noaa.gov/view/noaa/56564
	2018-2022	Mid-Atlantic Gillnet	*Delphinus delphis*	-	22 (CV=0.27)	https://repository.library.noaa.gov/view/noaa/56564
	2018-2022	Mid-Atlantic Gillnet	*Halichoerus grypus*	-	8 (CV=0.38)	https://repository.library.noaa.gov/view/noaa/56564
	2018-2022	Mid-Atlantic Gillnet	*Phocoena phocoena*	-	10 (CV=0.39)	https://repository.library.noaa.gov/view/noaa/56564
	2018-2022	Mid-Atlantic Gillnet	*Phoca vitulina*	-	13 (CV=0.24)	https://repository.library.noaa.gov/view/noaa/56564
	2018-2022	Mid-Atlantic Gillnet	*Pagophilus groenlandicus*	-	7 (CV=0.89)	https://repository.library.noaa.gov/view/noaa/56564
	2018-2022	Northeast Bottom Trawl	*Tursiops truncatus*	-	3 (CV=0.41)	https://repository.library.noaa.gov/view/noaa/56563
	2018-2022	Northeast Bottom Trawl	*Delphinus delphis*	-	23 (CV=0.21)	https://repository.library.noaa.gov/view/noaa/56563
	2018-2022	Northeast Bottom Trawl	*Halichoerus grypus*	-	25 (CV=0.15)	https://repository.library.noaa.gov/view/noaa/56563

	2018-2022	Northeast Bottom Trawl	*Phocoena phocoena*	-	5 (CV=0.39)	https://repository.library.noaa.gov/view/noaa/56563
	2018-2022	Northeast Bottom Trawl	*Phoca vitulina*	-	4 (CV=0.38)	https://repository.library.noaa.gov/view/noaa/56563
	2018-2022	Northeast Bottom Trawl	*Pagophilus groenlandicus*	-	1 (CV=1.45)	https://repository.library.noaa.gov/view/noaa/56563
	2018-2022	Northeast Bottom Trawl	*Globicephala melas*	-	4 (CV=0.66)	https://repository.library.noaa.gov/view/noaa/56563
	2018-2022	Northeast Bottom Trawl	*Grampus griseus*	-	1 (CV=3.02)	https://repository.library.noaa.gov/view/noaa/56563
	2018-2022	Northeast Bottom Trawl	*Lagenorhynchus acutus*	-	8 (CV=0.30)	https://repository.library.noaa.gov/view/noaa/56563
	2018-2022	Mid-Atlantic Bottom Trawl	*Tursiops truncatus*	-	13 (CV=0.74)	https://repository.library.noaa.gov/view/noaa/56563
	2018-2022	Mid-Atlantic Bottom Trawl	*Delphinus delphis*	-	285 (CV=0.12)	https://repository.library.noaa.gov/view/noaa/56563
	2018-2022	Mid-Atlantic Bottom Trawl	*Halichoerus grypus*	-	33 (CV=0.32	https://repository.library.noaa.gov/view/noaa/56563
	2018-2022	Mid-Atlantic Bottom Trawl	*Phoca vitulina*	-	3 (CV=0.80)	https://repository.library.noaa.gov/view/noaa/56563
	2018-2022	Mid-Atlantic Bottom Trawl	*Grampus griseus*	-	12 (CV=1.25)	https://repository.library.noaa.gov/view/noaa/56563

1.7 Auxiliary data (i.e., strandings, interviews) indicative of the impact of bycatch

1.7.1 Strandings networks to inform on marine mammal bycatch

The analyses of strandings are an important source of biological data, species composition, and distribution, but also contribute to knowledge on cause of death, including bycatch. When deployment of observers can be challenging and observation effort is low or non-existent, examination of stranded animals can provide relevant information on impact of fisheries activities on marine megafauna. However, the representativeness of strandings in relation to deaths at sea depends directly on various parameters such as drift conditions, which may or may not favor stranding, the buoyancy of the carcasses, and the nature and accessibility of the coasts and how often they are visited. While examining carcasses alone gives a minimum estimate of bycatch, these different factors must be considered to provide estimates for the numbers of bycatches at sea.

Please note only individual specimens presenting with bycatch evidence were considered here.

In **Belgium**, the Royal Belgian Institute of Natural Sciences (RBNIS) organises the collection of strandings. In cooperation with the University of Liège, a single database can be consulted online (http://www.marinemammals.be/).

Along the coasts of **Denmark,** the stranding network is run by the Aarhus University, Danish Nature Agency in collaboration with the Fisheries and Maritime Museum and the Zoological Museum, Natural History Museum of Denmark.

Along **French** coasts, 400 trained volunteers or employees constitute the French stranding network (Réseau National Echouage), coordinated by the Joint Service Unit *Observatoire Pelagis*, UMS 3462 University of La Rochelle/CNRS. It is funded by the Ministry in charge of the environment and the French Office for Biodiversity. The network collects standardized data following a common protocol, and a database can be consulted online (http://pelagis.in2p3.fr/public/histo-carto/index.php). Since the origin of the network in the 1980's, thousands of marine mammals have been recorded with high numbers, especially of common dolphins reported in recent years.

The **Irish** Whale and Dolphin Group (IWDG) established a stranding scheme in 1990 which operates throughout the island of Ireland, and has been partially funded by the DCHG National Parks and Wildlife Service (NPWS) annually since 2014. The scheme involves the collection of baseline data by local Stranding Network Volunteers (GPS location, date, species, length, gender, detailed images and skin samples stored in the Irish Cetacean Genetic Tissue Bank (ICGTB)). Volunteers are IWDG members who are provided with IWDG's Stranding Information Booklet containing detailed protocols for data collection, and training is provided at IWDG's annual Stranding Network Meeting. All stranding records going back one year are available online at www.iwdg.ie. Data going further back can be made available via a data request. With support from NPWS, the IWDG currently manages the Deep Diving and Rare species Investigation Programme (DDRIP), which carries out post-mortem examinations of the rarer species (Risso's and bottlenose dolphins for 2023). Ireland currently has no post-mortem scheme covering the more common species, such as common dolphins and harbour porpoises.

In **the Netherlands,** the strandings network consists of a consortium of a number of organizations and volunteers. The observation effort is unequal along Dutch coasts (approaching 100% in Western coasts, but very low in uninhabited Frisian islands and Wadden Sea). Approximately 10 to 20% of carcasses are necropsied every year at the Faculty of Veterinary Medicine of Utrecht University.

The **Portuguese mainland** stranding network is coordinated by the National Institute of Conservation of Nature and Forests (ICNF). Up to 2020, two regional stranding networks, one in the north (continuous since 2000) and one in the south (operating from 2010 to 2017) covered about 75% of the coast. Since 2020 national governmental funds provide support to the national stranding network, reactivating the southern regional stranding network and activating two new networks. Presently, four dedicated 24/7 on-call strandings teams cover 100% of the coast were operating in full since 2022, obtaining information on cetaceans and marine turtles The northwestern coast is covered by a team of biologists and a veterinarian with co-coordination by the University of Aveiro and the Portuguese Wildlife Society. The Lisbon and Tagus Valley Network (RALVT) has been operating between Lourinhã and Setúbal since November 2021 with a team of biologists and veterinarians, and coordinated by ISPA - Instituto Universitário. The other two teams operate in the Southwestern coast (Alentejo) and Southern coast (Algarve), being coordinated respectively by the University of Évora and Centre of Marine Science (CCMAR).

Along **Spanish** coasts, the NGO CEMMA has been in charge of the coordination of the Galician stranding network since the early 1990s. Since 1999, the Ministry of Environment-Xunta de Galicia provides financial support and grants administrative authorizations to cover the 1,190km of the coast of Galicia.

The collaborative Cetacean Strandings Investigation Programme (CSIP) in the **United Kingdom** is a consortium of partner organizations (Zoological Society of London, Scottish Rural University

College (Inverness), the Natural History Museum and Marine Environmental Monitoring) funded by Defra and the UK Devolved Governments of Scotland and Wales. The CSIP is collectively tasked with recording information on all cetaceans, marine turtles and basking sharks that strand around UK shores each year and with the routine investigation of causes of mortality through necropsy of suitable strandings. Stranding network was recently divided into two independent structures: Scottish Marine Animal Strandings Scheme operating along the Scottish shore, and CSIP covering the rest of the UK.

Table 1.5 Strandings of marine mammals, number of examinations on fresh and slightly decomposed carcasses, and proportion of examined stranded animals with evidence of fishery interaction (carcasses with bycatch evidence/examinations) reported for 2023 (Atl = Atlantic coasts, Med = Mediterranean coasts).

Species	Country	Strandings (n)	Examinations on fresh or slightly decomposed carcasses (n)	Bycatch evidence / examinations (%)
Phocoena phocoena	Belgium	26	7	1/7 (14%)
	Denmark	190	15	3/15 (20%)
	France (Atl)	218	75	14/75 (19%)
	Netherlands	501	47	10/47 (21%)
	Portugal	58	25	21/25 (84%)
	Spain (Galicia)	14	5	3/5 (60%)
	United Kingdom	557	36	1/36 (3%)
Delphinus delphis	France (Atl)	1756	788	558/788 (71%)
	Portugal	285	163	101/163 (62%)
	Spain (Galicia)	458	152	90/152 (59%)
	United Kingdom	467	54	8/54 (15%)
Stenella coeruleoalba	France (Atl)	47	23	3/23 (13%)
	France (Med)	36	10	1/10 (10%)
Tursiops truncatus	France (Atl)	64	11	4/11 (36%)
	France (Med)	26	4	1/4 (25%)
	Ireland	8	1	1/1 (100%)
	Portugal	8	3	2/3 (66%)
	Spain (Galicia)	43	11	3/11 (27%)
Grampus griseus	France (Atl)	6	1	1/1 (100%)
	Ireland	3	1	1/1 (100%)
	United Kingdom	23	4	1/4 (25%)

Species	Country	Strandings (n)	Examinations on fresh or slightly decomposed carcasses (n)	Bycatch evidence / examinations (%)
Balaenoptera acutorostrata	Portugal	5	2	1/2 (50%)
Megaptera novaeangliae	Spain (Galicia)	1	1	1/1 (100%)
Halichoerus grypus	France (Atl)	308	109	9/109 (8%)
	Belgium	16	8	3/8 (5%)
Phoca vitulina	France (Atl)	119	32	1/32 (3%)
	Belgium	14	8	4/8 (50%)

Thirteen stranding networks in eight countries reported strandings to WGBYC in 2023 (Table 1.5).

With an unprecedented record number of strandings recorded along the French coast of the Bay of Biscay, the common dolphin is the main species found stranded in 2023. The apparent bycatch rate is very high (>50%) in the Bay of Biscay and the Iberian Peninsula.

Harbour porpoises were the second detected species, from Denmark to southern Portugal. The proportion of bycaught porpoises ranged from 3% in UK waters, to 84% along the Portuguese coasts. The high proportion of bycaught porpoises in the Iberian Peninsula, the Bay of Biscay and the eastern coasts of North Sea highlighted an important pressure of fishing activities on porpoises in the management units of the Greater North Sea, Celtics Seas, and the Iberian Peninsula.

Bottlenose dolphins also presented high levels of interactions with fisheries, as 25% (French Mediterranean waters) to 100% (Ireland, although this is based on just one individual) of examined carcasses presenting evidence of bycatch in fishing gears.

Large whales with evidence of bycatch were observed in Portuguese and Galician waters (five Minke whales (*Balaenoptera acutorostrata*) and one humpback whale (*Megaptera novaeangliae*)).

Both grey seals and harbour seals were recorded along French Atlantic and Belgian coasts, but the proportion of animals with bycatch evidence remained low (below 10%), except for harbor seals along coasts of Belgium (50%). It should be noted that due to their fur, bycatch evidence based on external examination of seals can be hard to detect.

Correcting the stranding occurrences by drift conditions and probability of sinking (following Peltier *et al.*, 2016) provided bycatch estimates of common dolphins in the Bay of Biscay and Western Channel inferred from French data. During the winter of 2023, the highest levels of strandings ever recorded along the French coast were observed between the months of January and March. During these 3 months, the apparent bycatch rate reached 80%. During this year, the highest bycatch levels inferred from strandings have been estimated since 1990, reaching 11,330 common dolphins (CI95% [8 490 ; 15 990]) for this period in the Bay of Biscay and Western Channel. On the other hand, bycatch was estimated at 140 harbor porpoises (CI95% [100 ; 190]), below the average for the last 25 years for the Bay of Biscay and the English Channel (strandings recorded in France).

1.7.2 Interviews and questionnaires with fishermen

In Estonia, bycatch data is being gathered via interviews and questionnaires from a small sample of coastal fishermen (about 40). Results are not yet finalized.

1.8 Conclusions

The quality and scope of the information provided by the ICES WGBYC 2024 datacall for 2023 was variable, although WGBYC considered that the data quantity and quality have been steadily improving since the first data call in 2018. However, quality issues remain (and were corrected) during the WG in 2024. Data checks should be performed by data submitters in advance to avoid delays during the WG. Figures and tables of the TOR A were elaborated following the Transparent Assessment Framework (TAF) principles and are made available in the WGBYC github depository (here).

In total (all ecoregions combined), 952 marine mammals, 1238 seabird, 186 marine turtles, and over 230 thousand fish specimens were reported as bycaught in 2023 based on data submitted to WGBYC as part of the 2024 data call.

Most countries continue to rely on the DCF sampling programme to monitor ETP species bycatch. DCF sampling programs has been shown to underestimate bycatch events in some metiers, however, several countries have been running research projects or dedicated programs to monitor bycatch of ETP species to generate improved bycatch rate estimates. In the last three years there has been an increase in the submission of data from indirect monitoring methods, i.e., logbook data and port observers. This presents additional challenges when interpreting levels of bycatch across fisheries or Ecoregions.

Relying exclusively on observations carried out under the DCF may lead to underestimation or at worst non-detection of bycatch events in some metiers. WGBYC are aware of improvements to monitoring protocols within the DCF but reiterate that further consideration could be given to sampling designs and protocols moving forward to data collection driven by the EU-MAP and the Technical Conservation Measures Regulation.

A variety of monitoring methods are reported annually to ICES as part of the datacall, each with differing strengths and weaknesses. At-sea-observers and electronic monitoring are currently considered by WGBYC to be the most reliable source of data for the calculation of bycatch rates across a range of sensitive taxa for inclusion in detailed bycatch assessments. These methods also represent the source of the majority of bycatch records reported.

Some countries have restricted data collection via EM for certain taxa, such as marine mammals. We encourage the collection and reporting of data for all species when the ability of EM to detect and identify them has been demonstrated.

The use of strandings data highlighted probable bycatch interactions between 9 species and fishing gears combinations reported by 8 countries (7 cetacean species and 2 seal species). In certain areas strandings can provide bycatch mortality estimates when physical parameters such as drift conditions are accounted for. However, in all cases, these data constitute an overview of an often scarcely observed process and direct data collection is essential.

WGBYC expects that the consistency of bycatch data at a regional scale will be improved through EU-MAP and thereby ICES will be able to provide more robust advice on the impact of fisheries on protected and vulnerable species. However, this will only be achieved if countries take full account of the necessary sampling protocols for ETP species and carry out bycatch monitoring in the relevant métiers with sufficient observer or EM coverage.

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Section 2 (ToR B) Contents

2 ToR B: Collate and review information from WGFTB national reports, other ICES WGs and recent published documents relating to implementation of protected/sensitive species bycatch mitigation measures and summarize recent and ongoing bycatch mitigation trials.

This year the working group collected information on mitigation efforts across taxa, fishing gears, and countries by reviewing (i) national reports to the Working Group on Fishing Technology and Fish Behaviour (WGFTFB), ongoing projects named by WGBYC participants and (ii) grey and peer-reviewed literature (Section 2.2).

Effective mitigation solutions were suggested in ecoregions where a number of species from different taxa are known to interact with fishing gears based on known bycatch per unit effort estimates (ToR C), or in their absence for data-poor species (ToR D) (Section 4). Where available, regulatory or voluntary uptake was linked to a mitigation strategy (Table 2.1).

2.1 Reviews of national reports and list of ongoing projects

An overview of fishing gear mitigation trials with relevance in reducing bycatch of ETP species from the WGFTFB 2023 national reports and ongoing project work known by participants of the ICES WGBYC were listed below by country. In 2024, 20 national reports were submitted to WGFTFB from Argentina, Australia, Belgium, Canada, Denmark, England, France, Germany, Iceland, Ireland, Italy, Japan, The Netherlands, Norway, Portugal, Scotland, Spain, Sweden, United Kingdom (England, Scotland, Northern Ireland) and the United States of America. Reports were searched by keyword matching and semantic searches using a large language model. While keyword matching (for example, “bycatch” or “ETP species”) can be very effective in searching through larger report documents, the risk is that important content may be missed, if exact keywords or phrases are not matched. That is where semantic searches using large language models may provide a complimentary tool, because through AI and context analysis the semantic meaning can be analysed in response to a specific request/prompt that does not require keyword matching. Their increasing accessibility through tools like ChatGPT, WGBYC sought to investigate the potential of utilising these models for target keyword analysis of WGFTFB reports for projects of relevance for bycatch mitigation. To do this, the WGFTFB report was converted into a Word file or plain text file (.txt) containing only the text needed for input into the model. A prompt was designed to extract relevant information, following a two-step process. The first step focused on extracting country data and a list of projects related to EPTS. The second step provided a summary of the content for each selected project. Additionally, a second prompt was created to combine both steps, which was also tested. While the tool shows promise, further time and effort are required to optimise its functionality. Enhancing speed, accuracy and overall reliability is essential to enable the tool to handle more complex tasks and meet the higher demands of real-world applications.

2.1.1 Argentina

The WGFTFB report outlined an ongoing study in Argentina (from June 2020 to November 2024) to reduce catches of sharks and rays (chondrichthyans) in the common hake trawl fishery (www.inidep.edu.ar). A selective grid was designed, but the first trawls showed a significant loss of marketable fish. New modifications to the grid and any subsequent improvements to its ability to deselect sharks and rays were not reported. There is no current work going on within the WGBYC.

2.1.2 Australia

The Australian WGFTFB report described several projects to reduce bycatch of sea snakes, seahorses, elasmobranchs, and teleost fish from both active and passive fisheries. There are three projects investigating the utility of fisheye BRDs in reducing sea snake bycatches. One is testing a Tom's Fisheye (TFE) for the Queensland East Coast Otter Trawl Fishery (July 2023 – December 2025). In another two projects, a similar BRD was trialled to let sea snakes escape from prawn trawls in Shark bay, WA (2023 – ongoing; www.wafic.org.au). In South Australia, a number of simple modifications and fishing operation variations are being implemented by trawl fishers to increase the selectivity of their fishery and reduce the bycatch of ETP species. Modifications include changes in mesh size and mesh orientation, and to fishing operations (Improving and promoting fish-trawl selectivity in the Commonwealth Trawl Sector (CTS) and Great Australian Bight Trawl Sector (GABTS) of the Southern and Eastern Shark and Scalefish Fishery (SESSF), September 2020 – September 2024). For passive gillnet fisheries, An assessment of alternative gear types with the aim of minimizing the bycatch of threatened sharks, sawfishes, and turtles (listed under the Environment Protection and Biodiversity Conservation Act) in northern Australian gillnet fisheries is ongoing ("Mitigating threatened species gillnet bycatch in northern Australia"; May 2023 to September 2025). A new catch handling system termed Fish-First Barrel Hopper (FFBH) is being designed for prawn trawlers which should allow all catch from the codend to be immersed in fresh-flowing seawater for cleaning, preservation of life, and catch-component separation. This handling system should allow for a higher survivorship of bycatch and improve post-release survivorship of bycatch as catch is immediately emptied into a barrel hopper filled with seawater. The design has been developed to ensure broad applicability across the Australian prawn-trawl fleet and safety/stability issues and regulations are being considered and addressed in the product development process. The project duration is July 2023 to December 2024. There is also an ongoing issue of marine turtle interactions with crabbing apparatus (annual numbers of marine turtles entangled in crabbing apparatus in 2021 and 2022 were 53 and 50 respectively) and float line entanglement (295 recorded between 2011 and 2023). Available information is being collated to support the design of crabbing apparatus with the aim to reduce the risk of marine turtle entrapment in this gear. There is no current work going on within the WGBYC.

2.1.3 Belgium

Projects carried out by the FTFB group include 'LED there be Light' project (2022 - 2023) aimed to develop and optimize innovations in different fisheries practiced to reduce bycatch of undersized fish and/or optimize commercial catches. The project primarily aimed at reducing the bycatch of non-commercially sized flatfish but has further potential to also reduce bycatch of ETPs. Bycatch reduction is investigated through replacing ground gear (lighter chains for catching sole), usage of light on beam trawls, switching to Scottish seine, otter-trawl fisheries, and passive pot fishing, and the development of a smart catching device called i-catch.

In the "Accurate selection" project (2020 - 2023), machine builder de Boer RVS, the Research Institute for Agriculture, Fisheries and Food (ILVO), two Dutch shrimp-trawl skippers, and a fisheries representative organisation worked together in a study an on-board innovative processing line for shrimp fishing vessels. Through an on-board selection device, which makes use of computer vision to distinguish between target and non-target species, non-commercial shrimps and any bycatches would be returned to sea as soon as possible, while marketable shrimps are pre-sorted using high air pressure to blow them into corresponding compartments in the hold of the vessel.

Belgium has several projects that investigate innovations for pot fishing for improving its feasibility and selectivity, namely the TIP-TOP and POLUX project. The TIP-TOP project (2023 - 2025) aims to develop, optimize, and test innovations for pot fisheries, with a focus on attracting various species. Targeted species include the North Sea crab, spider crab, sole, plaice, and the saw-toothed shrimp. These innovations are designed to reduce bycatch, optimize commercial catches, and establish alternative fishing methods. The POLUX project (2023 - 20225) works on three topics relating to pot fishing: 1) acquiring new knowledge on the impact of light on the species usually caught in pots; 2) studying the impact of light on new potentially valuable species through pot fishing, usually caught with other fishing gear; and 3) evaluating the selective potential of light in pot fishing. In the waters of the Dover Strait, this includes evaluating the continued catch of crustaceans, while avoiding the catch of spider crabs *Maja brachydactyla*, which are common and difficult to valorise.

The VisTools project (2018 - 2022) provided fishers with a business intelligence tool to optimize their catching efficiency, while exchanging valuable high resolution oceanographic data with research institutes. This increased insight of fishing activities can provide the trigger for behavioural changes that increase the efficiency of the vessel and simultaneously reduce the impact on the environment. It may also open new research possibilities including catch prediction models, decision support tools, and avoidance of sensitive (bycatch) areas.

Within the WGBYC, work is being carried out in the EU LIFE CIBBRiNA (Coordinated Development and Implementation of Best Practice in Bycatch Reduction in the North Atlantic, Baltic and Mediterranean Regions) project (September 2023 to June 2029) led by the Dutch Ministry of Environment. Belgium is specifically involved in a case study on bottom trawl fisheries. The idea isto investigate the effects of sensory deterrents (ie. magnets) on ray species in lab trials, to examine the behavioural responses of rays towards beam-trawl at scale (flume tank experiment), and to test the effect of water-immersed catch sorting in reducing air exposure.

2.1.4 Canada

It was reported to WGFTFB that in response to government regulations requiring all fixed passive fishing gear to be whale safe by 2024, two whale safe fishing gear projects ("Whale-safe fishing gear", January 2021-March 2024; and "Evaluating the fishing performance of various technologies designed to mitigate entanglement with whales", January 2022-2025) were funded. These projects focus on developing and testing gear modifications falling within two broad categories: (1) gear with break-away or cutaway designs (e.g. weak ropes, links, and sleeves, alongside time-tension cutters), making it easier for entangled whales to free themselves and reduce the risk of serious injury, and (2) systems that negate the need for vertical lines in the water. A separate project "Reducing bycatch of Greenland shark in trawls" aims to modify grid systems in the northern shrimp trawls to allow easy escape of large bycatch species such as Greenland sharks (*Somniosus microcephalus*). Nordmøre grids are also being tested in shrimp fisheries for release of skates in shrimp trawls. Video analysis of skates interacting with the grid should give insight into its efficiency (June 2022-December 2024). Furthermore, the effectiveness of collapsible pot to longlines will be tested to determine if there is a reduction in marine mammal interactions (January 2024-November 2028).There is no current work going on within the WGBYC.

2.1.5 Denmark

In total 5 projects were reported in the WGFTFB reports. (1) "Trawlvision" (2023 - 2025) utilizes recent advancements in deep-learning models and camera technology to inform fishers in real time about the species entering their gear. Work was done to improve the performance of the hardware aimed at real-time processing. Additionally, front-end developments of the graphical user interface have been made. (2) The "Observing and quantifying fish behaviour in relation to active fishing gear" project (2022 - 2025) takes advantage of recent technological developments in split-beam acoustics to quantify animal behaviour in relation to fishing gear. From lab and sea trial data, tracks of individual gadoid fish, northern prawn, and Antarctic krill were made. From this output the response of fish to simulated trawl stimuli and crustacean behaviour in the trawl mouth will be described. This work is complementary to other efforts at DTU Aqua that evaluates observation technologies (optics, multibeam sonar, and split-beam acoustics).

(3) The BeFish Network project (2023 - present) aims to focus on how to overcome barriers preventing researchers from making substantial progress in understanding the responses of animals to fishing gear in the capture process to develop efficient and sustainable fishing gear. Furthermore, the network works on sharing knowledge and experiences, conducting supplementary studies, and preventing replication of studies, and establishing future research collaborations on the topic. The network meets online bimonthly for discussions.

(4) The Hydrolift project (2023 - 2025) investigates the use of hydrodynamic turbulence to lift benthic species into the path of a trawl net. The first case-study addressed the sea star trawl fishery in the Limfjorden (Denmark) where optimization experimental trials with industry are ongoing to maximize catch efficiency of the target species (star fish) and minimize the bycatch on different fishing grounds. Future work will explore the potential of using this approach in some of the important European mixed demersal trawl fisheries (e.g. shrimp, flatfish) and carry out sea trials with behaviour observations to assess the selective and environmental performance of the new gear design in these fisheries.

(5) The EveryFish project (2023 - 2026) DTU aims to develop and test, in a real-world application, how electronic monitoring (EM) can be used to curb illegal and unreported fishing (IUU), to simplify management while at the same time facilitating an increase in compliance with the technical conservation measures. This will be done by reviewing existing technical measures regulations within EU, undertaking a pilot study where participating vessels will be allowed to use gears they define and where aspects of the technical measures are removed, and providing feedback regarding the usage of quotas and avoidance of unwanted catch.

From DK it was reported to WGBYC that several mitigation projects are ongoing with respect to mitigation of ETP-species. In the gillnets fishery DK is investigating if a reduction in net-height and twine-diameter can lead to a reduction in bycatch of seabirds, cod, seals and porpoises. The trials are ongoing thus no results are available yet. Furthermore, pingers are being tested in the North Sea gillnet fisheries to reduce bycatch of harbour porpoises. Several different pinger brands, source levels, and spacings are being tested to improve knowledge about effects on bycatch-rates. The results have indicated that pinger effectiveness is reduced when spacing is increased from 200 to 500 m, but this can be mitigated if the source level is increased by 10 db.

Furthermore, Denmark has joined forces with other partners under the EU LIFE project CIBBRiNA to test if small pearl beads attached to gillnets can reduce bycatch of harbour porpoise. The results are still unknown as no porpoises were bycaught in neither pearl nor control nets. The trials, however, will continue.

2.1.6 Estonia

Within the WGBYC there is work being conducted in the "Püügivahendi parendamise toetus" (Support for improvement of fishing gear) project. Here, acoustic devices near fyke nets were implemented to deter seals as a measure to help fishers reduce the economic loss from seal depredation on the trapped fish. However, this can also be viewed as a mitigation measure to reduce seal bycatch. Further, a selective grid was used at the mouth of the fyke to avoid the entrance of seals.

2.1.7 France

Work conducted within the WGFTFB include the ESCAPE (understanding and modelling escapement behaviour of fish species in fishing gears, 2023 - 2027) project that aims to use knowledge on animal behaviour to design selective fishing devices and gear to avoid unwanted catches. This is achieved by combining fishing gear technology, artificial intelligence, behavioural concepts and functional ecology. The project further aims to quantify, understand, and mathematically model the various stages of fish capture and escape processes in active (trawl) and passive (trap) fishing gear. A dedicated cruise was conducted in June 2023, gathering over 35 hauls recorded with both imagery and multiple cover cod ends. Imagery and morphological data are being processed, with over 100,000 annotations of fish already complete in the cod end and extension. IFREMER are also partner in the Marine Beacon project (https://marinebeacon.eu/) and will develop and contribute to a peer2peer image annotation exchange platform to exchange annotated images of ETP species among consortium partners. Mitigation trials are planned to improve current developments within the Game of Trawls project to acoustically trigger a mechanism that allows for de/selection of non-/target species underwater. Current includes the Game of Trawls project in which underwater cameras inside the fishing gear and acoustic trigger devices are used to increase the fraction of landings and avoid and release unwanted catches underwater.

2.1.8 Germany

The WGFTFB reported ongoing work in several projects. During the STELLA II project (November 2021-October 2024), technical measures developed in the STELLA I project to reduce marine mammal and diving seabird bycatch were tested. Technical measures include gillnet modifications (increased visibility through attaching acrylic glass pearls, "PearlNets", and development of alternative gear - fish pots and pontoon traps). These devices are now tested on a larger scale under commercial settings. The PearlNets did not show a significant difference in captures of commercial species compared to a standard gillnet. The PearlNet will further be tested within the EU LIFE CIBBRiNA project (September 2023-August 2029). The MiniSeine project (January 2022-December 2023) developed a Danish seine reduced in size to be operable from a small gillnetter (<12m). Comparable catches to a gillnet were obtained while reducing the probability of harbour porpoise, seabird, and seal bycatch, and protecting the fish from seal depredation. Within the WGBYC, work is being carried out in the PAL-CE Project (October 2021-December 2024) which investigates whether the proven effect of PALs of reducing harbour porpoise bycatch persists over longer periods of time. There are currently no results reported on its efficiency.

2.1.9 Iceland

The WGFTFB is currently involved in the Project FISHSCANNER (Dec 2018-Dec 2023) which developed and tested a lightweight and user-friendly device that provides real time information on the catch composition. It was mounted as a circular frame in front of the cod end, containing stereo cameras and light, which scans all fish before they enter the cod end and uses artificial intelligence to perform real-time processing. Tests on a commercial trawler demonstrated its utility as a research tool, allowing tows through dense schools of fish with the codend open while still obtaining accurate information on species and size composition in the towed area. Further developments are ongoing with the aim to work towards remote selectivity capabilities.

The "mortality rate of spotted wolffish (*Anarhicas minor*) from various fishing gear" project aims at using the survival rates and subsequent release of surviving fish for improving the stock conditions. In 2020, Marine and Freshwater Research Institute (MFRI) demonstrated survival up to two hours on fishing ramps and conveyor belts for this species, and high survival rates associated with its release from longlines. In 2020, a releasing licence was granted for spotted wolfish. Results of ongoing work further indicated a high survival rate for spotted wolffish caught in trawls and longlines. In the longline test two release methods are examined: after passing through the crucifier and by cutting the snood line before the crucifier.

Within the WGBYC, tests were conducted during the EU LIFE CIBBRiNA project (September 2023-June 2029).The PearlNet and loud banana pingers were tested in the spring cod fishery in northern Iceland. Acoustic underwater recorders (FPODs and sound traps) were deployed to monitor porpoise behaviour around the nets. Some initial, but statistically non-significant results were recorded, and a more thorough analysis of the acoustic data is underway.

2.1.10 Ireland

None of the ongoing projects reported by the WGFTFB addressed bycatch of ETPs . There are also no ongoing projects within the WGBYC.

2.1.11 Italy

The WGFTFB reported on the Life DELFI project (2020-2024) that aims at reducing interactions between bottlenose dolphins (*Tursiops truncatus*) and fishing activities through technical, management, and socio-economic measures. In collaboration with the Università Politecnica delle Marche, Department of Information Engineering, a new interactive acoustic deterrent device based on dolphin recognition through artificial intelligence is being developed. Mitigation measures to be trialled include the use of pots as dolphin-safe and alternative gears to the passive nets and testing deterrent devices such as interactive pingers (DiD-01 by STM) and visual deterrents (LEDs), both in set nets and trawl fisheries. The device comprises a receiving part, a computing microPC and an emitting part. Each component is designed to be inexpensive and versatile to allow for future modifications and additions The devices aims at making use of a Convolutional Neural Network (CNN) capable of quasi-real time processing of the signal, followed by the execution of a sequence of tasks (automated identification of bottlenose dolphin whistles with more than 90% of accuracy and the emission of deterrent sounds to deter dolphins from fishing nets).

Further, the "National Biodiversity Future Centre– SPOKE 2" (2022 - 2025) project works on reducing fishing impacts and protection of biodiversity. In collaboration with the fishing sector, technical solutions (Bycatch Reduction Devices - BRDs) have been developed to avoid the capture of undersized individuals (e.g. Juveniles and Trash Excluder Device or JTED). A flexible grid (with bars spaced 20 mm of each other) was tested to assess its efficiency to reduce the juvenile fish while maintaining the commercial catch, but commercial loss occurred consistently. The project also worked on setting standards for TEDs (Turtle Excluder Devices) in the Mediterranean trawling, development of a new pinger (in the cooperation with the aforementioned Delfi project), and aims at introducing technical innovations (such as line setters and automatic squid jigging machines) for the modernisation of longline and line fishing.

The ELIFE (Elasmobranchs Low-Impact Fishing Experience, 2021 - 2025) aims to improve the conservation of elasmobranch species (sharks and rays) by promoting best conservation practices in European professional fisheries in the Mediterranean Sea. This will be achieved by carrying out pilot studies in Italian and Greek ports.

No ongoing projects were reported within the WGBYC.

2.1.12 Japan

Japan reported to WGFTFB that from 2014 to 2022, a monitoring programme utilising automated seal detection technology has been carried out on video images of Kuril harbour seal interacting with the salmon set-net fishery (September 2022 – April 2024). An analysis of the efficiency of the automated image-detection software showed a 90% recognition rate. Detection on longer recordings will be evaluated in the future. Another project called 'Reducing set-net bycatch based on model simulations' simulated the behaviour of young bluefin tuna with the aim of proposing a set-net configuration that should reduce the bycatch of non-targeted species (April 2020-March 2027). Further, Biodegradable fishing nets were developed. In one project called "comparisons of fishing efficiency for biodegradable gillnets and conventional nylon gill net" which showed no difference in its catch of haddock compared to a conventional net. In another project, "edible brown alga, *Mozuku, Cladosiphon okamuranus* cultivation with biodegradable fishing nets a plant-derived biodegradable fishing net was developed The loss of these biodegradable nets have the potential to reduce the impact of ghost gear on marine life and ETPs. None of the WGBYC participants knew about any other relevant mitigation projects.

2.1.13 The Netherlands

The WGFTFB currently work within the EU LIFE CIBBRiNA project (Coordinated Development and Implementation of Best Practice in Bycatch Reduction in the North Atlantic, Baltic and Mediterranean Regions) that started in 2023 and runs until August 2029. It sets out to establish a European flagship initiative in which fishers, scientists, environment ministries, and non-governmental organisations (NGOs) from 13 European countries work jointly to minimise incidental bycatch in fisheries which have a high risk of bycatch of priority marine ETP species and to work towards transparent and environmentally and socio-economically sustainable fisheries in the Northeast Atlantic, Baltic and Mediterranean regions. Mitigation specific objectives include: optimising, developing and evaluating bycatch mitigation methods for ETP species, support effective mitigation by implementing monitoring programmes, and secure long-term funding for the continuation and long-term sustainability of recommended incidental bycatch mitigation measures.

The' Practical assessment of the feasibility of gill netting in Dutch windfarms' project studies the feasibility of gill netting around Dutch wind farms. In the first study, two types of passive gear were examined: mechanical jigging (LHM) and different variants of pots (so-called multi-species pots, FPO). In a parallel study, handline fishing (LHP) and net fishing (GNS) were investigated.

In Phase 2 of the project, the safety, technical feasibility, catches/bycatches, ecology (birds/marine mammals), economic feasibility, and legal frameworks of, among other things, net fishing in the Borssele wind farm were examined. There were no projects reported within the WGBYC.

2.1.14 Norway

Projects reported within the WGFTFB include the estimation of bycatch of seabirds in coastal purse seine fisheries as well as the analysis of the process leading up to the bycatch event (""Bycatch of seabirds in purse seine fisheries"). Further, mitigation measurements were developed and tested (e.g. lights, sound, visual objects) (May 2022-April 2024). Preliminary results indicate that sound signals efficiently scare birds out of the net for short periods. Another project related to this fishery works on developing sounds that elicit an autonomous reflex associated with a flight response by whales near purse seiners to reduce their interaction with nets during the hauling process ("Bycatch of whales in purse seine fisheries" project). The project has successfully developed sound signals that keep killer whales away from the nets. For humpback whales further work is required. Herring did not show a reaction to the sounds although they are being emitted in its hearing range (July 2021-June 2026). In the Dsolve project (November 2020 – December 2028), alternative biodegradable fishing materials are being trialled to reduce ghost fishing.

Within the WGBYC, this winter, the IMR conducted a second set of pinger field trials in commercial cod and saithe gillnet fisheries. A total of 14 vessels participated, conducting about 360 fishing trips. Data are still being processed, but preliminary results indicate a total bycatch of 34 porpoises, 25 of which were caught in control (non-pingered nets). While the analyses are ongoing, these results appear to support the conclusions from a previous pinger study in Norwegian gillnet fisheries (https://doi.org/10.1016/j.fishres.2022.106564). However, the bycatch reduction recorded in the second trial appears to be smaller when compared to the first trial. The results of this study may help increase acceptance and thus ultimately uptake and use of pingers by fishers in Norway. Industry involvement was a big focus in this study.

2.1.15 Poland

Within the WGBYC, the "Development and use of trap fishing gear adapted to conditions in the Polish coastal zone of the Baltic Sea" project was carried out. For this aim, a consortium consisting of a producers' organisation – Darłowska Group of Fish Producers and Shipowners and West Pomeranian University of Technology in Szczecin were involvedin 2023. Researchers trialled using fish pods in specific conditions of Polish, small scale, coastal fisheries. In 2023 there was no other ongoing mitigation projects for ETPs in Poland. National Marine Fisheries Research Institute, as a partner of the EU LIFE CIBBRiNA project, is preparing for bycatch mitigation trials planned in upcoming years. There was no work reported within the WGFTFB concerning bycatch of ETPs.

2.1.16 Portugal

The report from the WGFTFB reported on the project "Improvement of the selectivity in trammel net using a modified multi-filament net - "aranha". Here, modified nets are used to target cuttlefish (*Sepia officinalis*) and have the potential to reduce unwanted bycatches. Within the WGBYC it was reported on the project LIFE + Ilhas-Barreira (2019-2024) funded by the EU´s LIFE program, which aims to improve knowledge on the bycatch assessment of seabirds in coastal southern Portuguese fisheries, and test mitigation measures to decrease bird bycatch.

2.1.17 Spain

The WGFTFB reported on the MITICET project ("Testing of the effectiveness of pingers in mitigating the incidental bycatch of dolphins in pair bottom trawling in the Bay of Biscay, January 2021-December 2024) which is testing acoustic active deterrent devices (pingers) to reduce the bycatch of dolphins in trawlers. For this, an alternated haul experiment design (with and without pingers) with electronic monitoring systems was implemented. Results in 2023 showed no reduction in the proportion of hauls with bycatch of common dolphin but the number of specimens per haul with bycatch was significantly reduced. The project continues in 2024 with the same approach but with a different model of pinger. Models of pingers were not specified.

Within the WGBYC, the "MERMA CIFRA" (Monitoring, Assessment and Reduction of Accidental Mortality of Cetaceans due the Interactions with the Spanish Fleet – Review and Action) project is ongoing between 2023 - 2024. Coordinated by the IIM-CSIC, it includes a WP focused on mitigation: "Technical measures for the reduction of accidental capture of cetaceans in Spanish fisheries in the Atlantic-Northwest national fishing ground" led by the IEO (Instituto Español de Oceanografía). This WP comprises 3 subtasks: a) to evaluate the technical fishing measures available to reduce the accidental capture of cetaceans in Spanish fisheries in the Atlantic northwest national fishing ground; b) to carry out experimental reduction tests in the fisheries with the highest catch rate (trawl and gillnet); and c) to propose the most appropriate technical measures for the fisheries and the fishing ground based on the results and the best available scientific information. Pilot trials were conducted in gillnet fisheries and purse seine fisheries of galician waters (NW Spain), evaluating the effectiveness of pingers (Marexi, Net Guard, DDD and Banana pingers) from different commercial brands. Currently, a campaign is underway to further test cetacean exclusion devices and pingers onboard bottom trawlers and pair trawlers.

2.1.18 Sweden

The WGFTFB reported on the "Secretariat for selective fishing gear" project (2014 - 2024) that aims to gather new ideas from fishers and industry. The industry's initiative and engagement are crucial to the successful development of new ideas. Project proposals are worked out in close collaboration between fishers and scientists and are then evaluated and funded by SwAM (Swedish Agency for Marine and Water Management), with over 50 projects completed. These range from the gentle handling of salmon in traps in the northern Baltic Sea, to large grids excluding saithe in the industrial pelagic trawl-fishery of herring in the Skagerrak, and experiments with pelagic trawl doors in the demersal trawl fishery.

Further,the "Round goby – from Risk to Resource" project (2021 - 2025) examined the catchability of the invasive round goby (*Neogobius melanostomus*) as part of a larger, four year project in Sweden. Two key issues were covered in the project, one focusing on retaining round goby while European eel (*Anguilla anguilla*) is released through selection panel, and the second focusing on the evaluation of selection panels for their retention potential for other commercial species.

No currently ongoing projects were reported within the WGBYC.

2.1.19 United Kingdom

The WGFTFB reported on the following projects. The Fishtek Marine project (November 2022-May 2023) aims to test the effectiveness of newly developed above-water deterrents in reducing bird bycatch in set nets. Their efficiency is limited to preliminary trials which showed promise with regards to deterring diving birds in the Baltic Sea but needs to be tested in further areas.

The Clean Catch project (Phase 1: 2019-2024, Phase 2: 2024-2027) works on researching and designing monitoring of ETPs populations (passive acoustics), ETPs bycatch (self-reporting and REM combined with AI and video processing), and on developing ETPs bycatch mitigation tools (passive acoustic deterrent devices). The Clean Catch project is developing and testing tools for monitoring bycatches, including a smartphone application and the use of Electronic Monitoring (EM). In 2024, the programme released a self-reporting 'Clean Catch' (CCUK) app to collect data on bycatches of sensitive species for use by multiple gear types following development and testing by fishers. Clean Catch uses EM on a subset of vessels where skippers are self-reporting bycatch events to assess the quality of these data types. Due to the high resource requirements to analyse the EM data, the project continues to collate images and contribute to collaborative databases required for training AI, in collaboration with the UK's Bycatch Monitoring Programme. Clean Catch has also deployed an acoustic array in the southwest of England which is being used to examine localized spatial and seasonal patterns of cetacean density in an area of higher bycatch risk. Approximately 1,733 days of data have been collected as of April 2024.

Clean Catch is also testing and developing bycatch reduction technologies. From August 2024, nine skippers in England's southwest small-scale gillnet fishery are testing Fishtek Marine's Banana pinger to assess whether they effectively deter cetaceans from becoming entangled in fishing gear. EM systems are being used to collect high-resolution data on fishing location and the level of cetacean bycatch, and the CC-UK app is being used by participating skippers to self-report details of their daily fishing activity, including information on location, time, gear type and length, number of pingers used and failed, target catch, bycatch, and seal interaction with the gear. Since 2019, Clean Catch and fishermen have been co-developing a low-cost Passive Acoustic Reflector (PAR) suitable for attachment to fishing gear via a single point attachment. Fishers provided feedback on the shape of the PAR in relation to use, handling, and robustness, expressing a preference for one that could replace a net headline float, with similar size and buoyancy, that was able to withstand commercial fishing practices. Following the testing of commercially available floats, a new prototype was developed. PARs are currently being tested for at-sea practicality and robustness with a volunteer skipper.

The following projects were reported by members of the WGBYC. The "Insight360" project which is developing and producing a cetacean bycatch electronic monitoring system. This project began in 2021 and is due to be delivered in 2024. Five vessels have the system installed to collect image and voice records. Research is continuing to improve software and hardware features such as automatic haul detection and speech-to-text tools.

In 2024, the 'Bycatch Risk Prioritisation Framework' project was initiated. This project seeks to identify areas, gear types, and/or fisheries in the UK which are potentially at a higher risk to bycatch and entanglement to direct future monitoring and mitigation initiatives. A framework for bringing species productivity and fishery sensitivity information, distribution data, and fishing activity data will be identified or developed and used with available data for the UK.

For elasmobranchs, the Spurdog (*Squalas acanthias*) Bycatch Management Programme operated in the Celtic Sea (Hetherington *et al.*, 2022) between 2016 and 2022. The project developed a real-time bycatch reporting and mapping tool for spurdog, allowing fishers to self-report the presence or absence of spurdog bycatch during normal fishing activity. Information was then fed back to participating fishers using a bycatch advisory map, to highlight areas of low, medium, and high risk of spurdog bycatch to allow informed decision-making when fishing. In 2023, the management of spurdog changed with the removal of the prohibited status and the allocation of UK-EU TACs for individuals less than 100 cm in length. However, catches of individuals greater than 100 cm in length are still prohibited as a measure to deter the targeting of large mature females. A self-reporting app, the Spurdog Catch Management Program, is being used by volunteer skippers to record information on the proportion of spurdog dead and alive in Cefas' Spurdog Management research project.

Other projects looking at reducing unwanted fish catches that were ongoing in 2022 include BATmap, a bycatch avoidance tool being trialed on the west coast of Scotland (Marshall *et al.*, 2021). This project developed an app for Scottish skippers to share real-time information about the location of hotspots of fish species that are choke species (cod, *Gadus morhua*) or of conservation interest (spurdog) with other participating skippers.

During the 'Collaborating with Scotland's creel fishers to reduce entanglement of minke whales, basking sharks and other megafauna through gear modifications" project, a negatively buoyant (sinking) groundline rope was tested to reduce entanglement. Fishers encountered few problems, and no seabed impacts were observed. The results are encouraging, as there may be a simple, low-cost option to greatly reduce
entanglement risk - and because of the very successful, bottom-up, partnership
approach with Scottish creel fishers. The full project report was published this year and is available here: https://scottishentanglement.org/downloads/new-project-report-2024-collaborating-with-scotlands-creel-fishers-to-reduce-entanglement-through-gear-modifications/.

2.1.20 United States of America

The WGFTFB reported on a series of projects. The "Automated video processing to support commercial fishing innovation in the walleye pollock (*Gadus chalcogrammus*) fishery in Alaska" project (2022 - 2024) investigated the possibility of using deep learning object detection and tracking to identify and track pollock and salmon in Alaska commercial pollock trawls. The developed models will help support a semi-automated video review process when evaluating Bycatch Reduction Devices - BRDs for this fishery and automated methods for triggering active BRD that will release salmon that are currently being developed for this fishery. Results show that YOLOv8 models performed the best at pollock and salmon detection, while the Centroid tracker performed the best at salmon tracking. Results indicate a promising approach for bycatch reduction and revealed additional measures that can be used to increase performance and reliability of deep-learning models for this application.

The ActSel (Improving and encouraging adoption of active selection systems to reduce bycatch in catch-share trawl fisheries of the North Pacific for Trawls, 2022 - 2024) project continued working with an active selection (ActSel) system, that uses a hydrodynamic kite to move a net panel covering an escape portal during normal fishing. Field trials led to a configuration providing consistent and rapid panel shifts, as well as insights for adapting the systems to new vessels. In 2024, ActSel will continue with deployments of the method into relevant fisheries.

The "Gear-based approaches to catch protection as a means for minimizing whale depredation in longline fisheries" (2021 - 2023) project aimed to develop low-cost devices to protect Pacific halibut and other flatfish caught on longlines from whale depredation, and indirectly aims at reducing interactions of EPT depredators with the gear. The approach involved working with fishermen and gear manufacturers to create catch-protection prototypes, including an underwater shuttle (modelled after a device invented by Sago Solutions) and a sliding shroud system (developed with consultation of Global Pesca, based on a modified 'slinky' pot manufactured by FishTech Inc, USA). These were tested in May 2023 on a longline vessel off the Oregon coast.

The "Optimizing the Implementation of Whale-Release (1700lbf breaking strength) ropes to reduce Large Whale Entanglement Risk" (2022 - 2024) project aims to reduce the risk of North

Atlantic right whale entanglement in pot fishery ropes by simulating entanglement outcomes when using whale-release ropes versus regular strength ropes in different configurations. The OrcaFlex software was adapted to create a detailed digital model of the whale, incorporating behaviours such as mouth movements. The objectives include reverse-engineering known entanglement cases, simulating weak rope configurations, and comparing their outcomes to standard ropes. The project will assess different rope elasticities, validate the model with real-world data, and share findings with fishermen.

A catch protection shuttle has demonstrated success in 2023 to minimize depredation in longline fisheries in presence of killer whales (*Orcinus orca*). The work in the project (November 2023-April 2025) will further investigate the logistics of (1) setting, fishing, and hauling an underwater shuttle catch protection device, and (2) investigate the basic performance of the gear on catch rates and fish size compared to traditional gear. A reduction of bycatch risk can be achieved if the depredation reward cycle is broken leaving less interactions in and around fishing gear.

In August 2022, the science NOAA centre received an exempted fishing permit allowing up to 100 vessels at a time to help test and improve on-demand gear systems. This effort continued and expanded trials of these systems, which the institute has been developing with fishermen. The 2023 Northeast Experimental On-Demand Gear System Trials aimed to reduce whale entanglement in American lobster and Jonah crab fisheries by testing ropeless fishing gear. Conducted between February and April 2023, the trials involved 12 commercial vessels and completed 527 hauls in restricted areas without gear conflicts. The project, supported by various stakeholders, focused on demonstrating successful gear retrievals, collecting operational data, and improving data collection methods. Future plans include expanding these efforts in the 2024 experimental fishery starting in February.

There was no ongoing work reported within the WGBYC.

2.2 Mitigation strategies from published literature 2023

To update the latest information on the development and trials of different mitigation measures across taxa, the TorB sub-group participants conducted a literature search using Scopus, Google scholar, and ScienceDirect as search engines for peer-reviewed literature published in 2023. The initial search strings used were:

Scopus:

TITLE-ABS-KEY (((bycatch OR by-catch OR by-caught OR discard*) AND (*whale* OR *bird OR cetacea* OR *dolphin* OR elasmobranch* OR fish* OR *porpoise OR marine mammal* OR PET* OR ETP OR TEP OR EPT OR pinniped* OR reptile* OR *turtle* OR Seal) AND (mitigation OR reduction OR elimination OR "bycatch mitigation"))) AND PUBYEAR = 2023.

Google scholar:

with **all** of the words: bycatch OR by-catch OR by-caught OR discard*

with **at least one** of the words: *whale* OR *bird OR cetacea* OR *dolphin* OR elasmobranch* OR fish* OR *porpoise OR marine mammal* OR PET* OR ETP OR TEP OR EPT OR pinniped* OR reptile* OR *turtle* OR Seal OR mitigation OR reduction OR elimination OR bycatch mitigation

Return articles **dated** between: 2023 and 2023

ScienceDirect (cetaceans only):

(bycatch OR by-catch OR discard) AND whale)

(bycatch OR by-caught OR discard) AND cetacea)

(bycatch OR by-caught OR discard) AND dolphin)

(bycatch AND (whale OR cetacea OR dolphin OR porpoise) AND mitigation)

(bycatch AND "whale entanglement" AND mitigation)

Following the first round of literature search, each member of ToR B explored alternative combinations of keywords depending on the taxa group assigned.

Table 2.1 List of peer-reviewed literature articles published in 2023 of mitigation approaches tested in different gears and regions to reduce bycatches of small and large cetaceans, elasmobranch, sea turtles and seabirds.

Literature	Group of species	Species	Gear	Area	Year	Method	Outcome	Uptake/regulation
Riekkola, L., Liu, O. R., Feist, B. E., Forney, K. A., Abrahms, B., Hazen, E. L., & Samhouri, J. F. (2023). Retrospective analysis of measures to reduce large whale entanglements in a lucrative commercial fishery. Biological Conservation, 278, 109880.	Large cetaceans	Blue whale (*Balaenoptera musculus*); Humpback whale (*Megaptera novaeangliae*)	Crab pots	NE Pacific coastline	2014 - 2018; 2019 - 2020	Using data from fishery logbooks, landings data and applying whale habitat models to assess risks as well as measure the impact of crab pot reductions. Two scenarios of entanglement risk were tested: constant fishing/ variable whale densities/probabilities scenario and constant whale distributions/variable fishing effort scenario.	During the mandatory crab pot reduction regulation (2 seasons), the entanglement risk for blue whales was reduced by up to 20% and 78% for humpback whales. When accounting for whale distribution, the results showed a strong 99.6% reduction in risk in pre-regulation seasons to 2019 and 93% for pre-regulation period to 2020 for humpback whales. Blue whales show a stronger overlap with fishing activities, thus they experienced an increase of 39% and 44% in the mentioned time periods respectively. The yields between pre- and post regulation seasons show a small increase in total summer revenue and total landings in period (16% and 18%, respectively) between pre-regulation to 2019 while in the pre-regulation time to 2020, same parameters show 6% decrease and no change, respectively.	The study shows the effectiveness of the crab pot reduction which can reduce the risk of bycatch for large cetaceans when carefully applied with regards to the prevailing fishing effort and its overlap with cetacean population density.
Puente, E., Citores, L., Cuende, E., Krug, I., & Basterretxea, M. (2023). Bycatch of short-beaked common dolphin (*Delphinus delphis*) in the pair bottom trawl fishery of the Bay of Biscay and its mitigation with an active acoustic deterrent device (pinger). Fisheries Research, 267, 106819.	Small cetaceans	Common dolphin (*Delphinus delphis*)	Trawl	NE Atlantic; Bay of Biscay; FAO 27.8c	2021 - 2022	Trials of Dolphin Dissuasive Device (DDD) was tested in demersal pair trawlers (one boat with and one boat without DDDs) equipped with Remote Electronic Monitoring (REM) system during periods March 1 2021 - May 26 2021 and Nov 1 2021 - April 30 2022. The trials	Out of 467 hauls, 25 common dolphins were bycaught in nets without DDDs and just 1 in the net with DDDs with most of the bycatch occurring in Jan and Feb 2022. No detection of malfunctions of DDDs during the experimental period with a proven battery life of 40h. Statistical analysis shows significant effect of DDDs on the reduction of bycatch while DDDs are employed (haul duration irrelevant), precisely estimated reduction	Demonstrated effectiveness of DDDs in reducing the bycatch of common dolphins where fishing zones and depth need to be accounted for future development of mitigation

Literature	Group of species	Species	Gear	Area	Year	Method	Outcome	Uptake/regulation
						were performed in south Bay of Biscay. Bycatch data were modelled through a logistic GLM.	of the proportion of hauls with bycatch 92.2% and reduction of bycatch rate is 95.6%. Only fishing zone and depth had a significant effect on the bycatch of common dolphins, where bycatch was higher in the North Capbreton Canyon, then the South. Shallower waters increased the bycatch occurrence. Other fishing operational parameters were not significant.	measures using DDDs.
Moan, A., & Bjørge, A. (2023). Pingers reduce harbour porpoise bycatch in Norwegian gillnet fisheries, with little impact on day-to-day fishing operations. Fisheries Research, 259, 106564.	Small cetaceans and seals	Harbour porpoise (*Phocoena phocoena*); Harbour seal (*Phoca vitulina*)	Gillnets	Norwegian Sea	2018 - 2020	Field trial using ADDs or pingers to test their effectiveness to deter harbour porpoise and seals from the gillnets in commercial settings while recording potential impact of ADDs on the catch and additional time/effort needed. Two types of pingers were used: standard Banana pinger (Fishtek Marine Industries) and Dolphin pinger (Future Oceans). Due to low numbers of bycatches, pinger types were not compared for efficiency. Pingers were turned on during "odd weeks" and off during "even weeks". Data analysis was performed using a GAMM model with Poisson distribution.	In total, 20 harbour porpoises and 9 harbour seals were bycaught during the trial period. All harbour porpoises were bycaught in nets without pingers. 3 out of 9 harbour seals were bycaught in gillnets without pingers. There was no significant difference in fishing effort between pingered and unpingered nets regardless of the target species. The catch rates in nets with and without pingers were not significantly different in cod and monkfish fisheries, while the catch rate in saithe fishery was on average 160% higher in control nets than pingered ones. Additional handling time and maintenance included an average time cost of 1.7 +- 4.2 min and 3.9 +- 3.8 min (mean and SD) for setting and hauling of pingered nets, while weekly maintenance was on average 7.3 +- 7.4 min more time costly for pingered nets. Based on the time costs observed in this study, this would amount to roughly 5.5 h of additional time cost for an average gillnet fisher conducting 77 hauls per year (i.e., 5 trip per week).	Demonstrated effectiveness of ADDs in reducing bycatch rate of harbour porpoises in gillnet fisheries under the commercial settings. Here, it is particularly informative for the fishing industry and managers concerning the low costs of handling and maintenance time in comparison to yields and thus, profit.

Literature	Group of species	Species	Gear	Area	Year	Method	Outcome	Uptake/regulation
Lusseau, D., Kindt-Larsen, L., & van Beest, F. M. (2023). Emergent interactions in the management of multiple threats to the conservation of harbour porpoises. Science of the Total Environment, 855, 158936.	Small cetaceans	Harbour porpoise (*Phocoena phocoena*)	Gillnets	Theoretical	NA	A MultiAgent-based model (DEPONS) was used to determine the effect of pingers prevalence on the bycatch reduction in gillnet fisheries, and its contribution to noise propagation, affecting population growth (or population consequences of acoustic disturbance: PCoD). The model was tuned to the Danish-Swedish gillnet fisheries and two scenarios were run: gillnets with only pingers on, and gillnets with pingers and area closure applied.	The study reported a significant increase in abundance for the pingers and area closure scenario, in comparison to the pinger-only scenario. However, abundance was affected by the inclusion of individuals' condition in the model. Mortality was lower for both scenarios. Bycatch rate decreases with the increasing number of pingers in both scenarios, whereas the pinger-only scenario showed higher bycatch rates when low numbers of pingers were applied. Weaning rate in female porpoises was higher in the pinger-only scenario, and it was further reduced with increasing number of pingers (more or equal to 90 pingers per net).	Study provides valuable information on the effectiveness and biological consequences of utilising pingers and area closure as mitigation measures, separately and jointly. The outcome of this study should be considered when utilising these mitigation measures in order to minimise their adverse effects on the porpoises, while ensuring effectiveness.
Pinn, E. H. (2023). Porpoises, by-catch and the 'pinger' conundrum. Aquatic Conservation: Marine and Freshwater Ecosystems, 33(11), 1360-1368.	Small cetacean	Harbour porpoise (*Phocoena phocoena*)	Static nets	UK	NA	A study focused on the policy and regulation aspect of protecting the harbour porpoise in UK waters following the Fisheries Act in 2020. This Act strengthens the effort to protect and reduce or eliminate the bycatch of protected species. All policy initiatives were integrated into the Marine Wildlife Bycatch Mitigation Initiative (BMI) that	The paper summarizes the current issues of regulation enforcement, pinger usage, and discusses the needed improvements for more effective mitigation measures, particularly for smaller vessels (<12m length) where the risk of bycatch is high. Smaller vessels are not covered by the current regulation and are not permitted to use pingers without a licence. For now, ADDs remain the most effective mitigation measure for static nets. Thus, pingers should also become available for a specific proportion of small vessels (if the licence	Through EU Regulations , the use of mitigation measures, ADDs or pingers, is required for gillnets or entangling nets for specific vessel sizes and in specific areas. The article provides insightful overview of the problem with pinger usage for

Literature	Group of species	Species	Gear	Area	Year	Method	Outcome	Uptake/regulation
						proposes a range of activities and actions that should be implemented to minimise bycatch.	approval is switched to regional inshore fisheries management) for which the bycatch rate is known to be high, until other solutions become available. In addition, the paper acknowledges the willingness of fishers to avoid harbour porpoise bycatch, the need for better communication of scientific findings and bycatch measures to fishers and the public, whilst including fishers in the decision-making process.	smaller vessels and strongly argues for a more effective mitigation strategy following the regulation already in place.
Barz, F. (2023). Identifying social practices to inform fisheries management—the case of bycatch practices of marine mammals and seabirds of German gillnet fishers. ICES Journal of Marine Science, 80(3), 458-468.	Marine mammals and seabirds	Unspecified	Gillnets	Regional; German Baltic Sea	NA	Investigating the sociological aspect and practices relating to bycatch reduction with a focus on fishers' behaviour and mitigation practices concerning bycatch of marine mammals and seabirds in the German gillnet fisheries. Fishers with the highest fishing effort near the Natura 200 sites were interviewed using semi-structured, problem-centred interviews. Interviews were analysed using reconstructive social science method. Results were interpretated using the structuration theory by Anthony Giddens.	Overall, the bycatch of marine mammals and seabirds is seen as normal and unavoidable by the fishers. Fishers used three typologies of narratives to explain and justify their behaviour (1) *widerfahrnis* [beyond one's control], (2) relativization, and (3) routinization. Generally, seabird bycatch was regarded as something that normally happens, while marine mammal bycatch was regarded as a critical issue. Fishers developed their own bycatch mitigation measures (based on knowledge and experience) to avoid net damage and additional operational costs. Among others, hose include avoidance of high seabird density areas and visual confirmation of seabird aggregations before fishing starts. Fishers also employ knowledge of seasonal presence of marine mammals and seabirds as well as a technical measure (PALs) which is a legal requirement for certain fishing areas.	The study demonstrates the motivation of fishers to apply bycatch mitigation measures for marine mammals and seabirds. Information here is valuable for the improvement of mitigation measures enforcement.

Literature	Group of species	Species	Gear	Area	Year	Method	Outcome	Uptake/regulation
Lucas, S., & Berggren, P. (2023). A systematic review of sensory deterrents for bycatch mitigation of marine megafauna. Reviews in Fish Biology and Fisheries, 33(1), 1-33.	Multi-taxa; marine megafauna	Cetaceans; Pinnipeds; Marine reptilia; Elasmobranchs; Sea birds	All gears	NA	1991 - 2022	Systematic review of sensory deterrents used to reduce bycatch of marine megafauna with little or no effect on the fishing catches. The literature search was conducted using ROSES (RepOrting standards for Systematic Evidence Syntheses) protocol. The final choice of studies retained was used for qualitative, quantitative and other types of synthesis protocols	Final number of articles included was 116. The results contain a detailed overview of all sensory deterrents used and are categorised within acoustic, visual, olfactory, echolocation, tactile, and electrosensory sensory systems. Majority of studies on sensory deterrents were performed in North America (29.3%) and Europe (19.0%), although another main group of studies were conducted in experimental settings (24.1%). The highest number of trials per fishing gear associated with bycatch were gillnets (36.9% published) and experimental trials (36.1%), followed by longlines (23.2%). The qualitative and narrative analysis gives a summary on the sensory deterrents used by taxa group (elasmobranchs, sea birds, marine mammals, sea turtles) and by sensory system. For each sensory system, the authors provide example of deterrents, their usage and effectiveness.	Comprehensive summary on all sensory deterrents currently applied or tested for different taxa of marine megafauna. The paper is a potential guide for researchers, fishing industry and policy makers concerning the present state-of-the-art deterrents and their pros/cons.
Lima, F. D., Parra, H., Alves, R. B., Santos, M. A., Bjorndal, K. A., Bolten, A. B., & Vandeperre, F. (2023). Effects of gear modifications in a North Atlantic pelagic longline fishery: A multiyear study. Plos one, 18(10), e0292727.	Sea turtles and elasmobranchs	loggerhead sea turtles (*Caretta caretta*), blue shark, (*Prionace glauca*) and shortfin mako (*Isurus oxyrinchus*)	Pelagic longline	Azores Archipelago (Portugal)	2000-2004	Gear modification (hook type): use of circle hooks instead of conventional J-hooks	In general, the blue shark catches using circle hooks were significantly higher compared to J (Mustad 9/0). Conversely, the circle hooks were efficient in reducing the loggerhead sea turtle. No significant differences were observed comparing hook type to either catch rates or size selectivity for shortfin mako. Bycatch and were related to fewer catches of small sea turtle individuals.	Not specified
Yan, H., Zhou, C., Zhu, J., Wan, R., & Wang, X. 2023.	Sea turtles	Review paper: Leatherback	Longlines	globally		Meta-analysis of 21 publications which	The results indicated that the use of circle hooks, circle hooks with a wire	Not specified

Literature	Group of species	Species	Gear	Area	Year	Method	Outcome	Uptake/regulation
Methods for mitigating sea turtle bycatch in longline fisheries: a meta-analysis. IOTC-2023-WPEB19-30_rev1		Turtle (*Dermochelys coriacea*), Green Turtle (*Chelonia mydas*), Loggerhead Turtle (*Caretta caretta*), Hawksbill Turtle (*Eretmochelys imbricata*), Olive Ridley Turtle (*Lepidochelys olivacea*), Kemp's Ridley Turtle (*Lepidochelys kempii*), and Flatback Turtle (*Natator depressus*).				included control experiments in longline fisheries comparing the use of mitigation methods to no mitigation methods for the same target species	appendage, fish bait, blue-white lights, and stingray-like bait can mitigate sea turtle bycatch. However, a single mitigating method to reduce sea turtle bycatch in longline fisheries for all turtle species has not been identified yet.	
Sepúlveda, M., Szteren, D., Alfaro-Shigueto, J., Crespo, E.A., Durán, L.R., Guerrero, A.I., Mangel, J.C., Oliva, D. and Oliveira, L.R. (2023), Sea lion and fur seal interactions with fisheries and aquaculture in South American waters: threats and management perspectives. Mam Rev, 53: 116-131. https://doi.org/10.1111/mam.12311	Seals	South American sea lion (*Otaria flavescens*) and South American fur seal (*Arctocephalus australis*)	All fisheries and salmon aquaculture	South America	2023	Review paper of last 25 years of operational and biological interactions between seals and fisheries.	Identifies most bycatch related to two species of sea lion, particularly male and sub-adult males.	Limited uptake of mitigation measures has occurred across South America. The paper highlighted a need for more greater uptake of available measures.
Choi K-S, Jo H-S, Kang M (2023) Investigation on bycatch reduction methods of marine mammals for fishing with gill net, trap, trawl, stow net and set net. J	Marine mammals	All	Trawl, gill net, trap, stow net and set net	Korea	2023	Review paper assessing bycatch and bycatch mitigation in Korean fisheries.	The study presents options to reduce bycatch in 5 fisheries in Korea, making recommendations to best methods.	Unknown - Only abstract in English

Literature	Group of species	Species	Gear	Area	Year	Method	Outcome	Uptake/regulation
Korean Soc Fish Technol 59:279–289. https://doi.org/10.3796/KSFOT.2023.59.4.279								
Wosnick, N., Giareta, E. P., Leite, R. D., Hyrycena, I. and Charvet, P. (2023). An overview on elasmobranch release as a bycatch mitigation strategy. ICES J. Mar. Sci. 80, 591–604.	Elasmobranchs	Multi taxa	Multi-gear	Global	2023	Review of the IPOA-Sharks of the FAO of the United Nations database and online databases of the main RFMOs.	Pronounced lack of national plans of action for elasmobranchs in Europe - only 2 plans out of 35. The recommended actions to mitigate the impacts of incidental captures rely on incentives for the adoption of new technologies to avoid the capture of threatened elasmobranchs or reduce mortality. When accounting for release, 48.53% of the NPOAs and 70=5% of the RPOAs encouraged this measure; however, the recommendations indicated varied between countries and regions. More specifically, some Plans bring release as a priority mitigation measure to be adopted for all species captured as bycatch, regardless of the animal's physical condition. Other Plans suggest releasing species with low commercial value, or when there are additional legal measures in place, such as the mandatory release of threatened species. Finally, a number of Plans encourage release only in cases where the animals are responsive and have a chance of surviving, however, no additional information regarding proxies to assess survival chances are cited.	National plan of Action for Elasmobranchs in the UK
Drynan, D., Baker, B. (2023) Annex 1: Technical mitigation techniques to reduce bycatch of sharks.	Sharks	Multi taxa	Trawl, purse seine,	Global		Trawls: Removal of tickler chains; purse seine: FADs construction and deployment, and	There is a lack of empirical evidence that chemical, active electrical, electropositive metals, and visual repellents are effective in reducing shark	Not specified

Literature	Group of species	Species	Gear	Area	Year	Method	Outcome	Uptake/regulation
UNEP/CMS/COP14/Doc.27. 1.1/Annex 1			longline, gillnets			change fishing strategy; release before haulback; handling techniques; longlines: Bait type; change of capture method; leader material; reduce soak time; hook type; handling method; gillnet: Visual deterrent; pots and traps: magnet repellent	bycatch, despite having shown some promise. Active, electrical repellents can deter sharks, but there are issues with initial set up cost, maintenance frequency and costs, miniaturisation and safety. Magnets work species-specific, but given expense costs, including for maintenance, their use was not recommended.	
Ganias K, Karatza A, Charitonidou K, Lachouvaris D. 2023 Mitigating bycatch in Mediterranean trammel net fisheries using species-specific gear modifications. R. Soc. Open Sci. 10: 231058. https://doi.org/10.1098/rsos.231058	Elasmobranchs	Batoid rays: marbled electric ray (*Torpedo marmorata*); *Raja radula*; *Dasyatis tortonesei*; *Dasyatis pastinaca*	Trammel nets	Aegean-Levantine Sea	2021	The following trammel-net gear modifications were trialled: (i) the use of a guarding net attached to the footrope, (ii) increasing the length of the rigging twine between the footrope and the netting panel, and (iii) decreasing the mesh size of the outer panels.	Modifications (ii) and (iii) were successful in lowering captures of the marbled electric ray (*Torpedo marmorata*), which is commonly discarded in the study area. Both modifications are relatively simple, their manufacturing does not represent an added cost to implement, and most importantly they do not negatively affect the catch of the target species.	Not specified?
Zemah-Shamir, S., Zemah-Shamir, Z., Peled, Y., Sørensen, O. J. R., Schwartz Belkin, I. and Portman, M. E. (2023). Comparing spatial management tools to protect highly migratory shark species in the Eastern Mediterranean Sea hot spots. J. Environ. Manage. 337, 117691.	Elasmobranchs	Sandbar shark (*Carcharhinus plumbeus*); dusky shark (*Carcharhinus obscurus*)		Aegean-Levantine Sea		Dynamic time-area closures	The main conclusion from this study was that dynamic time-area closures offered sustainable and effective management strategies.	Not specified?

Literature	Group of species	Species	Gear	Area	Year	Method	Outcome	Uptake/regulation
Cronin, M. R., Croll, D. A., Hall, M. A., Lezama-Ochoa, N., Lopez, J., Murua, H., Murua, J., Restrepo, V., Rojas-Perea, S., Stewart, J. D., *et al.* (2023). Harnessing stakeholder knowledge for the collaborative development of Mobulid bycatch mitigation strategies in tuna fisheries. ICES J. Mar. Sci. 80, 620–634.	Elasmobranchs	Manta and devil rays: Mobula mobular, Mobula munkiana, Mobula birostris, Mobula thurstoni, and Mobula tarapacana.	Purse seine	Eastern Pacific Ocean	1993 to 2014	Stakeholders were interviewed to identify the barriers to bycatch mitigation of mobulid rays and collect ideas on how to overcome them.	A two-tiered approach to mitigation is proposed: (1) the development of protocols to release Mobulids from the net before brailing; and (2) the development of onboard handling modifications during brailing to reduce post-release mortality. Finally, the fact that a small proportion of respondents (12%) report that they identify Mobulids before setting the net suggests that factors that influence pre-capture detection is a priority for further research.	Western and Central Pacific Fisheries Commission (WCPFC) - Setting, landing, retention, and trans shipment ban; requires the immediate release and use of best handling practices [19/03]; Inter-American Tropical Tuna Commission (IATTC).
Fauconnet, L., Catarino, D., Das, D., Giacomello, E., Gonzalez-Irusta, J. D. S. M., Afonso, P. and Morato, T. (2023). Challenges in avoiding deep-water shark bycatch in Azorean hook-And-line fisheries. ICES J. Mar. Sci. 80, 605–619.	Elasmobranchs	Deep-water sharks	Hook-and-line	Azores		Stakeholder interviews	There are strong barriers to effective mitigation: Many of the fishers interviewed were unwilling to avoid deep-water sharks and expressed discontent at not being allowed to fish them. "Considering the challenges in incentivizing fishers to avoid bycatch of deep-water sharks, it is essential to involve them in the process. Further research, including integration of fishers ecological knowledge, needs to be carried out with a close collaboration between fishers and scientists."	Not specificed?
Carbonara, P., Prato, G., Niedermüller, S., Alfonso, S., Neglia, C., Donnaloia, M., Lembo, G. and Spedicato, M. T. (2023). Mitigating effects on target and by-catch species fished by drifting longlines using circle hooks in the South Adriatic Sea	Elasmobranchs	Blue shark (*Prionace glauca*); pelagic stingray (*Pteroplatytrygon violacea*); (and loggerhead turtle, (*Caretta caretta*))	Longline	Adriatic Sea		"Comparing the bycatch rates per unit of effort in a longline fishery for swordfish *Xiphias gladius* in the South Adriatic Sea when using either traditional J-type hook with a circle hook	For all species, there was no significant difference in catch-per-unit-effort (CPUE) or specimen lengths between the two hook types.	Not specified

Literature	Group of species	Species	Gear	Area	Year	Method	Outcome	Uptake/regulation
(Central Mediterranean). Front. Mar. Sci. 10, 1124093.						(C-type hook) on target and by-catch species."		
Post, S. *et al.* (2023) Bycatch mitigation in the West Greenland lumpfish (*Cyclopterus lumpus*) fishery using modified gillnets. Royal Society Open Science, 10 (4)	Birds	Common eider (Somateria mollissima)	Gillnets	West Greenland	2021-2022	Adding a 45 cm high small-meshed net panel to the bottom part of the bottom-set gillnet.	The modified nets had a 71% reduced bycatch rate for common eider and a 25% reduced catch rate for female lumpfish.	Not specified?
Montevecchi W.A. et a. (2023) High-contrast banners designed to deter seabirds from gillnets reduce target fish cathc. Marine Ornithology, 51 (1), pp. 115 - 123	Birds, fish, invertebrates	Northern Gannet (*Morus bassanus*), Rock Crab (*Cancer irroratus*), Atlantic Salmon (*Salmo salar*), Sea Trout (*Salmo trutta*), Capelin (*Mallotus villosus*), Rock Cod (*Gadus macrocephalus ogac*), Sculpin (*Myoxocephalus* spp.), Lumpfish (*Cyclopterus lumpus*)	Gillnets	Newfoundland, Canada	2017-2018	High contrast black and white warning banners were attached to surface-set gillnets	The banners reduced target catch, creating a non-viable option for fishers. Seabird bycatch was low.	Not specified?
Darby *et al.* (2023) Decadal increase in vessel interactions by a scavenging pelagic seabird across the North Atlantic.	Birds	Northern fulmar (*Fulmarus glacialis*)	Fishing vessel	Northeast Atlantic	2006-2020	Night-setting	Prevalence of nocturnal vessel interactions in fulmars suggests that this measure (night-setting) alone may not prove effective in this case.	Not specified?
Rouxel et al (2023) Looming-eyes buoys fail to reduce seabird bycatch in the Icelandic lumpfish fishery:	Birds, Marine mammals	Black guillemot (*Cepphus grylle*), Common guillemot (*Uria	Gillnets	Iceland	2022	Looming-eyes buoys, depth-based fishing restriction	No effect of Looming-eyes buoys. Strong correlation between bycatch rates and fishing depths, suggesting that depth-based fishing restrictions	Not specified?

Literature	Group of species	Species	Gear	Area	Year	Method	Outcome	Uptake/regulation
depth-based fishing restrictions are an alternative. Royal Society Open Science, 10 (10)		*aalge*), Atlantic puffin (*Fratercula arctica*), European shag (*Gulosus aristotelis*), Great cormorant (*Phalacrocorax carbo*), Common eider (*Somateria mollissima*), Long-tailed duck (*Clangula hyemalis*), Red-throated diver (*Gavia stellata*), Northern fulmar (*Fulmarus glacialis*), Harbor seal (Phoca vitulina), Grey seal (*Halichoerus grypus*), Harp seal (*Pagophilus groenlandicus*), White-beaked dolphin (*Lagenorhynchus albirostris*), Bottlenose dolphin (*Tursiops truncatus*), Harbour porpoise (*Phocoena phocoena*)					could virtually eliminate the bycatch of seabirds in this fishery. The study estimated that limiting fishing to waters more than 50 m deep could save between 5000 and 9300 seabirds every year.	
Reid, K. et al (2023) Mitigation of seabird bycatch in New Zealand squid trawl fisheries provides hope for ongoing solutions. Emu, 123 (3), pp. 195 - 205	Birds	Albatrosses (Diomedeidae), petrels (Procellariidae)	Trawls (arrow squid (Nototodarus spp.) trawl fishery)	New Zealand	2003-2019	Seabird scaring devices: bird baffler, paired streamer lines, warp deflector	The rate of capture of albatrosses by warps decreased from a mean of 2.9 birds per 100 tows during the period 2003 to 2006 to a mean of 0.7 birds per 100 tows after 2007.	No specified?

Literature	Group of species	Species	Gear	Area	Year	Method	Outcome	Uptake/regulation
Almeida A. et al (2023) Using a visual deterrent to reduce seabird interactions with gillnets. Biological Conservation, 285, art. no. 110236	Birds	Yellow-legged gull (*Larus michahellis*), Lesser black-backed gull (*Larus fuscus*), Northern gannet (*Morus bassanus*)	Gillnets	Berlengas archipelago, Portugal	2019-2020	Scarybird device deployed during entire fishing trip (a bird of prey shape and a retractable system which keeps it constantly moving with just a light breeze (2 km/h) which intend to mimic a bird of prey flying over the fishing area).	Both the numbers and distribution of seabirds reduced around the vessel when BRDs were used. The deterrent device was more effective in the closest area to the vessel (0–20 m) where there was a significant reduction in the number of gulls (*Larus michahellis*/*fuscus*, −56 %) and northern gannets (*Morus bassanus*, −72 %) close to the vessel, by comparison to control fishing trips. The use of this aerial deterrent device had no impact on the fishery's target catches and revenue, which contributed to a good acceptance by fishermen.	Not specified?
O'Keefe C.E. Efficacy of Time-Area Fishing Restrictions and Gear-Switching as Solutions for Reducing Seabird Bycatch in Gillnet Fisheries. Reviews in Fisheries Science and Aquaculture, 31 (1), pp. 29 - 46	Birds	birds	Gillnets			review	review	
Tamini L.L. *et al.* (2023) Bird scaring lines reduce seabird mortality in mid-water and bottom trawlers in Argentina. ICES Journal of Marine Science, 80 (9), pp. 2393 - 2404	Birds	Southern royal albatross (*Diomedea epomophora*), Black-browed albatross (*Thalassarche melanophris*)	Trawls (mid-water and bottom trawls)	Argentine Patagonian shelf	2012-2019	bird-scaring lines	Use of bird-scaring lines (in combination with no discarding of fishes) reduced the number of collisions to zero. Estimation of fishery-wide mortality without the use of bird-scaring lines includes 108 [31-186] Southern royal albatross (Diomedea epomophora) and 279 [108-465] Black-browed albatross (Thalassarche melanophris) killed annually by the collisions with the net monitoring cable.	Not specified?

2.3 Conclusion

For the fourth-year in a row, information about ongoing projects to mitigate bycatch of ETP species was collated from national reports submitted to WGFTFB. This new approach has shown to be very useful with delegates of 20 countries submitting reports to WGFTFB in 2023. In total, 63 projects were identified that describe mitigation potential for ETP species.

Mitigation approaches include "within existing gear configurations" modifications (Uhlmann and Broadhurst, 2015) such as changing mesh sizes, or netting materials, or attaching small plastic beads to gillnets and also "beyond existing gear configurations". Under the latter category, there are some innovative and effective approaches such as whale-safe pot fisheries in Canada; remotely operated acoustic triggers together with automated underwater camera sensors that can help fishers in "seeing" underwater and in real time what enters the net and whether it will be released or not. Several solutions aim to create win-win situations for fishers by improving both the energy efficiency (e.g., savings on fuel) as well as reducing bycatch risks and thereby shortening catch processing time (e.g. Hydrolift in Denmark). Ideally, any modified gears are not compromised in their catch performance for the target species. For example, in trials of the PearlNet no significant reductions in target catches were noticeable. In those cases, where deleterious effects from bycatch cannot be mitigated, shifting to alternative gears has been proposed. For example, the mini-seine in Germany provides such a solution as an alternative to bycatch-intensive gillnets. Especially those, for which effective pinger designs cannot be configured.

The literature review consist 21 position of original papers, mostly published in well recognized, high-end journals. Among them, six are review papers, and the rest should be classified as original research papers, both experimental and theoretical/modelling ones. The review of sensory deterrents seems to be especially worth of attention, as well as reviews of bycatch mitigation methods used in more distant areas like South America or Korean waters. The review of sea turtles bycatch mitigation files the gaps in knowledge about mitigation methods for this group of animals. At least 4 original research papers are related to pingers and/or other ADD's describing their effectiveness in relation to small cetaceans, especially in north European waters, what is on of the current "hot issues". Reducing bycatch in long-line fishery is the another subject of many of research papers published in 2023, most of them are subjected to reducing birds bycatch, but is also one related to sea turtles bycatch mitigation. Relatively hight number od papers are related to elasmobranch bycatch mitigation, confirmed high research effort directed to this issue in last years. Hight variety of species, fishing gears and mitigation methods was described. In the other hand, also relatively hight number of papers related to birds bycatch mitigation methods not returned with promising mitigation methods. Some of tested methods not working, or delivered results that are rather points to discussion then real solutions. More promising are additional observations, like shifting fishing gears to deeper waters, than conclusion from tests of certain mitigation methods or devices. Last but not least, we included into this review also one paper presenting sociological aspect and practices relating to bycatch reduction with a focus on fishers' behaviour and mitigation practices.

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Section 3 (ToR C) Contents

3 ToR C: Consider the quality of data available for use in the estimation of bycatch rates of ETP species through a Bycatch Evaluation and Assessment Matrix, BEAM

3.1 Introduction

In 2022 and 2023, WGBYC developed a new approach, a 'Bycatch Evaluation and Assessment Matrix' (BEAM v.1) to address ToR C and to provide improved information to underpin the various requirements of the new ICES/DGMARE agreement (ICES, 2022; ICES, 2023). The main objective of BEAM is to provide a systematic methodology using standardised fishing effort data, monitoring effort data, and bycatch data obtained through annual ICES data calls (stored in the WGBYC and RDB databases which are maintained by the ICES Data Centre (see ToR-G for further details on the WGBYC data call). This is combined with information on available mortality thresholds and a judgement on within group Subject Matter Expertise (SME) to provide an evaluation of the likely reliability and utility of bycatch assessments for different areas and species. The long-term goal is to use this approach for all relevant species to provide a comprehensive overview and assessment of data quality issues, likely bycatch threats, and inform on where improvements to various elements of the matrix (such as data collection, markers of sustainability, etc.) are required. In 2024 the work focussed on increasing the transparency and replicability of BEAM 2.0 and extend estimation processes to sub-ecoregion levels. The improved coding is still under development, and a v.0 of a R library is now maintained at https://www.github.com/dlusseau/BEAM/lib with a view to working towards its integration in the WGBYC github account. The species that were assessed within ToR C were the priority species are defined in the EU action plan https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52023DC0102 as well as species defined in the road map for ICES bycatch advice on protected, endangered, and threatened species (ICES, 2024a). BEAM is described in last year's report (ICES, 2023) and we provide a succinct description of its steps in this section.

3.2 Data preparation: Bycatch monitoring and bycatch events

In the BEAM analyses, data on fishing effort, bycatch monitoring effort, and bycatch events for 2017-2023 submitted through ICES WGBYC data call were used. The ToR-C subgroup agreed that the monitoring and bycatch data should only include what is considered the most reliable data collection methods, i.e. at-sea observers, electronic monitoring, and vessel crew observers (Basran and Sigurdsson, 2021). Thus, data collected by logbooks or port observers were excluded from the analyses. In addition, Estonian data reported as collected by vessel observers were excluded. The group concluded that, since the monitored data matched the reported fishing effort data in terms of quantity, and no protected species were reported in any of the fisheries, it is highly likely that the data in question was from logbooks, which are typically excluded. However, data collected by a reference fleet or by crew observers where the sampling designs main focus is to collect data on bycatch have been included (specifically, logbook data from crew observers in Portugal and the monitoring method "other" from Norway were included, Moan *et al.*, 2020). For future reference, it may be worth noting that missing values in the number of bycaught individuals were occasionally reported as -9. In the data call, vessel length was reported as ranges. The ranges were categorized into a binary variable: below and above 12 meters. Note that some length ranges included 12 meters (0-15, 8-15 meters). In the analyses, these ranges were set to below 12 meters. The number of bycaught individuals in a fishing event was calculated as the sum of individuals caught in gear with and without pingers.

For the first set of BEAM analyses, the bycatch monitoring effort was summed by ecoregion, country, year, métier level 4 and level 5, vessel length category (below or above 12m), bycatch monitoring method, and bycatch sampling protocol (in general, the taxa monitored; it could also be group of species which includes several taxa, i.e. "Protected species"). The number of individuals bycaught was calculated using the same set of grouping variables, as well as species.

The BEAM analysis requires data on fishing events where bycatch was recorded, as well as fishing events where no bycatch was recorded. Through the data call, bycatch events and monitored effort are reported. Fishing events where no individuals of a species were bycaught do not appear in this data set, however, monitored effort with zero bycatch is available.

To add instances of fishing effort with zero bycatch to the dataset, we created a list of relevant species in each ecoregion, using a list of the priority species defined in the EU action plan as well as species defined by the road map for ICES bycatch advice. This complete set of relevant Species * Ecoregion combinations was used to expand the aggregated bycatch data, to include rows with zero bycatch. In a second step, the expanded bycatch data were filtered to only include rows where the focal taxa had been monitored (as described in the sampling protocol variable). Thus, rows where the taxa monitored were "All" or "Protected species" (which includes all taxa), or rows where taxa of the focal bycatch species were the same as the taxa monitored for bycatch (for example the sampling protocol is for fish and the focal species is a fish species), were kept for further BEAM analyses.

3.3 Development of the Bycatch Evaluation and Assessment Matrix (BEAM) – a traffic light approach.

As in previous years (ICES, 2023), BEAM used the original criteria defined in BEAM 1.0 and 2.0 (ICES, 2023). However, modifications were made to some criteria methods and/or definitions (Table 3.1).

The eight original criteria for the bycatch evaluation and assessment matrix, established in BEAM 1.0 and further modified in BEAM 2.0, are described below. The BEAM was applied to species across all four taxonomic groups (Appendix 1) informed by; 1) a list of prioritized species provided to WGBYC by the DGMARE, 2) the ICES Roadmap for providing advice on bycatch of protected species, and 3) species from these two lists that were recorded as bycaught the past 7 years in the WGBYC database.

The list used can be found at https://doi.org/10.17895/ices.pub.26124430

Table 3.1 The Bycatch Evaluation and Assessment Matrix (BEAM) 2.0. The BEAM framework applies a traffic light approach across eight criteria that evaluate the status of inputs required to assess the impact of bycatch on sensitive species populations, by ecoregion and metier level 4 (https://vocab.ices.dk/?ref=1498).

	Criteria	Pass	Borderline	Fail
1	BPUE (Bycatch per unit effort) Data Quality & Analysis	BPUE is homogenous or BPUE is heterogeneous (e.g. covariate effects present among nations, years, metierL5, vessel size) & represented in effort databases. A pooled or weighted average BPUE is estimated.	Unexplained partial heterogeneity	There is substantial heterogeneity in BPUE & effort data is not available for all monitored levels of factors to which BPUE heterogeneity can be attributed. BPUE can't be pooled and/or no incidental bycatch reported.
2	Fishing Effort (Days at Sea)	Yes = Total Effort can be sourced from one or more ICES databases.	Not Applicable (NA) or only partial effort data available	No = Total Effort not available at the same level as the BPUE
3	Bycatch Mortality Estimate (Bm)	Yes = Total bycatch estimate produced (Bm=BPUE * Fishing Effort)	Not Applicable (NA)	No = Bm not available or Criteria 2 is red
4	Population/Stock Abundance Estimate	Yes = there is a published estimate	Not Applicable (NA)	No = there is no published abundance estimate
5	Bycatch Reference Point (T)	Yes = there is published bycatch reference point	Not Applicable (NA) ǀ TBD (to be determined) = May be possible for WGBYC to calculate reference points or proxy threshold based on published formulas	No = there are no published or ICES accepted bycatch reference point
6	Bycatch Mortality > Bycatch Reference point	No = Bycatch mortality estimate is less than Bycatch Reference point	Bycatch mortality is in the vicinity of Bycatch Reference point	Yes = Bycatch mortality estimate is greater than bycatch Reference point
7	Subject Matter Expertise (SME)	Yes = SME available across relevant ecoregion, metier L4 and species combinations	Only partial SME available among relevant ecoregion, metier L4 and species combinations.	No = missing SME across relevant ecoregion, metier L4 and species combinations
8	Population	Yes = Can assess impact of bycatch on the population	Partial assessment (high variation in assessment or	No = Can't assess impact of bycatch on the population

	impact Assessment		limited information in reference point)	

Criteria 1: Development of a procedure to evaluate the representativeness of BPUE estimates

The working group engaged with this year's data to further refine methods in the BEAM. BPUE is estimated by collating observed bycatch events during the deployment of multiple monitoring schemes. These monitoring schemes can vary by observation method, the fishing gear deployed within the métier observed, the year in which they took place, the location of operations, and the reporting nation (which can capture spatial variability in fishing operations in some ecoregions as well). The latter can mean that the area covered in ecoregions can differ between nations. The challenge therefore is to understand how to pull this information together to get a unique BPUE estimate for a species observed interacting with a given Métier Level 4 in each ecoregion. Pooling BPUE estimates that are different can lead to a lack of representativeness of that estimate for the Ecoregion and Metier level 4 for many reasons. For example, monitoring is not necessarily stratified by effort at the level at which BPUE heterogeneity occurs. A lack of representativeness can lead to a biased BPUE estimate and therefore an inappropriate representation of bycatch. In 2023, WGBYC ToR C continued the development of methods to understand heterogeneity in BPUE observations and tried to account for sources of this variance heterogeneity. We used a meta-analytic approach (Harrer et al, 2021) to explicitly assess i) whether between BPUE variance heterogeneity could be detected and, ii) if so, whether this heterogeneity in variance could be explained by factors attributable to the design of monitoring programmes and the distribution of monitoring effort.

We used the data submitted through ICES WGBYC data calls. Fishing effort data for the year 2023 submitted through the ICES WGBYC data call in 2024 and bycatch events and monitoring effort data reported for 2017-2024 was used to estimate BPUE for each Species, Ecoregion pairs on the priority lists, and for each Metier level 4. To do so we first subset the data for each combination of Ecoregion, Metier level 4, and Species, accumulating monitoring effort (as Days at Sea, DaS) and the number of incidental catches of individuals for each combination of: year, reporting nation, metier level 5, observation method, sampling protocol, area where fishing operations took place (ICES areas or GSA areas), and vessel size (a 2 level categorical variable: vessel <12m or ≥12m). We therefore obtained a varying number of replicate BPUE observations (number of individuals per Days at Sea) for each Ecoregion, Metier Level 4, Species combination. If no incidental captures were observed in this subset, we did not proceed with the analysis for that combination of Ecoregion, Metier level 4, and Species.

If BPUE variance estimates are homogeneous between these monitoring factors, then we would expect the BPUE observations to be "close to each other" in value. We estimated *a pooled BPUE* by fitting to these BPUE observations an intercept-only generalized linear model where samples were the BPUE observations, the response variable was the number of incidentally caught individuals for each observation, an offset was included of log10 DaS monitored, and the assumption was that residuals would follow a negative binomial distribution. Models were implemented using glmmTMB in R. We chose this approach instead of a meta-regression (using meta in R) to be able to assume this negative binomial distribution.

We then tested for between-BPUE estimate heterogeneity – what would be between-study heterogeneity in a meta-analysis – by refitting the model using a generalized linear model approach to meta-analysis assuming an incidence rate model where the number of bycatch events was estimated given the number of DaS monitored. We used Cochran's Q derivation suitable for this glm approach (Wald-type test statistic) to test for between-BPUE observation heterogeneity. These test statistics, particularly when the number of studies, in our case BPUE estimates, considered is small (less than 20), can be quite approximate (Harrer *et al.*, 2021). In the future we aim to develop our own test statistic distribution, based on SCOTI simulations, to assess the significance of observed Cochran's Q like statistics that can be calculated for bycatch observations. If the Wald test statistics was significant (at 0.05 level), the BPUE observations were deemed to be heterogeneous. Note that here we did not adjust p-values for multiple testing so as to remain conservative in our conclusions that residuals are homogeneous.

We also fitted models with all possible combinations of crossed random effects based on the level of replication we blocked in the data compilation for each given Ecoregion, Metier level 4, and Species combination (effects considered: year, nation, metier level 5, observation methods, sampling protocol, area, and vessel size). We then selected the more parsimonious model (including the intercept only glm as a candidate model) using AIC. A possible limitation of the present methodology is the assumption that random effects are crossed but not nested, particularly when we are aware that some random effects do not have a reasonable number of levels. We are currently conservative in our acceptance of fitted models, but future work will extend to challenge our current modelling approach with alternative ways to account for sample structure.

At the end of this statistical modelling exercise, we had a pooled BPUE estimate, whether it emerged from a unique BPUE estimate or from heterogeneous BPUE observations and heterogeneity could be attributed to recorded factors associated with monitoring. In the latter case, the pooled BPUE estimate was used if we had an appropriate BPUE estimate for each level of the factors to which variance between BPUE observations could be attributed. In this instance, we used the random intercept for each of those levels.

We could then proceed to estimate total bycatch if: 1) BPUE observations were homogeneous (using the pooled BPUE estimate), or 2) if the BPUE observations were heterogeneous but recorded factors could explain this heterogeneity *and* fishing effort was available for all monitored levels for these factors. For example, if sampling protocol emerged as a source of variation in BPUE estimate, we could not estimate total bycatch because this is not a characteristic reported for the fishing effort dataset. In the future we aim to elicit from WGBYC a ranking of sampling protocol to know which sampling protocol should be used to estimate BPUEs in such circumstances. As another example, if nation emerged as a source of variance in the BPUE estimate and five nations were monitored but only three of those reported fishing effort, we could not estimate total bycatch.

If between-year heterogeneity was detected in the BPUE estimate, we only used the 2023 BPUE estimate to calculate total bycatch given the 2023 fishing effort. In this instance, it is worth noting that while we only used the 2023 intercept estimate, the model made use of the seven years of monitoring data in the 2023 random intercept estimation process; hence we did indeed make use of the seven years of monitoring data to inform the 2023 total bycatch estimate.

Finally, we applied a further check that for each Ecoregion, Metier level 4, and Species combination, the sampling protocol matched the species concerned, i.e. that bycatch estimates for fish emerged from monitoring where observers looked for fish (rather than e.g. birds or mammals only). The verification of all these aspects, as well as the control that the number of days monitored does not exceed the number of fishing days for each combination, are part of the "quality checks" conducted to estimate total bycatch.

Criteria 2: Fishing Effort (days at sea)

The fishing effort submitted through the ICES WGBYC data call was compared to the fishing effort submitted to the RDB. The group evaluated that the fishing effort submitted to ICES WGBYC was more complete and thereby used in the BEAM evaluation. If a measure of total fishing, measured as total days at sea, can be summed over relevant ecoregion, country, metier level 4, area, and vessel length (>12 meters or < 12 meters) combinations (i.e., relevant for BPUE estimates under criteria 1), the total fishing effort are reported as green. This, however, does not indicate that the summed fishing days is exhaustive for the focal BPUE estimated under criteria 1, but rather that there are numbers of reported fishing days available in the database for the specific ecoregion, country, metier level 4 and vessel length combination in the ICES WGBYC data call. The total fishing effort will be reported as red if there is no fishing effort available at the same level as the BPUE estimate. For example, if métier level 5 is deemed an important contributor to BPUE, and métier level 5 X, Y and Z were monitored, but no fishing effort is available for métier Z. We did not consider a yellow color (partly available fishing effort) for the current version of the BEAM.

Criteria 3: Bycatch mortality (Bm)

Once a BPUE has been estimated, a total bycatch can be estimated if fishing effort is available which can be related to the monitoring effort that is available. In the instance when no heterogeneity was detected in the BPUE estimate, the total bycatch could be estimated in a straightforward manner by predicting the number of bycaught individuals for the fishing effort. In instances when some heterogeneity in BPUE was detected, a total bycatch could only be estimated if the fishing effort was available for all levels of the variable identified as source of heterogeneity. For example, if there is between-country heterogeneity and four nations report monitoring, but six nations are identified as contributing to fishing effort, then a total bycatch cannot be estimated. Also, if between-vessel size heterogeneity is identified, both small and large vessels are monitored but only large vessels report fishing effort, then a total bycatch cannot be estimated. While so far, we have focussed on bycatch estimate accuracy, we make a distinction on the usefulness of the Bm depending on its precision as well here. In future, SCOTI will inform on the level of precision which can be used to make useful inferences about Bm, in this intermediate step, we simply:

1) Estimated that if the monitoring coverage was less than 0.1% then if a total bycatch estimate could be derived it was still labelled red (fail),
2) Looked at the orders of magnitude between the lower and upper confidence intervals of the Bm estimate. If there were more than 2 orders of magnitude in those intervals the Bm was flagged as yellow (use with caution).

This is a conservative estimate, it does not mean that others (green) are sufficiently precise, it simply means that those (red) are so unprecise that we need more data to make sense of Bm. In addition, in instances where between-year variability in BPUE was detected, we also flag that Bm must be treated with caution (yellow) because they represent Bm for the reported year (i.e. 2023) and have limited usefulness to understand Bm beyond that year.

Criteria 4: Population Abundance Estimate

The availability of an abundance estimate will be reported in green if it corresponds to the population in the ecoregion in which the species is distributed. The abundance estimate will be reported in yellow for species whose distribution spans more than one ecoregion or for species with several populations within an ecoregion and for which the abundance estimate is only available for a portion of the population or populations. Red will be used to report species that do not have available estimates of abundance at either the local or ecoregional level or higher. We have made requests to taxonomically specialist WG (e.g., WGBIRD and WGMME) to consider re-estimating ecoregion scale abundance of key species based on existing survey results (e.g. SCANS).

Criteria 5: Bycatch Reference Point

Bycatch Reference Points (Caddy & Mahon 1995), an example of which is the concept of Bycatch Removal Threshold, correspond to level of bycatch which need to elicit management actions to meet management objectives. For the BEAM, only published mortality threshold levels are reported and indicated with a green colour while unknown values or not formally accepted values are indicated by a red colour. The threshold level will be reported in yellow for species whose distribution spans more than one ecoregion or for species with several populations within an ecoregion and for which the threshold level is only available for a portion of the population or populations. For many species and ecoregions mortality threshold levels are missing. Nevertheless, methods to calculate them in a harmonized manner across taxa are under development for several ICES areas and species (BirdLife, 2022, CIBBRINA 2023). A general recommendation for seabirds for incidental bycatch was proposed at 1% of the natural annual adult population (BirdLife, 2019). This bycatch reference point was nevertheless not considered or calculated for the present estimations and reported 'thresholds' still relate to different management objectives.

Criteria 6: Bycatch Mortality > Bycatch Reference Point

This criterion compares the estimated bycatch mortality to the Bycatch Reference point. If the estimated total bycatch is below the Bycatch Reference point, the colour will be green indicating that the negative impact on the population due to bycatch is low. If the Bycatch mortality is in the vicinity of the Bycatch reference point, the colour will be yellow indicating that the Bycatch mortality can have a negative impact. Finally, if the Bycatch mortality is higher than the Bycatch Reference point than the colour red will appear which indicates that there is likely a negative impact on the population caused by bycatch.

Criteria 7: Subject Matter Expertise

Members of the WGBYC embody expertise in the biology, abundance, distribution, and bycatch among all 4 taxonomic groups: marine mammals, seabirds, sea turtles and sensitive (non-commercial) fish. However, this does not mean that WGBYC has all the relevant expertise for the entire spatial distribution of the species being assessed (e.g. seabirds with complex migratory routes, species bycatch across multiple gear types and ecoregions). Consequently, the subject matter expertise (SME) traffic lights were updated to reflect the dynamic nature of bycatch events for some sensitive species. SME is coded green if the WGBYC has expertise that covers all ecoregions and metier level 4 gears for the subject species applied to the BEAM. Alternatively, SME is coded yellow if there is partial expertise among all the ecoregion and metier level 4 combinations or coded red if there is no expertise for a subject species that been applied to the BEAM. It is possible for yellow cases to move to green if there are other ICES working groups that do have the required SME and can assist WGBYC with informing advice for such cases. Similarly, it may be possible for red cases to move to yellow or green in a similar manner.

Criteria 8: Population Impact Assessment

The last criteria, population impact assessment (PIA) is a final determination on whether a PIA can be made. For PIA to be green, most of the other seven criteria must be also green. When PIA is yellow, there is variability among the other criteria traffic lights, but a partial PIA may be possible. Finally, if PIA is red, it generally reflects a data poor situation among several of the criteria. It is important to note that when PIA is green or yellow, at this stage of the BEAMs development, WGBYC does not provide any definitive statements or conclusion on population impacts due to bycatch. The PIA criteria simply identifies if a determination of impact to a sensitive species population due to bycatch is possible, partially possible, or not possible.

3.4 RESULTS - Assessing Population Risk – Bycatch Evaluation and Assessment Matrix (BEAM)

3.4.1 Bycatch Estimates Beam Output

This year we could estimate a BPUE for 788 ecoregion x species pairs from the requested species list for given métier level 4 (Supplementary Table 1, Annex 6). Most of the scenarios for which we could not estimate BPUE were because there was no bycatch observed. We could estimate total bycatch for 319 of those 788 scenarios for which BPUE could be estimated this year (Annex 5) by contrast we could get an estimate for 165 such scenarios in 2023). It should be noted that there were clerical issues with the reporting of fishing effort for some scenarios in the 2023 data, and for those, the 2022 fishing effort was used instead (marked with an asterisk in the tables). There is heterogeneity in the ability to obtain a total bycatch between métiers with more success with GNS and OTB (Figure 3.1). There is also heterogeneity within-métier between-ecoregions, where some species are consistently hard to estimate (Figure 3.4), for example for GNS and OTB. We produced estimates at a smaller spatial scales for some of those scenarios (section 3.2). We could estimate total bycatch in several scenarios for priority species (Table 3.1, Figures 3.5-3.7).

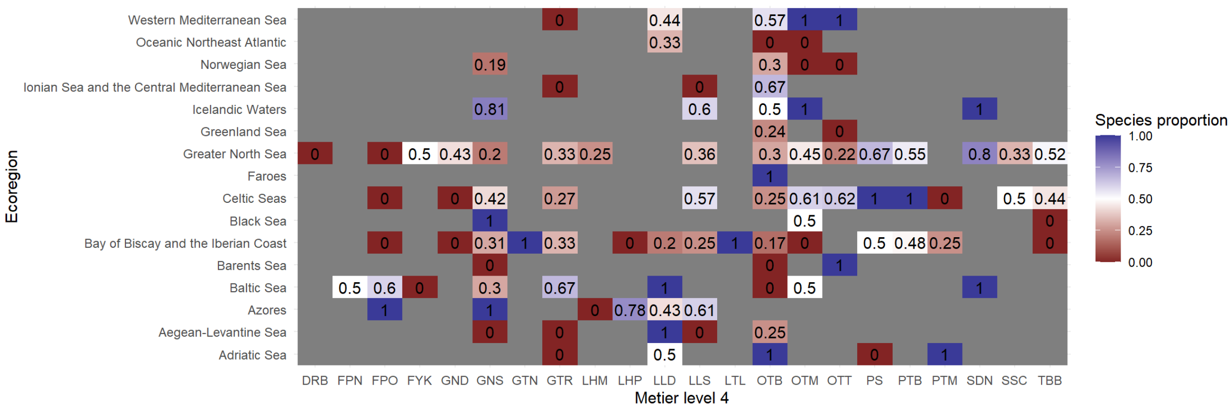

Figure 3.1 The proportion of Species monitored for which a total bycatch estimate could be drawn out of all species monitored for each combination of Ecoregion and Metier level 4. A grey cell means that a metier was not monitored in an ecoregion.

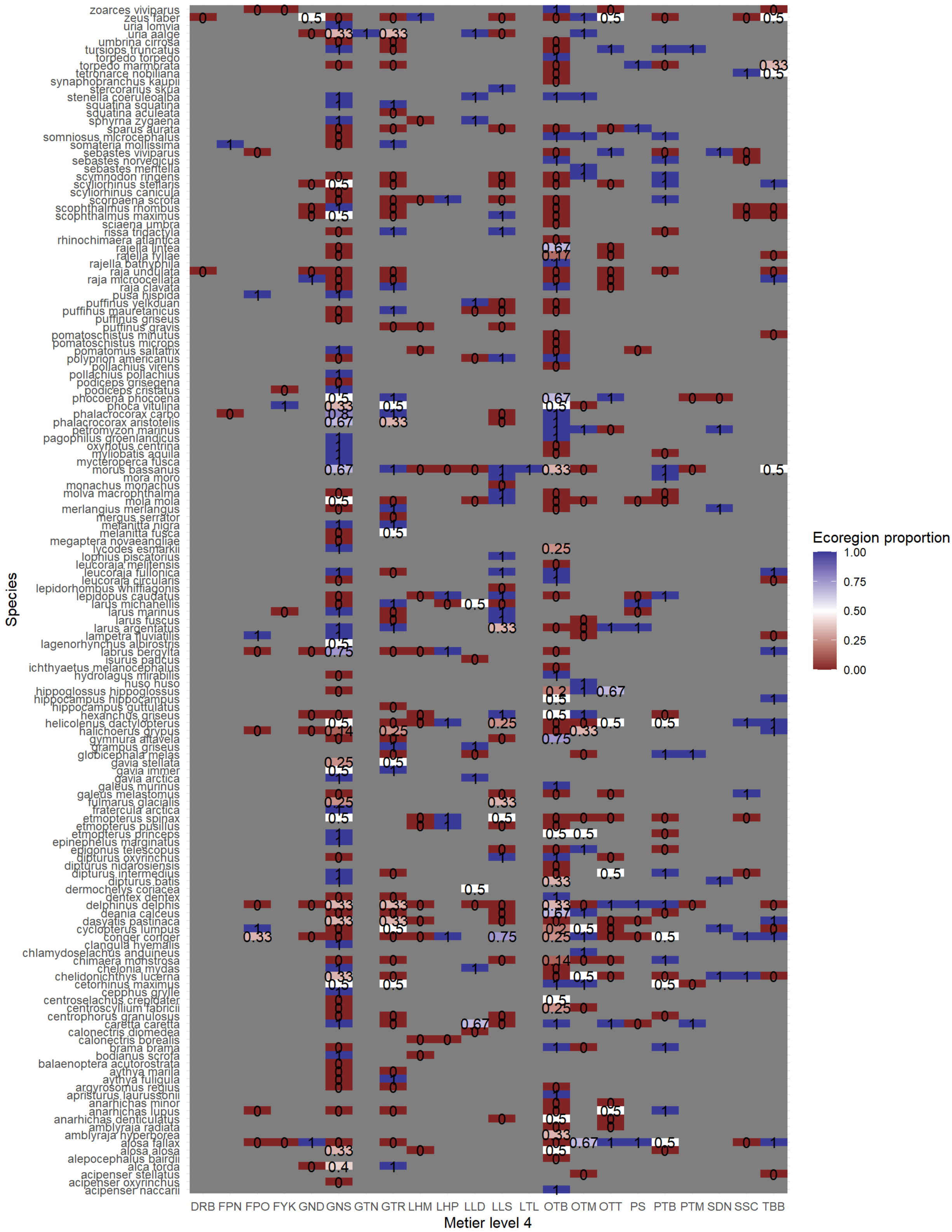

Figure 3.2 The proportion of Ecoregion monitored for which a total bycatch estimate could be drawn out of all ecoregions monitored for each combination of Species and Metier level 4.

Table 3.2 Total bycatch estimates (TB) for priority species that passed the BEAM this year (estimates for the year 2023) for different métiers in the ecoregions. TB lower and upper are 95% confidence intervals. * indicates that 2022 estimates presented using 2022 fishing effort (see text). The BPUE estimate should not be used if variability (last column) is identified.

Ecoregion	metier L4	Taxon	*Species*	Common name	# 2017 -23	monitoring effort (DaS) 2017-2023	Fishing effort (DaS) 2023	BPUE	lower	upper	total bycatch 2023	TB lower	TB upper	key variability in BPUE
Adriatic Sea	OTB	Turtles	*Caretta caretta*	Loggerhead	32	591	95,011	0.0339	0.0104	0.1109	2,887	530.9	15,825.6	between-vessel length category variability in BPUE
Adriatic Sea	PTM	Turtles	*Caretta caretta*	Loggerhead	59	1,010	8,446	0.0581	0.0400	0.0843	491	338.1	711.9	a constant BPUE appears to be representative
Aegean-Levantine Sea	LLD	Turtles	*Caretta caretta*	Loggerhead	1	99	1,569	0.0101	0.0014	0.0717	16	2.2	112.5	a constant BPUE appears to be representative
Aegean-Levantine Sea	LLD	Turtles	*Chelonia mydas*	Green Sea Turtle	6	99	1,569	0.0797	0.0129	0.4933	125	20.2	773.9	a constant BPUE appears to be representative
Aegean-Levantine Sea	OTB	Turtles	*Caretta caretta*	Loggerhead	8	927	38,259	0.0087	0.0041	0.0186	333	155.3	712.3	a constant BPUE appears to be representative
Azores	GNS	Turtles	*Caretta caretta*	Loggerhead	3	89	2,188	0.0337	0.0109	0.1045	74	23.8	228.7	a constant BPUE appears to be representative
Azores	GNS	Turtles	*Chelonia mydas*	Green Sea Turtle	1	89	2,188	0.0112	0.0016	0.0798	25	3.5	174.5	a constant BPUE appears to be representative

Ecoregion	metier L4	Taxon	*Species*	Common name	# 2017-23	monitoring effort (DaS) 2017-2023	Fishing effort (DaS) 2023	BPUE	lower	upper	total bycatch 2023	TB lower	TB upper	key variability in BPUE
Azores	LLD	Turtles	*Caretta caretta*	Loggerhead	29	475	2,392	0.0520	0.0118	0.2294	124	28.2	548.8	a constant BPUE appears to be representative
Azores	LLD	Turtles	*Dermochelys coriacea*	leatherback turtle	6	475	2,392	0.0125	0.0045	0.0348	30	10.8	83.2	a constant BPUE appears to be representative
Baltic Sea	GTR	Mammals	*Phocoena phocoena*	Harbor Porpoise	8	383	4,235	0.0095	0.0006	0.1480	45	9.8	624.5	spatial variability in BPUE
Bay of Biscay and the Iberian Coast	GNS	Mammals	*Delphinus delphis*	Short-beaked Common Dolphin	29	3,384	148,174	0.0124	0.0062	0.0249	1,834	912.1	3,688.8	a constant BPUE appears to be representative
Bay of Biscay and the Iberian Coast	GNS	Mammals	*Phocoena phocoena*	Harbor Porpoise	4	3,384	148,174	0.0008	0.0002	0.0035	123	29.5	514.8	a constant BPUE appears to be representative
Bay of Biscay and the Iberian Coast	GTR	Mammals	*Delphinus delphis*	Short-beaked Common Dolphin	49	1,964	55,930	0.0221	0.0132	0.0370	1,236	738.3	2,069.7	a constant BPUE appears to be representative
Bay of Biscay and the Iberian Coast	GTR	Mammals	*Phocoena phocoena*	Harbor Porpoise	14	1,964	55,930	0.0067	0.0036	0.0126	377	200.6	707.3	a constant BPUE appears to be representative

Ecoregion	metier L4	Taxon	*Species*	Common name	# 2017-23	monitoring effort (DaS) 2017-2023	Fishing effort (DaS) 2023	BPUE	lower	upper	total bycatch 2023	TB lower	TB upper	key variability in BPUE
Bay of Biscay and the Iberian Coast	OTB	Mammals	*Delphinus delphis*	Short-beaked Common Dolphin	11	2,177	71,910	0.0043	0.0018	0.0105	312	128.4	758.6	a constant BPUE appears to be representative
Bay of Biscay and the Iberian Coast	PS	Mammals	*Delphinus delphis*	Short-beaked Common Dolphin	16	1,117	61,453	0.0124	0.0060	0.0257	765	370.5	1,579.2	a constant BPUE appears to be representative
Bay of Biscay and the Iberian Coast	PTB	Mammals	*Delphinus delphis*	Short-beaked Common Dolphin	197	1,074	8,058	0.0057	0.0000	38.3937	744	240.9	4,907.5	spatial variability in BPUE
Bay of Biscay and the Iberian Coast	GTR	Seabirds	*Puffinus mauretanicus*	Balearic Shearwater	12	1,889	55,930	0.0076	0.0020	0.0287	425	112.6	1,604.4	a constant BPUE appears to be representative
Bay of Biscay and the Iberian Coast	GNS	Turtles	*Caretta caretta*	Loggerhead	2	3,078	148,174	0.0006	0.0001	0.0058	90	9.4	853.5	a constant BPUE appears to be representative
Bay of Biscay and the Iberian Coast	LLD	Turtles	*Caretta caretta*	Loggerhead	8	131	2,626	0.0634	0.0097	0.4152	166	25.4	1,090.4	a constant BPUE appears to be representative

Ecoregion	metier L4	Taxon	*Species*	Common name	# 2017 -23	monitoring effort (DaS) 2017-2023	Fishing effort (DaS) 2023	BPUE	lower	upper	total bycatch 2023	TB lower	TB upper	key variability in BPUE
Bay of Biscay and the Iberian Coast	OTB	Fish	*Gymnura altavela*	spiny butterfly ray	1	2,177	71,910	0.0005	0.0001	0.0033	33	4.7	234.5	a constant BPUE appears to be representative
Black Sea	GNS	Mammals	*Phocoena phocoena*	Harbor Porpoise	3	124	6,377	0.0198	0.0022	0.1824	126	13.7	1,163.0	a constant BPUE appears to be representative
Black Sea	OTM	Fish	*Huso huso*	European sturgeon	2	160	3,682	0.0112	0.0019	0.0659	41	7.0	242.6	a constant BPUE appears to be representative
Celtic Seas	GTR	Mammals	*Phocoena phocoena*	Harbor Porpoise	2	351	2,001	0.0137	0.0020	0.0915	27	4.1	183.0	a constant BPUE appears to be representative
Celtic Seas	OTB	Mammals	*Phocoena phocoena*	Harbor Porpoise	2	4,042	56,825	0.0005	0.0001	0.0032	31	5.2	180.7	a constant BPUE appears to be representative
Celtic Seas	OTT	Mammals	*Delphinus delphis*	Short-beaked Common Dolphin	2	1,249	10,729	0.0018	0.0003	0.0116	19	3.0	124.6	a constant BPUE appears to be representative
Celtic Seas	OTT	Mammals	*Phocoena phocoena*	Harbor Porpoise	2	1,249	10,729	0.0016	0.0004	0.0064	17	4.3	68.7	a constant BPUE appears to be representative
Celtic Seas	PS	Mammals	*Delphinus delphis*	Short-beaked Common Dolphin	1	70	122	0.0143	0.0020	0.1014	2	0.2	12.4	a constant BPUE appears to be representative

Ecoregion	metier L4	Taxon	*Species*	Common name	# 2017 -23	monitoring effort (DaS) 2017-2023	Fishing effort (DaS) 2023	BPUE	lower	upper	total bycatch 2023	TB lower	TB upper	key variability in BPUE
Greater North Sea	GTR	Mammals	*Phocoena phocoena*	Harbor Porpoise	13	638	10,554	0.0368	0.0061	0.2237	389	63.9	2,361.5	a constant BPUE appears to be representative
Greater North Sea	OTB	Mammals	*Phocoena phocoena*	Harbor Porpoise	1	4,701	110,959	0.0002	0.0000	0.0015	24	3.3	167.5	a constant BPUE appears to be representative
Greater North Sea	PS	Mammals	*Delphinus delphis*	Short-beaked Common Dolphin	7	83	2,481	0.0759	0.0264	0.2181	188	65.5	541.1	a constant BPUE appears to be representative
Icelandic Waters*	GNS	Mammals	*Phocoena phocoena*	Harbor Porpoise	254	1,045	1,974	0.2074	0.0628	0.6847	559	311.9	1,033.5	spatial variability in BPUE
Ionian Sea and the Central Mediterranean Sea	OTB	Fish	*Acipenser naccarii*	Adriatic sturgeon	1	417	63,691	0.0024	0.0003	0.0170	153	21.5	1,084.3	a constant BPUE appears to be representative
Ionian Sea and the Central Mediterranean Sea	OTB	Fish	*Gymnura altavela*	spiny butterfly ray	2	417	63,691	0.0035	0.0005	0.0249	221	30.9	1,584.2	a constant BPUE appears to be representative
Norwegian Sea	GNS	Mammals	*Phocoena phocoena*	Harbor Porpoise	356	10,118	58,830	0.0395	0.0174	0.0897	2,267	1,323.1	3,905.3	between-vessel length category variability in BPUE

Ecoregion	metier L4	Taxon	*Species*	Common name	# 2017 -23	monitoring effort (DaS) 2017-2023	Fishing effort (DaS) 2023	BPUE	lower	upper	total bycatch 2023	TB lower	TB upper	key variability in BPUE
Oceanic Northeast Atlantic	LLD	Turtles	*Caretta caretta*	Loggerhead	3	45	4,533	0.0667	0.0209	0.2124	302	94.9	962.8	a constant BPUE appears to be representative
Western Mediterranean Sea	LLD	Turtles	*Dermochelys coriacea*	leatherback turtle	1	2,268	32,551	0.0004	0.0001	0.0031	14	2.0	101.9	between-vessel length category variability in BPUE
Western Mediterranean Sea	OTB	Turtles	*Caretta caretta*	Loggerhead	8	5,599	159,484	0.0013	0.0006	0.0030	208	91.8	473.1	a constant BPUE appears to be representative
Western Mediterranean Sea	OTT	Turtles	*Caretta caretta*	Loggerhead	2	543	4,645	0.0037	0.0014	0.0098	17	6.4	45.6	a constant BPUE appears to be representative
Western Mediterranean Sea	OTB	Fish	*Gymnura altavela*	spiny butterfly ray	2	5,599	159,484	0.0004	0.0001	0.0021	63	12.0	328.5	a constant BPUE appears to be representative

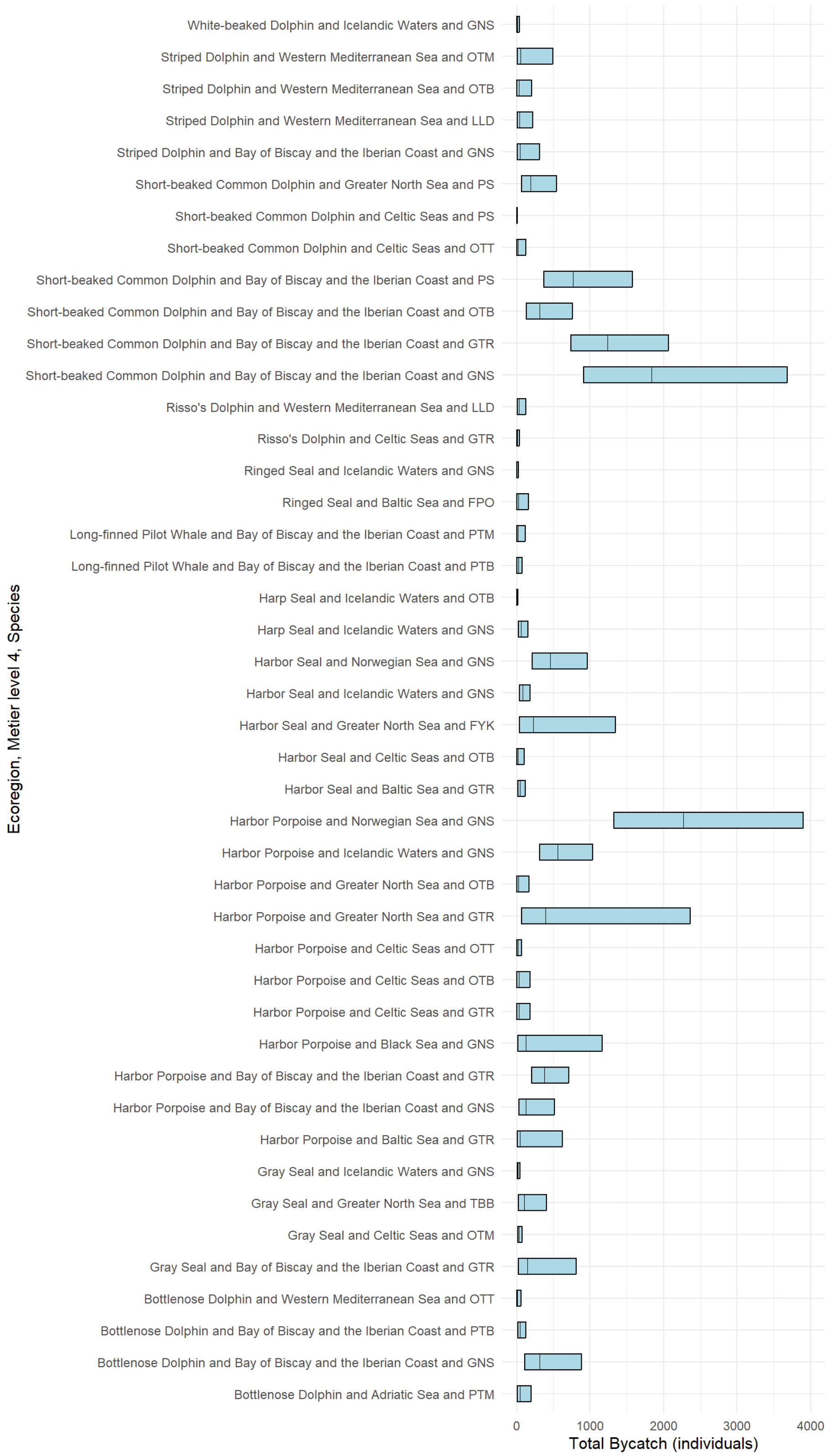

Figure 3.3 Total bycatch estimates for mammalian species (Table 3.2, Supplementary Table 1) by ecoregion and métier level 4 including confidence intervals (bars).

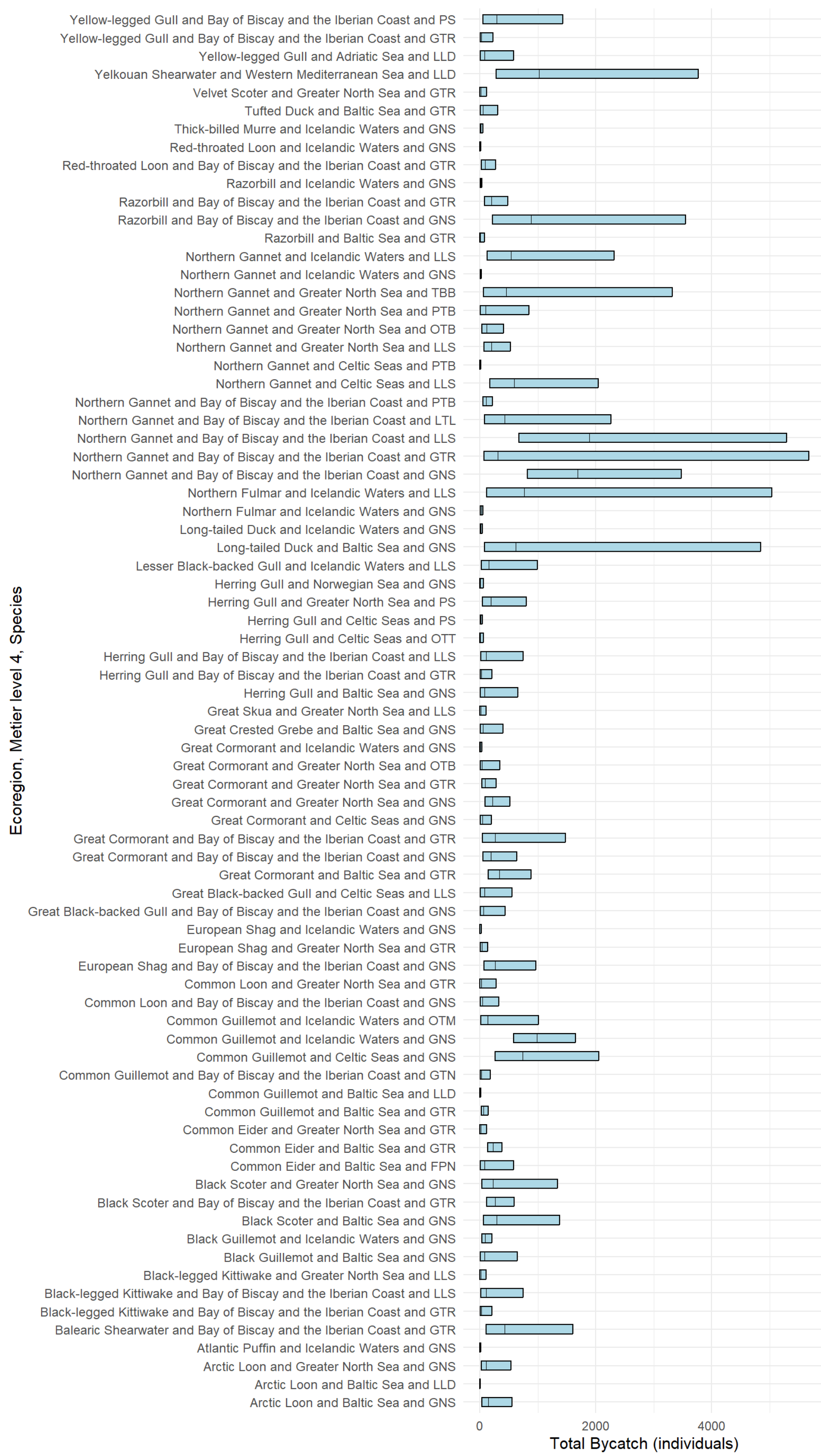

Figure 3.4 Total bycatch estimates for seabird species (Table 3.2, Supplementary Table 1) by ecoregion and métier level 4 including confidence intervals (bars).

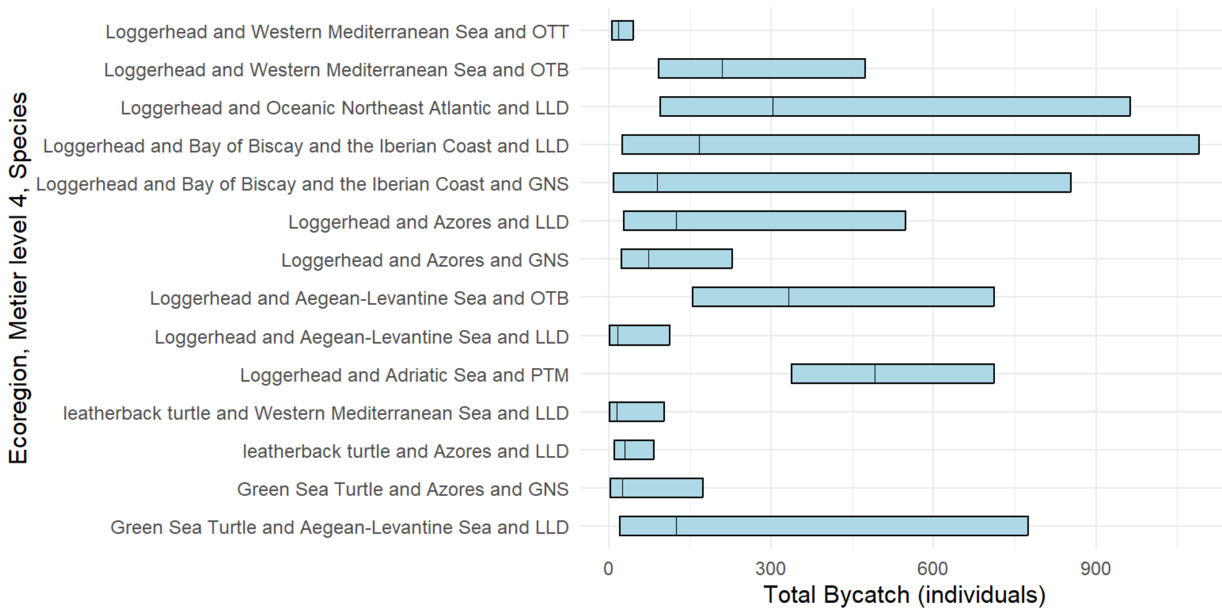

Figure 3.5 Total bycatch estimates for turtle species (Table 3.2, Supplementary Table 1) by ecoregion and métier level 4 including confidence intervals (bars).

For 31 instances (species x ecoregion) of the List, we had a total bycatch estimate for all métier level 4 fishing operations that took place in 2023 to which the species is sensitive and therefore we could derive a total bycatch estimate for the species at the ecoregion scale (Table 3.3). It is important to note that those estimates are based on the available fishing effort and for some ecoregions, some fishing countries are not represented (e.g., in the Black Sea and the Mediterranean Sea). **Note that these estimates rely on the assumption that we have a complete report of fishing effort, which is not met for all regions.**

It will be important to understand causes for differences between WGBYC bycatch estimates and others reported which are calculated using more approximate methods and data (e.g. Ramirez *et al.* 2024) in future WGBYC sessions. The estimates produced by WGBYC are considered the best available information. In 93 instances (species x ecoregion), total bycatch for the species and ecoregion scenario could not be estimated as information was missing for a single metier level 4. There is therefore scope for the number of total bycatch estimates to continue to grow using BEAM as data becomes available.

Table 3.3 Total bycatch estimates (TB) for 31 non-priority species x ecoregion scenarios requested which passed the BEAM criteria. Total bycatch is the sum of estimated total bycatches at métier level 4. Lower and upper limits are 95% confidence intervals. Most of those estimates aggregate only one métier and at most two. * indicates that 2022 estimates presented using 2022 fishing effort (see text).

Ecoregion	Taxon	Species	Common name	# 2017-2023	monitoring effort (DaS) 2017-2023	Fishing effort (DaS) 2023	total bycatch 2023	TB lower	TB upper
Azores	Turtles	dermochelys coriacea	leatherback turtle	6	475	2,392	30	10.8	83.2
Azores	Fish	bodianus scrofa	barred hogfish	3	89	2,188	63	12.0	331.8
Azores	Fish	lophius piscatorius	anglerfish	3	564	4,965	26	8.5	81.9
Azores	Fish	mora moro	googly-eyed cod	73	564	4,965	788	184.0	3,375.0
Azores	Fish	mycteroperca fusca	island grouper	4	89	2,188	98	36.9	262.0
Azores	Fish	sphyrna zygaena	smooth hammerhead	2	101	4,580	224	31.5	1,589.5
Baltic Sea	Seabirds	cepphus grylle	Black Guillemot	2	2,411	134,998	83	10.6	643.7
Baltic Sea	Seabirds	clangula hyemalis	Long-tailed Duck	3	2,411	134,998	623	80.1	4,843.0
Baltic Sea	Seabirds	gavia arctica	Arctic Loon	4	2,485	135,042	143	36.8	556.3
Black Sea	Mammals	phocoena phocoena	Harbor Porpoise	3	124	6,377	126	13.7	1,163.0
Black Sea	Fish	huso huso	European sturgeon	2	160	3,682	41	7.0	242.6
Celtic Seas	Fish	chlamydoselachus anguineus	frill shark	5	1,002	1,931	8	1.6	36.7
Celtic Seas	Fish	squatina squatina	angelfish	19	1,845	17,233	74	25.0	259.6
Greater North Sea	Seabirds	stercorarius skua	Great Skua	1	257	3,824	15	2.1	105.8
Greenland Sea	Fish	lycodes esmarkii	Esmark's eelpout	3	358	753	8	1.5	41.6
Greenland Sea	Fish	somniosus microcephalus	Greenland shark	42	358	753	117	19.4	709.1

Ecoregion	Taxon	Species	Common name	# 2017-2023	monitoring effort (DaS) 2017-2023	Fishing effort (DaS) 2023	total bycatch 2023	TB lower	TB upper
Icelandic Waters*	Mammals	lagenorhynchus albirostris	White-beaked Dolphin	4	1,045	1,974	7	1.5	34.7
Icelandic Waters*	Mammals	pagophilus groenlandicus	Harp Seal	32	3,182	7,437	63	24.6	171.1
Icelandic Waters*	Seabirds	alca torda	Razorbill	9	1,045	1,974	17	8.8	32.7
Icelandic Waters*	Seabirds	cepphus grylle	Black Guillemot	239	1,045	1,974	89	37.5	211.1
Icelandic Waters*	Seabirds	clangula hyemalis	Long-tailed Duck	9	1,045	1,974	16	5.9	41.1
Icelandic Waters*	Seabirds	fratercula arctica	Atlantic Puffin	3	1,045	1,974	5	1.4	21.1
Icelandic Waters*	Seabirds	fulmarus glacialis	Northern Fulmar	160	1,329	15,570	787	126.3	5,097.7
Icelandic Waters*	Seabirds	gavia stellata	Red-throated Loon	1	1,045	1,974	2	0.3	13.4
Icelandic Waters*	Seabirds	uria lomvia	Thick-billed Murre	10	1,045	1,974	18	5.9	55.5
Icelandic Waters*	Fish	amblyraja hyperborea	Arctic skate	153	2,137	5,463	261	41.5	1,645.4
Icelandic Waters*	Fish	apristurus laurussonii	Iceland catshark	86	2,137	5,463	145	27.3	768.3
Icelandic Waters*	Fish	galeus murinus	Mouse catshark	892	4,274	5,463	1,577	452.6	5,493.0
Icelandic Waters*	Fish	rajella bathyphila	deepwater ray	3	2,137	5,463	8	2.2	25.9
Ionian Sea and the Central Mediterranean Sea	Fish	acipenser naccarii	Adriatic sturgeon	1	417	63,691	153	21.5	1,084.3
Western Mediterranean Sea	Turtles	dermochelys coriacea	leatherback turtle	1	2,268	32,551	14	2.0	101.9

Table 3.4 BEAM final process for scenarios where total bycatch (TB) can be estimated at the ecoregion scale.

Ecoregion	Taxon	Species	Common name	Reference points	Abundance
Azores	Fish	*Bodianus scrofa*	Barred hogfish	No	No
Azores	Fish	*Lophius piscatorius*	Anglerfish	No	No
Azores	Fish	*Mora moro*	Googly-eyed cod	No	No
Azores	Fish	*Mycteroperca fusca*	Island grouper	No	No
Azores	Fish	*Sphyrna zygaena*	Smooth hammerhead	No	No
Azores	Turtles	*Dermochelys coriacea*	Leatherback turtle	No	No
Baltic Sea	Seabirds	*Cepphus grylle*	Black Guillemot	No	No
Baltic Sea	Seabirds	*Clangula hyemalis*	Long-tailed Duck	No	No
Baltic Sea	Seabirds	*Gavia arctica*	Arctic Loon	No	No
Black Sea	Fish	*Huso huso*	European sturgeon	No	No
Black Sea	Mammals	*Phocoena phocoena*	Harbor Porpoise	No	258900 (Popov *et al.*, 2023)
Celtic Seas	Fish	*Chlamydoselachus anguineus*	Frill shark	No	No
Celtic Seas	Fish	*Squatina squatina*	Angelfish	No	No
Greater North Sea	Seabirds	*Stercorarius skua*	Great Skua	No	No
Greenland Sea	Fish	*Lycodes esmarkii*	Esmark's eelpout	No	No
Greenland Sea	Fish	*Somniosus microcephalus*	Greenland shark	No	No
Icelandic Waters*	Fish	*Amblyraja hyperborea*	Arctic skate	No	No
Icelandic Waters*	Fish	*Apristurus laurussonii*	Iceland catshark	No	No
Icelandic Waters*	Fish	*Galeus murinus*	Mouse catshark	No	No
Icelandic Waters*	Fish	*Rajella bathyphila*	Deepwater ray	No	No

Icelandic Waters*	Mammals	*Lagenorhynchus albirostris*	White-beaked Dolphin	No	91277 (95% CI: 32351–257537) (NAMMCO, 2019)
Icelandic Waters*	Mammals	*Pagophilus groenlandicus*	Harp Seal	No	426000 (ICES, 2019)
Icelandic Waters*	Seabirds	*Alca torda*	Razorbill	No	313000 (Icelandic Red List, 2018)
Icelandic Waters*	Seabirds	*Cepphus grylle*	Black Guillemot	No	10000-15000 (Icelandic Red List, 2018)
Icelandic Waters*	Seabirds	*Clangula hyemalis*	Long-tailed Duck	No	No
Icelandic Waters*	Seabirds	*Fratercula arctica*	Atlantic Puffin	No	2000000 (Icelandic Red List, 2018)
Icelandic Waters*	Seabirds	*Fulmarus glacialis*	Northern Fulmar	No	120000 (Icelandic Red List, 2018)
Icelandic Waters*	Seabirds	*Gavia stellata*	Red-throated Loon	No	1000-2000 (Icelandic Red List, 2018)
Icelandic Waters*	Seabirds	*Uria lomvia*	Thick-billed Murre	No	327000 (Icelandic Red List, 2018)
Ionian Sea and the Central Mediterranean Sea	Fish	*Acipenser naccarii*	Adriatic sturgeon	No	50-100 (mature individuals, IUCN 2022)
Western Mediterranean Sea	Turtles	*Dermochelys coriacea*	Leatherback turtle	No	No

Table 3.5 . BEAM final process for scenarios where total bycatch (TB) can be estimated

Ecoregion	Metier L4	Taxon	Species	Common name	BPUE	TB 2023	Reference points	Abundance estimate
Adriatic Sea	OTB	Turtles	*Caretta caretta*	Loggerhead			No	27000* (95% CI = 24000-31000) (Fortuna *et al.* 2018) 34200* (95% CI = 28900-40400) (ACCOBAMS, 2021) *uncorrected for availability bias
Adriatic Sea	PTM	Turtles	*Caretta caretta*	Loggerhead			No	
Aegean-Levantine Sea	LLD	Turtles	*Caretta caretta*	Loggerhead			No	No
Aegean-Levantine Sea	OTB	Turtles	*Caretta caretta*	Loggerhead			No	No
Aegean-Levantine Sea	LLD	Turtles	*Chelonia mydas*	Green Sea Turtle			No	0.26–2.21 million for the whole Mediterranean Sea (Casale & Heppell, 2016)
Azores	GNS	Turtles	*Caretta caretta*	Loggerhead			No	5187 (95% CI = 2170 - 12399) (Saavedra *et al.*, 2018)

Azores	LLD	Turtles	*Caretta caretta*	Loggerhead			No	5187 (95% CI = 2170 - 12399) (Saavedra *et al.*, 2018)
Azores	GNS	Turtles	*Chelonia mydas*	Green Sea Turtle			No	No
Azores	LLD	Turtles	*Dermochelys coriacea*	leatherback turtle			No	No
Baltic Sea	GTR	Mammals	*Phocoena phocoena*	Harbor Porpoise			0.7 (IMR/NAMMCO 2018)	14403+491 (Gilles *et al.*, 2023 + Amundin *et al.*, 2022)
Bay of Biscay and the Iberian Coast	GNS	Turtles	*Caretta caretta*	Loggerhead			No	No
Bay of Biscay and the Iberian Coast	LLD	Turtles	*Caretta caretta*	Loggerhead			No	No
Bay of Biscay and the Iberian Coast	GNS	Mammals	*Delphinus delphis*	Short-beaked Common Dolphin			985 (OSPAR QSR, 2023)	302238 (95% CL = 106975 - 323306) (Gilles *et al.*, 2023)
Bay of Biscay and the Iberian Coast	GTR	Mammals	*Delphinus delphis*	Short-beaked Common Dolphin			985 (OSPAR QSR, 2023)	302238 (95% CL = 106975 - 323306) (Gilles *et al.*, 2023)

Bay of Biscay and the Iberian Coast	OTB	Mammals	*Delphinus delphis*	Short-beaked Common Dolphin			985 (OSPAR QSR, 2023)	302238 (95% CL = 106975 - 323306) (Gilles *et al.*, 2023)
Bay of Biscay and the Iberian Coast	PS	Mammals	*Delphinus delphis*	Short-beaked Common Dolphin			985 (OSPAR QSR, 2023)	302238 (95% CL = 106975 - 323306) (Gilles *et al.*, 2023)
Bay of Biscay and the Iberian Coast	PTB	Mammals	*Delphinus delphis*	Short-beaked Common Dolphin			985 (OSPAR QSR, 2023)	302238 (95% CL = 106975 - 323306) (Gilles *et al.*, 2023)
Bay of Biscay and the Iberian Coast	OTB	Fish	*Gymnura altavela*	spiny butterfly ray			No	No
Bay of Biscay and the Iberian Coast	GNS	Mammals	*Phocoena phocoena*	Harbor Porpoise			0 (OSPAR QSR, 2023)	4043 (95% CL = 1842 – 7309) (Gilles *et al.*, 2023)
Bay of Biscay and the Iberian Coast	GTR	Mammals	*Phocoena phocoena*	Harbor Porpoise			0 (OSPAR QSR, 2023)	4043 (95% CL = 1842 – 7309) (Gilles *et al.*, 2023)
Bay of Biscay and the Iberian Coast	GTR	Seabirds	*Puffinus mauretanicus*	Balearic Shearwater			41 (CI = 20 – 83) (Araújo *et al.*,2022)	17000 – 20000 (Bird Reporting (Portugal), 2019)
Black Sea	OTM	Fish	*Huso huso*	European sturgeon			No	No

Black Sea	GNS	Mammals	*Phocoena phocoena*	Harbor Porpoise			No	258900 (Popov *et al.*, 2023)
Celtic Seas	OTT	Mammals	*Delphinus delphis*	Short-beaked Common Dolphin			985 (OSPAR QSR, 2023)	162716 (95% CL = 83618 - 303467) (Gilles *et al.*, 2023)
Celtic Seas	PS	Mammals	*Delphinus delphis*	Short-beaked Common Dolphin			985 (OSPAR QSR, 2023)	162716 (95% CL = 83618 - 303467) (Gilles *et al.*, 2023)
Celtic Seas	GTR	Mammals	*Phocoena phocoena*	Harbor Porpoise			No	26870 (95% CL = 17745 - 41536) (Gilles *et al.*, 2023)
Celtic Seas	OTB	Mammals	*Phocoena phocoena*	Harbor Porpoise			No	26870 (95% CL = 17745 - 41536) (Gilles *et al.*, 2023)
Celtic Seas	OTT	Mammals	*Phocoena phocoena*	Harbor Porpoise			No	26870 (95% CL = 17745 - 41536) (Gilles *et al.*, 2023)
Greater North Sea	PS	Mammals	*Delphinus delphis*	Short-beaked Common Dolphin			985 (OSPAR QSR, 2023)	1814 (95% CL = 25 - 5981) (Gilles *et al.*, 2023)
Greater North Sea	GTR	Mammals	*Phocoena phocoena*	Harbor Porpoise			1622 (Taylor *et al.*, 2023)	338918 (95% CL = 243063 – 479203) (Gilles *et al.*, 2023)

Greater North Sea	OTB	Mammals	*Phocoena phocoena*	Harbor Porpoise			1622 (Taylor *et al.*, 2023)	338918 (95% CL = 243063 – 479203) (Gilles *et al.*, 2023)
Icelandic Waters	GNS	Mammals	*Phocoena phocoena*	Harbor Porpoise			3500 (IMR/NAMMCO, 2018)	86731 (IMR/NAMMCO, 2019)
Ionian Sea and the Central Mediterranean Sea	OTB	Fish	*Acipenser naccarii*	Adriatic sturgeon			No	No
Ionian Sea and the Central Mediterranean Sea	OTB	Fish	*Gymnura altavela*	spiny butterfly ray			No	No
Norwegian Sea	GNS	Mammals	*Phocoena phocoena*	Harbor Porpoise			700 (IMR/NAMMCO, 2018)	70314 (IMR/NAMMCO, 2019)
Oceanic Northeast Atlantic	LLD	Turtles	*Caretta caretta*	Loggerhead			No	No
Western Mediterranean Sea	OTB	Turtles	*Caretta caretta*	Loggerhead			102000 (95% CI = 94000-110750) (ACCOBAMS, 2021)	No

Western Mediterra-nean Sea	OTT	Turtles	*Caretta caretta*	Loggerhead			102000 (95% CI = 94000-110750) (AC-COBAMS, 2021)	No
Western Mediterra-nean Sea	LLD	Turtles	*Dermo-chelys coriacea*	leatherback turtle			No	No
Western Mediterra-nean Sea	OTB	Fish	*Gym-nura al-tavela*	spiny butter-fly ray			No	No

Table 3.5 shows some of the available relevant abundance estimates. It should be noted that, in many cases, these estimates -obtained from distance sampling methods- are uncorrected for the availability bias (i.e. proportion of time that animals are visible to the observer, which is linked to diving behaviour). Correction factors for availability and perception bias are simple multipliers that would be added to the uncorrected numbers and thus would have affected the density and abundance in all strata equally (Fortuna *et al.* 2018). For example, these multipliers could increase these numbers for loggerhead turtles up to alsmost a order of magnitude, having an impact of the resulting Bycatch Reference Points.

3.4.2 Bycatch Estimates Beam Output at the sub-ecoregion scale

For the incidents where there was too much heterogeneity, or missing data, within ecoregion levels to produce total bycatch, we could still estimate total bycatch at the ICES/GSA area scale for 103 scenarios within reasonable confidence levels (Table 3.6). Of these 103 scenarios, 23 estimates of total bycatch were calculated for mammal species (Figure 3.6), 19 for bird species (Figure 3.7), 3 for turtles (Figure 3.8) and 58 for fishes (Figure 3.9)

These scenarios are from a list of 211 (Supplementary table 2, Annex 7) where we were able to estimate an BPUE at the area scale (i.e., were able to fit a glmm to obtain a BPUE-estimate). However, due to the distribution of the recorded bycatch incidents, (e.g., very few incidents, but with a high number of individuals caught) and/or a lack of fishing effort data at the area x métier L4 level, we were unable to produce sensible total bycatch estimates for 107 of these 211 cases, particularly related to fish species.

Table 3.6 Total bycatch estimates (TB) for 103 species x area x métier level 4 scenarios for which full estimation on ecoregion level was not possible due to heterogeneity in the data. Lower and upper limits are 95% confidence intervals

Area	metier L4	Taxon	Species	# individuals 2017-2023	monitoring effort (DaS) 2017-2023	Fishing effort (DaS) 2023	BPUE model	BPUE	lower	upper	total bycatch 2023	TB lower	TB upper	interannual	key variability in BPUE
27.3.a.20	FPO	Fish	anarhichas lupus	44	52	10,757	n_ind ~ 1	0.8699	0.2297	3.2944	9,357	2,470.6	35,438.6	none apparent	a constant BPUE appears to be representative
27.3.a.20	OTB	Fish	alosa fallax	3	663	19,843	n_ind ~ 1	0.0045	0.0015	0.0140	90	29.0	278.3	none apparent	a constant BPUE appears to be representative
27.3.a.20	OTB	Fish	chelidonichthys lucerna	13	663	19,843	n_ind ~ 1	0.0220	0.0052	0.0939	437	102.7	1,863.0	none apparent	a constant BPUE appears to be representative
27.3.a.20	OTB	Fish	rajella lintea	9	663	19,843	n_ind ~ 1	0.0715	0.0087	0.5877	1,420	172.8	11,662.5	none apparent	a constant BPUE appears to be representative
27.3.a.20	OTB	Fish	zeus faber	5	663	19,843	n_ind ~ 1	0.0057	0.0012	0.0263	113	24.4	521.3	none apparent	a constant BPUE appears to be representative
27.3.a.20	OTT	Fish	galeus melastomus	1	208	3,960	n_ind ~ 1	0.0048	0.0007	0.0342	19	2.7	135.3	none apparent	a constant BPUE appears to be representative
27.3.a.21	GNS	Mammals	phoca vitulina	15	167	2,742	n_ind ~ 1	0.1078	0.0444	0.2619	296	121.7	717.9	none apparent	a constant BPUE appears to be representative

Area	metier L4	Taxon	Species	# individuals 2017-2023	monitoring effort (DaS) 2017-2023	Fishing effort (DaS) 2023	BPUE model	BPUE	lower	upper	total bycatch 2023	TB lower	TB upper	interannual	key variability in BPUE
27.3.a.21	OTB	Fish	alosa fallax	1	390	9,932	n_ind ~ 1	0.0026	0.0004	0.0182	25	3.6	180.6	none apparent	a constant BPUE appears to be representative
27.3.a.21	OTB	Fish	anarhichas lupus	5	390	9,932	n_ind ~ 1	0.0270	0.0036	0.2010	268	36.0	1,996.1	none apparent	a constant BPUE appears to be representative
27.3.b.23	GNS	Mammals	phoca vitulina	15	1,243	1,939	n_ind ~ 1	0.0136	0.0063	0.0292	26	12.3	56.5	none apparent	a constant BPUE appears to be representative
27.3.b.23	GNS	Mammals	phocoena phocoena	40	1,243	1,939	n_ind ~ 1	0.0361	0.0222	0.0587	70	43.0	113.8	none apparent	a constant BPUE appears to be representative
27.3.b.23	GNS	Seabirds	alca torda	10	1,243	1,939	n_ind ~ 1 + (1 | year)	0.0078	0.0018	0.0338	18	6.0	53.0	there is between-year variability in BPUE	a constant BPUE appears to be representative
27.3.b.23	GNS	Seabirds	melanitta fusca	8	1,243	1,939	n_ind ~ 1	0.0060	0.0025	0.0140	12	4.9	27.1	none apparent	a constant BPUE appears to be representative
27.3.c.22	GNS	Mammals	phoca vitulina	29	594	6,798	n_ind ~ 1	0.0389	0.0194	0.0783	265	131.7	532.2	none apparent	a constant BPUE appears to be representative

Area	metier L4	Taxon	Species	# individuals 2017-2023	monitoring effort (DaS) 2017-2023	Fishing effort (DaS) 2023	BPUE model	BPUE	lower	upper	total bycatch 2023	TB lower	TB upper	interannual	key variability in BPUE
27.3.c.22	GNS	Mammals	phocoena phocoena	48	594	6,798	n_ind ~ 1	0.0578	0.0307	0.1089	393	208.5	740.1	none apparent	a constant BPUE appears to be representative
27.3.c.22	GNS	Seabirds	melanitta fusca	14	594	6,798	n_ind ~ 1	0.0132	0.0031	0.0559	90	21.1	379.9	none apparent	a constant BPUE appears to be representative
27.3.c.22	GNS	Seabirds	phalacrocorax carbo	10	594	6,798	n_ind ~ 1	0.0152	0.0053	0.0440	104	35.9	298.9	none apparent	a constant BPUE appears to be representative
27.3.c.22	GNS	Seabirds	uria aalge	2	594	6,798	n_ind ~ 1	0.0029	0.0004	0.0212	20	2.7	144.2	none apparent	a constant BPUE appears to be representative
27.3.d.24	GNS	Mammals	phoca vitulina	4	168	12,104	n_ind ~ 1	0.0198	0.0053	0.0745	240	63.7	902.0	none apparent	a constant BPUE appears to be representative
27.3.d.24	GNS	Seabirds	alca torda	2	168	12,104	n_ind ~ 1	0.0091	0.0012	0.0676	110	14.9	817.7	none apparent	a constant BPUE appears to be representative
27.3.d.24	GNS	Seabirds	phalacrocorax carbo	1	168	12,104	n_ind ~ 1	0.0060	0.0008	0.0423	72	10.2	511.7	none apparent	a constant BPUE appears to be representative
27.3.d.24	GNS	Fish	acipenser oxyrinchus	21	168	12,104	n_ind ~ 1	0.1052	0.0293	0.3780	1,274	354.5	4,575.3	none apparent	a constant BPUE appears to be representative

Area	metier L4	Taxon	Species	# individuals 2017-2023	monitoring effort (DaS) 2017-2023	Fishing effort (DaS) 2023	BPUE model	BPUE	lower	upper	total bycatch 2023	TB lower	TB upper	interannual	key variability in BPUE
27.3.d.25	GNS	Seabirds	alca torda	2	123	10,874	n_ind ~ 1	0.0163	0.0041	0.0650	177	44.2	707.0	none apparent	a constant BPUE appears to be representative
27.3.d.25	GNS	Seabirds	phalacrocorax carbo	5	123	10,874	n_ind ~ 1	0.0157	0.0023	0.1074	170	24.8	1,167.3	none apparent	a constant BPUE appears to be representative
27.3.d.25	GNS	Seabirds	uria aalge	20	123	10,874	n_ind ~ 1	0.1615	0.0412	0.6334	1,756	447.6	6,887.9	none apparent	a constant BPUE appears to be representative
27.3.d.25	OTB	Fish	alosa fallax	7	160	1,554	n_ind ~ 1 + (1 | country)	0.0267	0.0046	0.1559	9	1.6	54.5	none apparent	there is spatial variability in BPUE
27.3.d.26	FPO	Fish	alosa fallax	118	80	88	n_ind ~ 1	5.8862	0.7704	45.0000	521	68.2	3,980.3	none apparent	a constant BPUE appears to be representative
27.3.d.28.1	FPO	Mammals	halichoerus grypus	8	46	763	n_ind ~ 1	0.2089	0.0645	0.6763	160	49.2	516.3	none apparent	a constant BPUE appears to be representative
27.3.d.28.1	GNS	Seabirds	gavia stellata	1	27	11,881	n_ind ~ 1	0.0370	0.0052	0.2629	440	62.0	3,123.7	none apparent	a constant BPUE appears to be representative
27.3.d.28.2	FPO	Fish	alosa fallax	9	3	145	n_ind ~ 1	2.3634	0.3296	16.9000	344	47.9	2,463.6	none apparent	a constant BPUE appears to be representative

Area	metier L4	Taxon	Species	# individuals 2017-2023	monitoring effort (DaS) 2017-2023	Fishing effort (DaS) 2023	BPUE model	BPUE	lower	upper	total bycatch 2023	TB lower	TB upper	interannual	key variability in BPUE
27.4.a	OTB	Mammals	halichoerus grypus	1	2,144	22,079	n_ind ~ 1 + (1 | year)	0.0005	0.0001	0.0033	10	1.5	73.1	there is between-year variability in BPUE	a constant BPUE appears to be representative
27.4.a	OTB	Fish	conger conger	32	2,144	22,079	n_ind ~ 1 + (1 | year)	0.0000	0.0000	0.0148	858	102.8	7,152.1	there is between-year variability in BPUE	a constant BPUE appears to be representative
27.4.a	OTB	Fish	zeus faber	3	2,144	22,079	n_ind ~ 1	0.0010	0.0001	0.0097	22	2.2	214.0	none apparent	a constant BPUE appears to be representative
27.4.a	SSC	Fish	sebastes viviparus	1	208	2,638	n_ind ~ 1 + (1 | year)	0.0048	0.0007	0.0345	13	1.8	91.0	there is between-year variability in BPUE	a constant BPUE appears to be representative

Area	metier L4	Taxon	Species	# individuals 2017-2023	monitoring effort (DaS) 2017-2023	Fishing effort (DaS) 2023	BPUE model	BPUE	lower	upper	total bycatch 2023	TB lower	TB upper	interannual	key variability in BPUE
27.4.b	OTM	Mammals	halichoerus grypus	23	79	2,658	n_ind ~ 1	0.2657	0.0652	1.0831	706	173.2	2,878.5	none apparent	a constant BPUE appears to be representative
27.4.b	OTB	Fish	cyclopterus lumpus	4	539	22,627	n_ind ~ 1	0.0057	0.0013	0.0244	129	30.0	551.2	none apparent	a constant BPUE appears to be representative
27.4.b	OTB	Fish	helicolenus dactylopterus	6	539	22,627	n_ind ~ 1	0.0085	0.0015	0.0471	192	34.7	1,066.7	none apparent	a constant BPUE appears to be representative
27.4.b	OTB	Fish	rajella lintea	1	539	22,627	n_ind ~ 1	0.0019	0.0003	0.0132	42	5.9	298.1	none apparent	a constant BPUE appears to be representative
27.4.b	OTB	Fish	zeus faber	5	539	22,627	n_ind ~ 1	0.0090	0.0035	0.0229	204	80.3	518.0	none apparent	a constant BPUE appears to be representative
27.4.c	OTT	Fish	dasyatis pastinaca	1	8	153	n_ind ~ 1	0.1250	0.0176	0.8874	19	2.7	136.0	none apparent	a constant BPUE appears to be representative
27.5.a	OTB	Fish	petromyzon marinus	2	1,403	456,965	n_ind ~ 1	0.0014	0.0004	0.0057	651	162.9	2,604.6	none apparent	a constant BPUE appears to be representative
27.5.a.2	OTB	Mammals	pagophilus groenlandicus	1	734	28	n_ind ~ 1	0.0014	0.0002	0.0097	0	0.0	0.3	none apparent	a constant BPUE appears to be representative

Area	metier L4	Taxon	Species	# individuals 2017-2023	monitoring effort (DaS) 2017-2023	Fishing effort (DaS) 2023	BPUE model	BPUE	lower	upper	total bycatch 2023	TB lower	TB upper	inter-annual	key variability in BPUE
27.6.a	OTB	Fish	etmopterus spinax	10	1,465	14,224	n_ind ~ 1	0.0116	0.0019	0.0706	165	27.2	1,003.8	none apparent	a constant BPUE appears to be representative
27.7.c.2	OTB	Fish	conger conger	20	232	3,351	n_ind ~ 1 + (1 | year)	0.0126	0.0005	0.3262	56	11.7	270.7	there is between-year variability in BPUE	a constant BPUE appears to be representative
27.7.c.2	OTB	Fish	hexanchus griseus	13	232	3,351	n_ind ~ 1	0.0615	0.0212	0.1786	206	70.9	598.5	none apparent	a constant BPUE appears to be representative
27.7.d	GNS	Mammals	phoca vitulina	1	122	4,175	n_ind ~ 1	0.0082	0.0012	0.0582	34	4.8	242.8	none apparent	a constant BPUE appears to be representative
27.7.d	GNS	Fish	raja microocellata	20	122	4,175	n_ind ~ 1	0.1284	0.0338	0.4882	536	140.9	2,038.1	none apparent	a constant BPUE appears to be representative
27.7.d	GNS	Fish	raja undulata	88	122	4,175	n_ind ~ 1 + (1 | country)	0.0640	0.0002	21.1000	1,344	486.8	4,411.9	none apparent	there is spatial variability in BPUE
27.7.d	GNS	Fish	scyliorhinus stellaris	10	122	4,175	n_ind ~ 1	0.0693	0.0099	0.4838	289	41.4	2,019.9	none apparent	a constant BPUE appears to be representative

Area	metier L4	Taxon	Species	# individuals 2017-2023	monitoring effort (DaS) 2017-2023	Fishing effort (DaS) 2023	BPUE model	BPUE	lower	upper	total bycatch 2023	TB lower	TB upper	interannual	key variability in BPUE
27.7.d	GNS	Fish	zeus faber	1	122	4,175	n_ind ~ 1	0.0082	0.0012	0.0582	34	4.8	242.8	none apparent	a constant BPUE appears to be representative
27.7.e	GNS	Mammals	delphinus delphis	5	650	11,709	n_ind ~ 1 + (1 | year) + (1 | vesselLength_group)	0.0075	0.0017	0.0325	44	10.2	190.4	there is between-year variability in BPUE	there is between-vessel length category variability in BPUE
27.7.e	GTR	Mammals	delphinus delphis	5	203	5,198	n_ind ~ 1 + (1 | vesselLength_group)	0.0328	0.0027	0.3917	141	30.2	677.0	none apparent	there is between-vessel length category variability in BPUE
27.7.e	OTB	Mammals	delphinus delphis	11	739	17,134	n_ind ~ 1	0.0120	0.0041	0.0347	205	70.7	594.3	none apparent	a constant BPUE appears to be representative
27.7.e	OTB	Mammals	halichoerus grypus	1	739	17,134	n_ind ~ 1	0.0014	0.0002	0.0096	23	3.3	164.6	none apparent	a constant BPUE appears to be representative
27.7.e	GTR	Seabirds	uria aalge	5	203	5,198	n_ind ~ 1	0.0246	0.0103	0.0592	128	53.3	307.8	none apparent	a constant BPUE appears to be representative
27.7.e	GNS	Fish	dasyatis pastinaca	5	650	11,709	n_ind ~ 1	0.0074	0.0022	0.0256	87	25.3	299.9	none apparent	a constant BPUE appears to be representative

Area	metier L4	Taxon	Species	# individuals 2017-2023	monitoring effort (DaS) 2017-2023	Fishing effort (DaS) 2023	BPUE model	BPUE	lower	upper	total bycatch 2023	TB lower	TB upper	interannual	key variability in BPUE
27.7.e	GNS	Fish	raja microocellata	27	650	11,709	n_ind ~ 1	0.0337	0.0083	0.1372	395	97.1	1,606.7	none apparent	a constant BPUE appears to be representative
27.7.e	GTR	Fish	raja undulata	5	203	5,198	n_ind ~ 1	0.0361	0.0055	0.2369	188	28.5	1,231.4	none apparent	a constant BPUE appears to be representative
27.7.e	OTT	Fish	chimaera monstrosa	1	63	1,047	n_ind ~ 1	0.0158	0.0022	0.1120	16	2.3	117.2	none apparent	a constant BPUE appears to be representative
27.7.e	OTT	Fish	dasyatis pastinaca	2	63	1,047	n_ind ~ 1	0.0357	0.0050	0.2571	37	5.2	269.1	none apparent	a constant BPUE appears to be representative
27.7.f	GNS	Mammals	halichoerus grypus	13	278	2,232	n_ind ~ 1	0.0472	0.0258	0.0863	105	57.6	192.6	none apparent	a constant BPUE appears to be representative
27.7.f	GNS	Mammals	phoca vitulina	2	278	2,232	n_ind ~ 1	0.0175	0.0018	0.1735	39	3.9	387.1	none apparent	a constant BPUE appears to be representative
27.7.f	OTB	Mammals	delphinus delphis	3	34	1,313	n_ind ~ 1	0.1146	0.0170	0.7730	151	22.3	1,015.3	none apparent	a constant BPUE appears to be representative
27.7.f	TBB	Fish	conger conger	17	438	1,727	n_ind ~ 1	0.0359	0.0068	0.1895	62	11.7	327.2	none apparent	a constant BPUE appears to be representative

Area	metier L4	Taxon	Species	# individuals 2017-2023	monitoring effort (DaS) 2017-2023	Fishing effort (DaS) 2023	BPUE model	BPUE	lower	upper	total bycatch 2023	TB lower	TB upper	interannual	key variability in BPUE
27.7.g	OTB	Mammals	delphinus delphis	6	560	7,523	n_ind ~ 1	0.0125	0.0019	0.0837	94	14.0	629.4	none apparent	a constant BPUE appears to be representative
27.7.g	GNS	Fish	zeus faber	78	159	2,815	n_ind ~ 1 + (1 | year)	0.0001	0.0000	0.3076	5,391	1,416.3	20,523.8	there is between-year variability in BPUE	a constant BPUE appears to be representative
27.7.g	OTB	Fish	chelidonichthys lucerna	90	560	7,523	n_ind ~ 1 + (1 | year)	0.0001	0.0000	1.0572	3,683	974.8	13,913.8	there is between-year variability in BPUE	a constant BPUE appears to be representative
27.7.g	OTB	Fish	conger conger	12	560	7,523	n_ind ~ 1 + (1 | year)	0.0001	0.0000	3.0753	309	57.7	1,658.2	there is between-year variability in BPUE	a constant BPUE appears to be representative

Area	metier L4	Taxon	Species	# individuals 2017-2023	monitoring effort (DaS) 2017-2023	Fishing effort (DaS) 2023	BPUE model	BPUE	lower	upper	total by-catch 2023	TB lower	TB upper	inter-annual	key variability in BPUE
27.7.g	OTB	Fish	etmopterus spinax	1	560	7,523	n_ind ~ 1	0.0018	0.0003	0.0127	13	1.9	95.4	none apparent	a constant BPUE appears to be representative
27.7.g	TBB	Fish	conger conger	32	525	3,962	n_ind ~ 1	0.0857	0.0155	0.4758	340	61.2	1,884.9	none apparent	a constant BPUE appears to be representative
27.7.h	GTR	Mammals	halichoerus grypus	4	84	1,752	n_ind ~ 1	0.0502	0.0146	0.1723	88	25.7	301.8	none apparent	a constant BPUE appears to be representative
27.7.h	OTB	Mammals	delphinus delphis	1	289	4,612	n_ind ~ 1	0.0035	0.0005	0.0246	16	2.2	113.3	none apparent	a constant BPUE appears to be representative
27.7.h	OTB	Fish	tetronarce nobiliana	9	289	4,612	n_ind ~ 1	0.0379	0.0050	0.2875	175	23.0	1,326.0	none apparent	a constant BPUE appears to be representative
27.7.h	OTM	Fish	mola mola	8	37	57	n_ind ~ 1	0.2910	0.0373	2.2703	17	2.1	129.7	none apparent	a constant BPUE appears to be representative
27.7.j.2	GTR	Mammals	halichoerus grypus	137	244	70	n_ind ~ 1	0.5068	0.3713	0.6919	36	26.1	48.6	none apparent	a constant BPUE appears to be representative
27.7.j.2	OTB	Fish	hexanchus griseus	2	235	9,563	n_ind ~ 1	0.0068	0.0009	0.0489	65	9.0	467.2	none apparent	a constant BPUE appears to be representative

Area	metier L4	Taxon	Species	# individuals 2017-2023	monitoring effort (DaS) 2017-2023	Fishing effort (DaS) 2023	BPUE model	BPUE	lower	upper	total bycatch 2023	TB lower	TB upper	interannual	key variability in BPUE
27.7.k.2	OTB	Fish	chimaera monstrosa	196	443	3,845	n_ind ~ 1 + (1 | year)	0.1144	0.0048	2.7150	5,940	1,884.0	18,729.8	there is between-year variability in BPUE	a constant BPUE appears to be representative
27.7.k.2	OTB	Fish	conger conger	32	443	3,845	n_ind ~ 1	0.0494	0.0226	0.1080	190	86.8	415.4	none apparent	a constant BPUE appears to be representative
27.7.k.2	OTB	Fish	etmopterus spinax	95	443	3,845	n_ind ~ 1 + (1 | year)	0.0627	0.0122	0.3225	903	438.6	1,860.0	there is between-year variability in BPUE	a constant BPUE appears to be representative
27.7.k.2	OTB	Fish	helicolenus dactylopterus	6,802	443	3,845	n_ind ~ 1 + (1 | year)	0.2745	0.0012	62.1000	70,119	50,625.8	97,118.3	there is between-year variability in BPUE	a constant BPUE appears to be representative

Area	metier L4	Taxon	Species	# individuals 2017-2023	monitoring effort (DaS) 2017-2023	Fishing effort (DaS) 2023	BPUE model	BPUE	lower	upper	total bycatch 2023	TB lower	TB upper	interannual	key variability in BPUE
27.7.k.2	OTB	Fish	hexanchus griseus	5	443	3,845	n_ind ~ 1	0.0113	0.0047	0.0271	43	18.1	104.2	none apparent	a constant BPUE appears to be representative
27.8.a	GNS	Mammals	halichoerus grypus	2	774	13,265	n_ind ~ 1 + (1 | year)	0.0026	0.0006	0.0104	34	8.6	137.1	there is between-year variability in BPUE	a constant BPUE appears to be representative
27.8.a	GNS	Seabirds	uria aalge	150	774	13,265	n_ind ~ 1 + (1 | vessel-Length_group)	0.1053	0.0231	0.4797	1,006	412.5	2,477.7	none apparent	there is between-vessel length category variability in BPUE
27.8.a	OTB	Seabirds	larus argentatus	2	344	16,924	n_ind ~ 1	0.0058	0.0015	0.0233	98	24.6	393.8	none apparent	a constant BPUE appears to be representative
27.8.b	OTB	Seabirds	morus bassanus	38	484	7,802	n_ind ~ 1 + (1 | country)	0.0087	0.0000	10.8000	182	60.9	1,892.1	none apparent	there is spatial variability in BPUE
27.8.b	OTB	Fish	mola mola	3	484	7,802	n_ind ~ 1	0.0036	0.0005	0.0266	28	3.9	207.6	none apparent	a constant BPUE appears to be representative
27.8.c	OTB	Seabirds	morus bassanus	2	499	6,779	n_ind ~ 1	0.0031	0.0004	0.0224	21	3.0	151.5	none apparent	a constant BPUE appears to be representative

Area	metier L4	Taxon	Species	# individuals 2017-2023	monitoring effort (DaS) 2017-2023	Fishing effort (DaS) 2023	BPUE model	BPUE	lower	upper	total bycatch 2023	TB lower	TB upper	interannual	key variability in BPUE
27.8.c	GNS	Fish	centrophorus granulosus	1	728	12,164	n_ind ~ 1	0.0014	0.0002	0.0097	17	2.4	118.5	none apparent	a constant BPUE appears to be representative
27.8.c	GNS	Fish	conger conger	9	728	12,164	n_ind ~ 1	0.0434	0.0129	0.1461	528	156.7	1,777.4	none apparent	a constant BPUE appears to be representative
27.8.c	GNS	Fish	hexanchus griseus	8	728	12,164	n_ind ~ 1	0.0100	0.0037	0.0270	122	45.2	328.2	none apparent	a constant BPUE appears to be representative
27.8.c	GNS	Fish	torpedo marmorata	22	728	12,164	n_ind ~ 1 + (1 | year) + (1 | vessel-Length_group)	0.0249	0.0023	0.2728	213	28.1	1,637.0	there is between-year variability in BPUE	there is between-vessel length category variability in BPUE
27.8.c	OTB	Fish	lepidopus caudatus	6	499	6,779	n_ind ~ 1	0.0110	0.0038	0.0319	75	25.7	216.5	none apparent	a constant BPUE appears to be representative
27.8.c	OTB	Fish	mola mola	5	499	6,779	n_ind ~ 1	0.0237	0.0039	0.1437	161	26.5	974.2	none apparent	a constant BPUE appears to be representative
27.8.c	OTB	Fish	scophthalmus rhombus	2	499	6,779	n_ind ~ 1	0.0040	0.0007	0.0230	27	4.7	155.9	none apparent	a constant BPUE appears to be representative

Area	metier L4	Taxon	Species	# individuals 2017-2023	monitoring effort (DaS) 2017-2023	Fishing effort (DaS) 2023	BPUE model	BPUE	lower	upper	total by-catch 2023	TB lower	TB upper	inter-annual	key variability in BPUE
27.8.c	OTB	Fish	torpedo marmorata	20	499	6,779	n_ind ~ 1	0.0306	0.0068	0.1374	208	46.4	931.2	none apparent	a constant BPUE appears to be representative
27.8.d.2	GNS	Fish	centroselachus crepidater	1	39	484	n_ind ~ 1	0.0254	0.0036	0.1800	12	1.7	87.2	none apparent	a constant BPUE appears to be representative
27.9.a	GNS	Seabirds	larus michahellis	7	1,490	117,943	n_ind ~ 1	0.0064	0.0023	0.0180	756	268.9	2,126.9	none apparent	a constant BPUE appears to be representative
27.9.a	LLS	Seabirds	puffinus mauretanicus	1	150	17,733	n_ind ~ 1	0.0067	0.0009	0.0473	118	16.7	839.3	none apparent	a constant BPUE appears to be representative
27.9.a	OTB	Fish	tetronarce nobiliana	85	731	40,309	n_ind ~ 1 + (1 | year)	0.0000	0.0000	0.0379	7,076	855.6	58,510.0	there is between-year variability in BPUE	a constant BPUE appears to be representative
27.9.b.1	LLD	Turtles	dermochelys coriacea	1	22	525	n_ind ~ 1	0.0455	0.0064	0.3227	24	3.4	169.4	none apparent	a constant BPUE appears to be representative
5	LLD	Turtles	caretta caretta	54	277	1,826	n_ind ~ 1	0.1949	0.1493	0.2545	356	272.6	464.7	none apparent	a constant BPUE appears to be representative

Area	metier L4	Taxon	Species	# individuals 2017-2023	monitoring effort (DaS) 2017-2023	Fishing effort (DaS) 2023	BPUE model	BPUE	lower	upper	total bycatch 2023	TB lower	TB upper	inter-annual	key variability in BPUE
6	LLD	Seabirds	calonectris diomedea	8	544	2,528	n_ind ~ 1	0.0313	0.0078	0.1257	79	19.7	317.7	none apparent	a constant BPUE appears to be representative
6	LLD	Turtles	caretta caretta	35	544	2,528	n_ind ~ 1	0.0408	0.0124	0.1337	103	31.5	338.1	none apparent	a constant BPUE appears to be representative

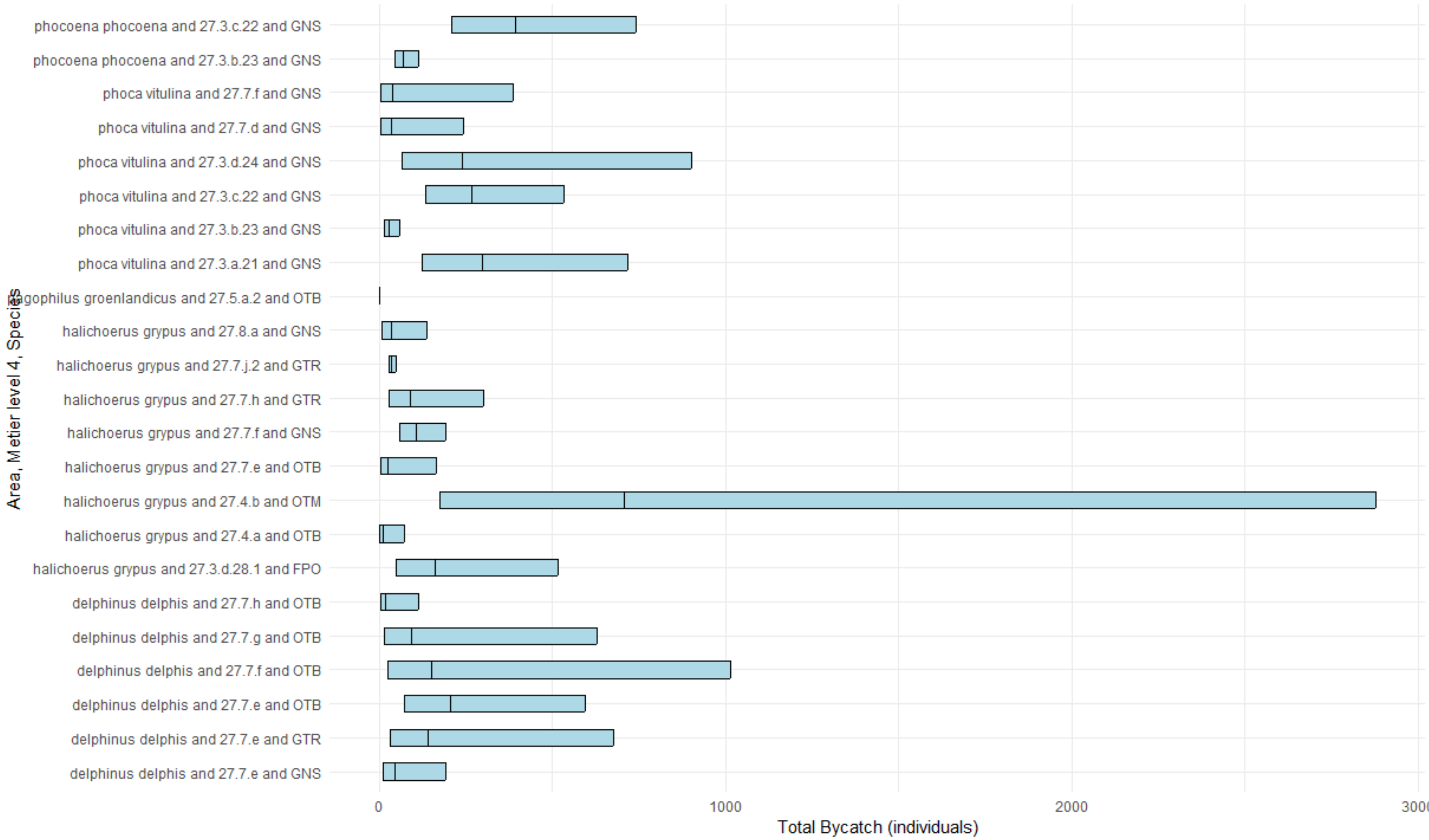

Figure 3.6 Total bycatch estimates for mammal species (Table 3.5, Supplementary table 2) by area and métier level 4 including confidence intervals (bars).

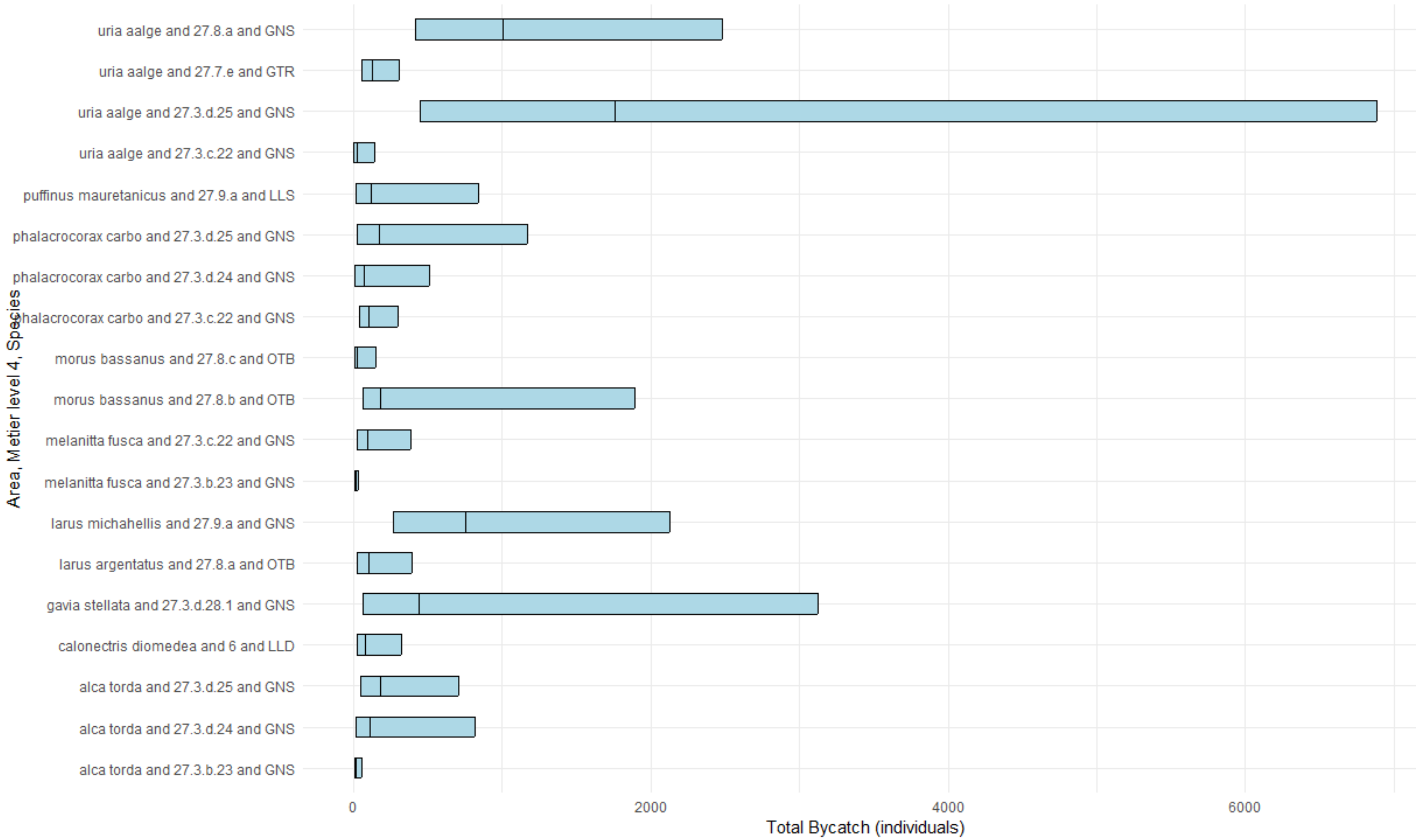

Figure 3.7 Total bycatch estimates for seabirds species (Table 3.5, Supplementary Table 2) by area and metier métier level 4 including confidence intervals (bars).

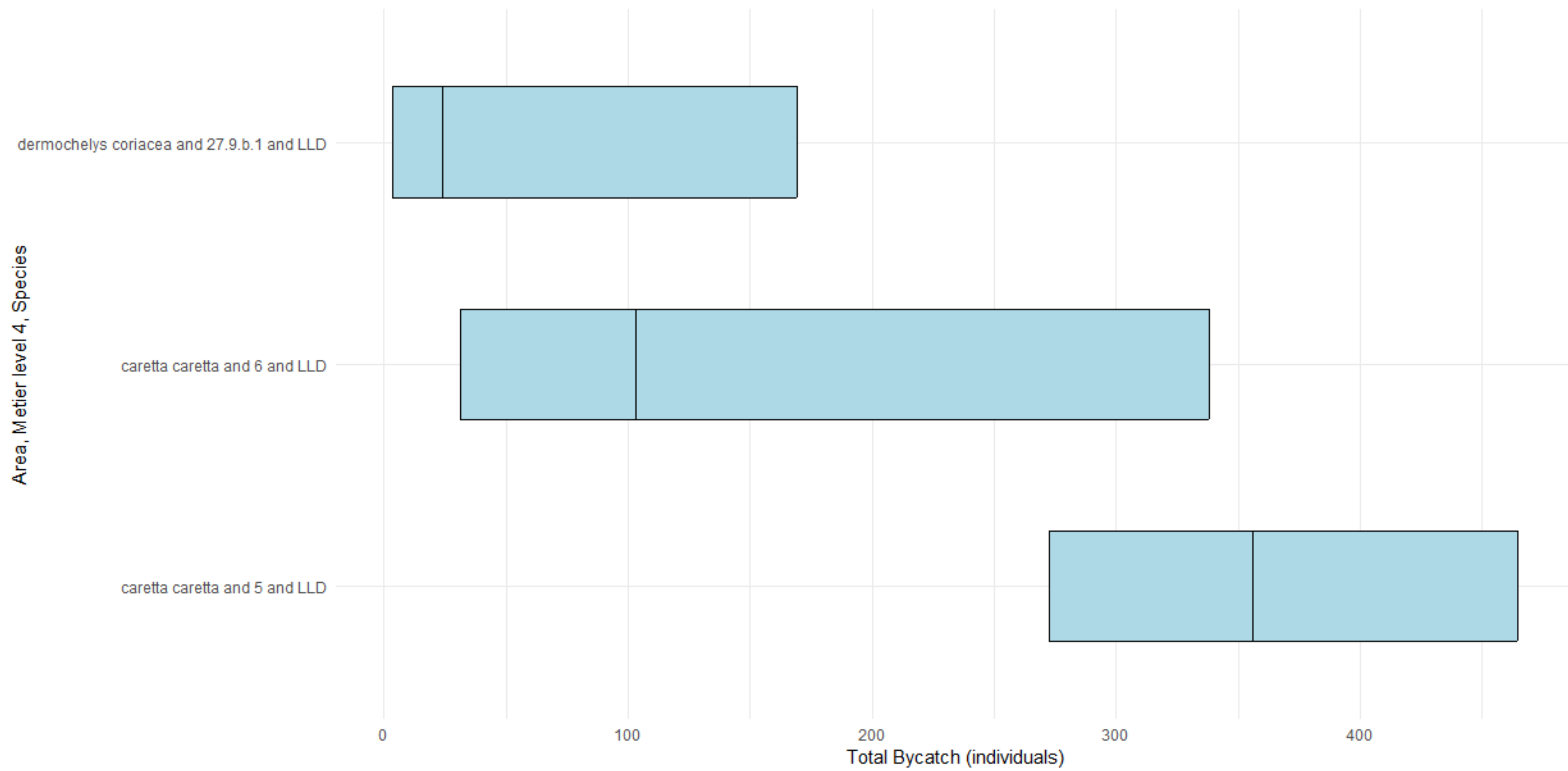

Figure 3.8 Total bycatch estimates for turtle species (Table 3.5, Supplementary Table 2) by area and métier level 4 including confidence intervals (bars).

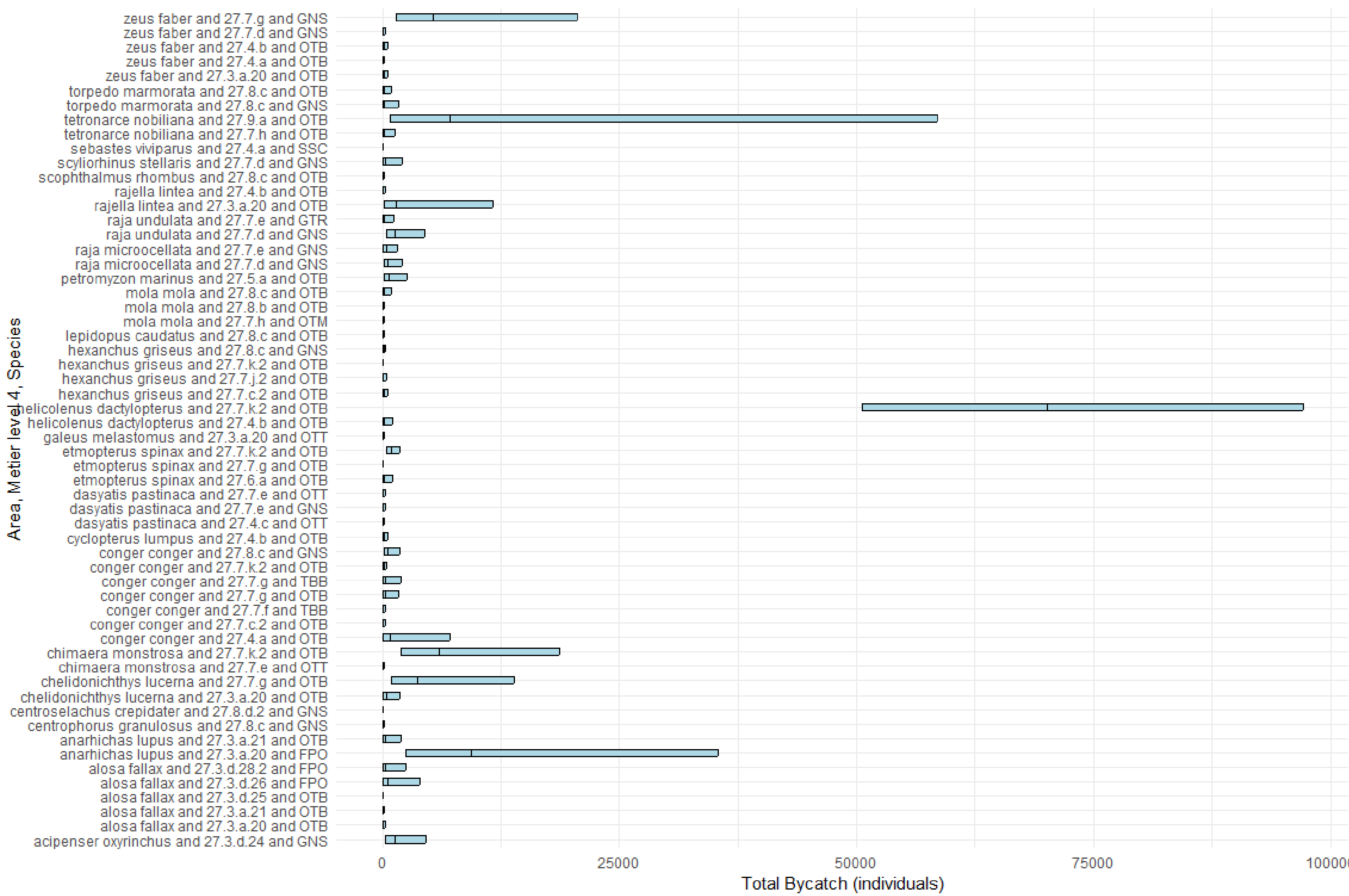

Figure 3.9 Total bycatch estimates for fish species (Table 3.5, Supplementary Table2) by area and métier level 4 including confidence intervals (bars).

3.5 Conclusions

The approach we have proposed over the past three years relies on cumulating insights between years about bycatch rate to derive a best estimate for the reporting year. As more data has become available, BEAM has been able to improve the range of species and ecoregions for which it can provide a total bycatch estimate with some quantitative measure of uncertainty and qualitative measure of precision. However, these are limited to EU fleets only and exclusively to a subset of those fisheries managed by MSs.

For the first time this year, we were able to provide total bycatch estimate at the ecoregion scale for some species. However, we remain unable to finalise bycatch assessments for these cases as the relevant ecoregion-level abundance estimates are lacking and Bycatch Reference Points (or methods to estimate them) are not agreed for all regions nor officially by relevant management bodies. There is now a need for a concerted effort with other WGs focusing on species ecology to develop at-sea density estimations at the ecoregion scale, with a clear indication of how those relate to naturally occurring population distributions. This would not only support the BEAM process, but also help appraise species ecology influences on BPUE intra-ecoregion variability and therefore help guide the most efficient mitigation techniques which can be deployed.

This year we extended the total bycatch estimation process to allow for sub-ecoregion scale estimations when an estimate could not be reached at the ecoregion scale, and it was clearly identified in the BPUE estimation process that sub-ecoregion variability existed. The resulting estimates show that sub-ecoregion patterns in bycatch may not be solely driven by fishing effort patterns but also by other factors, something fisheries ecoregion experts also believe. For example, the same métier can have varying BPUE for the same species within an ecoregion, depending on the areas fished in that ecoregion (e.g. *Phoca vitulina* or *Caretta caretta*). While we cannot discard the possibility that those are attributable to variability in fisher behaviour at the individual vessel-level (Roberson & Wilcox 2022), in many instances sub-ecoregion division capture the fishing characteristics of many vessels. This then points to ecological drivers of BPUE which include both population ecology variables such as density, as well as behavioural ecology variables such as foraging tactics or behavioural budget spatial assortment. Having established those, we can now assess their temporal variability as we progress through future cycles of BEAM (i.e., whether the same species x ecoregion x métier level 4 consistently display the same intra-ecoregional variability in BPUE).

The method used in BEAM is limited to circumstances where bycatch has been recorded. Most of the scenarios for which we cannot estimate BPUE are because there is no bycatch observed. It may be that bycatch is not observed because it does not exist, the monitoring coverage is too low, or the BPUE is very low (WKPETSAMP3, ICES, 2024b). We now need to devise informed rules in which we can appraise whether those zero BPUE can be used in an indicative manner when cumulating total bycatch for a species x ecoregion scenario. We can use SCOTI (in the manner it was used in ICES 2024 WKPETSAMP3, ICES, 2024b) to appraise the likelihood of observing a zero BPUE given the monitoring coverage and the fishing effort if bycatch was very rare, rare, or likely. We propose to extend this evaluation at the next WGBYC in 2025.

Some ecoregion estimates and sub-ecoregion estimates of total bycatch are very imprecise (the range of the confidence intervals extends over several orders of magnitude). We need to understand the causes of this imprecision and its bearing on the accuracy of the estimates. The work on sub-ecoregion scale analyses points to the need for case-by-case focus for these scenarios. We therefore propose that BEAM be complemented by an annual programme, most likely inter-sessionally, where we consult fisheries experts for a given ecoregion to assess in detail sub-ecoregion scale variability. Benchmarking BEAM would allow WGBYC to have more time to extend this case work in the current proceedings of the working group. Therefore, we plan to finalise

BEAM in its current form and engage with a benchmarking process in 2025. This benchmarking of the BEAM methodology would allow more time during the annual WGBYC meetings to develop a work programme rotating through case work where imprecision and sub-ecoregion analyses are required.

Population Impact Assessments by WGBYC continue to be limited by a lack of species abundance estimates at the ecoregion scale and Bycatch Reference Points. For both, some information is available, but it is difficult to reconcile to the appropriate geographic scale. In addition, the robustness and reliability of abundance estimates to be used in a process of management advice should be evaluated. For Bycatch Reference Points, there continues to be a lack of harmonisation in the objectives those reference points aim to meet which stem from the plurality of objectives in the declared European policy objective (no bycatch, bycatch not affecting the conservation of the species, and bycatch not impairing the restoration of the species) and the lack of agreed "management units" (e.g. putative local populations, all individuals in a region, global population, etc.). This leads to widely varying and semi-official bycatch 'thresholds' for the same mammalian species in relation to its abundance. For future iterations we propose to discuss threshold estimation methods which are robust across taxa and can be integrate in BEAM.

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Section 4 (ToR D) Contents

4 ToR D: Continue to develop and refine the methodology to assess data poor species, for which bycatch rates and associated markers of sustainability are unavailable.

4.1 Introduction

A new ToR was established for WGBYC in 2023 to explore and develop robust and repeatable methodologies for evaluating bycatch risk for species identified by the EU Commission (DGMARE) as "high priority" for which data are lacking or insufficient to be quantitatively analysed within the BEAM context as carried out under ToR C. A subgroup was tasked with developing a framework that could be applied across taxa to help highlight the types of fishing gears and fishing activities which pose the greatest risk to these species.

Detailed discussions at the 2023 meeting led to a proposal for a two-part methodology to support the requirements of this ToR into the future. The first step consists of the production of a metadata table where information on a species/population biology, distribution and status (ideally by ICES WGs on ecology of relevant taxa, e.g., WGMME, JWGBIRD, etc.), and bycatch data availability (by WGBYC) is compiled. The second step involves the completion of a series of three risk tables relating to relative risk by gear type, species/population overlap with those fishing activities identified as carrying a moderate or high risk, and the relative risk of population level impacts where overlap exists (ideally carried out by the WGBYC). Following reviewers' comments on the 2023 report, a concise description of the proposed methodology is provided in Section 4.2.

In 2024, prior to, during and after the WGBYC meeting, further work was carried out in support of this ToR following suggestions made in the WGBYC 2023 report.

WGBYC/ICES requested the Working Group on Marine Mammal Ecology (WGMME) to carry out some preliminary testing and review of the methodology, and to contribute background information on the "first step" to support the completion of the risk assessment procedure. WGMME carried out work at their latest meeting and intersessionally related to this request and the full details are described in the 2024 WGMME report. A brief description of the WGMME work is provided in Section 4.3, along with a description of several considerations highlighted by WGMME and WGBYC participants, and suggestions to further improve the current methodology.

In addition to those species specifically listed on the DGMARE high priority list, there are other species on the ICES bycatch roadmap ecoregion species lists that are of conservation concern (e.g. IUCN red-listed species and populations ranging from vulnerable to critically endangered classifications). WGBYC began developing a systematic approach for identifying these species to provide an objective and transparent method for selecting candidate species for inclusion in risk assessments under this ToR. The approach also includes an appraisal of the likely scale of each species geographic distribution which can help inform efforts to ensure relevant and sufficient species and fisheries expertise is garnered for supporting future risk assessments. This work is described in Section 4.4

Section 4.5 describes efforts undertaken by WGBYC to prepare draft tables on the relative gear risks for selected seabird, turtle, elasmobranch, and fish species. Initial risk tables are presented along with text describing the species selection process, justification for the draft scoring and suggestions for methodological improvements.

Section 4.6 provides overall conclusions on the recent work undertaken to develop the proposed risk methodology and suggested improvements to help ensure that this ToR can provide objective, reliable, transparent, and informed risk assessments to improve overall understanding of the relative risks posed by different fishing activities to bycatch data-limited species/populations of conservation concern.

4.2 Description of proposed method.

A concise description of the proposed methodology developed by WGBYC 2023 is presented here following comments made by external reviewers to provide greater clarity and to assist in readability for the remainder of this section. A full description is available in the WGBYC 2023 report (ICES 2024).

The schematic in Figure 4.1 is taken directly from the WGBYC 2023 report and shows the conceptual framework proposed by the ToR D subgroup to support the development of risk assessments to inform on the relative impacts of different fishing activities on high priority but data-limited ETP species (i.e., rare species, species rarely bycaught or species subject to low monitoring levels, for which there is insufficient data for quantitative assessments under ToR C). The framework consists of two main steps.

The compilation of relevant background biological, species/population distribution, fishery, and bycatch data availability information (ideally by ICES WGs on fisheries and/or ecology of relevant taxa e.g., WGBYC, WGSFD, WGMME, JWGBIRD, etc.).

Sequential production of three risk matrices (carried out by WGBYC with support of other WGs) describing:

Relative bycatch risk by gear type.

Likelihood of spatial and temporal overlap between gear type and species/population occurrence by ICES Ecoregion.

Likelihood of impact on the species/population by gear type and Ecoregion.

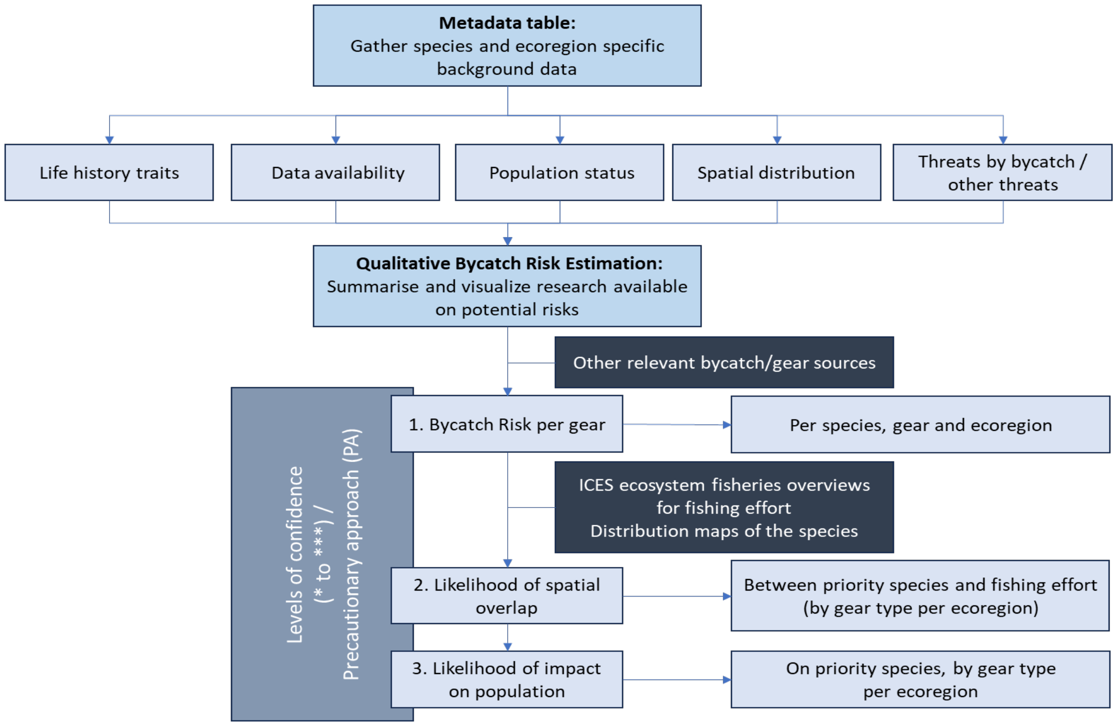

Figure 4.1 Conceptual risk assessment framework as developed by WGBYC 2023.

To improve usability and evaluation of information/data availability, background metadata information would be optimally provided in a tabulated format. An agreed template to facilitate this has not currently been developed by WGBYC and will need contributions from other ICES WGs. The purpose of collating available background metadata is to centralise information that can be used to support the development of the scoring procedures applied in the subsequent risk matrices, in terms of population dynamics data (aiming to assess the population status), distribution/density of species and any available data on bycatch rates. The proposal from WGBYC was that this information should be compiled from existing literature and databases, by various ICES working groups listed under the ICES Roadmap for Bycatch Advice (WGBIRD, WGBYC, WGEF, WGMME, WGSFD and any other relevant ICES groups) and external expertise as appropriate.

Following the compilation of supporting background information, the proposed procedure involves the generation of three risk tables.

Risk table 1 estimates the relative risk of bycatch associated with different fishing gears for each species/population considered (irrespective of any spatio-temporal fishery/species overlap), based on available evidence from literature, external datasets, WGBYC database, or expert judgement if necessary. If no specific knowledge is available in an ecoregion for a particular species/population about the direct risk of bycatch in the fishing gear under consideration, then knowledge from other ecoregions or from other similar species can be used as an auxiliary basis for estimating the risk. Risk scoring is applied using a scale of: 0 to 3, where 0 = no/negligible evidence of risk, 1 = low evidence of risk, 2 = moderate evidence of risk and 3 = high evidence of risk. An associated confidence rating is also provided using: * = low confidence, **=medium confidence and *** high confidence. The specific meanings of the risk and confidence categories used are not currently defined. Table 4.1 is a hypothetical example of Risk Table 1.

Table 4.1. (Risk Table 1 example): Overall bycatch risks of species associated with specific fishing gear types.

Species	Pelagic Trawls (PTM, OTM)	Bottom Trawls (PTB, OTB, OTT, TBB)	Dredges (DRB, DRH, DRM)	Purse Seines (PS, LA)	Bottom Seines (SDN, SPR, SSC)	Gill nets (GNS, GTR, GNC, GTN)	Drift nets (GND)	Long lines (LLS, LLD)	Pots & Traps (FPO, FPN)
Species 1	1^{*}	1^{***}	0^{**}	1^{*}	1^{**}	3^{*}	2^{*}	1^{*}	2^{***}
Species 2	2^{**}	1^{*}	2^{*}	2^{*}	1^{**}	2^{**}	1^{*}	3^{***}	1^{*}
Species 3	2^{PA}	1^{***}	1^{**}	1^{*}	1^{***}	3^{**}	3^{***}	2^{**}	1^{*}

Risk table 2 then estimates the likelihood of spatial and temporal overlap between those gear types scored as medium or high risk in Table 1 using best available information on fishing effort and species/population distributions. Table 2 is generated separately by species and presents the risk scores and associated confidence by gear type and ecoregion. The risk score is applied using: blank cell = no overlap, 1 = low overlap, 2= moderate overlap, 3= high overlap. The specific meanings of risk scores 1-3 are not currently defined. The same confidence rating approach as in Table 1 is used and, in this case, high confidence (***) is associated with situations where fishing effort and species density distributions have been accurately mapped, medium confidence (**) where only one density distribution component has been accurately mapped, and low confidence (*) where only basic (i.e., perimeter maps) or partial spatial information is available for both elements. Table 4.2 is a hypothetical example of Table 2.

Table 4.2 (Risk Table 2 example): Likelihood of spatial and temporal overlap between fishing effort and a species' occurrence (only for gear types considered moderate or high evidence of risk for that species).8F

Gear Type of Moderate or High Risk	Arctic Ocean	Azores	Baltic Sea	Barents Sea	Bay of Biscay & Iberian Coast	Celtic Seas	Faroes	North Sea	Greenland Sea	Iceland	Norwegian Sea	Oceanic Northeast Atlantic
Pelagic trawls		2^{**}			3^{**}	1^{***}		1^{**}				2^{***}
Purse seines		1^{***}			3^{***}	1^{*}		1^{*}				1^{***}
Gill nets		1^{**}			3^{**}	2^{***}		1^{*}				1^{***}
Long lines		2^{***}			3^{**}	2^{*}		1^{*}				2^{**}

Finally, risk Table 4.3 estimates the relative likelihood of population level impacts by gear type and ecoregion. The scoring in this table is supported by the information compiled in the metadata table on population parameters (demographic trend, abundance etc) and/or the species life history traits (generation length, fecundity etc). Similar to the previous tables, a scoring system is used to classify the likelihood of population impacts with: blank cell = no impact, 1 = low impact, 2 = moderate impact, 3 = high impact. The specific meanings of scores 1-3 are not currently defined. The same confidence rating approach as in Tables 1 and 2 is used but is not fully defined in this context.

Table 4.3 (Risk Table 3 example): Estimation of the likelihood of impact on the species (population) by gear type per ecoregion (only for gear types considered moderate or high evidence of risk for that species).

Gear Type of Moderate or High Risk	Arctic Ocean	Azores	Baltic Sea	Barents Sea	Bay of Biscay & Iberian Coast	Celtic Sea	Faroes	North Sea	Greenland Sea	Iceland	Norwegian Sea	Oceanic Northeast Atlantic
Pelagic trawls		1^{***}			2^{**}	2^{*}		1^{**}				1^{***}
Purse seines		1^{***}			2^{*}	2^{***}		1^{**}				1^{*}
Gill nets		1^{***}			2^{*}	2^{**}		1^{**}				1^{**}
Long lines		1^{***}			3^{**}	2^{PA}		1^{**}				2^{PA}

In 2023, the ToR D subgroup made a series of recommendations to ensure sufficient quality in the risk assessment scoring procedure and these are summarised as follows:

Strengthen the quantitative (or semi-quantitative) rigour of the process as much as possible.

Consider adding ground-truthing steps to enhance the method's accuracy and reliability.

Evaluate data sources for relevance by encouraging participating experts to consider the age and recurrence of results to avoid issues with outdated and/or unsupported information or with extreme or peculiar events unduly influencing risk scores.

Tailor gear classifications to regional contexts to account for possible regional differences in impacts.

Account for regional variation in external conditions that may affect a species susceptibility to bycatch.

Assess the required expertise to ensure sufficient and relevant people are involved in the development of risk assessments for each species/population.

Clarify terminology and assessment structure to avoid confusion amongst participants and end users.

The framework developed during 2023 was an initial proposal and usability testing and further developmental work was carried out in 2024. These are described in the following sections.

4.3 Preliminary testing of the risk methodology by WGMME

4.3.1 Description of the request from WGBYC/ICES to WGMME and the process undertaken by MME.

Following the initial development work by WGBYC on the framework proposed in 2023, WGBYC/ICES requested WGMME to review the methodology and provide background information to contribute towards the development of the metadata table for high-priority marine mammal species (ICES, 2024).

During 2024, several members of WGMME (with contributions from some members of WGBYC and external experts) carried out considerable work compiling biological and fisheries information to contribute to the metadata table and the three risk matrices as part of the request.

WGMME undertook their review of the methodology by fully applying the proposed procedure to three threatened or endangered harbour porpoise (*Phocoena phocoena*) subpopulations (Baltic Proper, Iberian and Black Sea) and the Mediterranean monk seal (*Monachus monachus*) as listed on the DGMARE high priority list. In addition, WGMME also chose to apply the method to the striped dolphin (*Stenella coeruleoalba*), long-finned pilot whale (*Globicephala melas*) and common minke whale (*Balaenoptera acutorostrata*) representing three more widely distributed and less threatened species.

Full details of this work are presented in the 2024 WGMME report (ICES, 2024) so are not repeated here. The work carried out by WGMME provided useful background information and important insights into which elements of the risk assessment procedure need refinement going forward. In this section, we focus on summarising the conclusions of the WGMME participants in relation to the proposed methodology, highlight points raised by members of WGBYC following the work of WGMME, and provide suggestions on how the risk assessment procedure to support the objectives of this ToR can be improved to ensure the process provides a reliable reflection of relative risk for the population/gear combinations concerned.

4.3.2 WGMME review of the proposed risk procedure.

4.3.2.1 WGMME reflections on the proposed methodology from the WGMME 2024 report.

WGMME provided a short discussion on the proposed methodology, the main points raised were in relation to:

Expert input to Risk Table 1:

The WGMME intention was to have five or six experts for each species population independently assess risk and then to collate those independent assessments, but in a few cases some experts joined together and therefore a consensus scoring approach was provided in those situations.

Where experts were based at widely spaced geographical locations across the population's geographical range, some experts favoured making more localised assessments of relative risk based upon their regional experience, whereas other assessments were more wide-scale and drew largely from available literature across the species range. It is important that the basis for the risk scoring is clearly described so the resulting scores can be viewed in the appropriate context.

Assessing fishery/population overlap for Risk Table 2:

WGMME concluded that assessing the degree of overlap between the fishing effort of gear types of moderate or high risk and the relevant population was more straightforward than the scoring applied in Table 1. WGMME note that this is particularly the case in situations where effort and population distributions had already been mapped and overlaid but noted that confidence in this estimation procedure may be affected by the distributional range of each component of the analysis.

Assessing potential population impacts for Risk Table 3:

WGMME note that "The level of impact of current bycatch anticipated on the population requires knowledge of the population size and status, information on its life history, and the human pressures additional to bycatch. For many species, that information is available at least to the degree that one can assess the likely impact in relative terms."

4.3.2.2 Subsequent reflections on the proposed methodology provided by the WGMME co-chair (PE).

Subsequent to the WGMME report and WGBYC meeting, a further short document was prepared by one of the co-chairs of WGMME (and a WGBYC member) summarising additional personal thoughts on the methodology. Points not already previously highlighted were as follows:

The procedure was well-received by WGMME, and the methodology was quickly understood and generally resulted in good agreement across regional experts.

For wide ranging species, it is suggested that at least two experts per ecoregion (where the species occurs) contribute to the procedure.

It is suggested that following individual scoring contributing to risk table 1, there is then discussion between all contributors to reach an overall agreement on a final score that incorporates the individual scoring.

The quality of fishing effort and population distribution data varies by species, fishery and ecoregion, and efforts should be made to provide more comprehensive and consistent data to support the overlapping procedure in risk Table 2, particularly for those situations where data availability is currently poor.

For marine mammals, it was suggested that making the procedure more refined or complex would not be helpful, but that there is room for appropriate refinement in certain cases (e.g., improving estimation of spatio-temporal overlap for migratory species and/or seasonal fisheries).

It was suggested that the risk procedure could be integrated with the work of WGBYC ToR E which provides analyses to support the development of coordinated sampling plans for ETP species.

Efforts should be made to improve understanding of regional differences in gear design and operational characteristics that may affect bycatch risk.

There is scope to incorporate more detailed knowledge on the ecology and behaviour of selected species to help refine the basic spatio-temporal overlap measures currently used.

4.3.3 WGBYC reflections on the proposed methodology following the work of WGMME.

Following review of the work carried out by WGMME, WGBYC have highlighted the following points about the current procedure.

<u>Metadata table:</u> Background information

WGBYC consider that background biological, demographic and bycatch data availability information would be more usefully provided in a standardised table format rather than in sections of text. This would provide a clearer summary of relevant information and would facilitate easier comparison across taxa/species/populations. The format and content of such a table should be developed by WGBYC and other taxa specific working groups. Ideally a single format would be applicable to all taxa.

In the absence of sufficient metadata to inform potential population level risks, WGBYC suggest that the relevant IUCN status could be used as an interim proxy measure to help inform on potential population impacts. The choice of the relevant IUCN status listing (e.g., global, regional, subpopulation, etc.) for each species should be made in line to the geographical scale of the risk assessment.

Risk table 1: Relative gear risk

The list of gears considered in the Table 1 scoring undertaken by WGMME was not exhaustive. WGBYC consider that a more comprehensive assessment would be achieved by including all major gear types separated as appropriate (based on knowledge or expectation of operational differences or perceived bycatch risk profiles) at the outset of the risk assessment procedure.

WGBYC raised general concerns about the potential impact on the relative risk scores if participants provided a mix of independent and group scores. This was not evaluated but WGBYC recommend that participants should provide independent scores wherever possible because it was not clear how group consensus decisions were reached. Independent scoring also provides a more reliable way of judging inter-rater variability which is an important consideration for understanding how much confidence can be attached to the results.

WGBYC raised general concerns about the potential for different participants to allocate scores based either on local/regional knowledge, or more widely based on available literature. This has the potential to introduce biases into the scoring procedure that may affect the reliability of the results. WGMME partially addressed this by asking participants to clarify how they were undertaking the scoring, but WGBYC suggest that a single consistent approach would be more beneficial.

WGBYC raised specific concerns about the scores provided for some species/area/metier combinations and felt those scores did not accurately reflect the relative risk of those gears in those particular cases. 2 examples are provided below.

EXAMPLE 1:

Table 1 in this exercise should have the same scores for a given species in all three cases irrespective of the ecoregion because the risk score is related to the characteristics of the gear. Only the level of confidence would differ between ecoregions (based on “evidence”). This should not be a subjective table.

Table 4-1. Bycatch Risk for the Baltic Proper Harbour Porpoise population for specific fishing gear types

Assessor	Pelagic Trawls	Bottom Trawls	Purse Seines	Bottom Seines	Gill Nets	Drift Nets	Long Lines	Pots & Traps
	(PTM, OTM)	(PTB, OTB, OTT)	(PS, LA)	(SDN, SPR, SSC)	(GNS, GTR, GNC, GTN)	(GND)	(LLS, LLD)	(FPO, FYK)
IC, JC	1**	1**	1*	1*	3***	3***	0**	0**
OL	1*	1*	0**	0**	2**	n/a**	0**	1*
AM	2**	1**	1**	1**	3***	2**	1***	1**
KK	2**	1*	1*	1*	3***	3**	1*	0*
MD	1***	0***	1*	1*	3***	3***	1**	1**

*Notes: n/a = not applicable (because gear is absent), 0 = negligible risk (gear poses no threat), 1 = low evidence of risk, 2 = moderate evidence of risk, 3 = high evidence of risk; * = low confidence; ** = medium confidence; *** = high confidence*

Table 4-4. Bycatch Risk for the Iberian harbour porpoise for specific fishing gear types

Assessor	Pelagic Trawls (PTM, OTM)	Bottom Trawls (PTB, OTB, OTT)	Purse Seines (PS, LA)	Bottom Seines (SDN, SPR, SSC)	Gill Nets (GNS, GTR, GNC, GTN)	Drift Nets (GND)	Long lines (LLS, LLD)	Pots & Traps (FPO)	Beach Seine (SB)
MP, GP, AH, DF (Spain & Portugal)	1*	1*	2**	0*	3***	3*	0*	0*	3***
AM (Portugal)	0	1***	2**	1**	3***	3***	1**	1**	2***
NO (Portugal)	1**	1**	2**	0**	3**	3**	1*	1*	2***
CS (Spain)	0**	1**	0**	0***	3***	n/a	0***	0***	n/a
JV (Spain)	1**	1**	1**	0*	3***	3**	0**	0**	1**

Notes: n/a = not applicable (because gear is absent), 0 = negligible risk (gear poses no threat); 1 = low evidence of risk; 2 = moderate evidence of risk; 3 = high evidence of risk * = low confidence; ** = medium confidence; *** = high confidence

Table 4-9. Bycatch Risk to harbour porpoise for specific fishing gear types

Assessor	Pelagic Trawls (PTM, OTM)	Bottom Trawls (PTB, OTB, OTT)	Purse Seines (PS, LA)	Bottom Seines (SDN, SPR, SSC)	Gill Nets (GNS, GTR, GNC, GTN)	Drift Nets (GND)	Long Lines (LLS, LLD)	Pound Nets (FPN)
DP, PG	0***	0***	1**	n/a	3***	1*	0***	1***
MP	1**	1**	1**	n/a	3***	1*	1**	1***
NK	0***	0***	0***	n/a	2**	0*	0***	0***
MPaiu	0***	0**	0***	n/a	3***	0*	0***	1***
TR	2***	1**	1**	n/a	3***	0*	0**	0***

Notes: n/a = no applicable (because gear is absent), 0 = negligible risk (gear poses no threat), 1 = low evidence of risk, 2 = moderate evidence of risk, 3 = high evidence of risk; * = low confidence; ** = medium confidence; *** = high confidence;

EXAMPLE 2:

Although the table indicates high overlap with high confidence for pelagic trawls there is in fact almost no overlap in the Mediterranean between striped dolphins and pelagic trawls (which 95% operate in the northern Adriatic where striped dolphin are not found), hence the risk should be either 0 or 1 for the whole Mediterranean Sea.

Table 4-19 Spatial Overlap between striped dolphin occurrence and fishing effort by gear type per ecoregion (only for gear types considered moderate or high evidence of risk)

Gear Type of moderate or high risk	Bay of Biscay & Iberian Coast	Celtic Seas	Oceanic North Atlantic	Azores	Mediterranean Sea
Pelagic trawls	3***	1***	1*	1**	2**
Bottom trawls	2***	2***	1*	1**	2**
Purse seines	2***	1***	1*	2***	2**
Drift nets	0**	0**	0**	0**	1*

Notes: 0 = no overlap, 1 = slight overlap, 2 = moderate overlap, 3 = high overlap; * = low confidence; ** = medium confidence; *** = high confidence; The highest score has been assigned to pelagic trawls given their wide distribution in the Bay of Biscay potentially overlapping with the species distribution.

<u>Risk table 2:</u> Fishery/population overlap

Under the current proposal, risk Table 2 should only consider those gear types scored as moderate or high risk in risk Table 1. WGMME did not follow the proposed approach and applied the overlap scoring to all gear types considered in risk Table 1 for each assessment. On reflection WGBYC consider that this seems a more appropriate approach because under the initial proposal there is potential for low risk, high effort gears to be excluded from the subsequent steps in the procedure. This could lead to potentially important sources of mortality being overlooked.

WGBYC noted the potentially partial nature of the effort data used for the fishery/population overlap meaning important components of total effort could be missing for some fisheries. As highlighted by WGMME, this particularly applies to small scale fisheries where effort data collection approaches are not currently well established. WGBYC also noted the issue of using positional data (such as VMS and AIS) to infer the distribution of fishing effort, particularly for passive gears, because the vessel position only reflects the gear position some of the time and so could represent an inaccurate and likely overestimate of the true distribution of effort. Ongoing work to develop predictive models of actual effort from positional data will help in this regard.

WGBYC noted that the allocation of overlap into categories of 0 (no overlap),1 (slight), 2 (moderate), 3 (high) currently lacks guidance on what each category represents so is overly subjective and could lead to inconsistent scoring by participants within and between risk assessments. Additionally, it was not clear from the work carried out by WGMME how many participants contributed to the development of the Table 2 scores for each species considered and WGBYC felt that information clarifying this would be informative.

WGBYC also raised the issue of the interaction between relative risk and confidence scores and suggested that a more informative presentational approach should be developed that reflects both elements in a singular way rather than the current proposal presents relative risk using a numeric score and colour scheme and confidence with an asterisk system because this might lead to under/over emphasis on either element.

<u>Risk table 3:</u> Relative population impacts

As with Table 2, WGBYC noted that if the initial proposal of only including gears scored as moderate or high risk were included in the subsequent table it could mean low risk high effort situations were overlooked. WGBYC consider that also including low risk gears, as was done by WGMME, provides a more comprehensive approach.

As with the other risk tables WGBYC suggest that it would be useful if the terms low, moderate and high are defined to improve consistency of scoring and interpretation of results.

It was not clear to WGBYC how the scoring carried out by WGMME in risk Table 3 incorporated relevant background information, or which participants contributed to the scoring procedure.

4.3.4 Suggested improvements to the procedure (all)

Following consideration of the work carried out by WGMME at the WGBYC 2024 meeting, the ToR D subgroup made several suggestions to help improve the transparency, reliability, and repeatability of the proposed approach as follows:

WGBYC suggest that selection criteria are developed to ensure appropriate biological and fisheries knowledge/expertise is obtained across the full distribution range of species/populations from each ecoregion under consideration.

WGBYC is aware that clear guidance on the purpose of the risk assessments, terminology used and required scoring approach for each risk table needs to be developed and provided to all participants prior to full application of the methodology. This should include definitions (or preferably semi-quantitative categories) of what is meant by no/negligible, low, moderate and high risk and confidence. WGBYC will develop guidance as the methodology is agreed and stabilises.

To improve the collation and usability of background information, a metadata table template applicable across species and taxa should be developed by appropriate WGs and include relevant biological, demographic and bycatch data fields.

Approaches for systematically evaluating and classifying reference material should be explored to help transparency around the relevance (spatial and temporal) and reliability of cited sources. For example, studies based on scientific observations at sea can be considered more reliable than studies based on interviews, while recent publications will reflect the current risk of interaction better than historical records. There are several published examples of how experts have been consulted to address bycatch data gaps or disparate data of bycatch rates and risks.

For example, Lewison *et al.* (2014) described a procedure whereby experts were tasked to score “bycatch intensity”, which integrates bycatch rate, species-specific susceptibility and fishing effort information. These scores were generated by at least three experts independently and then averaged.

For conservation priority setting in general, there are established approaches on how to solicit expert knowledge, minimize bias and encode it into quantitative information (Martin *et al.*, 2012).

Another example of how literature can be scrutinized for robustness and quality was provided from the ICES Working Group on Establishing Methods for Estimating Discard Survival (WGMEDS unpubl. data). There, in addressing a ToR in critically reviewing published studies where researchers have empirically estimated discard survival of a given species (either from vitality/at-vessel assessments; containment in captivity; or tagging), a template was developed with concisely formulated ‘yes/no’ phrased questions to minimize any ambiguity that as a minimum standard should be addressed in the published information. These questions were assigned scores. A positive response meant that the ICES guidance was followed, which translated into a score of 1, or 0, where it was not followed, or there was no evidence. The most important criteria were captured in five key guidance questions with each carrying a weighted score of 10, where there was evidence, the guidance was followed, or 0 where there was no evidence. Some of the questions were specific to the method in question, so that overall achievable totals can vary across methods. Two reviewers independently scored identified literature against this list of questions. In case, of any disagreement, a third-party mediator resolved it. The resulting quality scores were ranked to delineate robustness of studies and resulting estimates and were initially considered as a weighting factor for a meta-analysis (ICES, 2015). This template has been adopted by STECF to evaluate any evidence put forward to apply for exemptions to discarding based on high survival.

For species of conservation concern not specifically listed on the DGMARE high priority list, WGBYC recommend that an objective species selection procedure is developed to support prioritisation of other candidate data limited species for risk assessment. The most recent IUCN assessments at the relevant spatial scale could help in this regard.

WGBYC recommend that guidance is developed to explain how the results from risk tables 1 and 2 and background metadata should be incorporated into the scoring in risk table 3. This will help avoid inconsistent approaches being undertaken by groups involved in different risk assessments.

When species have been selected for assessment, WGBYC should prepare initial drafts of risk table 1 (or at minimum compile information on potential bycatch risks where insufficient expertise is unavailable within the group to undertake scoring) for further review by relevant experts from other ICES WGs or externally.

WGBYC should explore the potential of all available fishing effort data sources to support the requirements of risk table 2. This should be undertaken through close collaboration with ICES WGs that focus on fishing effort (e.g. WGSFD). The aim will be to develop comprehensive and accurate effort distribution maps for all gear types considered in the risk assessment procedure using standardised methods, effort metrics, and scales where possible.

WGBYC recommend that after the preparation of risk table/s for a given species, a WGBYC-lead meeting including participants from relevant groups that contributed to an assessment should be held to review and agree the final outcomes of each assessment.

WGBYC recommend, that to avoid duplication of efforts, situations where this risk approach is unlikely to add significant value because of other more focused ongoing work (e.g. Baltic proper porpoise (WKEMBYC, WKSUP, other non-ICES initiatives)) should be identified to help inform decisions about which species/populations are considered under the work of this ToR.

4.4 Development of a process for informing species selection for risk assessment procedure

Under the '*EU Action Plan: Protecting and restoring marine ecosystems for sustainable and resilient fisheries*', several marine mammal, seabird, elasmobranch and fish species/populations are listed as requiring action to reduce fisheries impacts. In addition to those named high-priority species, the Action Plan also contains a longer-term objective to consider any other species that are susceptible to bycatch by prioritising those in '*unfavourable conservation status*' or threatened by extinction. To support this longer-term objective the ToR D subgroup began developing a systematic and objective method for selecting species (outwit the high-priority named Action Plan species) that are considered to be of highest conservation concern and which due to data limitations are not suitable for quantitative assessments carried out under ToR C. Following discussions at the 2024 meeting it was agreed that the method should also include a component to help inform on the appropriate number of experts that should contribute to risk assessments for data limited species. The developments made are described below.

As a first step, a list of all species/ecoregion combinations that were not suitable for quantitative assessments was provided by ToR C. This list contained 242 species (40 marine mammal, 62 seabird, 137 fish and 3 turtle species).

The next step was to add information about the likely geographical range of each species. This was done by calculating the number of ecoregions in which each species was considered to be present.

Next, population status data was downloaded from the IUCN red list and a script was developed to process this data systematically. A subset was made to filter for those species on the WGBYC species list. This subset resulted in 211 species. 31 species on the list received from ToR C were missing from the IUCN Red List download: 19 birds, 8 fish and 4 mammals. Due to time constraints, the subgroup was not able to look further into these missing species and for now they were excluded from the subsequent steps.

With the resulting subset (211 species), the script was designed to take the following steps: For species with only one IUCN assessment, we retained that assessment.

For species with multiple assessments but consistent classification (e.g., critically endangered or vulnerable), we selected the most recent assessment irrespective of the scope of the assessment (e.g. global, European).

For species with multiple regional assessments and classifications but no subpopulations, we kept both the Mediterranean assessment and the most recent one.

For species with multiple assessments, classifications, and subpopulations, we retained all available assessments.

While the script was standardized, certain cases, (e.g., where a species has multiple assessments and classifications) will require expert judgment, as it was not feasible to write generic code for such situations.

The final output from the script included a list of species with key information: assessment date, scope (global or European), classification status, and the year of the assessment. This list was then merged with data on the number of ecoregions associated with each species.

With this refined list, we can now more easily select species based on their population status and use the number of ecoregions they inhabit to guide the level and geographical scope of expert participation required to carry out informed risk assessments.

4.5 Description of risk table 1 production by WGBYC for selected species

One of the suggestions from the work in 2023 was that the ToR D subgroup should prepare initial drafts of risk table 1 for selected species to test and provide insights on the methodology and for subsequent review by taxa specific groups or external experts to also obtain their views on the process. During 2024 work to begin this was initiated for several high priority species that were not being fully considered under the quantitative assessment approach (BEAM) carried out by ToR C.

ToR C provided a list of all species and ecoregion combinations for which there was insufficient data in the WGBYC database to calculate reliable bycatch rates. This list was then used by ToR D as the starting point for species selection for consideration under the proposed risk assessment approach.

Several species on both the DGMARE high priority list and the list from ToR C were selected (essentially arbitrarily because the work to aid species selection described in Section 4 was ongoing at the meeting) to provide examples across different taxa including seabirds, turtles and fish. The species selected were Balearic shearwater, loggerhead turtle, angel shark, common skate and several sturgeon species (see Table 4.4). Two subgroup members also developed draft risk scores for Atlantic puffin, a species not listed on the DGMARE high priority list (see Table 4.5) but currently classified as vulnerable on the IUCN global list and as endangered on the European red list.

Following observations that the Risk Table 1 template used in the review work carried out by WGMME was not comprehensive, a first step was to produce a new template that contained all major gear types (at metier level 4 but sometimes grouped as considered appropriate). This template was then used as the basis for draft risk scoring (see Table 4.4 and Table 4.5). The same qualitative risk and confidence scoring approach used by WGMME was also used here but as these are initial draft tables that require additional review, the colour grading scheme has not been applied to the risk scores at this point to avoid potentially misleading readers.

To assist in the draft scoring a data extraction was made from the WGBYC database for the relevant species detailing the bycatch numbers recorded and monitored days by metier and ecoregion.

It should be noted that Table 4.4and Table 4.5were developed and populated simply to test the procedure and the preliminary results presented **should not** be used other than for review purposes. Many of the species considered are widely distributed and are found in several ecoregions (nine in the case of Atlantic puffin) meaning the number of contributors inputting to the tables is below that considered to be appropriate for a reliable assessment.

Explanatory supporting text related to the draft scoring is provided in sections 4.5.1.1to 4.5.1.7 and a short discussion is presented in section 4.5.2.

Table 4.4 Draft table 1 (not for use) completed by WGBYC for selected species from the DGMARE high priority list.

		Pelagic Trawl		Bottom Trawl		Boat Dredge	Bottom Seine		Purse Seine	Gill Nets		Long Lines	Hand & Pole Lines	Pots & Traps	Fyke & Pound Nets
Species	Assessor	PTM	OTM	PTB OTB OTT	TBB	DRB	SDN SPR SSC	SVB	PS LA	GNS GTR GNC GTN	GND	LLS LLD	LHM LHP LTL	FPO	FYK FPN
Puffinus mauretanicus	PE	2*	2*	2*	0*	0**	0*	0**	3***	3***	3*	3***	0**	0**	0**
	SK	2*	2*	2**	Not scored	0*	0*	0*	3***	3***	3*	3***	0*	0*	Not scored
Caretta caretta (Atlantic)	RF, CF, AF	3**	3**	3**	Not scored	1*	0*	1*	2**	3**	3*	3***	1*	1**	Not scored
Caretta caretta (Mediterranean)	RF, CF, AF	3***	3***	3***	Not scored	1*	n/a	n/a	2***	3***	3**	3***	1*	1**	Not scored
Squatina squatina	AK	0***	0***	2***	1**	1**	1***	1**	1**	3***	3**	1***	2**	1***	1**
Squatina aculeata	AK	0***	0**	2**	1*	1*	1*	1*	1**	3**	3*	1***	2*	1***	1**
Squatina oculata	AK	0***	0**	2**	1*	1*	1*	1*	1**	3**	3*	1***	2*	1***	1**

		Pelagic Trawl		Bottom Trawl		Boat Dredge	Bottom Seine		Purse Seine	Gill Nets		Long Lines	Hand & Pole Lines	Pots & Traps	Fyke & Pound Nets
Dipturis batis	KB, JM	Not scored	Not scored	Not scored	Not scored	Not scored	Not scored	Not scored	Not scored	Not scored	Not scored	Not scored	Not scored	Not scored	Not scored
Acipenser sturio; *A. naccarii;* *A. gueldenstae-dii; A. ruthenus.*	CVD	Not scored	Not scored	Not scored	Not scored	Not scored	Not scored	Not scored	Not scored	Not scored	Not scored	Not scored	Not scored	Not scored	Not scored

Table 4.5 Draft table 1 (not for use) completed by WGBYC for other selected species.

		Pelagic Trawl		Bottom Trawl		Boat Dredge	Bottom Seine		Purse Seine	Gill Net		Long Line	Hand & Pole Line	Pots & Traps	Fyke & Pound Net
Species	**Assessor**	**PTM**	**OTM**	**PTB** **OTB** **OTT**	**TBB**	**DRB**	**SDN SPR SSC**	**SVB**	**PS** **LA**	**GNS GTR** **GNC** **GTN**	**GND**	**LLS** **LLD**	**LHM LHP** **LTL**	**FPO**	**FYK** **FPN**
Fratercula arctica	PE	1*	1*	0*	0*	0*	0*	0**	0*	3***	3***	2**	0*	0**	1*

SK	0*	0*	0*	0*	0*	0*	0*	0*	3***	3**	3*	0*	2*	Not scored

Notes:

n/a = not applicable (because gear is absent)

0 = negligible risk (gear poses no threat), 1 = low evidence of risk, 2 = moderate evidence of risk, 3 = high evidence of risk.

* = low confidence; ** = medium confidence; *** = high confidence.

4.5.1 – Table 1 scoring justification text.

4.5.1.1 Balearic Shearwater (*Puffinus mauretanicus*)

Draft risk scores for the Balearic shearwater were assessed by Peter Evans (PE) and Sven Koschinski (SK).

PE:

Bycatch in longlining activities is a well-known threat to shearwaters globally, although there may be some differences in their vulnerability across species, relating to differences in foraging and flocking behaviour. Nevertheless, in the case of Balearic shearwater, there is strong evidence of bycatch from longlines affecting this species (see, for example, Garcia-Barcelona *et al.* 2010, Laneri *et al.* 2010, Oliveira *et al.* 2015, Cortes *et al.* 2017, 2021). Examination of bycatch data between 2017 and 2023 in the BYC database submitted to ICES shows bycatch records only from two ecoregions: The Western Mediterranean and the Bay of Biscay and Iberian Coast, which constitute the main range of the species. In 487 days observing at sea of longlining (LLS) effort in the Bay of Biscay and Iberian Coast, one Balearic shearwater was reported bycaught, and in 2,659 days of longlining (LLD) observation in the Western Mediterranean, 71 were reported bycaught. Thus, evidence of bycatch risk for longlining was rated high with high confidence.

Static nets are also a major cause of bycatch mortality. From the ICES WGBYC database between 2017 and 2023, 64 Balearic shearwaters were reported bycaught in 4,584 days of trammel netting (GTR) from questionnaire surveys (PO) and 12 in 1,964 days at sea of onboard observations, and 5 bycaught in 3,529 days of gill netting (GNS) onboard observations in the Bay of Biscay and Iberian Coast ecoregion. Information from questionnaires and onboard observers in Portuguese waters reported regular bycatch from both gillnetters and purse-seines as well as some from trawlers (Boué *et al.* 2013, ICES 2013, SEO/Bird Life 2014, Oliveira *et al.* 2015).

The habit of following trawlers in the eastern North Atlantic, exploiting fish that spill out of the trawl during hauling as well as taking discards has exposed Balearic shearwaters to some incidental mortality (Abelló & Esteban 2012, Meier *et al.* 2017). In the BYC database from 2017-2023, two Balearic shearwaters were reported in 2,337 observed days at sea of otter bottom trawling (OTB), and three in 2,355 observed days at sea of purse seining (PS) in the Bay of Biscay and Iberian Coast ecoregion. Both pelagic and bottom trawls were rated as moderate evidence of risk with low confidence whereas static gears and purse seines were rated high evidence of risk with high confidence since there were data from both onboard observations and questionnaire surveys in the Portuguese fishery (Oliveira *et al.* 2015).

Drift netting has been banned in Europe since 2013, although some may still be used illegally. There is little information on bycatch of Balearic shearwaters in driftnets before the ban, complicated by the fact that Balearic shearwater was only recognised as a distinct species rather than a subspecies of Manx shearwater in the 1990s. However, shearwaters of the genus *Puffinus* are well-known to have suffered high bycatch globally (Northridge 1991, Ogi *et al.* 1993, Johnson *et al.* 1993, Uhlmann *et al.* 2005). This was therefore rated high evidence of risk but low confidence since there was not information available for this species.

SK:

Although there may be regional differences in the relative contribution of gears to bycatches (which are based on differences in fishing fleets and individual fishing behaviours rather than gear related mechanisms) there is a broad agreement in the scientific literature that purse seines, gill nets and longlines pose the greatest bycatch risk to Balearic shearwaters (Garcia Barcelona *et al.* 2010, Laneri *et al.* 2010, Meier 2015, Oliveira *et al.* 2015, Cortes *et al.* 2017). Hence these gears were rated with (3) high evidence of risk. Since this is based on data from observer programmes (including from the WGBYC database) and studies from various fisheries (e.g., large scale, artisanal) the confidence is high.

Drift nets were also rated (3) high evidence of risk as it is anticipated that there is no difference in entangling mechanisms between gears anchored and gears drifting. Since no studies directly point to bycatch in drift nets (if occurring at all), the confidence in this assessment is low.

Bycatch is also reported to a minor extent in bottom trawls (WGBYC data, Abello & Esteban 2012) which occurs during hauling. Relative risk is thus rated with (2) moderate evidence of risk which comes with a moderate confidence in bottom trawls based on WGBYC data and one study. Pelagic trawls were also rated (2) but with a low confidence as no bycatch data were available but it can be assumed that bycatch also occurs during hauling of pelagic trawls. A possible reason for the lack of data in pelagic hauls might be a smaller overlap as it is described that bycatch in bottom trawls occurred in shallow Iberian shelf waters.

4.5.1.2 Loggerhead turtle (*Caretta caretta*)

Draft risk scores for loggerhead turtles were assessed by Ruth Fernandez (RF), Caterina Fortuna (CF) and Andrea Farinas (AF).

General comments on the process of scoring bycatch risk table 1.

It was considered that the level of bycatch risk per gear to loggerhead turtles would vary between the Mediterranean and Atlantic basins within ICES areas. These differences relate on the one hand to differences in fishing effort and gears used in the two areas (but this would be addressed by the table on "likelihood of spatial overlap"), and on the other hand to differences in ecology and habitat use of the species between the two areas (e.g. differences in "catchability" depending on the area). The latter is related to the biology and habitat use of the species. For example, loggerhead turtles in feeding and nesting grounds in certain areas of the Mediterranean *versus* open sea distribution of juvenile specimens, whereas in the NE Atlantic their distribution is more scattered with the exception of pelagic foraging grounds for juveniles in the Macaronesian archipelagos (Bolten *et al.*, 1993, Monzón-Argüello *et al.*, 2009, Varo-Cruz *et al.*, 2019). For this reason, the general methodology to estimate bycatch risk could benefit in future from some consideration of the "catchability" as qualifier linked to the local species and fishery "ecology".

Hence, the bycatch risk per gear scored in Table 4.4 does not consider such potential ecological differences between areas for a given species. Therefore, risks were equal between the Atlantic and Mediterranean basins. However, both the level of confidence assigned to the risk and the evidence behind it differed between basins.

The proposed process does not consider that there may be strong differences in survivability among gears. For example, longline, pelagic trawls and purse seines show in general high survivability for loggerhead turtles (e.g., Casale *et al.* 2014; Pucinella *et al.*, 2019) while survivability of individuals caught in bottom trawls is lower because trawling speed, duration and depth can cause severe wounds, and decompression sickness (Casale *et al.* 2014; Stabenau *et al.*, 2003; Sasso *et al.*, 2006; García-Párraga *et al.*, 2014; Parga *et al.*, 2020). Nevertheless, the highest direct mortality ratios in the Mediterranean were found in set nets (Lucchetti *et al.* 2017, Casale 2011); however, these accounts are difficult to be evaluated because they are dated and based on sparse and scarce information, often of anecdotical and/or opportunistic nature.

The evidence reviewed in this section correspond to bycatch incidents reported for loggerhead turtles. There is additional evidence of other turtle species bycaught in various gears. However, those additional records have not been incorporated in the justification provided here. Differences in ecology and habitat use between species influences the level of bycatch risk for each species and gear.

4.5.1.3 Justification for the bycatch risk scores associated with each gear

Pelagic trawls (PTM, OTM)

The risk is evaluated as high, 3, with high confidence in the Mediterranean (***) and medium confidence in the Atlantic (**). There is indisputable evidence of bycatches of loggerhead sea turtles in PTM in the Adriatic Sea in the ICES bycatch database and in published literature (Casale *et al.* 2004; Fortuna *et al.* 2010; Pulcinella *et al.* 2019; Bonanomi *et al.* 2022).

Bottom trawls (PTB, OTB, OTT, TBB)

The risk is evaluated as high, 3, with high confidence in the Mediterranean (***) and medium confidence in the Atlantic (**). There is strong evidence of bycatches of loggerhead sea turtles in OTB and OTT in several Ecoregions with the Mediterranean in the ICES bycatch database and from literature sources (on board observations: Lazar and Tvrtkovic 1995; Casale *et al.* 2004; Lazar et al 2004; El Arraf et al 2024 - interviews: Marco et al, 2020; Touloupaki et al, 2020; Lucchetti 2021; Ahannach & Aksissou 2023). In contrast, there were no records of bycaught loggerheads in bottom trawls from interviews in Portugal (Marçalo, pers. comment).

Purse seines (PS, LA)

The risk is evaluated as medium, 2, with high confidence in the Mediterranean (***) and medium confidence in the Atlantic (**). There is evidence of bycatches of loggerhead sea turtles in PS in the Adriatic Sea in the ICES bycatch database. In addition, several literature sources based on fisheries observer data (El Arraf et al 2024) and interviews (Marco et al, 2020; Touloupaki et al, 2020; Ahannach & Aksissou 2023) identify purse seiners as gears that bycatch loggerhead turtles in both Atlantic and Mediterranean waters.

Bottom seines (SDN, SPR, SSC)

This gear type is not in use in the Mediterranean. Therefore, it is scored as not applicable (na) in this region. In the Atlantic it was given a score of 0 with low confidence (*) because to our knowledge there is no evidence of interaction between bottom seines and loggerheads.

Gillnets (GNS, GTR, GNC, GTN)

The risk is evaluated as high, 3, with high confidence in the Mediterranean (***) and medium confidence in the Atlantic (**). There is evidence of bycatches of loggerhead sea turtles in GNS and GTR in several Ecoregions within the Mediterranean (GTR) and Atlantic (GNS) basins in the ICES bycatch database. In addition, several literature sources based on fisheries observer data (Lazar et al 2006; Echwikhi *et al.* 2010; Louhichi *et al.*, 2024), interviews (Marco et al, 2020; Touloupaki et al, 2023) and a specific review on this gear for the Mediterranean (Echwikhi et al 2012) identify GNS as gears that bycatch loggerhead turtles in the Mediterranean.

In addition, according to information from interviews with fishers along the coast of mainland Portugal bycatch of loggerheads in gillnets is the highest when compared to bycatch in longlines, trawlers and purse seiners.

Driftnets (GND)

The risk is evaluated as high, 3, with medium confidence in the Mediterranean (**) and low confidence in the Atlantic (*). The use of this gear is currently limited to coastal waters (not targeting pelagic species), and it is totally banned in some regions. Therefore, there are no bycatch records of loggerheads in GND in the ICES bycatch database.

Longlines (LLS, LLD)

The risk is evaluated as high, 3, with high confidence in the Mediterranean and Atlantic basins (***). There is evidence of bycatches of loggerhead sea turtles in LLS and LLD in several Ecoregions within the Mediterranean (LLS and LLD) and Atlantic (LLD) basins in the ICES bycatch database. Many literature sources based on fisheries observer data (e.g., Baez et al, 2019), literature review (e.g. Casale 2011) and interviews (e.g., Marco et al, 2020; Touloupaki et al, 2023) identify LLS and LLD as gears that bycatch loggerhead turtles in the Mediterranean. Other literature sources note loggerhead bycatches in LLD the Oceanic Atlantic based on fisheries observer data (Parra *et al.*, 2023).

Pots, traps and pound net (FPO, FYK, FPN)

The risk is evaluated as very low, 1, with medium confidence in the Mediterranean and Atlantic basins (**). There is one record of bycatch of loggerhead turtles in the Adriatic Sea in the ICES bycatch database.

Boat dredge (DRB)

The risk is evaluated as low, 1, with low confidence in the Mediterranean and the Atlantic (*). There is no evidence of bycatches in the ICES bycatch database, but monitoring in this gear type is very limited. However, Murray (2004) reports bycatches of loggerheads in the Mid-Atlantic Sea Scallop Dredge Fishery.

Hand and pole lines (LHM, LHP, LTL)

The risk is evaluated as very low, 1, with medium confidence in both the Mediterranean and Atlantic basins (**). In the Mediterranean there is some evidence of interaction with loggerheads with LHP in the Croatian Adriatic in the ICES bycatch database. There is low probability of a loggerhead turtle interacting with LHP. There have been also few observations in the Canary Islands and Portugal -mainly swordfish sport fishing.

Beach seine (SVB)

This gear type is not in use in the Mediterranean. Therefore, it is scored as not applicable (na) in this region. The risk is evaluated as low with low confidence in the Atlantic, 1*. There is evidence of 6 bycatch records of loggerheads in beach seines in Portugal based on interviews (WGBYC 2013, Marçalo, pers. comment), but the level of confidence is low since bycatch monitoring is scarce for this fishery in the ICES area. High bycatch rates of loggerhead sea turtles in beach seines have been reported outside the ICES area, such as in the southwestern Indian Ocean (2901 individuals/year; Mellet 2015).

4.5.1.4 Angel sharks (*Squatina squatina; Squatina aculeata; Squatina oculata*)

<u>Draft</u> risk scores for angel sharks were assessed by Ailbhe Kavanagh (AK)

Squatina squatina, S. aculeata, and *S. oculata* are listed as Critically Endangered on the IUCN red list. They historically occurred across much of the eastern Atlantic and throughout Mediterranean waters, however the distribution of all species has been greatly reduced in recent years largely due to bycatch in fishing gears (Miller 2016). These species have been identified as species of concern and are on the EU Priority List of species.

The WGBYC database contains 19 records of bycatch for *Squatina squatina* in GTR and GNS in the Celtic Seas ecoregion. Only a single record of bycatch for *S. aculeata* in GTR in the Ionian Sea and the Central Mediterranean Sea ecoregion was present in the database. No records of *S. oculata* are present in the WGBYC database.

Miller (2016) primarily attributes the historical decline in *Squatina* species to its "overutilization" by demersal fisheries. As angel shark are relatively sedentary, bottom-dwelling species, they are susceptible to being caught in trawl fisheries (Miller 2016). Additionally, given their low productivity, they are unable to quickly rebound from impacts that decrease their abundance (Miller 2016). Generally, the biological characteristics of the species mean they are susceptible to overexploitation and bycatch (Ellis *et al.* 2021)

In Turkish and eastern Mediterranean waters, unidentified *Squatina* species and *S. oculata* specifically were recorded caught by small-scale fishers using bottom set nets, *S. aculeta* were recorded caught by gillnetters, and *S. squatina* by hook and line fisheries (Ulman *et al.* 2024). This study suggests that bottom set nets used by small-scale fishers pose less of a risk to mortality for angel sharks as they are almost always encountered alive after a typical 12h soak time and suggested that bottom trawling in critical habitats is of more concern to angel shark species.

Relatively recent surveys and fishery observations in Ireland have recorded the occurrence of the remnants of formerly large populations of *S. squatina* off the southwest coast (Shepherd *et al.* 2019). Concurrently, reports of *S. squatina* bycatch in the tangle net fishery for crayfish (*Palinurus elephas*) off the southwest coast of Ireland have been recorded by Tully *et al.* (2020).

The level of relative gear risk provided in Table 4.4 is based on the bycatch record information held in the WGBYC database as well as references in the scientific and grey literature to bycatch of each species in specific metiers. If bycatch records and/or references to bycatch were found in the literature for a species/metier combination they were considered to be at high risk of bycatch for that species, i.e. gillnets. If only the literature contained references to bycatch for a species/metier combination they were considered to be at moderate risk of bycatch for that species, i.e. bottom trawls. If no bycatch records or references were found for a species/metier combination that metier was considered to be low risk. If no bycatch records and no references were found for a species/metier combination, and the species ecology does not overlap with the metier then it was considered negligible risk.

The level of confidence was assigned based on the amount of monitoring effort available for a specific metier. If there was a substantial amount of monitoring effort in a metier or group of metiers, there was high confidence in the risk level assigned. If there was a substantial amount of monitoring effort in some but not all of the metiers in a group of metiers, there was medium confidence in the risk level assigned. If there was little or no monitoring effort in a metier or group of metiers, there was low confidence in the risk level assigned.

4.5.1.5 Common skate (*Dipturus batis*)

Draft scoring to contribute to table 1 was not undertaken for common skate but background information was compiled by Jo Murray (JM) and Katinka Bleeker (KB).

The common skate complex is best described as two species, the flapper skate (*Dipturus intermedius*) and the common blue skate (*D. batis*) (Last *et al.*, 2016). This taxonomic uncertainty may contribute to errors in understanding the distribution range of the two species and their interactions with fisheries which may pose a higher risk of bycatch.

Dipturus intermedius and *D. batis* exhibit strong K-strategist life-history characteristics including large body size, long life expectancy, and the production of fewer offspring, which like many other elasmobranchs make them vulnerable to overfishing (Walls & Dulvy, 2021; Garbett *et al.*, 2023).

While Frost *et al.*, 2020 found that both *D. batis* and *D. intermedius* were widespread, inhabiting many of the same habitats within the same regions and with overlapping distributions, Garbett et al (2023) reported that *D. intermedius* has a more constrained distribution than is described for the 'common skate', with most observations recorded from Norway and the western and northern seaboards of Ireland and Scotland, with occasional specimens from Portugal and the Azores.

As dorsoventrally flattened benthic species, skate are generally found on, or close to the seafloor with *D. intermedius* spending prolonged periods, up to 30 h, resting there (Wearmouth & Sims, 2009). As a result, they are especially vulnerable to bottom-trawl fisheries (Kynoch *et al.*, 2015, Phillips *et al.*, 2015), and most of the bycatch records for the two species in the WGBYC database are associated with bottom trawl gears (*D. batis*: OTB 8,793 records, OTT 91 records, TBB 3013 records; *D. intermedius:* PTB 1 record, OTB 414 records, OTT 62 records).

Both species are also bycaught in set net fisheries (WGBYC database: *D. batis*: GNS 258 records, GTR 38 records; *D. intermedius*: GNS 3 records, GTR 64 records). In the Celtic Sea, bycatch and discards of *D. batis* and *D. intermedius* is reportedly significant in the trammel net fishery with an average CPUE of 46 common blue skate per 1,000 panel-hours, reported in 2015 by Heatherington *et al.*, (2018). In addition, between August 2011 and September 2015, a total of 3,024 common skate (2971 blue skate; 53 flapper skate) were biologically recorded in bycatch of 19 separate commercial trammel net fishing trips targeting whitefish species (3 – 10 days in duration) (Heatherington *et al.*, 2018).

Drift nets (*D. batis*: 26 records), bottom seines (*D. batis*: SSC 22 records; *D. intermedius:* 2 records) and longlines (*D. batis*: LLS 26 records, LLD 13 records; *D. intermedius*: LLS 2 records) have observed bycatch of common skate within the WGBYC database.

While the large size of common skate makes it vulnerable to bycatch in bottom trawl and set net fisheries, larger skate tend to show high levels of discard survival. While there is no or limited information about the discard survival of *D. batis* and *D. intermedius,* other studies have found that individual fish length can be an important factor in immediate survival with larger skates have a greater chance of survival (Van Bogaert *et al.*, 2020). Discard survival may therefore have an influence on bycatch risk which should be considered when categorising bycatch risk scores.

Draft scoring to contribute to table 1 was not undertaken because various factors such as life history information, discard survival and current management measures all contribute to the risk scoring and could not be fully incorporated at the meeting. Using a Productivity Susceptibility Assessment (PSA) or similar approach would provide a structured framework for collating this information. Existing PSA's for elasmobranchs have assessed the confidence of independently derived expert opinions. Phillips et al (2015) found that "…scoring of biological attributes can be agreed by a small group of experts with appropriate knowledge of life history and biology. However, it was felt more important to collate the range of views on susceptibility attributes, where a lack of published data means the scores are much more open to interpretation and scores can be more subjective. The range in the distribution of susceptibility scores and associated confidences highlights the importance of collating a range of independently derived expert opinions, to allow these subjectivities to be 'smoothed' out".

4.5.1.6 Sturgeons (*Acipenser sturio; Acipenser naccarii; Acipenser gueldenstaedii; Acipenser ruthenus*)

Background information on sturgeon bycatch was compiled in a spreadsheet but draft scoring to contribute to table 1 was not undertaken because sufficient expert knowledge about the potential risks for the considered species in the different ecoregions was missing in the subgroup. In addition, there were very few bycatch events observed in the WGBYC database. Secondly, very few literature sources with figures or reports on bycatch of sturgeons in the respective ecoregions could be found, so the information is of mainly anecdotal value.

4.5.1.7 Atlantic puffin (*Fratercula arctica*)

<u>Draft</u> risk scores for the Atlantic puffin were assessed by Peter Evans (PE) and Sven Koschinski (SK)

PE:

Historical fisheries bycatch of auks, including Atlantic puffin, were reviewed by Evans and Nettleship (1985). During the 1960s, annual mortality from the longline fishery in northern Norway was estimated to be 21,000 guillemots and 18,000 puffins (Brun 1979). However, this was extrapolated from a study of a single vessel using 1,040 hooks per day during the 1969 season (75 days of longlining from mid-March to mid-June) which caught 294 birds: 52 fulmars, 3 gannets, 43 kittiwakes, 107 guillemots, and 89 puffins. Brun (1979) reported that if this sample was representative, the 100 or so Norwegian boats using longlines plus about 20 Danish boats (using 4,000-6,000 hooks per day and consequently catching more birds per day) would have caught roughly 21,000 guillemots and 18,000 puffins in the 1969 season. Following high numbers of seabird bycatch, longlining along the Norwegian coast was then prohibited (Barrett & Vader 1984). Drift-netting also occurred in Norwegian waters but was reported to be less damaging to seabirds than longlining although no actual figures were provided.

Pound nets have also been reported as causing puffin bycatch under particular circumstances. In 1969, at Runde, Norway, 85 birds, mainly auks, shags and some diving ducks, were caught in 24 hours in fishing gear especially pound nets set along the coast, often close to bird colonies (Brun 1979). Strann *et al.* (1991) also reported observations of puffin bycatch in pound nets set for salmon in Norway, and this was supported by interviews with fishermen. According to a local fisherman in Gjesvaer, a single pound net set immediately below the bird cliff Gjesvaerstappan yearly killed thousands of puffins. On some days, there were so many birds that two men could not pull the net into the boat. He estimated that in one single season he could catch as many as 10,000 puffins (Strann *et al.* 1991). Elsewhere, there has been very little evidence of bycatch mortality in pound nets, probably because in most locations they are not in areas where puffins occur in large concentrations. Evidence of bycatch risk is therefore rated as low (based primarily on taped interviews) with medium confidence. The design of these Pound nets deployed in Troms and Finnmark is said to differ from the ones typically deployed elsewhere in that instead of being attached to stakes on the sea bottom, they are moored on the surface to trap pelagic salmon as they travel along the coast. They are still used, but not near any bird cliffs as they used to be, numbers have dropped and those still in use are set on only a very few days a year (R. Barrett, pers. comm.).

At the end of the 19th century, annual losses in drift nets off the east coast of Scotland (McIntosh 1903), and in the 1950s along the coast of northern Norway (Holgerson 1961) were considered to number in the thousands. There is much evidence of auk mortality from drift-netting during the 1960s and 1970s when they were operated to catch salmon along the coasts of eastern Canada, West Greenland, western Ireland, the UK, and Scandinavia (Evans & Nettleship 1985). Guillemots (common and Brunnich's) were recorded in the greatest numbers, in eastern Canada and West Greenland. This may have reflected the much greater population sizes of those two species in those regions, although small numbers of puffins were also recorded (Tull *et al.* 1972, Evans & Waterson 1976, Piatt *et al.* 1984). Lower numbers of puffins were believed to be due not only to their lower population sizes but also their more dispersed rafting nature. In West Greenland, most birds were caught during night fishing (97% of birds sampled - Christensen & Lear 1977) mainly in autumn when they were in annual moult, and the total annual mortality of all auks was estimated at between 215,000 and 350,000 birds (Christensen & Lear 1977). More recently, during two years of observation (1996 & 1998), puffin bycatch was recorded in driftnet fisheries for albacore tuna south-west of Ireland (Rogan & Mackey 2007). Evidence of bycatch risk from drift nets is therefore scored as high with high confidence.

Gill nets are well-known to cause incidental mortality in members of the auk family (guillemots, razorbills and puffins), in several cases leading to population level impacts (Evans & Nettleship 1985; Kampp *et al.* 1994; Tasker *et al.* 2003; Zydelis *et al.* 2013).

Off Newfoundland in eastern Canada, auk bycatch in cod and salmon gill nets increased dramatically from the 1950s to the early 1970s as guillemot populations increased and inshore fisheries intensified in the vicinity of major colonies (Piatt *et al.* 1984, Evans & Nettleship 1985). Ringing recoveries indicated that locally breeding common guillemots and Atlantic puffins formed the majority of the net bycatches, with guillemots caught primarily in cod gillnets and puffins mainly in salmon gillnets. A minimum of 4,200 guillemots and 7,900 puffins were estimated to be killed in gill nets in 1980 in the area sampled, representing an adult guillemot and puffin mortality of 2.7 and 1.6%, respectively of the local alcid breeding populations, with even higher numbers estimated in earlier time periods when capelin were more abundant (Piatt *et al.* 1984). An offshore gillnet fishery east of Newfoundland caught mainly puffins (Evans & Nettleship 1985, Piatt & Nettleship 1987). Since the 1980s, the breeding population sizes were much reduced, as was bycatch numbers. In 2001, an estimated 649 (range 97-1,358) puffins were bycaught in an inshore gillnet fishery for cod off Newfoundland (Benjamins *et al.* 2008). Onboard observations of a cod gillnet fishery in Witless Bay, eastern Newfoundland between 1998 and 2011, recorded that 12% of 281 bird bycatches were Atlantic puffins (Hedd *et al.* 2015). Elsewhere, three puffins were recorded bycaught in the lumpsucker gillnet fishery in Iceland between 2014 and 2017 in 1,045 observed days at sea (Christensen-Dalsgaard *et al.* 2019; ICES BYC database, 2017-2023).

In the Northeast Pacific, the Japanese salmon gillnet fishery recorded bycatch of two related species, the tufted puffin (Fratercula cirrhata) and horned puffin (Fratercula corniculata), accounting for about 20% and 3% of the total bycatch numbering across all species at c. 278,500 in 1978 during a US observer programme (DeGange 1978, King 1984).

Based on the above evidence, bycatch risk from gillnets is scored high with high confidence. The relatively low number of records of Atlantic puffin bycatch in European gillnet fisheries in more recent times is likely related to where gillnet fishing effort is concentrated. Puffins have generally declined and gillnetting is no longer undertaken close to breeding colonies (where puffins typically aggregate below the breeding cliffs); elsewhere, puffins are generally widely dispersed at low densities (Waggitt *et al.* 2020, Evans *et al.* 2021).

For other gear types, there is limited evidence of bycatch. Since puffins are a pursuit diving species taking shoaling fish, similar to other auks, like those species there may be some risk of bycatch in pelagic trawls. This is therefore rated as slight but with low confidence. For other gears, evidence of bycatch risk is scored as low, with low confidence.

SK:

Bycatch of Atlantic puffin is known to currently occur in gillnet fisheries, e.g. for cod or lumpsucker, and driftnet fisheries for albacore tuna (Rogan & Mackey 2007, Benjamins *et al.* 2008, Hedd *et al.* 2015, Christensen-Dalsgaard *et al.* 2019). Additionally, there is information that in Pacific driftnet fisheries other species of puffins which have a similar behaviour are being bycaught (Smith & Morgan 2005). Compared to other alcid species such as the common guillemot which are comparable with respect to feeding behaviour and entangling mechanisms, the bycatch numbers reported for this species in recent studies are relatively low. Further, the WGBYC database has only 3 records of bycatch, all in GNS. But since bycatch numbers are a function of catchability of a gear (assessed in this step) and overlap with fisheries, low reported bycatch numbers may not correctly reflect the gear-associated risk. In older studies, very high bycatches of Atlantic puffin were reported from gillnet fisheries which by that time took place in areas where puffins were locally abundant (Holgerson 1961, Piatt & Nettleship 1987).

Based on entangling mechanisms and target species (e.g., predatory fish which might exploit the same prey as Atlantic puffins), the score for gillnets and driftnets is rated both 3 (high evidence of risk) although for driftnet fisheries there are less records. The confidence is high for gillnets due to numerous old records of high bycatch in these nets and existing records in the WGBYC database for Icelandic waters where there is well–functioning bycatch monitoring in place. The confidence is moderate for driftnets due to a lower number of records which however likely also reflects differences in the use of gears.

Like other auks which are similar with respect to feeding behaviour and occurrence, Atlantic puffins are also highly vulnerable to being bycaught in longlines. Again, recent data on this is scarce but decades ago, puffins were reported to being bycaught in high numbers (Brun 1979). Thus, the risk is rated 3 (high evidence of risk) although with a low confidence as systematic bycatch studies are lacking and the data is based on a low number of longlines investigated. The risk likely also depends on the size of hooks and type of bait used (as well as overlap with bird occurrence not rated in this step).

There is also a high bycatch risk associated with pots and traps as shown by anecdotal historic records where single traps resulted in extremely high bycatch numbers of auks, likely including puffins. Catchability of traps is likely design and fishery specific and depends much on the circumstances under which traps are set. Extremely large bycatch numbers of auks reported from a single pound net at Runde (Norway) investigated 1969 (Brun 1979) must also be seen in the light of the setting in close proximity to the major puffin breeding colony on the island. The risk is rated 2 (moderate evidence of risk) reflecting the expected span of the risk in various designs of pots and traps, with the specific pound net design (which is unknown) set at Runde more likely being at the high end. The confidence is low as data is more or less anecdotal and fishermen did not always report at species level.

4.5.2 Discussion

This was a first attempt by WGBYC to undertake draft scoring for Risk Table 1 of the proposed approach. A new Risk Table 1 template was developed which now provides a more comprehensive format for allocating risk and confidence scores which has benefitted the procedure. The work undertaken on draft scoring for Risk Table 1 was designed to test the process and has provided important insights. The following observations on the method were made by contributors:

There is no clear or defined way to incorporate post-release survival rates of bycaught fish and turtles into the process. For some species survival rates can vary widely between gear types (or metier level) (see sections 4.5.1.2 and .4.5.1.3for examples). Without considering this within the procedure, or at the very least providing guidance on how "bycatch risk" is being defined in this context (i.e. occurrence vs mortality), there is potential for the risk table to provide an inaccurate impression of the relative risk at the species or population level associated with different gear types.

Similarly, the current approach does not provide an obvious way to incorporate differences in a species behavioural ecology between areas or life stages (see 4.5.1.2) and this would affect the resulting scoring generally providing a more negative overall picture. This was also raised by WGBYC in 2023 and needs attention, especially in the sense of clarifying how this method can provide guidance to managers. This largely qualitatively approach should be considered as Decision Support Tool to advise on interim decisions or decision based on a high level of precaution.

In the case of sturgeons, background information on bycatch rates was compiled but there was not sufficient species or fishery (for some ecoregions) expertise available within the WGBYC participants at the meeting to reliably interpret and translate the available literature into risk scores.

Exploration of possible ways to incorporate post-release survivability and fine and large scale behavioural/ecological differences into the current proposed approach for Risk Table 1 would be beneficial in some circumstances and efforts will be made to adapt the proposed methodology to incorporate that.

More generally, despite being familiar with the intention behind Risk Table 1 the contributors have applied the risk and confidence scoring in different ways. This is not a criticism of the contributors, it simply reflects the lack of clear guidance in the current proposed approach on how scoring should be carried out in terms of how to consider and weight available bycatch data, quantitative and anecdotal reports from the literature and personal perception into the scoring system in a way that provides a realistic impression of the evidence of relative risk of different gear types. This may not be of major significance when only considering the results of a single species assessment, provided all contributors discussed and agreed in advance how the allocation of scores was being approached. However, variable approaches to scoring across assessments could have important implications for the overall reliability and utility of the approach. For example, if managers wanted to use the outputs from multiple species assessments to prioritise where monitoring or management attention should be focussed it will be important that all assessments were conducted following a consistent procedure.

Further work to develop a well-documented and more prescriptive methodology (including guidance for contributors on the purpose of risk table 1 and how to generate risk and confidence scores from available information) should be undertaken. This will provide a more transparent and consistent approach to scoring and will improve the proposed approach which is currently considered by many members of the subgroup working on this ToR to be overly subjective and too open to interpretation.

Clearly there is a trade-off between ensuring the methodological basis for scoring in Risk Table 1 is as scientifically rigorous as possible (despite the paucity of data and information) to ensure that the methodology can provide transparent, objective and consistently reliable results, and the time and effort required to achieve that. Intersessional work by various groups will help in this regard. There is also no obvious reason why further development work on Risk Table 2 cannot be carried out simultaneously now that it has been proposed to include gears of all risk levels in the fishing effort / species distribution overlapping exercise rather than just those considered moderate or high risk as previously proposed.

Additionally, it will be important that as the risk procedure matures and is ready for full application, that draft risk tables produced by WGBYC are reviewed by other taxa and fishery experts in a timely way. This will ensure that prolonged delays do not occur in the provision of information about the relative risks of different gears and the likelihood of population level impacts to relevant populations, many of which are already of significant or critical conservation concern.

It is worth noting that once improved methodologies to ensure consistency in table compilation will be codified, the ToR D approach could also produce essential material for a better application of some existing Fisheries Certification Processes (e.g., Good *et al.* 2024).

4.6 Conclusions

The currently proposed methodology provides a largely qualitative and partially subjective estimation of bycatch risk to bycatch data limited populations where quantitative assessments are not possible with the data currently available to ICES. The framework can be applied to a broad range of species and estimates relative bycatch risks across a range of gear types and species so can be used to inform prioritisation of management attention to those gear/population combinations considered to be of most risk. However, the work carried out during 2024 has highlighted several areas where further development work is widely considered to be required to ensure the utility of this procedure. The main areas are:

- A suitable template for compiling metadata in a tabulated format should be developed. This will provide a clearer and more useful way of assessing avaibale information and highlighting potential data gaps.
- Methods for evaluating the relevance and quality of literature supporting risk scoring should be explored. This will provide improved transparency about the influence different cited literature has on the scoring process.

- A standardised selection process to ensure sufficient and relevant expertise is included in all assessements should be developed.
- A standardised selection process to ensure objective selection of candidate species (beyond those listed on the DGMARE priority list) for inclusion in risk assessments should be developed.
- Clarification is needed on the meaning of the risk classes "low", "moderate", and "high", and if possible, standardised semi-quantitative measures should be developed relevant to each risk table.
- Clarification is needed on the confidence ratings and if possible, standardised semi-quantitative or descriptive categories should be developed relevant to each risk table.
- Clarification is needed on the linkages between risk tables and clarification and standardisation of how the risk scores in risk tables 1 and 2, and the the background metadata, contribute to the final risk scores in table 3.
- Ideally the scoring for risk table 1 is carried out independently by each contributor and that is followed with a group discussion to agree a final combined score.
- Risk tables 2 and 3 should include all gear types scored in risk table 1 to avoid overlooking low risk but high effort fisheries that might be sources of significant mortality.
- Incorporating better information on differences in post-release survival rates and ecological/behavioural aspects will be beneficial in some cases at least.
- People contributing to each step of the assessment (metadata and risk tables 1-3) should be listed in each case for transparency and evaluation of the level of relevant expertise and possible diversity of views. However, when new standardised procedures will be identified to clarify some of the points above, the latter factor should not longer be an issue or influence the outputs.
- All fishing effort data sources should be considered for incorporation into effort maps to provide the best possible estimate of the likely distribution and scale of fishing effort at relevant scales.
- Maps of fishery effort density for different metiers/gears should be available for visual comparison all with the same or comparable metrics and with the same colour classes. The same should apply to species density maps.
- Species distribution data sources should be scrutinised to ensure results of overlapping procedures are viewed in the appropriate context.
- Other Ecological Risk Assessment (ERA) approaches should be reviewed to check if there are elements within them that can be drawn on to help improve the proposed methodology.

Recommendations

JWGBird to review the proposed methodology at their 2024 meeting and provide critical feedback to the general framework, suggest appropriate fields for the metadata table and review draft Risk Table 1 scoring for Balearic shearwater and Atlantic puffin.

Request to other relevant groups (e.g. WGEF, RCGs intersessional group on ETP species bycatch) to review Risk Table 1's and contribute species and fishing information to Risk Tables 2 and 3.

WGSFD to discuss with WGBYC fishing effort data needs to support future risk assessments.

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Section 5 (ToR E) Contents

5 ToR E – Review ongoing monitoring of different taxonomic groups in relation to spatial bycatch risk and fishing effort to inform coordinated sampling plans.

In 2023 WGBYC produced a series of maps describing fishing effort (in Days at Sea) at métier level 3, monitoring effort (in Days at Sea), and monitoring coverage (monitoring effort relatively to fishing effort in %) to provide a visual representation of fishing effort and data collection activities in the ICES area, and in the GFCM area in what concerns fisheries from EU member states. These maps were, as in previous years, considered as a useful addition to the work of WGBYC because:

1) They highlight data reporting discrepancies that might otherwise not have been identified,

2) They provide an informative picture of area and gear combinations with relatively low and high monitoring coverage,

3) They indicate that apparently high levels of monitoring coverage in some areas were due to monitoring methods (i.e. logbook, port observers) that are not considered by WGBYC to be reliable methods for quantifying ETPs bycatch rates. Reliable methods in this context are scientific observers at sea, vessels crew observers, and EM (see ToR A, Section 1 for details).

During the WGBYC 2024 meeting, the ToR E subgroup agreed to produce the same maps as in the WGYBC 2023 report but updated with 2023 data. As in the 2023 report, monitoring data obtained via vessel logbooks and port observers were omitted to present an accurate picture of monitoring levels appropriate for bycatch recording.

In addition to what was presented in the 2023 report, the current report also includes maps of monitoring effort and monitoring coverage considering all monitoring methods. In the 2023 report effort maps were presented for métier level 3, however, it was considered that these presented a limited overview of the data and did not match the level used in several analyses of the WGYC report. Therefore, in the present report, the ToR E subgroup also included maps at métier level 4.

These maps are presented and described in section 5.1 below and in Annexes 6 and 7.

With the aim of informing the design of sampling plans, in 2024, the ToR E subgroup implemented a method to indicate which métiers (level 4) may be relatively under-sampled with respect to ETPs bycatch. This followed on from work by WGBYC in 2020-2023 that used métier specific bycatch risk index scores [produced by expert judgement and based on literature, within the fishPi project and the most up to date data on fishing effort and monitoring effort from the WGBYC database. This approach provides an overview of how fishing effort, monitoring effort, monitoring coverage, and fishPi bycatch risk scores are ranked across combinations of ecoregion x ICES Division (or GFCM GSA) x métier level 4, and how they are related (see ICES 2020; ICES 2021, ICES 2022, ICES 2023). It should be noted that for the analysis in the current report, the fishing effort submitted by one country had considerable errors that could not be solved in time, and therefore 2022 fishing effort were used instead for that country only. Also, there was a minor mismatch between fishing effort and monitoring effort for one combination of ICES Division x Métier level 4 in the data submitted by one country which could not be solved in time, and those values for that combination were not included in this analysis.

Following the first analyses of this type undertaken by WGBYC in 2020, the WG agreed that this was a useful general approach that could be informative for highlighting métiers that may be of relatively higher risk in relation to ETP bycatch, but which are currently relatively under-sampled. Consequently, WGBYC proposed a new Term of Reference for 2021, which is being maintained in 2024, to continue to develop this approach to help inform future sampling designs.

During the 2024 meeting, the method first developed in 2020 was repeated using more recent data obtained through the WGBYC 2024 data call. In addition, considering some of the issues that were identified in previous years, one more action was taken, namely:

- Added previously missing ecoregion from the ICES area in the Atlantic Ocean, namely "Oceanic Northeast Atlantic", which had not been included previously.
- In addition, other actions were taken:
- Added all ecoregions from the Mediterranean Sea, which had not been included previously.
- Added to the bycatch risk score matrix métiers that were present in the 2023 data set but had not been previously scored (LH, GN);
- Revised bycatch risk scores for some specific métier x group combinations.
- Table is ordered first by ecoregion and then by combined risk score.
- In section 5.2, we describe in these actions in detail, and present and discuss the results.

5.1 Maps of fishing effort, monitoring effort and monitoring coverage (%)

Figures 5.1 to 5.3 show the 2023 metier level 3 fishing effort (in days at sea), monitoring effort (in days at sea), and monitoring coverage (monitoring effort relative to fishing effort in %) by ICES Division and GFCM GSA, based on 2023 data contained in the WGBYC database. For these maps, data on monitoring effort obtained from logbooks and collected by port observers are not presented because WGBYC do not consider these to be reliable methods for consistent and accurate bycatch reporting (see ToR A section 1 and Basran & Sigurdsson 2021). The monitoring data used in the analysis include data collected by at-sea scientific observers, electronic monitoring, and by vessel observers (crew members tasked with collecting data specifically on behalf of a scientific institution, following the same protocols as the scientific observers). In addition, monitoring categorized as 'Other' was included in this report; its inclusion in future reports will be determined later in collaboration with the three countries that used it in the data call. The inclusion of the data collected by crew members was agreed by the group, after validation of the quality of the data collected by the institutes that used this data collection method.

This section provides an overview of sampling activities by monitoring types that WGBYC consider potentially useful for the quantification of ETPs bycatch (Figure 5.1, 5.2 and 5.3). It does not consider the specific data collection protocols used within different monitoring programmes, some of which may be more, or less, appropriate for consistent and accurate recording of ETPs bycatch.

A second set of figures presents maps of monitoring effort at métier level 3 and monitoring coverage considering all monitoring methods (i.e. also including logbooks and port observers; (Annex 6), and a third set of figures presents maps of fishing effort, monitoring effort, and coverage (not considering logbooks and port observers) at métier level 4 (Annex 7).

The maps were produced in R, using shapefiles available for the ICES Area and Mediterranean Sea from the ICES (https://gis.ices.dk/sf/) and the GFCM (http://www.fao.org/gfcm/data/maps/gsas/es/) websites. In the previous report, maps were produced in ArcGIS. The R scripts were developed for better automation and documentation of the analysis and to facilitate their presentation as interactive maps in the future. As new data are collected every year and because there is a need to examine fishing and monitoring effort at various temporal and spatial levels, visualizing the data using seasons or months and focusing on different areas using interactive maps will assist in understanding the finer scale overlap between fishing effort and densities of species which varies seasonally. It will also allow data from multiple years to be easily combined.

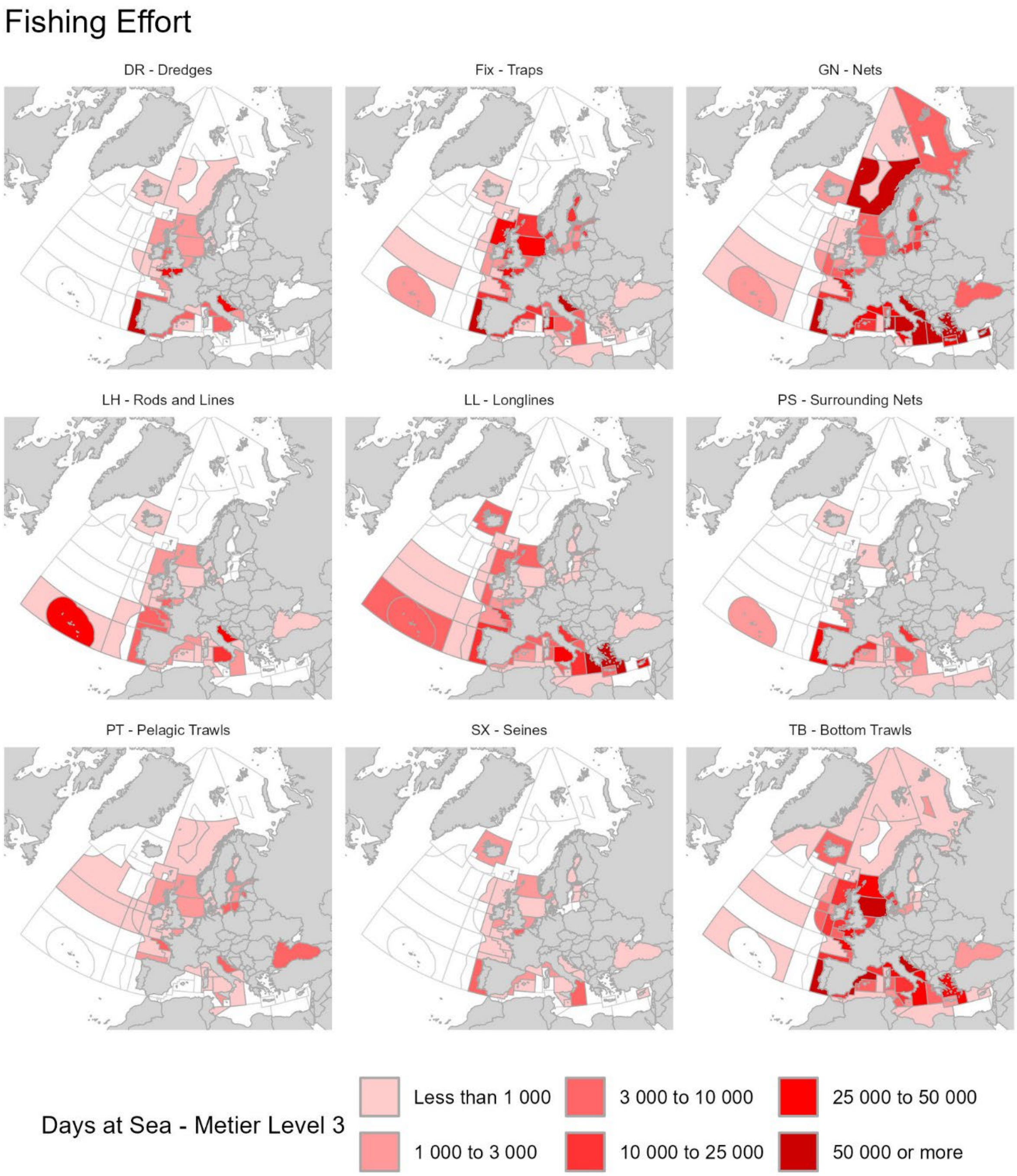

Figure 5.1 2023 Metier Level 3 fishing effort (Days at Sea) submitted to the WGBYC database. Transparent=no data or zero.

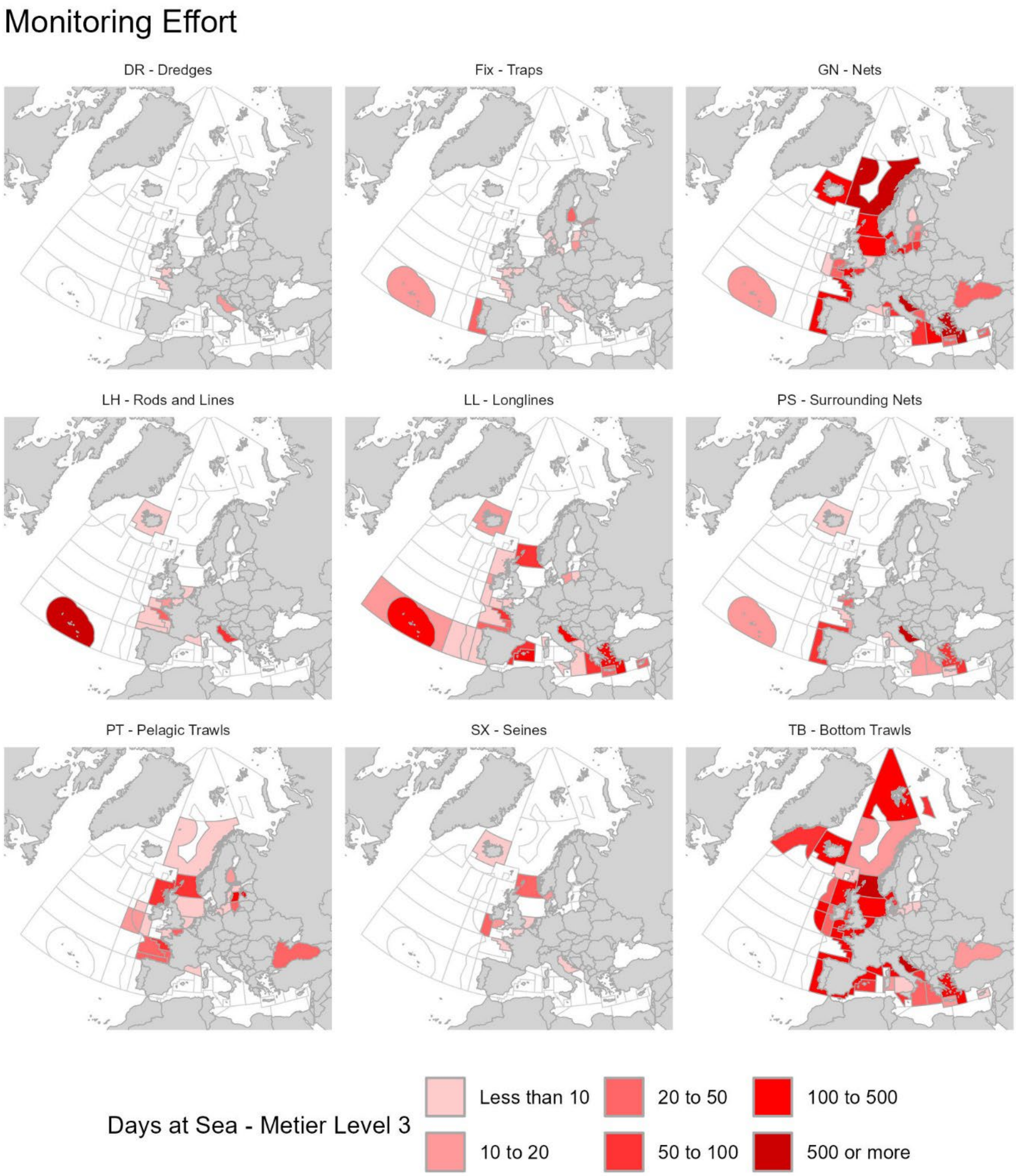

Figure 5.2 2023 Metier level monitoring effort (Days at Sea) submitted to the WGBYC database. The data presented here includes Electronic monitoring (EM), Vessel Observer (VO), Vessel Crew Observer (VO) and Other (OTH). Transparent = no data or zero.

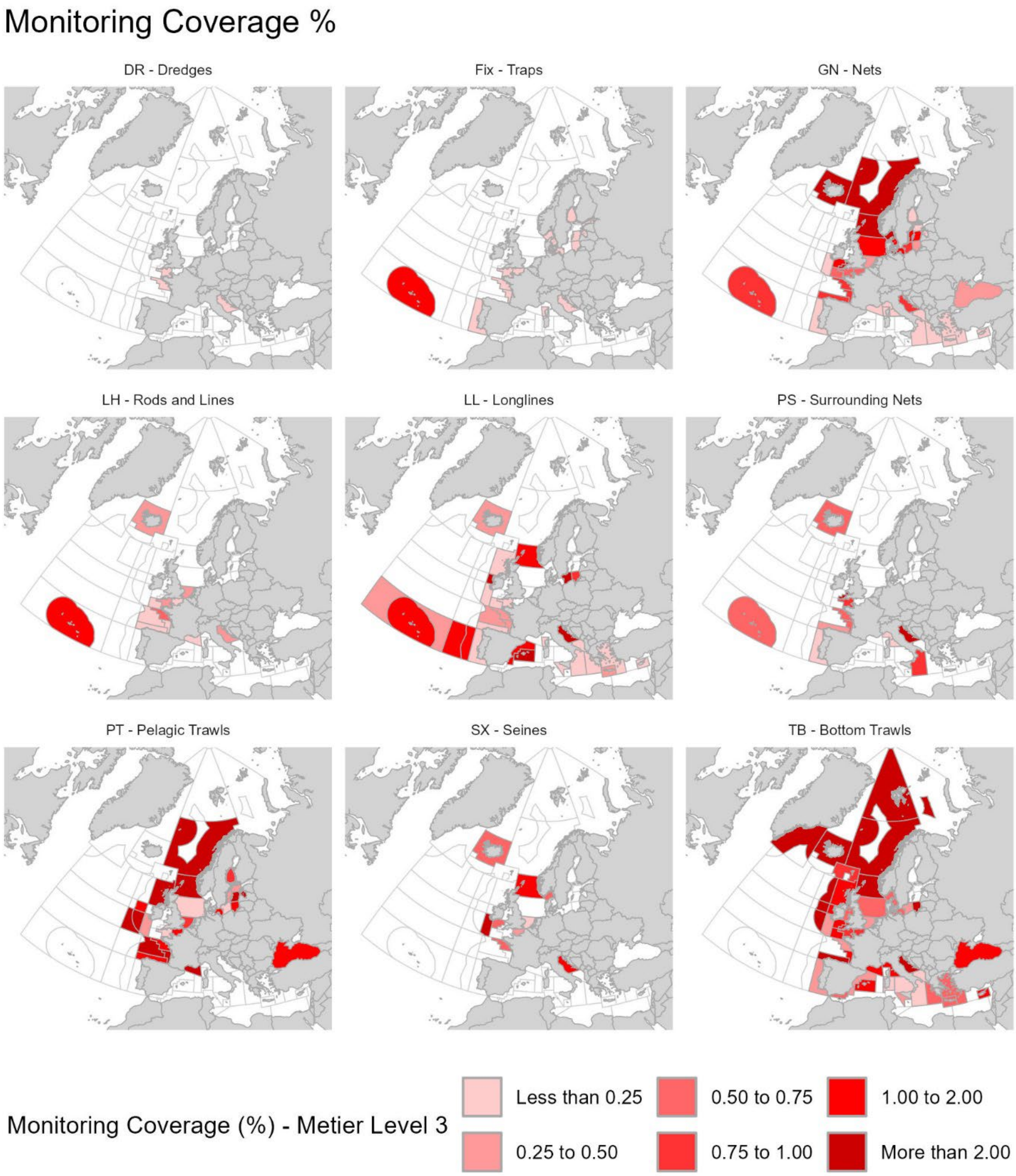

Figure 5.3 2023 Metier level monitoring coverage (%) based on data submitted to the WGBYC database. The data presented here includes Electronic monitoring (EM), Vessel Observer (VO), Vessel Crew Observer (VO) and Other (OTH). Transparent = no data or zero.

Based on the available fishing effort data and viewed at the scale of ICES/GFCM Division it is evident that some broad gear types are used more widely and at higher levels than others within the ICES and GFCM areas (Annex 7 – Fig XXX). As in previous years, **Bottom trawls and nets** are used in most Divisions and at relatively high levels in some areas. **Traps, longlines and dredges** are also quite widely used and exhibit high effort levels in some Divisions. **Rod and line, surrounding nets, pelagic trawls and seines** are less widespread and are typically associated with lower overall effort than the other gear types. The broad patterns of reported fishing effort in 2023 was similar to previous years (e.g., ICES 2023).

Monitoring effort is most widespread in **bottom trawl and net** fisheries. Less monitoring is carried out in all other gear types with **dredges, trap fisheries, seines, and surrounding net** fisheries generally having patchy and comparatively low monitoring coverage.

As in 2023, the main effect of removing the Vessel Logbook and Port Observer data from this analysis appears to be a reduction in monitoring coverage in the **Baltic Sea** (see ICES 2021 for comparison).

The maps provide an overview of fishing and data collection activity across the ICES Areas (and GFCM Areas considering only data from some countries) but are not informative in terms of which metiers might be suitable candidates for increased monitoring that would incrementally improve the data available for future bycatch assessments. The following Section 6.2 describes a methodology developed within WGBYC to inform that subsequent step.

Additionally, fishing effort is currently presented by Days at Sea, the lowest common denominator across various datasets. This metric does not necessarily properly reflect the actual exposure to risk for protected species for all gear types.

5.2 Identifying candidate metiers for increased monitoring with respect to ETPs bycatch quantification.

With the aim of helping to inform the design of sampling plans, in 2024, the ToR E subgroup implemented a method indicate which métiers (level 4) may be relatively under-sampled with respect to ETPs bycatch.

This analysis is designed to provide general guidance, through a structured and reproducible analytical process, on where additional monitoring might best be targeted to help improve our overall understanding of patterns of sensitive species bycatch and bycatch assessments. It is not intended to answer detailed questions about optimal sampling levels to produce bycatch estimates with targeted levels of statistical precision, or the appropriateness of sampling protocols for bycatch in different programmes, and it does not provide detail on which specific fisheries within each metier level 4 category should or should not be monitored more intensely.

The basic concept of the method is to combine fishing effort data, monitoring effort data, and information on the perceived risk of bycatch by different metiers across a range of sensitive taxa to produce a tabulated risk-score.

Within this procedure species are grouped into "functional groups". The groups currently considered include most of those originally included by fishPi, with some exceptions and additions for this year's analysis (similar to last year's report). The set of groups include: lampreys, turtles, diving birds, surface birds, seals, dolphins, harbour porpoise, large whales, deep water sharks, demersal sharks, pelagic sharks, skates and rays. (As a note: sturgeons are not included in this or the 2023 report, contrary to what was reported in the 2023 report).

Each functional group gets a risk score (1-3, where 3 is the highest bycatch risk) for each metier (level 4) based on data or knowledge from any ecoregion. The underlying hypothesis is that the risk of interaction with each fishing gear is independent of area provided the bycatch species/group are present in that area. This risk-score is therefore multiplied by an area dependent absent/present indicator (0 or 1). Risk scores for all functional groups are then summarised to get a "final risk score fishPi". An area/gear combination will get a high final risk-score fish if species from many functional groups are present and if the gear is known to interact with those species in any region.

New species groups or individual species can be added or modified in the future if their inclusion is considered essential. This would require the production of new functional groups and associated risk scores. In order to carry out this task, it is essential to involve the ICES expert groups studying these species (e.g. WGMME, WGEF, JWGBIRDS etc.)

For each combination of métier level 4 and Division, Table in Annex 10 (downloadable in Excel format) shows fishPi scores (scaled to range from 0 to 100), fishing effort (scaled to range from 0 to 100), monitoring coverage (%) as well as a combined risk score which results from the multiplication of scaled fishPi risk score and scaled fishing effort. The table is ordered by ecoregion and combined fish score. Metiers positioned towards the top of each ecoregion in the table generally consist of a combination of high effort and relatively high perceived risk of bycatch occurring, so they can be considered of higher priority for monitoring coverage. Métiers positioned towards the bottom of each ecoregion in the table generally consist of a combination of relatively lower fishing effort, and relatively lower perceived risk of bycatch, so might be considered of lower priority for monitoring coverage. And for each of these combinations the monitoring coverage is presented, so that this level of coverage can be readily accessed and compared with other combinations.

As mentioned above, the objective of this analysis is to give a first overview of the risk of the different metiers and their monitoring effort and coverage at metier level 4, for each Division/GSA in each ICES/GFCM ecoregion. The Advice published based on the WGBYC 2024 report highlighted the five combinations of each ecoregion with the highest combined risk score. For that reason, the present report presents the table ordered by ecoregion and combined risk score within each ecoregion. In the ecoregions from the Northeast Atlantic, the top five combinations within each ecoregion remain similar to those in the 2023 report, with a few exceptions. It should be noted that the Oceanic Northeast Atlantic and all ecoregions in the Mediterranean are included in the analysis for the first time this year.

Download fishPi scores table from the ICES library: https://doi.org/10.17895/ices.pub.27762723

It is relevant to highlight that this analysis was done at métier level 4, and that the set of level 5 métiers included with a métier level 4 may have contrasting levels of bycatch risk. To illustrate this, a simple analysis was carried out. The top five metiers from each ecoregion were disaggregated from métier level 4 (gear) to level 5 (gear + target assemblage based on the main species type) based on the data reported to WGBYC in 2023 (Table 5.1). In most cases, the monitoring of métier level 4 in a Division / GFCM GSA includes several level 5 métiers, i.e. métiers with different target assemblages of species. As a result, the technical characteristics of the fishing gears used and/or and the way they behave may differ which may affect their risk for ETP species.

Furthermore, a similar situation may occur for the level 6 métiers within the level 5 metiérs. For example, for the GNS_DEF métier, the characteristics of the fishing gear mesh size used may differ depending on the target species within that target assemblage of demersal species, which could impact ETP species differently.

Table 5.1. Top 5 risk metier by ecoregion at metier level 4 and level 5.

Ecoregion	ICES SubDivision/ GFCM GSA	Métier Level 4	Métier Level 5
Adriatic Sea	17	GNS	DEF, SLP
	17	OTB	DEF, DWS, MDD
	18	GNS	DEF, SLP

Ecoregion	**ICES SubDivision/ GFCM GSA**	**Métier Level 4**	**Métier Level 5**
	17	GTR	DEF
	18	OTB	DEF, DWS, MDD
Aegean Levantine Sea	22	GTR	DEF
	22	GNS	DEF
	22	LLS	DEF
	25	GNS	DEF
	25	GTR	DEF
Azores	27.10.a	LHP	CEP, FIF, LFP
	27.10.a	LLS	DWS
	27.10.a	LLD	LPF
	27.10.a	GNS	MPD, DEF
	27.10.a	PS	SPF
Baltic Sea	27.3.d	GNS	ANA, CAT, CRU, DEF, FWS, SPF
	27.3.d	FYK	ANA, CAT, DEF, FWS, SPF
	27.3.d	OTM	DEF, FWS, SPF
	27.3.c	GNS	ANA, CAT, CRU, DEF, FWS, SPF
	27.3.c	GTR	ANA, CAT, CRU, DEF, SPF
Barents Sea	27.1.b	GNS	DEF
	27.1.a	OTB	CRU, MCD
	27.1.b	OTB	CRU, DEF, DWS
	27.1.b	OTT	DEF
	27.1.a	TBB	CRU
Bay of Biscay and Iberian coast	27.9.a	GNS	DEF
	27.9.a	OTB	CRU, DEF, MCD, MPD
	27.9.a	FPO	CRU, FIF, MOL
	27.9.a	GTR	DEF
	27.9.a	DRB	MOL
Black Sea	29	GNS	DEF

Ecoregion	ICES SubDivision/ GFCM GSA	Métier Level 4	Métier Level 5
	29	OTM	MPD
	29	TBB	MOL
	29	FPO	SPF
	29	LLD	DEF
Celtic Seas	27.6.a	OTB	CEP,CRU,DEF,DWS,MOL
	27.6.a	FPO	CRU,DEF,MOL
	27.7.j	OTB	CEP,CRU,DEF
	27.7.a	OTB	CRU,DEF,MOL,SPF
	27.7.g	OTB	CEP,CRU,DEF,MCD
Faroes	27.5.b	OTB	CRU, DEF, DWS
	27.5.b	OTM	SPF, MIS
	27.5.b	FPO	CRU
	27.5.b	OTT	DEF
	27.5.b	LLS	DEF
Greater North Sea	27.3.a	OTB	CRU, DEF, MCD, SPF
	27.4.a	OTB	CEP, CRU, DEF, DWS, MOL, SPF
	27.4.b	OTB	CEP, CRU, DEF, MCD, MOL, SPF
	27.7.e	OTB	CEP, CRU, DEF, DWS, MOL, SPF
	27.4.b	TBB	CRU, DEF, MCD, MOL
Greenland Sea	27.14.b	OTB	CRU, DEF, DWS
	27.14.a	OTB	DWS
	27.14.b	OTT	DEF, DWS
Icelandic waters	27.5.a	OTB	CRU,DEF, DWS
	27.5.a	LLS	DEF
	27.5.a	GNS	DEF
	27.5.a	OTM	SPF
	27.5.a	SDN	DEF
	20	GTR	DEF

Ecoregion	ICES SubDivision/ GFCM GSA	Métier Level 4	Métier Level 5
Ionian and the Central Mediterranean sea	20	GNS	DEF
	20	LLS	DEF
	19	GTR	DEF
	16	GTR	DEF
Oceanic Northeast Atlantic	27.10.b	LLD	LPF
	27.12.c	OTB	CEP,CRU,DEF,SPF
	27.12.c	LLD	LPF
	27.12.c	OTT	DEF
	27.10.b	GNS	DEF
Norwegian Sea	27.2.a	GNS	DEF
	27.2.b	OTB	CRU,DEF,DWS
	27.2.a	OTM	SPF, MIS
	27.2.b	OTT	DEF,DWS
	27.2.a	OTB	DEF,DWS
Western Mediterranean Sea	10	GTR	DEF
	6	OTB	DEF, DWS, MDD
	10	GNS	DEF, SLP
	11.2	GTR	DEF
	11.2	GNS	DEF, SLP

5.3 RCG document review (CE+CL tables documentation)

A request from RCGs NANSEA (North Atlantic, North Sea Eastern Artic) & Baltic for WGBYC to review and provide feedback on a template to document the RDBES effort and landings methods used by MS. The document provided by the North Atlantic, North Sea and Baltic Sea RCGs was reviewed by WGBYC during the meeting and the group. This template will help data users to better understand how catch and effort estimates are calculated and uploaded to the ICES RDBES database.

The main objective was to document, on the part of the data providers, how the required fields in the templates have been filled in. This brings more transparency to all the processing performed, and identifies if there is information that has not been reported (e.g. specific metiers, fleets, etc.), methodology used etc.

WGBYC considers it very important that this document is completed by providing as much information as possible in the required fields. WGBYC recommends it making the possible answer options more structured and standardized, rather than free text boxes, as this could lead to significant differences in the answers reported by these data providers. WGBYC considers it important for the ICES group WGCACTH to analyse this document in detail, as the experts in this group are most familiar with the templates, with the functioning of the RDBES, and many of these experts are the data providers.

5.4 Discussion

The comparison of fishPi (and further developed WGBYC) risk scores, fishing effort, and monitoring effort and coverage was undertaken to determine where high risk fisheries occur but monitoring coverage would benefit from being strengthened. The approach provides a broad overview on the overall risk of bycatch in different métiers and across taxa in relation to the distribution of monitoring effort. Understanding how monitoring effort corresponds to general bycatch risk provides information on which métiers are undersampled. This can then guide overall sampling effort given the complexity of sampling for many bycatch species and different bycatch risks. However, it should be noted that this approach is a simplification of a potentially highly complex reality of patterns in bycatch of those species contained within the functional groups. Nonetheless, there are some further developments that could be made that would further improve the utility of this approach and which should be considered when interpreting the current tabulated outputs results:

- • The functional groups should be revised as necessary. Within fishPi, risk scores are added up between functional groups. However, those groups vary in terms of the number of species from one (e.g., harbour porpoise) to several (up to 26 species in the case of dolphins depending on the ecoregion). This may affect the weighting given to any resulting risk score. Furthermore, some functional groups combine species with different habitat and/or foraging ecologies, likely exposing them to different risk at the métier level.
- • The timing for revision of the risk scores. The subgroup suggested that an appropriate time to review risk scores may be when ToR C and D have further progressed on tasks currently being developed in terms of the development of bycatch occurrence, rates, estimates per species, and métier. This timeline would avoid duplication of work and deviating results for the same type of species.
- • The fishing effort is currently aggregated by ICES Division and GFCM GSA. The overlap between fishing effort at the métier level and the spatial distribution of a species may vary considerably at small scales, particularly as a function of heterogeneity in habitats and prey availability. In the longer-term, the current approach would benefit from a finer-scale spatial aggregation. This is feasible considering the resolution of the data submitted currently, but needs to be reappraised in the future.
- • The assignment of risk scores to some ICES Divisions which are in (or between) two Ecoregions also requires attention, particularly when significant biogeographical changes in species distributions occur (e.g. 27.7.3 - Celtic Seas / Greater North Sea, 27.3.b – Greater North Sea / Baltic Sea).
- • The examination of fishing and monitoring effort at finer temporal scales would be useful as relative bycatch risk can vary seasonally. The feasibility of this has not yet been explored.
- • Fishing effort is currently measured as Days at Sea, the most widely available effort metric. However, this does not always accurately reflect the relative exposure to risk for some gear types. Net lengths and soak times for static gear, and swept areas for trawls, could better represent fishing effort. Additionally, small vessels, which are a significant part of the fleet in some ecoregions, are not monitored by VMS. Using a combination of VMS, AIS, and logbooks would improve the measurement of actual risk. It would also

be beneficial to review and improve the effort data available to WGBYC in collaboration with other working groups (WGCATCH, WGSFD, and RCG ISSG PETS). Future exploration should focus on how existing data subsets, where multiple fishing variables exist, can be used to estimate the consequences for bycatch risk (in the context of this ToR) or for bycatch rates and estimates (in the context of other ToRs).

- • Métier level 4 resolution was used in this analysis, as a result it is likely that fisheries with different bycatch risk profiles are being grouped under this metier level. The higher the level of disaggregation at the metier level, the better the risk that each of the fisheries may have in relation to the different functional groups/species of PTEs can be classified.
- Overall, despite the documented limitations identified, the information contained in Table 6.1 provides useful insights. The results highlight métiers that may be relatively under-sampled with respect to bycatch. This overview could be used to indicate how monitoring might best be allocated and carried out within under-sampled métiers, and providing insights into where closer inspection of monitoring levels may be required. This would be best achieved by national or regional collaboration.

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Section 6 (ToR F) contents

6 ToR F: For data deficient situations as highlighted in ToR C, propose measures necessary to obtain the required information

A new ToR was established for WGBYC in 2024 to examine data deficient situations highlighted in ToR C and to propose measures to obtain the required information to improve the data situation in these cases. We evaluated what is affecting the calculation of bycatch rates (BPUEs) or the total bycatch estimates. This informed us where data is poor and we suggest where and how monitoring can be improved to achieve future BPUE and total bycatch estimates.

6.1 Improving Data Utilization

WGBYC data goes through multiple filtering/criteria checks before being used in the BEAM assessment. One of the criteria for the data is that the taxa reported as bycatch must match the monitoring protocols. Thus, where the taxa monitored were recorded as “All” or “Protected species” (which includes all taxa), or where taxa of the bycatch species of interest were the same as the taxa monitored for bycatch (for example, the sampling protocol is for fish and the bycaught species is a fish species), were kept for further BEAM analyses. The number of monitored days at sea where there are records of the various taxa but the data was excluded due to taxa recorded not matching the sampling protocol are presented in Table 6.1.

In some ecoregions, there is a high number of monitored sea days where fish bycatch has been observed, although the monitoring protocol focuses on marine mammals. This is unsurprising, especially if methods like EM (electronic monitoring) are used, where identification of fish species can be challenging. However, in certain areas and métiers, marine mammals are observed bycaught, but the monitoring protocols are focusing on turtles. As a result, WGBYC considers these observations sporadic/ad hoc, and the data is not used in assessments.

For example, in the Norwegian Sea, there are over 3000 days at sea where marine mammals were recorded as bycatch in gillnet fisheries, however, the monitoring protocols focus on birds and so these records are considered ad hoc/sporadic. Similarly, in the North Sea there were 2200 monitored days at sea in gillnet fisheries, with monitoring protocols focused on birds, however mammals recorded as bycatch. In the Baltic Sea, in otter trawl fisheries, over 1100 monitored days at sea were conducted, but seabird observations were not considered as the monitoring protocols focus on marine mammals. Another area where valuable data may be underutilized due to differences in monitoring protocols and target taxa is the Azores, where longline fisheries are being monitored.

This highlights the need for clearer specifications on how the monitored effort can be applied in assessments. For example, if turtles are reported even though the monitoring protocol is for marine mammals, can this data still be used in turtle assessments?

Table 6.1 Monitored days at sea by ecoregion and métier where the monitoring protocols does not align with the recorded taxa.

Ecoregion	Taxa reported	Taxa monitored	DRB	FPO	GND	GNS	GTR	LHM	LHP	LLD	LLS	OTB	OTM	OTT	PS	PTB	PTM	SSC	TBB
Adriatic Sea	Fish	Turtles								167									
	Mammals	Turtles								167									
	Seabirds	Turtles								167									
Aegean-Levantine Sea	Mammals	Fish										10							
	Seabirds	Fish										10							
	Turtles	Fish										10							
Azores	Fish	Mammals						2685	1147										
	Fish	Turtles								463									
	Mammals	Turtles								463									
	Seabirds	Mammals						2685	1147										
	Seabirds	Turtles								463									
	Turtles	Mammals						2685	1147										
Baltic Sea	Fish	Mammals										4	1493						
	Mammals	Fish		2		51	16			34		153	1148	3					
	Seabirds	Fish		2		51	16			34		153	1148	3					
	Seabirds	Mammals										4	1493						

Ecoregion	Taxa reported	Taxa monitored	DRB	FPO	GND	GNS	GTR	LHM	LHP	LLD	LLS	OTB	OTM	OTT	PS	PTB	PTM	SSC	TBB
Barents Sea	Fish	Mammals				174							88						
	Mammals	Fish										651							
	Seabirds	Fish										651							
	Seabirds	Mammals				174							88						
Bay of Biscay and the Iberian Coast	Fish	Mammals				306	75								185				
	Fish	Seabirds				108					40								
	Fish	Turtles								88									
	Mammals	Fish															46		
	Mammals	Seabirds				108					40								
	Mammals	Turtles								88									
	Seabirds	Fish															46		
	Seabirds	Mammals				306	75								185				
	Seabirds	Turtles								88									
	Turtles	Fish															46		
	Turtles	Mammals				306	75								185				
	Turtles	Seabirds				108					40								
Celtic Seas	Fish	Turtles								18									
	Mammals	Fish	45	2	69	215	15	1				463	161	80			10	19	641

Ecoregion	Taxa reported	Taxa monitored	DRB	FPO	GND	GNS	GTR	LHM	LHP	LLD	LLS	OTB	OTM	OTT	PS	PTB	PTM	SSC	TBB
	Mammals	Turtles								18									
	Seabirds	Fish	45	2	69	215	15	1				463	161	80			10	19	641
	Seabirds	Turtles								18									
	Turtles	Fish	45	2	69	215	15	1				463	161	80			10	19	641
Greater North Sea	Fish	Mammals				2200													
	Mammals	Fish	60	23	82	172	44	78			7	590	12	304		1			786
	Seabirds	Fish	60	23	82	172	44	78			7	590	12	304		1			786
	Seabirds	Mammals				2200													
	Turtles	Fish	60	23	82	172	44	78			7	590	12	304		1			786
	Turtles	Mammals				2200													
Ionian Sea and the Central Mediterranean Sea	Fish	Turtles								130									
	Mammals	Turtles								130									
	Seabirds	Turtles								130									
Norwegian Sea	Fish	Mammals				3117							1						
	Mammals	Fish											129						
	Seabirds	Fish											129						
	Seabirds	Mammals				3117							1						

Ecoregion	Taxa reported	Taxa monitored	DRB	FPO	GND	GNS	GTR	LHM	LHP	LLD	LLS	OTB	OTM	OTT	PS	PTB	PTM	SSC	TBB
Oceanic Northeast Atlantic	Fish	Turtles								41									
	Mammals	Turtles								41									
	Seabirds	Turtles								41									
Western Mediterranean Sea	Fish	Turtles								155									
	Mammals	Turtles								155									
	Seabirds	Turtles								155									

6.2 Enhance data quality and BPUE

Guidelines on monitoring levels were established in the recent PETSAMP3 workshop. In the advice from the workshop, levels of monitoring coverage were suggested to reduce CVs (coefficient of variation) to previously proposed target levels (e.g. a CV of 0.3 from EU Regulation 812/2004) based on the rarity of the bycaught species in question (Table 6.2).

Table 6.2 Categories of bycatch probability and suggested monitoring coverage levels based on the PETSAMP3 workshop and advice. Two monitoring levels are suggested, one where additional sampling provides limited return of investment (infliction point) and another where the coefficient of variation reaches the set target of 0.3 (CV).

Bycatch probability (observed n/Days at sea)	Monitoring level (infliction point)	Monitoring level (CV)
Very high (1/10)	0.5%	0.5%
Medium/high (1/100)	3%	7%
Rare (1/1000)	5-8%	30%
Very rare/Extremely rare	Reliable bycatch rates would be unachievable with any level of monitoring effort	Reliable bycatch rates would be unachievable with any level of monitoring effort

ICES WKPETSAMP3 (2023) found that the precision of BPUE improves when more vessels are monitored. However, this means that each individual vessel will have fewer fishing operations observed if the total amount of monitored days at sea remains the same. Additionally, the variability associated with how monitoring is distributed among vessels decreases as the proportion of monitored fishing operations increases.

However, there are exceptions to this general outcome (ICES, 2024). The precision and accuracy of BPUE can be affected by how monitoring efforts are stratified or distributed. This is especially true when a fleet consists of various known fishing characteristics such as different métiers, practices, and fishing areas, which leads to different probabilities of bycatch for species. Stratifying by métier can lead to more precise and accurate BPUE estimates for species with very low bycatch probabilities. However, the benefits of stratification become less significant as bycatch probability increases. Importantly, stratification is particularly useful when the total monitoring coverage must be spread across fewer vessels (still stratified by métier), allowing for an increase in the number of monitored fishing operations per vessel. The precision of BPUE estimates is sensitive to vessel effects, whether they arise from spatial, temporal, or spatio-temporal variations in fishing effort.

Out of 90 ecoregion/metier level 4/species combinations in 2023 with species on the EU priority list, only 45 combinations had sufficient coverage to produce BPUE and/or bycatch estimates according to the guidelines established in the WKPETSAMP3 (Table 6.3). Twenty-two of the species combinations observed were considered very or extremely rare, suggesting that reliable bycatch rates would be unachievable with any level of monitoring effort including harbour porpoise in the Baltic, Bay of Biscay, and North Sea (Table 6.3). The remaining 64 species combinations that had insufficient monitoring coverage according to the PETSAMP 3 guidelines. These include, for example, common dolphins caught in gillnets (GNS) and pots and traps (FPO) in the Bay of Biscay, loggerhead turtles in gillnets (GNS) in the Azores, various metiers in the Mediterranean ecoregions, harbour porpoises in trammel nets (GTR) in the Baltic and Celtic Seas, and in gillnets (GNS) in the Black Sea and Icelandic waters (Table 6.3).

Table 6.3 Ecoregion/metier level 4/species combinations out of the EU priority species list where further monitoring would potentially improve data quality sufficiently to be included in the BEAM.

Ecoregion	Taxa	Species	Metier L4	PETSAMP definition on bycatch probability	Coverage %	Sufficient coverage?	Sufficient monitoring (inflection)	Sufficient monitoring (cv)
Adriatic Sea	Turtle	*Caretta caretta*	GTR	Rare	0,08	No	5-8%	30%
	Turtle	*Caretta caretta*	LLD	Very high	1,14	Yes CV	0,5	0,5
	Turtle	*Caretta caretta*	OTB	Medium/high	0,13	No	3%	0,5
	Turtle	*Caretta caretta*	PS	Medium/high	0,35	No	3%	0,5
Aegean-Levantine Sea	Turtle	*Caretta caretta*	GTR	Rare	0,08	No	5-8%	30%
	Turtle	*Caretta caretta*	LLD	Medium/high	0,96	No	3%	7%
	Turtle	*Caretta caretta*	LLS	Rare	0,09	No	5-8%	30%
	Turtle	*Caretta caretta*	OTB	Rare	0,56	No	5-8%	30%
	Turtle	*Chelonia mydas*	LLD	Medium/high	0,96	No	3%	7%
	Turtle	*Chelonia mydas*	OTB	Rare	0,56	No	5-8%	30%
	Fish	*Gymnura altavela*	GNS	Rare	0,10	No	5-8%	30%
	Fish	*Gymnura altavela*	GTR	Very rare	0,08	NA	Not possible	Not possible
	Fish	*Gymnura altavela*	LLS	Rare	0,09	No	5-8%	30%
	Pinniped	*Monachus monachus*	LLS	Very rare	0,09	NA	Not possible	Not possible
Azores	Turtle	*Caretta caretta*	GNS	Medium/high	0,78	No	3%	7%
	Turtle	*Caretta caretta*	LLD	Medium/high	3,14	Yes inflection point	3%	7%
	Turtle	*Chelonia mydas*	GNS	Medium/high	0,78	No	3%	7%
	Turtle	*Dermochelys coriacea*	LLD	Medium/high	3,14	Yes inflection point	3%	7%
Baltic Sea	Sturgeon	*Acipenser oxyrinchus*	GNS	Very rare	0,58	NA	Not possible	Not possible
	Cetacean	*Phocoena phocoena*	GNS	Extremely rare	0,58	NA	Not possible	Not possible

Ecoregion	Taxa	Species	Metier L4	PETSAMP definition on bycatch probability	Coverage %	Sufficient coverage?	Sufficient monitoring (infliction)	Sufficient monitoring (cv)
	Cetacean	*Phocoena phocoena*	GTR	Rare	4,25	No	5-8%	30%
Bay of Biscay and the Iberian Coast	Turtle	*Caretta caretta*	GNS	Very rare	0,24	NA	Not possible	Not possible
	Turtle	*Caretta caretta*	LLD	Medium/high	0,98	No	3%	7%
	Turtle	*Dermochelys coriacea*	LLD	Very rare	0,98	NA	Not possible	Not possible
	Cetacean	*Delphinus delphis*	FPO	Rare	0,04	No	5-8%	30%
	Cetacean	*Delphinus delphis*	GNS	Medium/high	0,24	No	3%	7%
	Cetacean	*Delphinus delphis*	GTR	Medium/high	0,80	No	3%	7%
	Cetacean	*Delphinus delphis*	LLS	Rare	0,17	No	5-8%	30%
	Cetacean	*Delphinus delphis*	OTB	Rare	0,69	No	5-8%	30%
	Cetacean	*Delphinus delphis*	OTM	Very high	0,09	No	0,5	0,5
	Cetacean	*Delphinus delphis*	PS	Medium/high	0,22	No	3%	0,5
	Cetacean	*Delphinus delphis*	PTB	Rare	3,50	No	5-8%	0,5
	Cetacean	*Phocoena phocoena*	GNS	Very rare	0,24	NA	Not possible	Not possible
	Cetacean	*Phocoena phocoena*	GTR	Rare	0,80	No	5-8%	30%
	Cetacean	*Phocoena phocoena*	OTB	Rare	0,69	No	5-8%	30%
	Cetacean	*Phocoena phocoena*	PTM	Rare	1,88	No	5-8%	30%
	Fish	*Gymnura altavela*	OTB	Very rare	0,69	NA	Not possible	Not possible
	Bird	*Puffinus mauretanicus*	GNS	Rare	0,24	No	5-8%	30%
	Bird	*Puffinus mauretanicus*	GTR	Rare	0,80	No	5-8%	30%

Ecoregion	Taxa	Species	Metier L4	PETSAMP definition on bycatch probability	Coverage %	Sufficient coverage?	Sufficient monitoring (infliction)	Sufficient monitoring (cv)
	Bird	*Puffinus mauretanicus*	LLS	Rare	0,17	No	5-8%	30%
	Bird	*Puffinus mauretanicus*	OTB	Rare	0,69	No	5-8%	30%
Black Sea	Sturgeon	*Acipenser stellatus*	OTM	Medium/high	1,36	No	3%	7%
	Sturgeon	*Acipenser stellatus*	TBB	Medium/high	1,51	No	3%	7%
	Sturgeon	*Huso huso*	OTM	Medium/high	1,36	No	3%	7%
	Cetacean	*Phocoena phocoena*	GNS	Medium/high	0,47	No	3%	7%
Celtic Seas	Cetacean	*Delphinus delphis*	GNS	Rare	0,40	No	5-8%	30%
	Cetacean	*Delphinus delphis*	GTR	Rare	0,47	No	5-8%	30%
	Cetacean	*Delphinus delphis*	OTB	Very rare	1,41	NA	Not possible	Not possible
	Cetacean	*Delphinus delphis*	OTT	Rare	0,24	No	5-8%	30%
	Cetacean	*Delphinus delphis*	PS	Medium/high	13,93	Yes CV	3%	7%
	Cetacean	*Delphinus delphis*	PTM	Rare	0,09	No	5-8%	30%
	Fish	*Dipturus intermedius*	GNS	Rare	0,55	No	5-8%	30%
	Fish	*Dipturus intermedius*	GTR	Medium/high	0,47	No	3%	7%
	Fish	*Dipturus intermedius*	OTB	Extremely rare	1,43	NA	Not possible	Not possible
	Fish	*Dipturus intermedius*	OTT	Extremely rare	0,24	NA	Not possible	Not possible
	Cetacean	*Phocoena phocoena*	GNS	Rare	0,40	No	5-8%	30%
	Cetacean	*Phocoena phocoena*	GTR	Medium/high	0,47	No	3%	7%
	Cetacean	*Phocoena phocoena*	OTB	Very rare	1,41	NA	Not possible	Not possible

Ecoregion	Taxa	Species	Metier L4	PETSAMP definition on bycatch probability	Coverage %	Sufficient coverage?	Sufficient monitoring (infliction)	Sufficient monitoring (cv)
	Cetacean	*Phocoena phocoena*	OTT	Rare	0,24	No	5-8%	30%
	Fish	*Squatina squatina*	GNS	Very rare	0,55	NA	Not possible	Not possible
	Fish	*Squatina squatina*	GTR	Medium/high	0,47	No	3%	7%
Greater North Sea	Cetacean	*Delphinus delphis*	GNS	Extremely rare	2,18	NA	Not possible	Not possible
	Cetacean	*Delphinus delphis*	GTR	Very rare	0,75	NA	Not possible	Not possible
	Cetacean	*Delphinus delphis*	OTB	Extremely rare	0,76	NA	Not possible	Not possible
	Cetacean	*Delphinus delphis*	PS	Medium/high	0,84	No	3%	7%
	Fish	*Dipturus intermedius*	OTB	Extremely rare	0,83	NA	Not possible	Not possible
	Fish	*Dipturus intermedius*	OTT	Extremely rare	2,10	NA	Not possible	Not possible
	Fish	*Dipturus intermedius*	PTB	Rare	1,65	No	5-8%	30%
	Fish	*Dipturus intermedius*	SSC	Rare	0,75	No	5-8%	30%
	Cetacean	*Phocoena phocoena*	GNS	Medium/high	2,18	No	3%	7%
	Cetacean	*Phocoena phocoena*	GTR	Medium/high	0,75	No	3%	7%
	Cetacean	*Phocoena phocoena*	OTB	Very rare	0,76	NA	Not possible	Not possible
	Cetacean	*Phocoena phocoena*	SDN	Rare	0,54	No	5-8%	30%
Icelandic Waters	Cetacean	*Phocoena phocoena*	GNS	Very high	0,04	No	0,5	0,5
Ionian Sea and the Central Mediterranean Sea	Sturgeon	*Acipenser naccarii*	OTB	Rare	0,23	No	5-8%	0,5
	Turtle	*Caretta caretta*	GTR	Rare	0,08	No	5-8%	0,5
	Fish	*Gymnura altavela*	GTR	Rare	0,08	No	5-8%	30%
	Fish	*Gymnura altavela*	LLS	Rare	0,05	No	5-8%	30%
	Fish	*Gymnura altavela*	OTB	Rare	0,23	No	5-8%	30%

Ecoregion	Taxa	Species	Metier L4	PETSAMP definition on bycatch probability	Coverage %	Sufficient coverage?	Sufficient monitoring (infliction)	Sufficient monitoring (cv)
	Fish	*Leucoraja melitensis*	OTB	Extremely rare	0,23	NA	Not possible	Not possible
	Fish	*Squatina aculeata*	GTR	Rare	0,08	No	5-8%	30%
Norwegian Sea	Cetacean	*Phocoena phocoena*	GNS	Medium/high	2,07	No	3%	7%
Oceanic Northeast Atlantic	Turtle	*Caretta caretta*	LLD	Medium/high	0,44	No	3%	7%
	Turtle	*Dermochelys coriacea*	LLD	Medium/high	0,44	No	3%	7%
Western Mediterranean Sea	Turtle	*Caretta caretta*	LLD	Rare	0,68	No	5-8%	30%
	Turtle	*Caretta caretta*	OTB	Rare	0,60	No	5-8%	30%
	Turtle	*Caretta caretta*	OTT	Rare	2,30	No	5-8%	30%
	Fish	*Dermochelys coriacea*	LLD	Very rare	0,68	NA	Not possible	Not possible
	Fish	*Gymnura altavela*	GTR	Medium/high	0,01	No	3%	7%
	Fish	*Gymnura altavela*	OTB	Very rare	0,60	NA	Not possible	Not possible

6.3 Reasons for failing to estimate total bycatch

The primary issues preventing the calculation of BPUE for an ecoregion/metier/species combination relates to data availability. In many cases there are no bycatch records due to low monitoring coverage in a particular area or metier, or there is heterogeneity in the data provided, for example from the different monitoring programmes.

The issues preventing the calculation of total bycatch for species/ecoregion/metier combinations can be grouped into three categories and relate to:

1) deficient fishing data, where the monitoring effort (in days) is greater than the fishing effort reported (in days),
2) incomplete or lack of fishing effort data for an ecoregion/metier combination, and
3) not all levels of a factor(s) influencing a BPUE are available in fishing or monitoring effort data. For example, when the BPUE is influenced by a country (i.e., the country has been retained in the model), if not all the countries of an ecoregion have fishing effort data available, we will not be able to calculate the total bycatch estimate.

Overall, for the fish taxa 47% of the species/ecoregion/metier combinations failed to achieve a total bycatch estimate due to (2) data availability, and almost 30% failed due to (3) factors influencing the BPUE (Table 6.4). Similarly, for the mammal taxa, over half failed due to (2) data availability, and 26 % due to (3) factors influencing the BPUE (Table 6.4). For the seabird taxa 44% and 17% failed due to (2) data availability and (3) factors influencing BPUE respectively

(Table 6.4). For the turtle taxa, 28% failed due to (2) data availability and 8% due to (3) factors related to the BPUE (Table 6.4).

The ability to generate total bycatch estimates was influenced by (2) fishing effort data availability in all ecoregions to a greater or lesser extent, and these effects were metier specific (Table 6.4). For examine, in the Adriatic Sea, the Bay of Biscay and Iberian Coast, Celtic Seas, Greater North Sea, and Icelandic Waters Ecoregions (2) fishing effort data availability is the most significant impact on the calculation of total bycatch, with metiers GNS, GTR, OTB, OTM, OTT, PS, PTM, and TBB among the affected metiers. Similarly, (3) factors influencing BPUE reduced the number of species/ecoregion/metier combinations where total bycatch could be estimated by over 50% in the Baltic Sea, Bay of Biscay and Iberian Coast, Celtic Seas, Greater North Sea, Icelandic Waters and the Western Mediterranean Sea Ecoregions for a number of taxa and metiers (Table 6.4).

For EU priority species, there were no instances where total bycatch could not be estimated due (1) incomplete fishing data, specifically the availability of more monitoring data than fishing effort data. Several of the EU priority species/ecoregion/metier combinations failed to achieve a total bycatch estimate due to (2) fishing data availability, while only a small number of EU priority species/ecoregion/metier combinations failed to due to (3) factors influencing the BPUE (Table 6.5).

Table 6.4 Percentage of species per taxa, metier level 4 and ecoregion where total bycatch estimate could not be estimated, and the reasons estimates were not achieved.

Ecoregion	Metier L4	Taxa	Total Species Assessed	1.Monitoring vs Fishing Effort	2. Data Availability	3. Factors influencing BPUE
Adriatic Sea	GTR	Seabirds	1		100	
		Turtles	1		100	
	LLD	Seabirds	1			
		Turtles	1			
	OTB	Mammals	1		100	
		Seabirds	1		100	
		Turtles	1		100	
	PS	Turtles	1			
	PTM	Mammals	1			
		Turtles	1			
Aegean-Levantine Sea	GNS	Fish	1		100	
	GTR	Fish	1			
		Seabirds	1			
		Turtles	1			
	LLD	Turtles	2			

Ecoregion	Metier L4	Taxa	Total Species Assessed	1.Monitoring vs Fishing Effort	2. Data Availability	3. Factors influencing BPUE
	LLS	Fish	1			
		Mammals	1			
		Seabirds	3			
		Turtles	1			
	OTB	Fish	1		100	
		Turtles	2		100	
Azores	FPO	Fish	1			
	GNS	Fish	8			
		Turtles	2			
	LHM	Fish	12			33.33
		Mammals	1			
	LHP	Fish	7			
	LLD	Fish	1			
		Turtles	2			
	LLS	Fish	15			
Baltic Sea	FPN	Seabirds	2			
	FPO	Fish	3			33.33
		Mammals	2			50.00
	FYK	Fish	1			
		Seabirds	2			
	GNS	Fish	5			80.00
		Mammals	3			100.00
		Seabirds	15			46.67
	GTR	Fish	4			
		Mammals	3			
		Seabirds	8			
	LLD	Seabirds	2			
	OTB	Fish	3			33.33

Ecoregion	Metier L4	Taxa	Total Species Assessed	1.Monitoring vs Fishing Effort	2. Data Availability	3. Factors influencing BPUE
	OTM	Fish	3			33.33
	SDN	Fish	2			
Barents Sea	GNS	Mammals	3			
	OTB	Fish	5			
	OTT	Fish	1			
Bay of Biscay and the Iberian Coast	FPO	Mammals	1			
	GND	Seabirds	2			
	GNS	Fish	32			62.50
		Mammals	5			20.00
		Seabirds	10			20.00
		Turtles	1			
	GTN	Seabirds	1			
	GTR	Fish	21		100	38.10
		Mammals	3		100	
		Seabirds	13		100	7.69
	LHP	Seabirds	1			
	LLD	Turtles	2			
	LLS	Fish	11			54.55
		Mammals	1			
		Seabirds	4			25.00
	LTL	Seabirds	1			
	OTB	Fish	36			63.89
		Mammals	2			
		Seabirds	3			66.67
	OTM	Fish	2		100	
		Mammals	1		100	
		Seabirds	2		100	
	PS	Fish	8			12.50

Ecoregion	Metier L4	Taxa	Total Species Assessed	1.Monitoring vs Fishing Effort	2. Data Availability	3. Factors influencing BPUE
		Mammals	1			
		Seabirds	1			
	PTB	Fish	23		100	26.09
		Mammals	3		100	
		Seabirds	2		100	
	PTM	Fish	1		100	100.00
		Mammals	2		100	
	TBB	Fish	1			
Black Sea	GNS	Mammals	1			
	OTM	Fish	2			
	TBB	Fish	1			
Celtic Seas	FPO	Fish	1			
	GND	Fish	3		100	
	GNS	Fish	12			25.00
		Mammals	4			100.00
		Seabirds	3			33.33
	GTR	Fish	7			14.29
		Mammals	4			25.00
	LLS	Fish	2			
		Seabirds	3			
	OTB	Fish	26		100	46.15
		Mammals	3		100	33.33
		Seabirds	1		100	100.00
	OTM	Fish	21		100	14.29
		Mammals	2		100	
	OTT	Fish	5		100	
		Mammals	2		100	
		Seabirds	1		100	

Ecoregion	Metier L4	Taxa	Total Species Assessed	1.Monitoring vs Fishing Effort	2. Data Availability	3. Factors influencing BPUE
	PS	Mammals	1		100	
		Seabirds	1		100	
	PTB	Seabirds	1			
	PTM	Mammals	1		100	
		Seabirds	1		100	
	SSC	Fish	8			
	TBB	Fish	7			57.14
Faroes	OTB	Fish	1			
Greater North Sea	DRB	Fish	2			
	FPO	Fish	5			20.00
	FYK	Fish	1			
		Mammals	1			
	GND	Fish	7		100	
	GNS	Fish	18		100	55.56
		Mammals	5		100	80.00
		Seabirds	11		100	18.18
	GTR	Fish	10		100	20.00
		Mammals	4		100	50.00
		Seabirds	7		100	28.57
	LHM	Fish	3			
		Seabirds	1			
	LLS	Fish	4			
		Seabirds	7			14.29
	OTB	Fish	33		100	54.55
		Mammals	4		100	50.00
		Seabirds	2		100	
	OTM	Fish	7		100	14.29
		Mammals	2		100	50.00

Ecoregion	Metier L4	Taxa	Total Species Assessed	1.Monitoring vs Fishing Effort	2. Data Availability	3. Factors influencing BPUE
		Seabirds	1		100	
	OTT	Fish	23		100	52.17
	PS	Mammals	1			
		Seabirds	2			50.00
	PTB	Fish	10			10.00
		Seabirds	1			
	SDN	Fish	4			
		Mammals	1			
	SSC	Fish	6			16.67
	TBB	Fish	19		100	15.79
		Mammals	1		100	
		Seabirds	1		100	
Greenland Sea	OTB	Fish	7			
	OTT	Fish	1			
Icelandic Waters	GNS	Fish	6		100	
		Mammals	7		100	
		Seabirds	13		100	
	LLS	Fish	1		100	
		Seabirds	4		100	
	OTB	Fish	13			7.69
		Mammals	1			100.00
	OTM	Seabirds	1			
	SDN	Fish	1			
Ionian Sea and the Central Mediterranean Sea	GTR	Fish	2		100	
		Turtles	1		100	
	LLS	Fish	1			
	OTB	Fish	3		100	33.33
Norwegian Sea	GNS	Fish	8			37.50

Ecoregion	Metier L4	Taxa	Total Species Assessed	1.Monitoring vs Fishing Effort	2. Data Availability	3. Factors influencing BPUE
		Mammals	3			33.33
		Seabirds	5			
	OTB	Fish	10		100	10.00
	OTM	Fish	2		100	50.00
	OTT	Fish	7			
Oceanic Northeast Atlantic	LLD	Turtles	2			50.00
	OTB	Fish	3			
	OTM	Fish	1		100	
Western Mediterranean Sea	GTR	Fish	1		100	
	LLD	Mammals	3		100	
		Seabirds	4		100	50.00
		Turtles	2		100	50.00
	OTB	Fish	2			
		Mammals	2			50.00
		Seabirds	2			100.00
		Turtles	1			
	OTM	Mammals	1			
	OTT	Mammals	1			
		Turtles	1			

Table 6.5 Summary of the EU priority species assessed for BPUE by metier level 4 and ecoregion, and the reason estimates were not achieved.

							Total Bycatch Estimate Fails		
Ecoregion	**Taxa**	**Species**	**Metier L4**	**Monitored Days at Sea**	**BPUE**	**Total By-catch Esitmate**	**Monitoring vs Fishing Effort**	**Data Availabil-ity**	**Factors influ-encing BPUE**
Adriatic Sea	Turtles	*Caretta caretta*	GTR	180.0	Yes	No		Fail	
			LLD	200.0	Yes	Yes			
			OTB	591.0	Yes	No		Fail	
			PS	450.0	Yes	Yes			
			PTM	1010.0	Yes	Yes			
Aegean-Levantine Sea	Fish	*Gymnura alta-vela*	GNS	1315.0	Yes	No		Fail	
			GTR	2100.0	Yes	Yes			
			LLS	1105.0	Yes	Yes			
	Mammals	*Monachus mona-chus*	LLS	1105.0	Yes	Yes			
	Turtles	*Caretta caretta*	GTR	2100.0	Yes	Yes			
			LLD	99.0	Yes	Yes			
			LLS	1105.0	Yes	Yes			
			OTB	927.0	Yes	No		Fail	
		Chelonia mydas	LLD	99.0	Yes	Yes			

			OTB	927.0	Yes	No		Fail	
Azores	Mammals	*Delphinus delphis*	LHM	2868.0	Yes	Yes			
	Turtles	*Caretta caretta*	GNS	89.0	Yes	Yes			
			LLD	475.0	Yes	Yes			
		Chelonia mydas	GNS	89.0	Yes	Yes			
		Dermochelys coriacea	LLD	475.0	Yes	Yes			
Baltic Sea	Fish	*Acipenser oxyrinchus*	GNS	2461.6	Yes	No			Fail
	Mammals	*Phocoena phocoena*	GNS	2410.6	Yes	No			Fail
			GTR	383.2	Yes	Yes			
Barents Sea			GNS	193.5	Yes	Yes			
Bay of Biscay and the Iberian Coast	Fish	*Gymnura altavela*	OTB	2177.2	Yes	Yes			
	Mammals	*Delphinus delphis*	FPO	145.2	Yes	Yes			
			GNS	3384.1	Yes	Yes			
			GTR	1963.9	Yes	No		Fail	
			LLS	447.2	Yes	Yes			
			OTB	2177.2	Yes	Yes			
			OTM	40.3	Yes	No		Fail	

			PS	1117.1	Yes	Yes			
			PTB	1074.4	Yes	No		Fail	
		Phocoena phocoena	GNS	3384.1	Yes	Yes			
			GTR	1963.9	Yes	No		Fail	
			OTB	2177.2	Yes	Yes			
			PTM	1040.5	Yes	No		Fail	
	Seabirds	*Puffinus mauretanicus*	GNS	3186.1	Yes	Yes			
			GTR	1888.9	Yes	No		Fail	
			LLS	487.2	Yes	No			Fail
			OTB	2177.2	Yes	Yes			
	Turtles	*Caretta caretta*	GNS	3078.1	Yes	Yes			
			LLD	130.8	Yes	Yes			
		Dermochelys coriacea	LLD	130.8	Yes	Yes			
Black Sea	Fish	*Acipenser stellatus*	OTM	160.0	Yes	Yes			
	Fish	*Acipenser stellatus*	TBB	107.0	Yes	Yes			
	Fish	*Huso huso*	OTM	160.0	Yes	Yes			
	Mammals	*Phocoena phocoena*	GNS	124.0	Yes	Yes			

Celtic Seas	Fish	*Dipturus intermedius*	GNS	1479.3	Yes	Yes			
			GTR	365.9	Yes	No			Fail
			OTB	4504.8	Yes	No		Fail	Fail
			OTT	1329.2	Yes	No		Fail	
		Squatina squatina	GNS	1479.3	Yes	Yes			
			GTR	365.9	Yes	Yes			
	Mammals	*Delphinus delphis*	GNS	1264.3	Yes	No			Fail
			GTR	350.9	Yes	Yes			
			OTB	4041.8	Yes	No		Fail	Fail
			OTT	1249.2	Yes	No		Fail	
			PS	70.0	Yes	No		Fail	
			PTM	355.0	Yes	No		Fail	
		Phocoena phocoena	GNS	1264.3	Yes	No			Fail
			GTR	350.9	Yes	Yes			
			OTB	4041.8	Yes	No		Fail	
			OTT	1249.2	Yes	No		Fail	
Greater North Sea	Fish	*Dipturus intermedius*	OTB	5291.0	Yes	No		Fail	Fail
			OTT	1640.9	Yes	No		Fail	
			PTB	703.8	Yes	Yes			

			SSC	235.4	Yes	Yes			
	Mammals	*Delphinus delphis*	GNS	5929.6	Yes	No		Fail	Fail
			GTR	638.2	Yes	No		Fail	Fail
			OTB	4701.4	Yes	No		Fail	Fail
			PS	82.9	Yes	Yes			
		Phocoena phocoena	GNS	5929.6	Yes	No		Fail	Fail
			GTR	638.2	Yes	No		Fail	
			OTB	4701.4	Yes	No		Fail	
			SDN	136.3	Yes	Yes			
Icelandic Waters	Mammals	*Phocoena phocoena*	GNS	1045.0	Yes	No		Fail	
Ionian Sea and the Central Mediterranean Sea	Fish	*Acipenser naccarii*	OTB	417.0	Yes	No		Fail	
		Gymnura altavela	GTR	879.0	Yes	No		Fail	
			LLS	295.0	Yes	Yes			
			OTB	417.0	Yes	No		Fail	
		Leucoraja melitensis	OTB	417.0	Yes	No		Fail	Fail
		Squatina aculeata	GTR	879.0	Yes	No		Fail	
	Turtles	*Caretta caretta*	GTR	879.0	Yes	No		Fail	

Norwegian Sea	Mammals	*Phocoena phocoena*	GNS	10117.6	Yes	Yes			
Oceanic Northeast Atlantic	Turtles	*Caretta caretta*	LLD	45.0	Yes	Yes			
		Dermochelys coriacea	LLD	45.0	Yes	No			Fail
Western Mediterranean Sea	Fish	*Gymnura altavela*	GTR	377.0	Yes	No		Fail	
			OTB	5598.7	Yes	Yes			
	Turtles	*Caretta caretta*	LLD	2268.0	Yes	No		Fail	Fail
			OTB	5598.7	Yes	Yes			
			OTT	542.8	Yes	Yes			
		Dermochelys coriacea	LLD	2268.0	Yes	No		Fail	

6.4 Conclusion

In several areas and métiers, threatened and endangered species are observed as bycatch, but the monitoring protocols focus on a different taxa. As a result, WGBYC treats these observations as sporadic/ad hoc, and the data is not included in the assessments. This underscores the need for clearer specifications on how the monitored effort can be used in assessments. A question for the database subgroup would be how to better define and categorize the incoming data to ensure its appropriate use. Data submitter should be consulted where possible for clarification on the appropriate use of such data.

Based on the suggestions from ICES WKPETSAMP3, several species/ecoregion/métier combinations lack sufficient monitoring, when monitoring coverage and bycatch probability are considered. However, improving monitoring to estimate bycatch is not only about increasing coverage; it also requires strategically targeting efforts based on bycatch probability. For some species, it's essential to consider fishing characteristics like different métiers or fishing areas. When bycatch probability is low, stratifying monitoring by métier proves to be more effective.

There are several EU priority species/ecoregion/metier combinations that failed to achieve a total bycatch estimate due to fishing effort data availability, while only a small number of combinations failed to due to factors influencing the BPUE. Therefore, WGBYC can conclude that improved reporting of fishing effort would increase the proportion of species/ecoregion/metier combinations that achieve a total bycatch estimate.

Reference list

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Section 7 (ToR G) contents

7 ToR G: Continue, in cooperation with the ICES Data Centre to develop, improve, populate, and maintain the WGBYC and RDBES databases on ETP species bycatch monitoring and fishing effort in ICES and Mediterranean waters through formal data calls (Intersessional).

7.1 Introduction

European Council Regulation 812/2004 was officially repealed on the 13th of August 2019. Many of the monitoring and mitigation requirements of Regulation 812/2004 were transposed into Regulation (EU) 2019/1241 (hereafter termed the Technical Measures Regulation / TMR) which came into force on 20 June 2019.

The repeal of Regulation 812/2004 was expected for some years by WGBYC and so, since 2017, the group had been preparing for transitioning away from using Member States' annual Regulation 812/2004 reports as the main source of bycatch data as these would no longer be available after the repeal of Regulation 812/2004. The first step in this transition was the development and issuing of an informal ICES/WGBYC data call in 2017 to obtain data on fishing effort, monitoring effort and bycatch records from EU and other ICES Member States. These data were held in a standalone WGBYC database. Formal ICES/WGBYC data calls have been issued on an annual basis since 2018.

A subgroup within WGBYC, the Database Subgroup (DbSg), was established in 2016 to develop the first data call and maintains an active role in WGBYCs activities related to data acquisition, preparation and quality checks. The DbSg is comprised of several long-term members of WGBYC and has significant support from staff at the ICES secretariat and ICES data centre. Much of the DbSg's work is carried out intersessionally, to prepare and where necessary modify the annual data call. The group also meets prior to the WGBYC meeting each year to review and check the national annual data submissions to ensure that the working group have a clean dataset to work with during the meeting.

This section provides a summary of the 2024 data call and describes some minor changes that were made to the data format since the 2021 data call.

A summary of the issues found in the submitted data is also provided. Many of these were identified and corrected prior to the WGBYC 2024 meeting. Other minor issues were identified and resolved during the meeting, while others could not be addressed during the meeting but were recorded and will be addressed before the next WGBYC data call is issued in spring 2025.

7.2 ICES WGBYC data call

On 16 June 2024 ICES issued an official data call[1] for the seventh time in support of the work of WGBYC.

The data call aimed to obtain data describing total fishing effort, monitoring/sampling effort, and protected species bycatch records for marine mammals, seabirds, turtles, and fish species of relevance to bycatch advice.

The data obtained through the annual data calls support ICES annual advice on the impact of bycatch on a range of protected or sensitive marine species/taxa, to answer a standing request from the European Commission for advice on the impacts of fisheries on the marine environment.

Data were formally requested from 17 of the 20 ICES member countries (all except The Russian Federation, USA and Canada). In addition, six EU Mediterranean non-ICES countries were included in the call (Croatia, Cyprus, Greece, Italy, Malta, and Slovenia) and two EU Black Sea non-ICES countries (Bulgaria and Romania). Two countries, France and Spain, have fisheries operating in ICES and GFCM (Mediterranean and Black Seas) areas and data were provided by each country for both regions.

Most of the contacted countries submitted data (23 of 25 countries; Romania and Malta did not submit any data). The consistency of the data provided by different countries continues to improve, possibly reflecting better instructions within the data call text, and a growing familiarity of data submitters with the required format. However, some countries only provided partial data related to specific gear types as part of their submission. In most cases, the accuracy of self-reported records cannot be independently verified and so these are generally considered by WGBYC to be of lower value for inclusion in detailed assessments, but they may flag the occurrence of bycatch in gears/fisheries that are not monitored by more reliable methods.

WGBYC reiterates that to facilitate efficient data submission, processing and analysis, it is recommended that each nation strictly adheres to the specified data call format and nominates a single organization to coordinate and provide data in future ICES WGBYC data calls. The data submission template includes fixed/mandatory vocabularies for several data fields, which facilitates efficient data collation across countries but can give rise to submission challenges, particularly for nations and individual data submitters that submit data for the first time, and for which tailored vocabularies may be needed. For a summary of data submissions by country from the 2024 data call see Table 7.1.

Table 7.1 Summary of the data submissions

Country	Number of fishing effort entries	Fishing effort days at sea	Number of monitoring effort entries	Monitoring effort days at sea	Number bycatch events reported (not individuals)
BE	321	12406	45	238	153
BG	648	101010	110	391	9
CY	127	102247	79	640	13
DE	1347	36109	104	412	119

[1]ICES (2024). WGBYC Data call 2024: Bycatch of protected species for ICES advisory work. Data Calls. Report. https://doi.org/10.17895/ices.pub.26124430

Country	Number of fishing effort entries	Fishing effort days at sea	Number of monitoring effort entries	Monitoring effort days at sea	Number bycatch events reported (not individuals)
DK	2726	70984	196	937	208
EE	231	59296	233	58865	28
ES	4840	665120	433	2410	572
FI	602	63274	744	63765	59
FR	6740	393576	820	1668	106
GB	7975	285125	231	1160	773
GR	142	1282393	280	1423	324
HR	57	268898	173	6574	20
IE	1605	44695	70	648	172
IS	322	1535494	79	573	132
IT	3986	1013394	453	2124	169
LT	152	6474	161	6179	19
LV	461	12218	58	482	13
NL	866	36583	83	330	66
NO	293	71429	76	1656	169
PL	1060	55574	75	399	24
PT	689	199394	107	271	29
PT	316	40145	87	733	158
SE	1886	45905	267	574	206
SI	184	5265	16	25	

7.3 Minor changes to the 2023 data call

The format of the data call has not changed. However, there were some minor updates to the quality control (QC) process. For instance, a new QC check was added to ensure that each record in the event log is properly linked (i.e. for every bycatch event there is a correspondent monitoring event, and for each monitoring event there is a corresponding fishing effort event.

7.4 Data issues found and addressed

As is customary since the data call began, the first step in data quality control is a data submission screening program that rigorously examines the data prior to submission.

In addition to the format and vocabulary assessments, a total of 31 other quality control checks are then carried out when it has been confirmed that the data conforms to the specified format. The list of the quality checks can be found here: http://datsu.ices.dk/web/rptChk.aspx?Dataset=128

If the data successfully clear the screening process without any errors, the submitter can upload the file to the database.

After the data call submission deadline (19 August 2024) further checks on the submitted data were then carried out by members of the DbSg in a series of meetings and through individual review of each country's data. This second stage of quality checks is undertaken through data mining by experts who have worked extensively with fishing effort, monitoring effort, and bycatch data, and were instrumental in the development of the data call. This exercise also highlighted a number of possible issues in the submitted data which were, where possible, corrected before WGBYC meet. These issues are listed in Table 7.2 below.

Note: it is not possible for WGBYC to identify data entries that are incorrect but plausible.

Table 7.2 Data issues discovered during data checks by the DbSg.

Issue	Correction	Comment
In several countries the reported number of fishing trips is similar to the reported number of days at sea. DaysAtSeaF == TripsF, even for larger vessel sizes (18-24m and 24-40m).	The countries were contacted to confirm the data in the submission is correct.	The experts reported that for some of the larger vessels trip length could be longer than one day. However, countries contacted confirmed that the submitted data was correct.
Information on VesselsF (Total number of vessels operating at Metier Level 5) is not provided.	The countries were contacted to confirm the data in the submission is correct.	This was detected when the DbSg ran quality checks. VesselsF is not a mandatory field.
Some of the monitoring effort is submitted under “OTH” MonitoringMethod.	No correction	The group asked for a clarification. For some countries it was clarified that these entries corresponded to self-sampling by some of the fishers.
No data reported for small vessels (lengths below 12m)	No correction	Countries were queried about the lack of small fleet.
Missing metier level 6	No correction	The field is not mandatory
Some metiers have higher monitoring effort days than fishing effort days reported	No correction	WGBYC considers this to be because there are more than one monitoring method for the same metier. This can be highlighted as a warning in the quality check process.
Vessel length unknown	No correction	Some countries clarified that they lacked this information.
Only bycatch of birds and mammals provided even though sampling method targets all taxa	No correction	

Fishing effort reported for FAO Major Fishing Area 48	Area corrected	
In some instances, the number of Days at Sea observed is lower than the number of trips observed.	No correction	Sometimes a fisher may visit the fyke/gillnet multiple times per day, especially when the catches are good. And therefore, trips per day may be higher than 1.
In some instances, the number of Days at Sea is lower than the number of fishing trips.	No correction	Sometimes a fisher may visit the fyke/gillnet multiple times per day, especially when the catches are good. And therefore, trips per day may be higher than 1.
One country reported significantly more effort in days at sea compared to previous years, which was discovered during WGBYC.	For that country the data from 2022 was used instead of 2023	Next year, we will implement a comparison of the variance in DaysAtSea and DaysAtSeaObs between years to identify anomalies in the newly submitted data when compared to previous years.

7.5 Species reported that were not included in the reference lists of species of bycatch relevance as specified in the data call.

ICES has compiled ecoregion lists of species to be reported in the data call as indicated in the Roadmap for ICES bycatch advice[2] . In 2023 and 2024 ICES also included within the data call a further list of high priority species from the EU Action Plan (Annex 1 WGBYC_2024_Data-Call_Species_per_Ecoregion): Protecting and restoring marine ecosystems for sustainable and resilient fisheries. These reference lists of species provide a minimum guide for data submitters, but some countries have also reported species that were not included these lists.

For completeness, species reported but which are not included in the reference lists annexed to the data call are shown in Table 7.3.

Table 7.3 Species for which bycatch incidents were reported but that were not specifically requested under the ICES-WGBYC 2024 data call

Ecoregion	Species	Class Name (Super class)	Vernacular	Total Individuals
Adriatic Sea	*Gulosus aristotelis*	Aves (Reptilia)		2
Aegean-Levantine Sea	*Gulosus aristotelis*	Aves (Reptilia)		1
Bay of Biscay and the Iberian Coast	*Gulosus aristotelis*	Aves (Reptilia)		4
Celtic Seas	*Gulosus aristotelis*	Aves (Reptilia)		1
Greater North Sea	*Gulosus aristotelis*	Aves (Reptilia)		8
Aegean-Levantine Sea	*Puffinus yelkouan*	Aves (Reptilia)	Mediterranean shearwater	1
Western Mediterranean Sea	*Puffinus yelkouan*	Aves (Reptilia)	Mediterranean shearwater	9

[2] ICES. 2024. ICES Roadmap for Bycatch on Endangered, Threatened, and Protected (ETP) Species. ICES Convention, policies, and strategy. 48 pp. https://doi.org/10.17895/ices.pub.26003467; see annex 1-3

Ecoregion	Species	Class Name (Super class)	Vernacular	Total Individuals
Aegean-Levantine Sea	*Aetomylaeus bovinus*	Elasmobranchii		7
Ionian Sea and the Central Mediterranean Sea	*Aetomylaeus bovinus*	Elasmobranchii		4
Western Mediterranean Sea	*Aetomylaeus bovinus*	Elasmobranchii		7
Bay of Biscay and the Iberian Coast	*Alopias superciliosus*	Elasmobranchii	bigeye thresher	20
Bay of Biscay and the Iberian Coast	*Alopias vulpinus*	Elasmobranchii	common thresher	1
Icelandic Waters	*Apristurus aphyodes*	Elasmobranchii	white ghost catshark	46
Ionian Sea and the Central Mediterranean Sea	*Bathyraja brachyurops*	Elasmobranchii	blonde ray	2
Western Mediterranean Sea	*Bathyraja brachyurops*	Elasmobranchii	blonde ray	5
Celtic Seas	*Centroscymnus coelolepis*	Elasmobranchii	Portuguese dogfish	1
Greenland Sea	*Centroscymnus coelolepis*	Elasmobranchii	Portuguese dogfish	6
Celtic Seas	*Centroselachus crepidater*	Elasmobranchii	longnose velvet dogfish	1
Icelandic Waters	*Centroselachus crepidater*	Elasmobranchii	longnose velvet dogfish	282
Aegean-Levantine Sea	*Galeorhinus galeus*	Elasmobranchii	sweet william	2
Ionian Sea and the Central Mediterranean Sea	*Heptranchias perlo*	Elasmobranchii	sharpnose sevengill shark	4
Azores	*Isurus oxyrinchus*	Elasmobranchii	Atlantic mako shark	23
Bay of Biscay and the Iberian Coast	*Isurus oxyrinchus*	Elasmobranchii	Atlantic mako shark	13
Celtic Seas	*Isurus oxyrinchus*	Elasmobranchii	Atlantic mako shark	3
Ionian Sea and the Central Mediterranean Sea	*Isurus oxyrinchus*	Elasmobranchii	Atlantic mako shark	33
Oceanic Northeast Atlantic	*Isurus oxyrinchus*	Elasmobranchii	Atlantic mako shark	2
Western Mediterranean Sea	*Isurus oxyrinchus*	Elasmobranchii	Atlantic mako shark	1
Celtic Seas	*Lamna nasus*	Elasmobranchii	(common) Atlantic mackerel sha	4

Ecoregion	Species	Class Name (Super class)	Vernacular	Total Individuals
Greater North Sea	*Lamna nasus*	Elasmobranchii	(common) Atlantic mackerel sha	1
Adriatic Sea	*Mustelus mustelus*	Elasmobranchii	smooth hound	375
Aegean-Levantine Sea	*Mustelus mustelus*	Elasmobranchii	smooth hound	80
Ionian Sea and the Central Mediterranean Sea	*Mustelus mustelus*	Elasmobranchii	smooth hound	98
Adriatic Sea	*Mustelus punctulatus*	Elasmobranchii	blackspotted smoothhound	7
Aegean-Levantine Sea	*Mustelus punctulatus*	Elasmobranchii	blackspotted smoothhound	7
Ionian Sea and the Central Mediterranean Sea	*Mustelus punctulatus*	Elasmobranchii	blackspotted smoothhound	1
Celtic Seas	*Prionace glauca*	Elasmobranchii		6
Western Mediterranean Sea	*Prionace glauca*	Elasmobranchii		1
Adriatic Sea	*Pteroplatytrygon violacea*	Elasmobranchii	pelagic stingray	8
Bay of Biscay and the Iberian Coast	*Pteroplatytrygon violacea*	Elasmobranchii	pelagic stingray	1
Western Mediterranean Sea	*Pteroplatytrygon violacea*	Elasmobranchii	pelagic stingray	23
Aegean-Levantine Sea	*Raja asterias*	Elasmobranchii	Mediterranean starry ray	41
Ionian Sea and the Central Mediterranean Sea	*Raja asterias*	Elasmobranchii	Mediterranean starry ray	216
Ionian Sea and the Central Mediterranean Sea	*Raja montagui*	Elasmobranchii	homelyn ray	1
Ionian Sea and the Central Mediterranean Sea	*Raja polystigma*	Elasmobranchii	speckled ray	2
Western Mediterranean Sea	*Raja polystigma*	Elasmobranchii	speckled ray	89
Aegean-Levantine Sea	*Raja radula*	Elasmobranchii	rough ray	478
Ionian Sea and the Central Mediterranean Sea	*Raja radula*	Elasmobranchii	rough ray	11
Adriatic Sea	*Squalus acanthias*	Elasmobranchii	picky dog	94
Aegean-Levantine Sea	*Squalus acanthias*	Elasmobranchii	picky dog	64
Celtic Seas	*Squalus acanthias*	Elasmobranchii	picky dog	42
Ionian Sea and the Central Mediterranean Sea	*Squalus acanthias*	Elasmobranchii	picky dog	12

Ecoregion	Species	Class Name (Super class)	Vernacular	Total Individuals
Western Mediterranean Sea	*Squalus acanthias*	Elasmobranchii	picky dog	4
Baltic Sea	*Lutra lutra*	Mammalia	Eurasian otter	3
Azores	*Alepisaurus ferox*	Teleostei (Actinopteri)	lancetfish	2
Bay of Biscay and the Iberian Coast	*Alepisaurus ferox*	Teleostei (Actinopteri)	lancetfish	9
Azores	*Lepidocybium flavobrunneum*	Teleostei (Actinopteri)	escolar	1
Bay of Biscay and the Iberian Coast	*Lepidocybium flavobrunneum*	Teleostei (Actinopteri)	escolar	7
Azores	*Thunnus obesus*	Teleostei (Actinopteri)	bigeye tuna	2
Bay of Biscay and the Iberian Coast	*Thunnus thynnus*	Teleostei (Actinopteri)	Atlantic bluefin tuna	6

Species that are in the list, but not for that specific Eco-region:

Ecoregion	Species	Class name	Super-Class	Vernacular	AphiaID	TotalIndividuals
Azores	*Dipturus intermedius*	Elasmobranchii	NULL	NULL	711846	22
Barents Sea	*Cyclopterus lumpus*	Teleostei	Actinopteri	henfish	127214	34
Bay of Biscay and the Iberian Coast	*Dipturus batis*	Elasmobranchii	NULL	common skate	105869	1
Bay of Biscay and the Iberian Coast	*Sphyrna zygaena*	Elasmobranchii	NULL	hammerhead	105819	2
Celtic Seas	*Dipturus batis*	Elasmobranchii	NULL	common skate	105869	3910
Celtic Seas	*Galeus melastomus*	Elasmobranchii	NULL	black-mouthed dogfish	105812	24
Celtic Seas	*Isurus paucus*	Elasmobranchii	NULL	longfin mako	105840	18
Celtic Seas	*Leucoraja circularis*	Elasmobranchii	NULL	sandy ray	105873	1
Celtic Seas	*Leucoraja fullonica*	Elasmobranchii	NULL	shagreen ray	105874	179
Celtic Seas	*Leucoraja naevus*	Elasmobranchii	NULL	cuckoo ray	105876	486.15

Ecoregion	Species	Class name	Super-Class	Vernacular	AphiaID	TotalIndividuals
Celtic Seas	*Raja clavata*	Elasmobranchii	NULL	roker	105883	197
Celtic Seas	*Raja microocellata*	Elasmobranchii	NULL	painted ray	105885	73
Celtic Seas	*Raja undulata*	Elasmobranchii	NULL	undulate ray	105891	1
Celtic Seas	*Scyliorhinus stellaris*	Elasmobranchii	NULL	greater spotted dogfish	105815	98
Celtic Seas	*Torpedo torpedo*	Elasmobranchii	NULL	NULL	271691	3
Celtic Seas	*Lycodes esmarkii*	Teleostei	Actinopteri	Esmark's eelpout	127103	17
Celtic Seas	*Sebastes norvegicus*	Teleostei	Actinopteri	golden redfish	151324	1
Faroes	*Sebastes norvegicus*	Teleostei	Actinopteri	golden redfish	151324	97
Greater North Sea	*Amblyraja radiata*	Elasmobranchii	NULL	starry ray	105865	2840
Greater North Sea	*Dipturus batis*	Elasmobranchii	NULL	common skate	105869	1
Greater North Sea	*Leucoraja naevus*	Elasmobranchii	NULL	cuckoo ray	105876	574
Greater North Sea	*Raja clavata*	Elasmobranchii	NULL	roker	105883	2300
Greater North Sea	*Scyliorhinus canicula*	Elasmobranchii	NULL	dogfish	105814	181
Greater North Sea	*Merlangius merlangus*	Teleostei	Actinopteri	NULL	126438	10
Greater North Sea	*Scophthalmus maximus*	Teleostei	Actinopteri	NULL	127149	379
Greater North Sea	*Scophthalmus rhombus*	Teleostei	Actinopteri	brill	127150	771.5
Greenland Sea	*Etmopterus spinax*	Elasmobranchii	NULL	velvet-belly	105913	22
Greenland Sea	*Helicolenus dactylopterus*	Teleostei	Actinopteri	blackbelly rosefish	127251	1
Norwegian Sea	*Dipturus batis*	Elasmobranchii	NULL	common skate	105869	9

Note: In the WORMS species list, the species Phalacrocorax aristotelis was updated to the species Gulosus aristotelis like described here: https://www.marinespecies.org/aphia.php?p=taxdetails&id=137178, but in the data call the species in the list was Phalacrocorax aristotelis, ICES should update the list for next year data call.

7.6 Quality checks

To understand the variability of the data provided in 2024, a set of exploratory analyses was applied to the WGBYC database. The complete analysis was processed following the transparent assessment framework (TAF)principles and is available in the WGBYC GitHub directory (link). Figure 7.1 shows the temporal evolution of the total days at sea reported by ecoregion and gear, illustrating the stability of fishing activities on a large spatial scale across European waters between 2017 and 2023. Figure 7.2 shows the temporal evolution of the bycatch observation effort for the same strata. The at-sea observer monitoring method is the most frequently reported and appears to have remained stable since 2017. It is beyond the scope of this report to discuss in detail the evolution of bycatch observation efforts reported by member states, but the national trends in fishing and observation efforts are available on the WGBYC GitHub directory (link) and can be used to compare fishing effort and bycatch monitoring effort at the national level when needed.

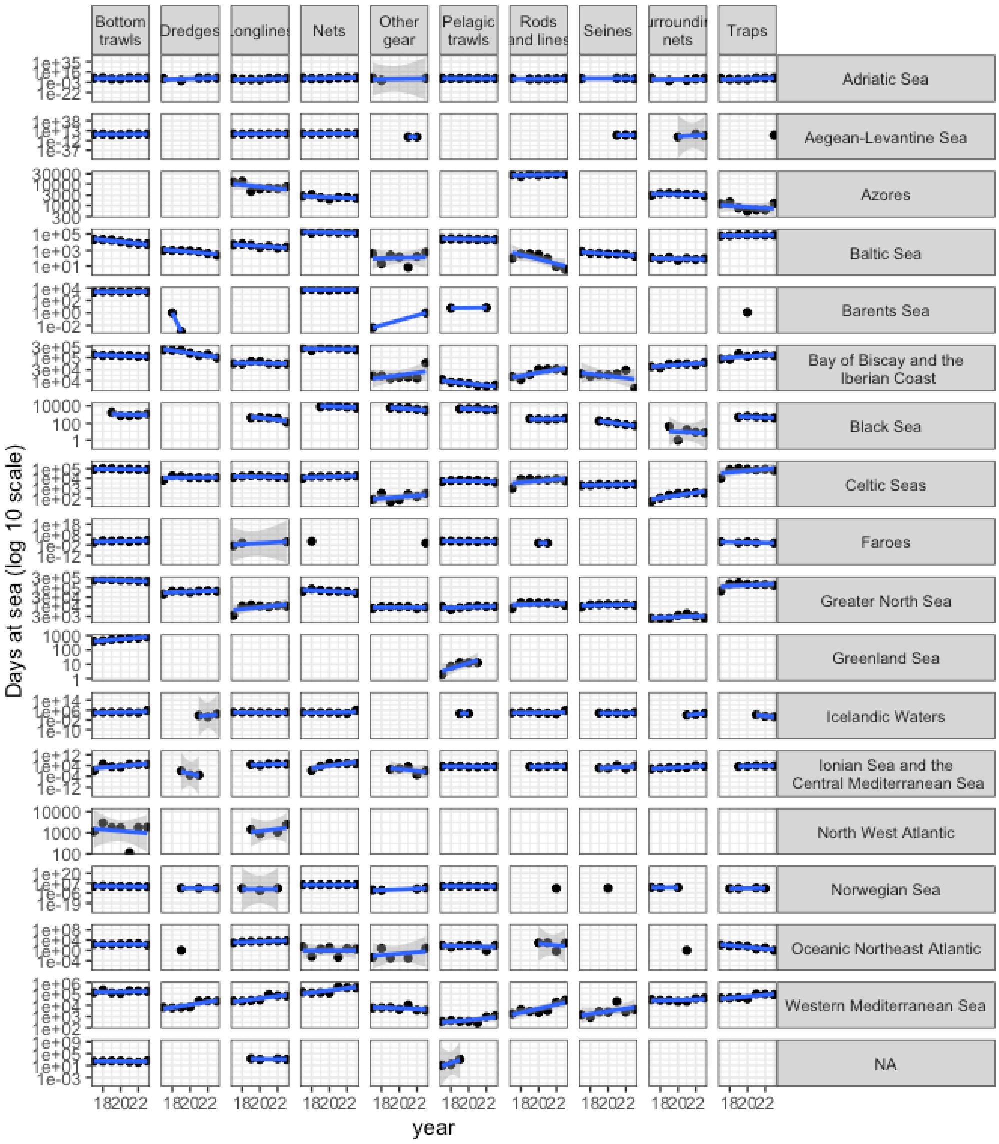

Figure 7.1 Temporal evolution of the fishing effort by ecoregion and metier level 3 from 2017 to 2023. In blue, linear model highlight the temporal trends over the 5 years.

Figure 7.2 Temporal evolution of the fishing effort by ecoregion and metier level 3 from 2017 to 2023 by monitoring program. Coloured lines by monitoring methods highlight the linear temporal trends over the 5 years.

Contents

Annex 1: List of participants

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Annex 2: Terms of reference

WGBYC – Working Group on Bycatch of Protected Species

Only experts appointed by national Delegates or appointed in consultation with the national Delegates of the expert's country can attend this Expert Group.

2024/OT/HAPISG01 The **Working Group on Bycatch of protected species (WGBYC**), chaired by Lotte Kindt-Larsen*, Denmark, Ailbhe Kavanagh*, Ireland, and Guðjón Már Sigurðsson, Iceland, will meet at IFREMER, Bayeux, France, on 16-20 September 2024 to:

a) Review and summarize information submitted through the annual bycatch data call and other means for assessment of endangered, threatened and protected (ETP) species bycatch;

b) Collate and review information from WGFTFB national reports and recent published documents relating to implementation and tests of ETP species bycatch mitigation measures and summarize recent and ongoing bycatch mitigation trials;

c) Consider the quality of data available for use in the estimation of bycatch rates of ETP species through a Bycatch Evaluation and Assessment Matrix, BEAM, to:

    a. underpin assessments on the bycatch range (minimum/maximum) as appropriate,

    b. highlight data deficient situations,

    c. where possible, assess population impacts;

d) Continue to develop and refine the methodology to assess data poor species, for which bycatch rates and associated markers of sustainability are unavailable;

e) Review ongoing monitoring of different taxonomic groups in relation to spatial bycatch risk and fishing effort to inform coordinated sampling plans;

f) For data deficient situations as highlighted in ToR c, propose measures necessary to obtain the required information;

g) Continue, in cooperation with the ICES Data Centre to develop, improve, populate, and maintain the WGBYC and RDBES databases on ETP species bycatch monitoring and fishing effort in ICES and Mediterranean waters through formal data calls (Intersessional).

WGBYC will report by 25 October 2024 for the attention of ACOM.

Supporting information

Priority	The current activities of this Group will lead ICES into issues related to the ecosystem effects of fisheries, especially with regard to the application of the Precautionary Approach. Consequently, these activities are considered to have a very high priority. The activities of the WG are essential to use in answering part of the European Commission annual request for advice on estimates of the annual total numbers of specimens of sensitive species taken as bycatch.

Scientific justification	ToRs a-e) Bycatch monitoring and assessment is fundamental to the work of the expert group and forms the basis to answer the recurrent advice request from the European Commision. Recent changes in legislation have resulted in prioritization of sensitive species and also impacted monitoring programs for ETP species bycath, which both require the regular evaluation of input data and resulting bycath assessments. ToR f) will contribute to practical recommendations on how to improve data collection and data quality. ToR g) Operational databases allow for more efficient response to future advice requests and an audit trail for information used in the Group's reports. By remaining intersessional, it will increase effeciency for WGBYC.
Resource requirements	None beyond usual Secretariat facilities
Participants	25–30
Secretariat facilities	Secretariat support with data call and meeting organization, database maintenance, and final editing of report.
Financial	No financial implications.
Linkages to advisory committees	ACOM
Linkages to other committees or groups	JWGBIRD, WGFTFB, WGMME, WGEF, WGCATCH, WGTIFD, WGSFD, WGRFS, WGJCDP WKSUP, WGRDBESGOV, HAPISG, SCICOM
Linkages to other organizations	NAMMCO, ASCOBANS, ACCOBAMS, GFCM, OSPAR, HELCOM, RCGs, IWC

Annex 3: Reported fishing and monitoring days (ToR A)

Download Excel table from GitHub here: link

Or from the ICES library here: https://doi.org/10.17895/ices.pub.27762723

Table 1 Reported fishing and monitoring days (only for those metiers that reported bycatch) and number of bycaught specimens and incidents in 2023 provided through the ICES WGBYC 2024 data call by ecoregion for all reported species. Note: some metiers have higher reported number of monitoring days than fishing effort days, some electronic monitoring does not have associated DaS, while some ecoregions reported incidents but not number of specimens and vice versa, please see ToR G for further details of data issues identified. Monitoring method: SO = at-sea observers, PO = port observers, EM = electronic monitoring, VO = vessel crew observer, LB = logbooks and OTH = other unspecified method (e.g. interviews with fishers).

Annex 4: Modelling outcome for each combination of Ecoregion, Species and Metier level 4. (ToR C)

Download table in PDF format from the ICES library: https://doi.org/10.17895/ices.pub.27762723

Annex 5: List of ecoregion x species x métier level 4 for which a BPUE estimate can be derived (ToR C)

List of ecoregion x species x métier level 4 for which a BPUE estimate can be derived, or multiple BPUE estimates are needed and those can be estimated, and the resulting total bycatch estimate (TB) for 2023. Total bycatch estimates are provided only when it is possible to derive them. If there is interannual variability in BPUE (interannual is "present") or a constant BPUE is not representative (key variability in BPUE), then the BPUE estimate is not representative of the scenario considered.

Download table in excel format from the ICES library: https://doi.org/10.17895/ices.pub.27762723

Annex 6: Supplementary Table 1 (ToR C)

Download Supplementary Table 1 from the ICES library:

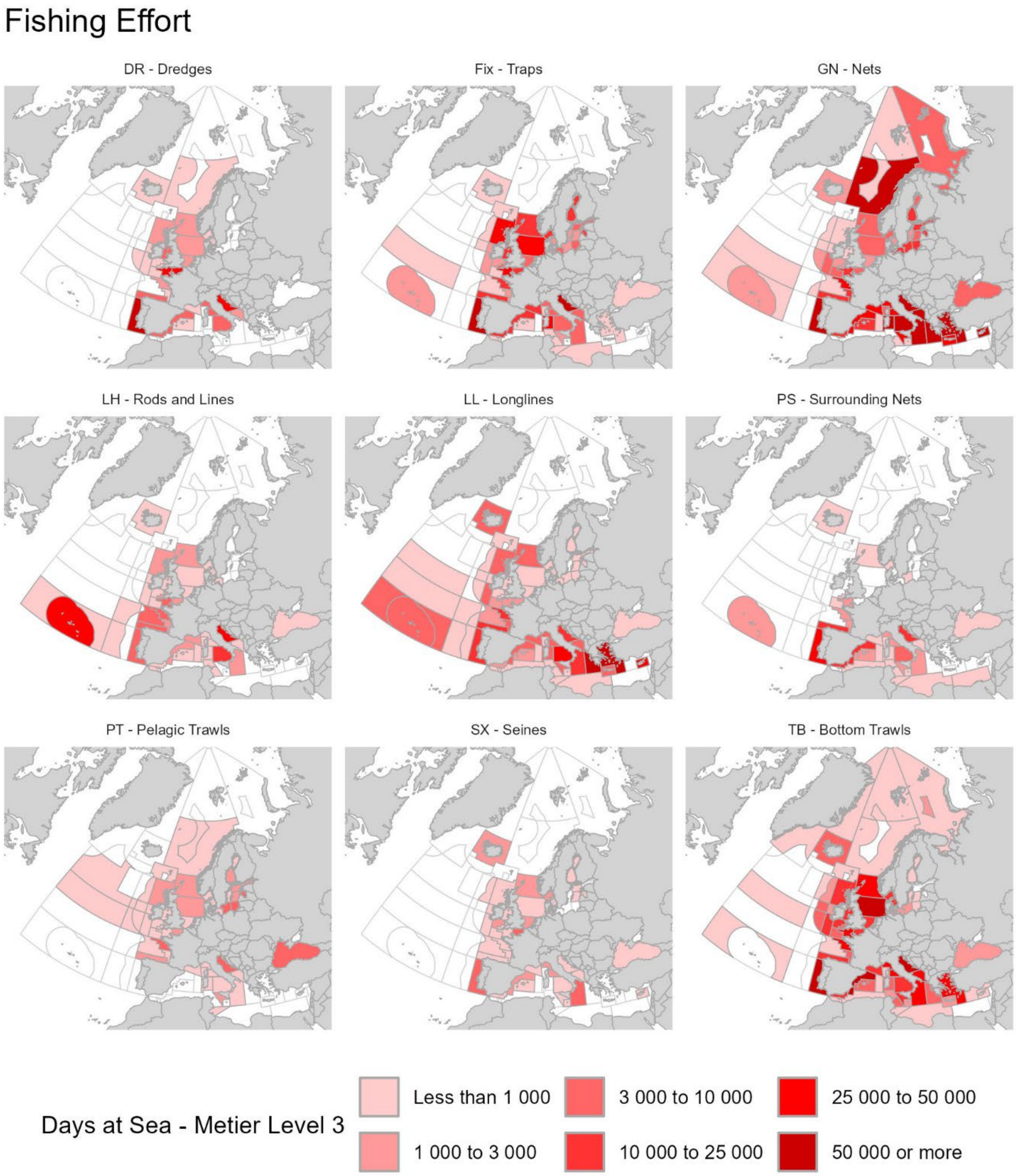
https://doi.org/10.17895/ices.pub.27762723

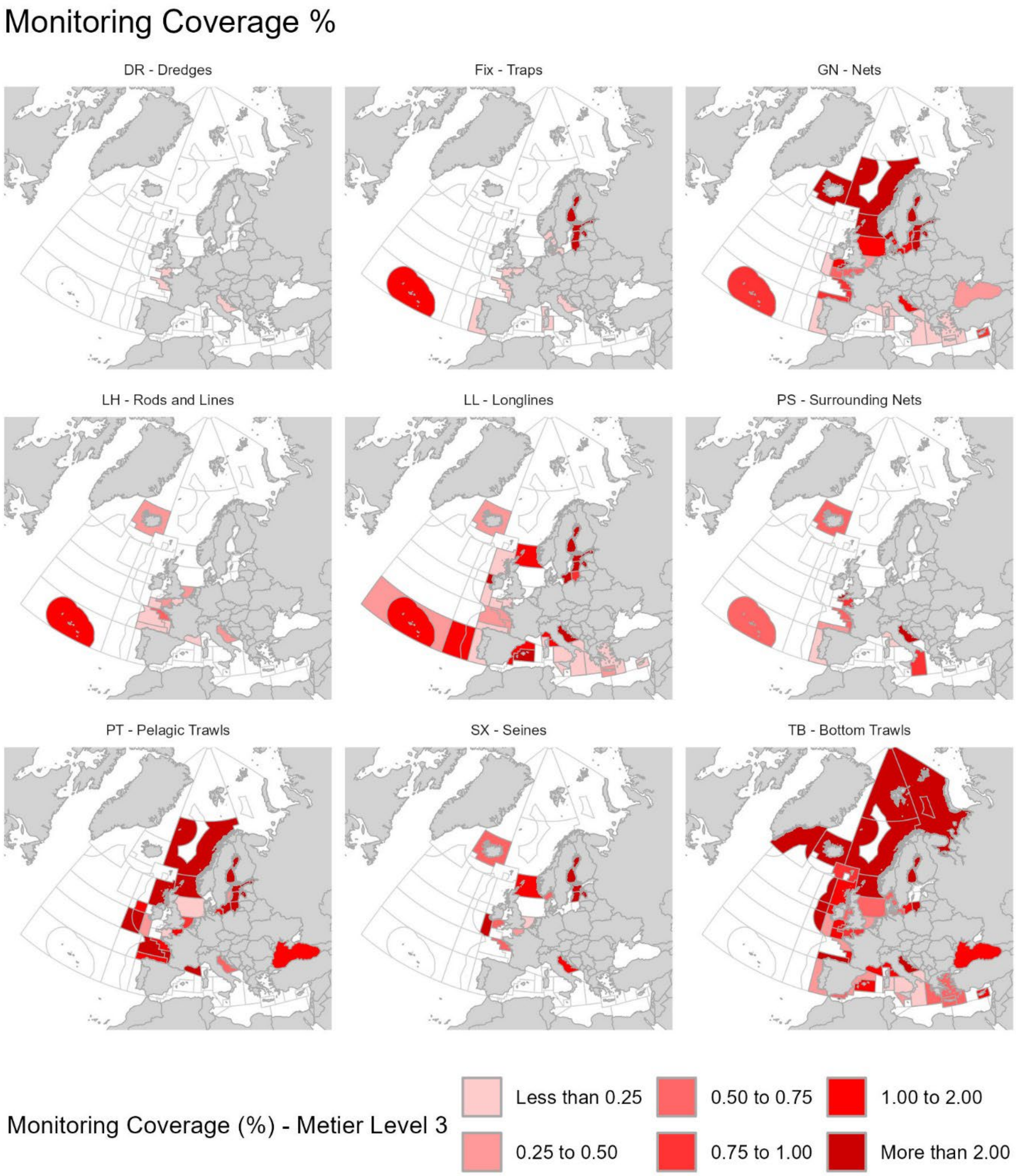
Annex 7: Supplementary Table 2 (ToR C)

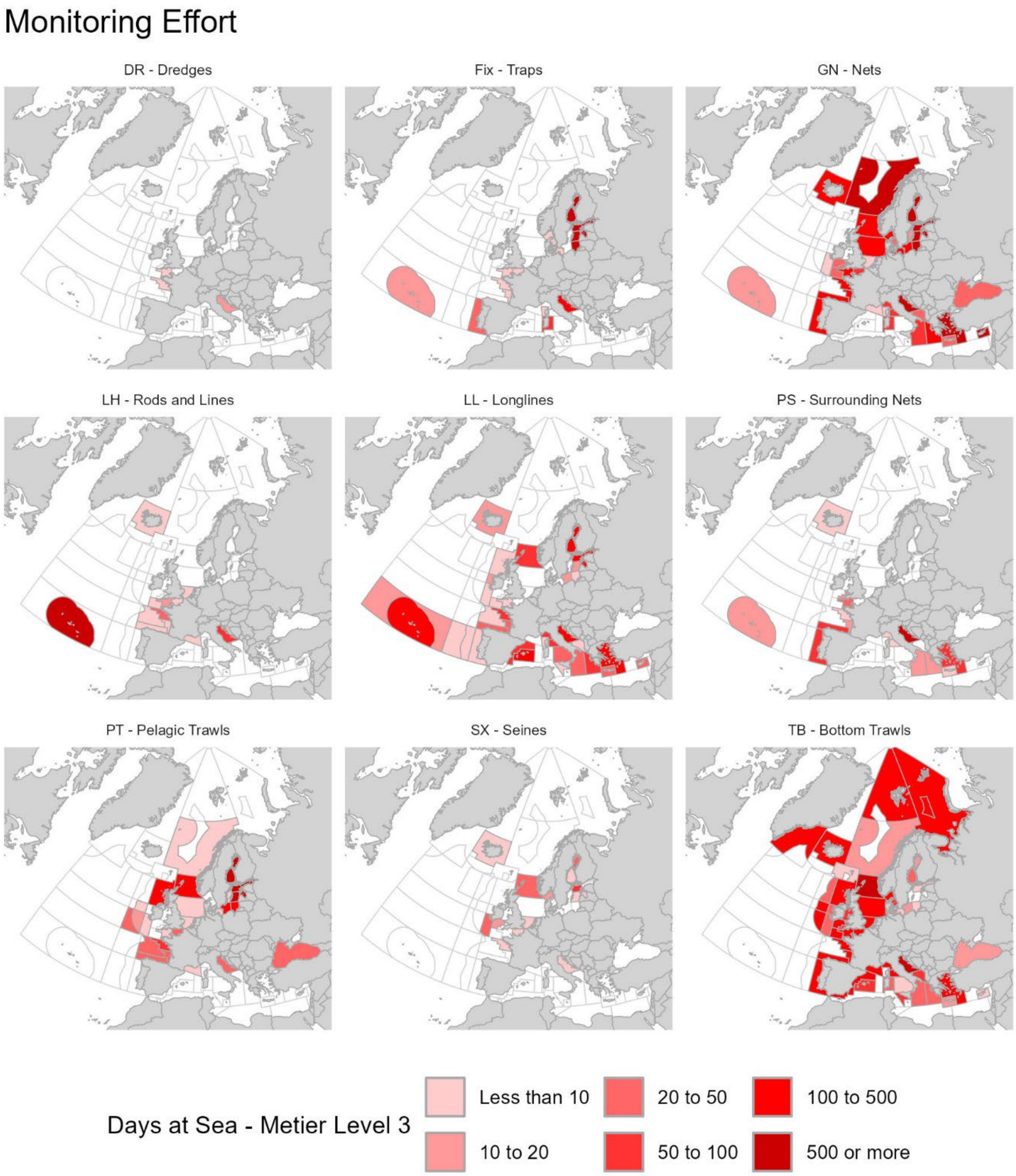
Download Supplementary Table 2 in PDF format from the ICES library:

https://doi.org/10.17895/ices.pub.27762723

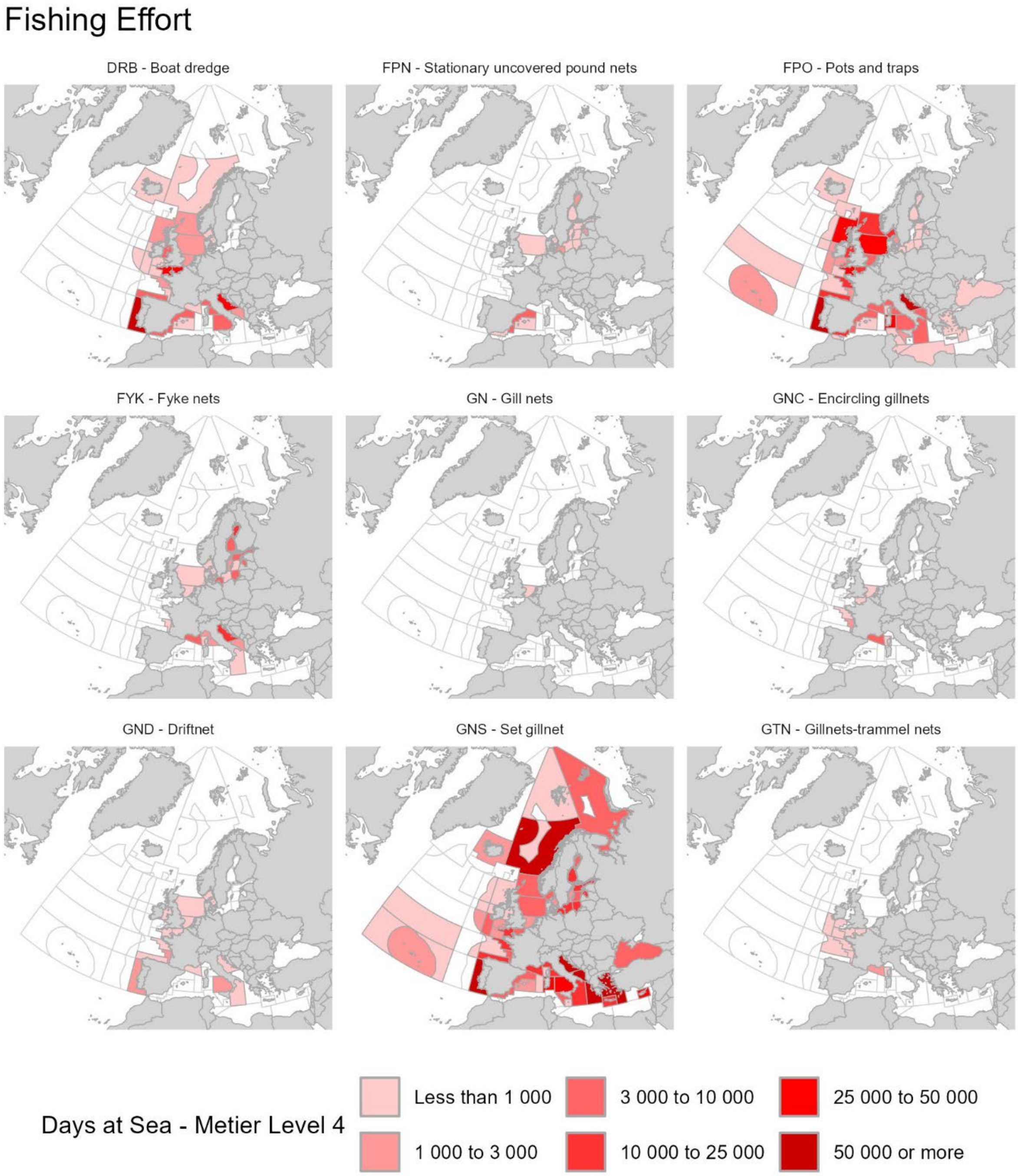
Annex 8: Fishing effort, monitoring effort and monitoring coverage maps, including logbook and port observer data. Metier L3. (ToR E)

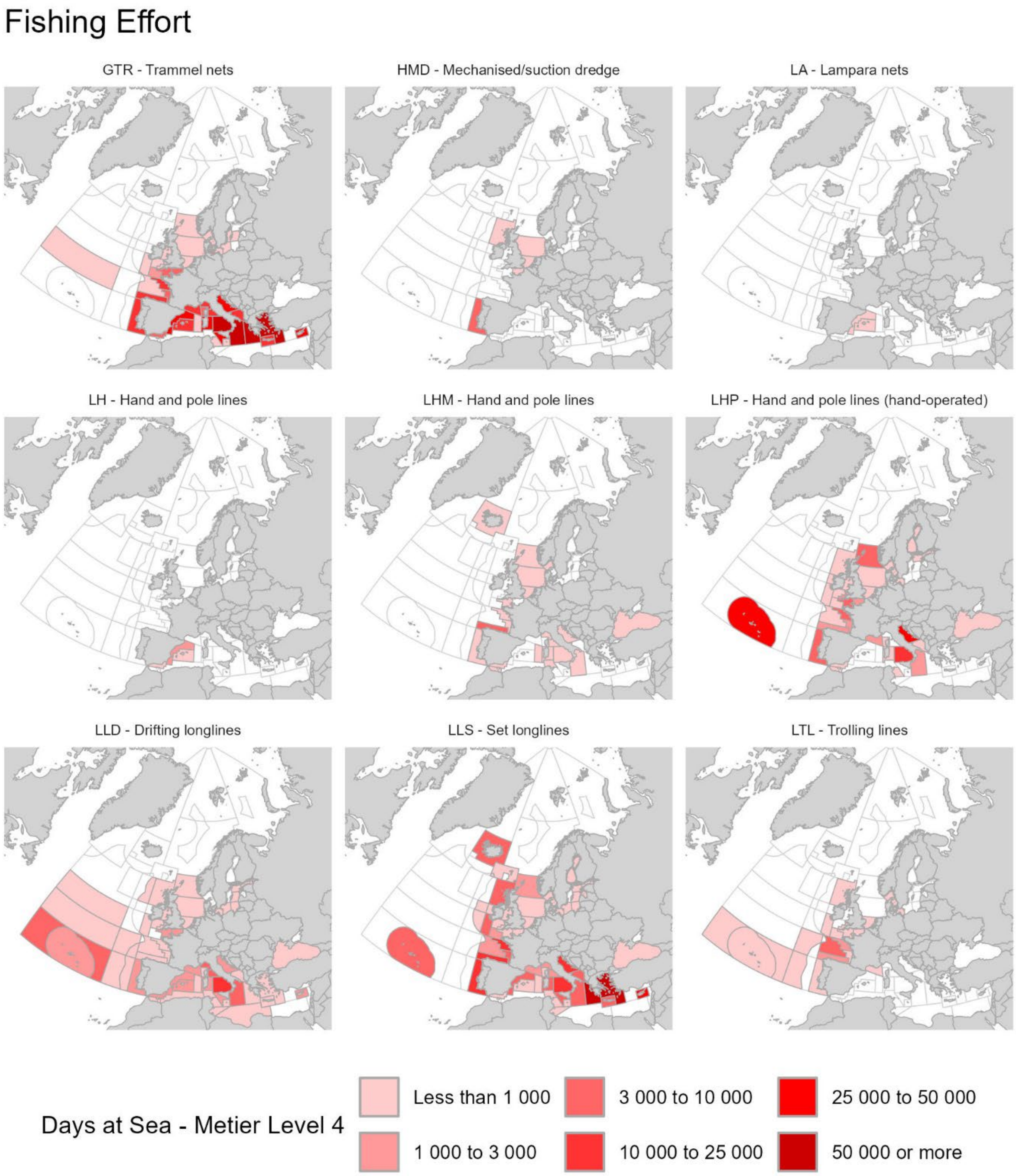


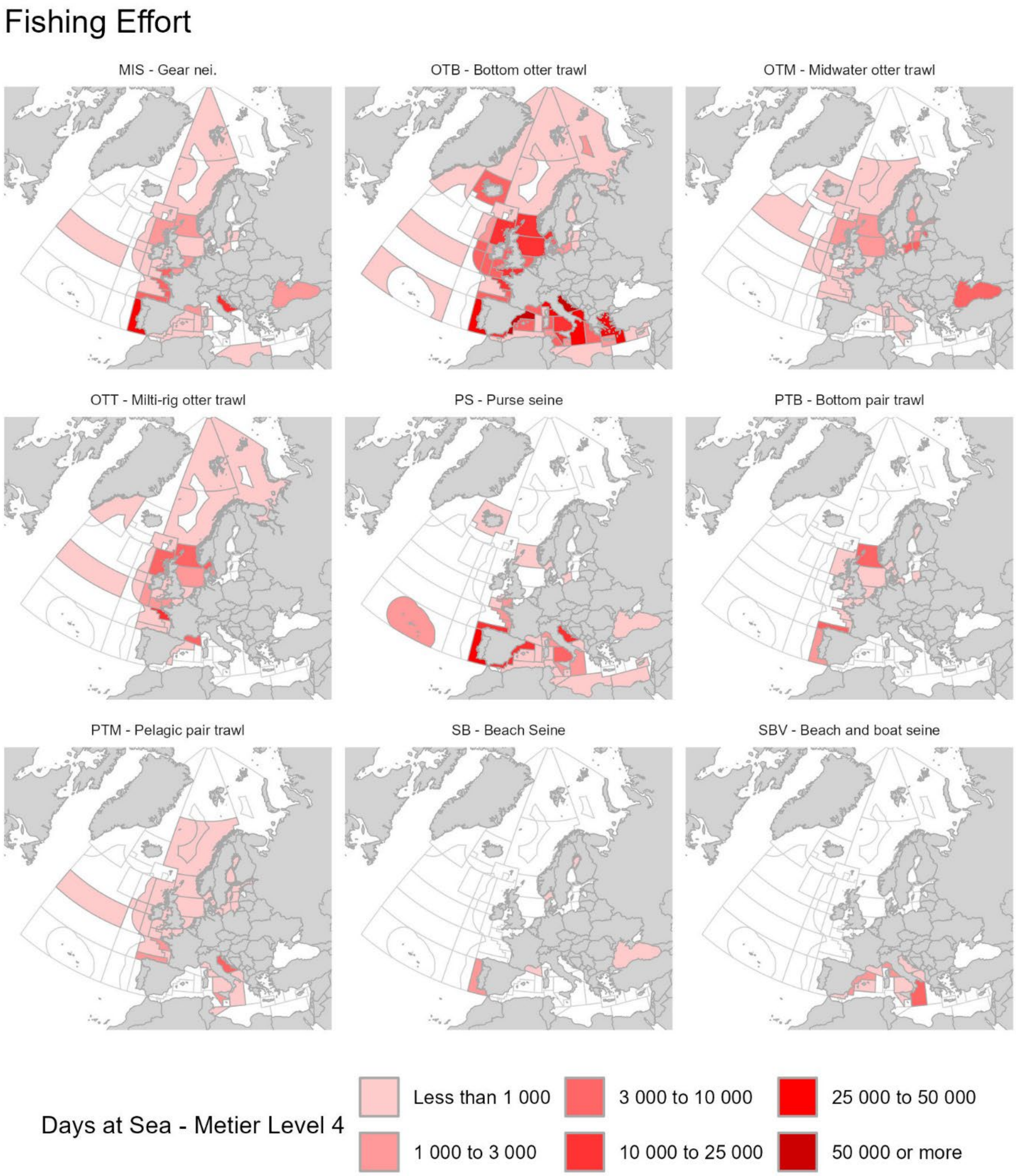

Monitoring Coverage %
DR - Dredges
Fix - Traps
GN - Nets
LH - Rods and Lines
LL - Longlines
PS - Surrounding Nets
PT - Pelagic Trawls
SX - Seines
TB - Bottom Trawls
Monitoring Coverage (%) - Metier Level 3
Less than 0.25
0.25 to 0.50
0.50 to 0.75
0.75 to 1.00
1.00 to 2.00
More than 2.00


Monitoring Effort
DR - Dredges
Fix - Traps
GN - Nets
LH - Rods and Lines
LL - Longlines
PS - Surrounding Nets
PT - Pelagic Trawls
SX - Seines
TB - Bottom Trawls
Days at Sea - Metier Level 3
Less than 10
10 to 20
20 to 50
50 to 100
100 to 500
500 or more

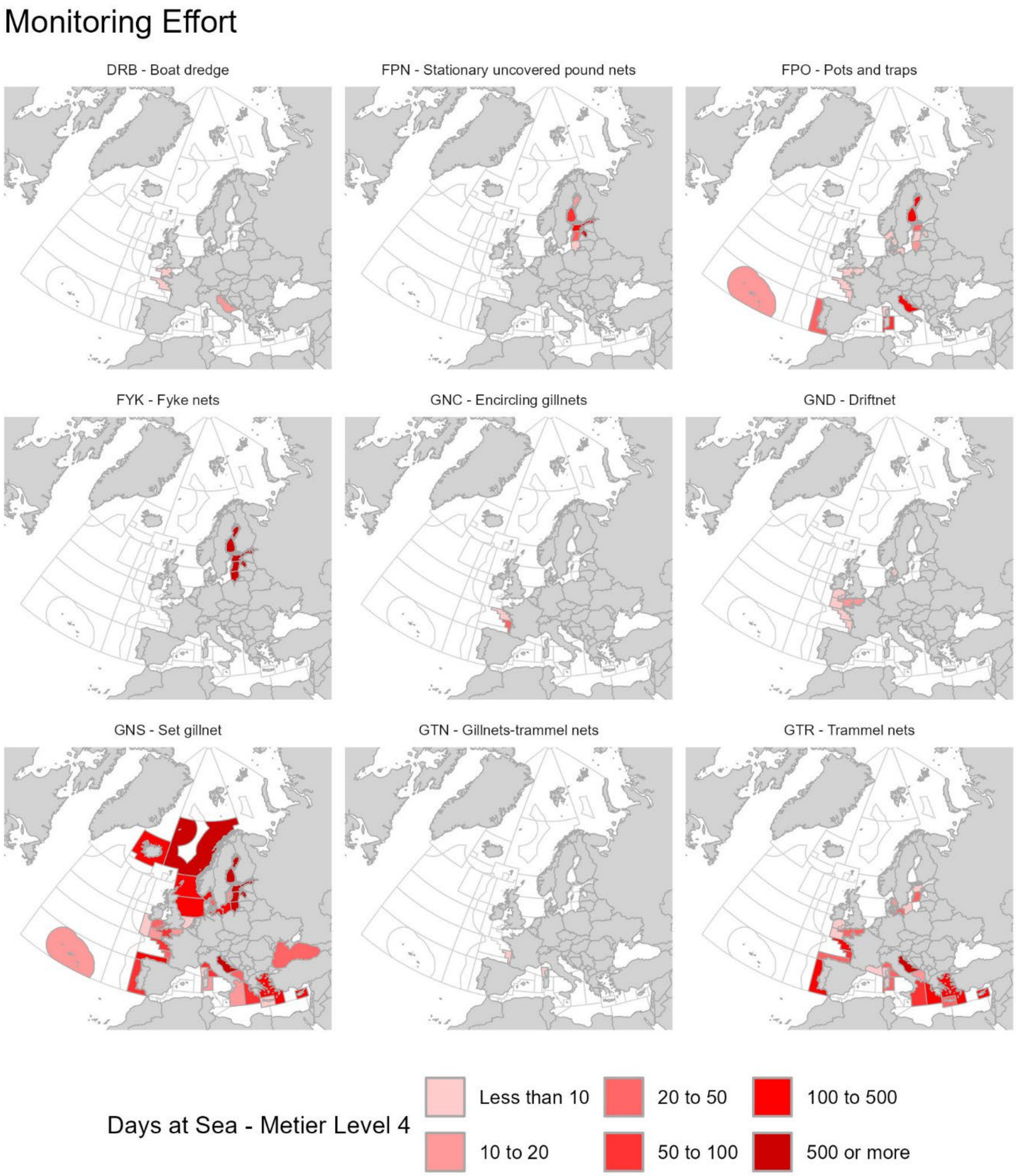
Annex 9: Fishing effort, monitoring effort, and monitoring coverage maps. Metier L4. (ToR E)

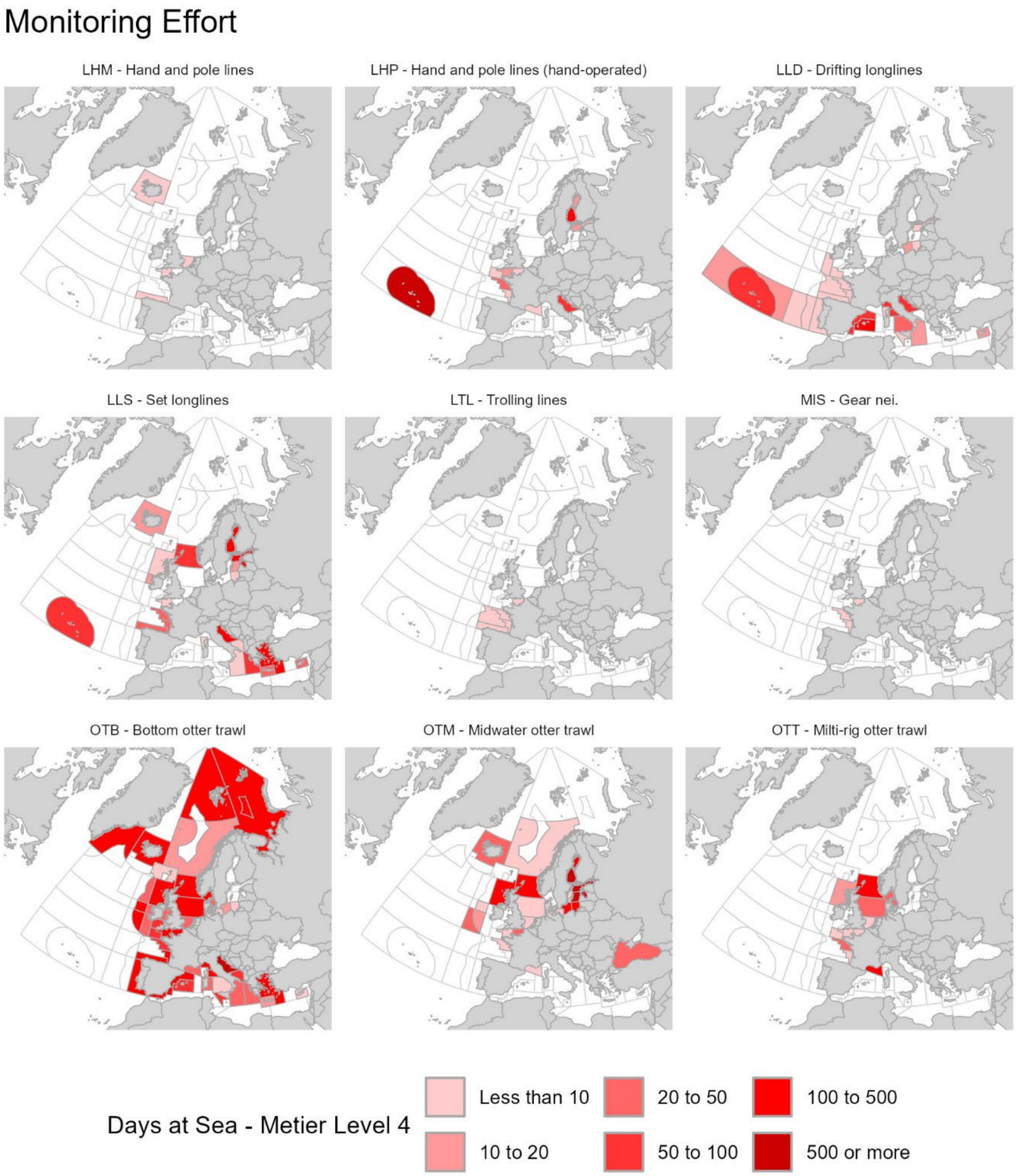


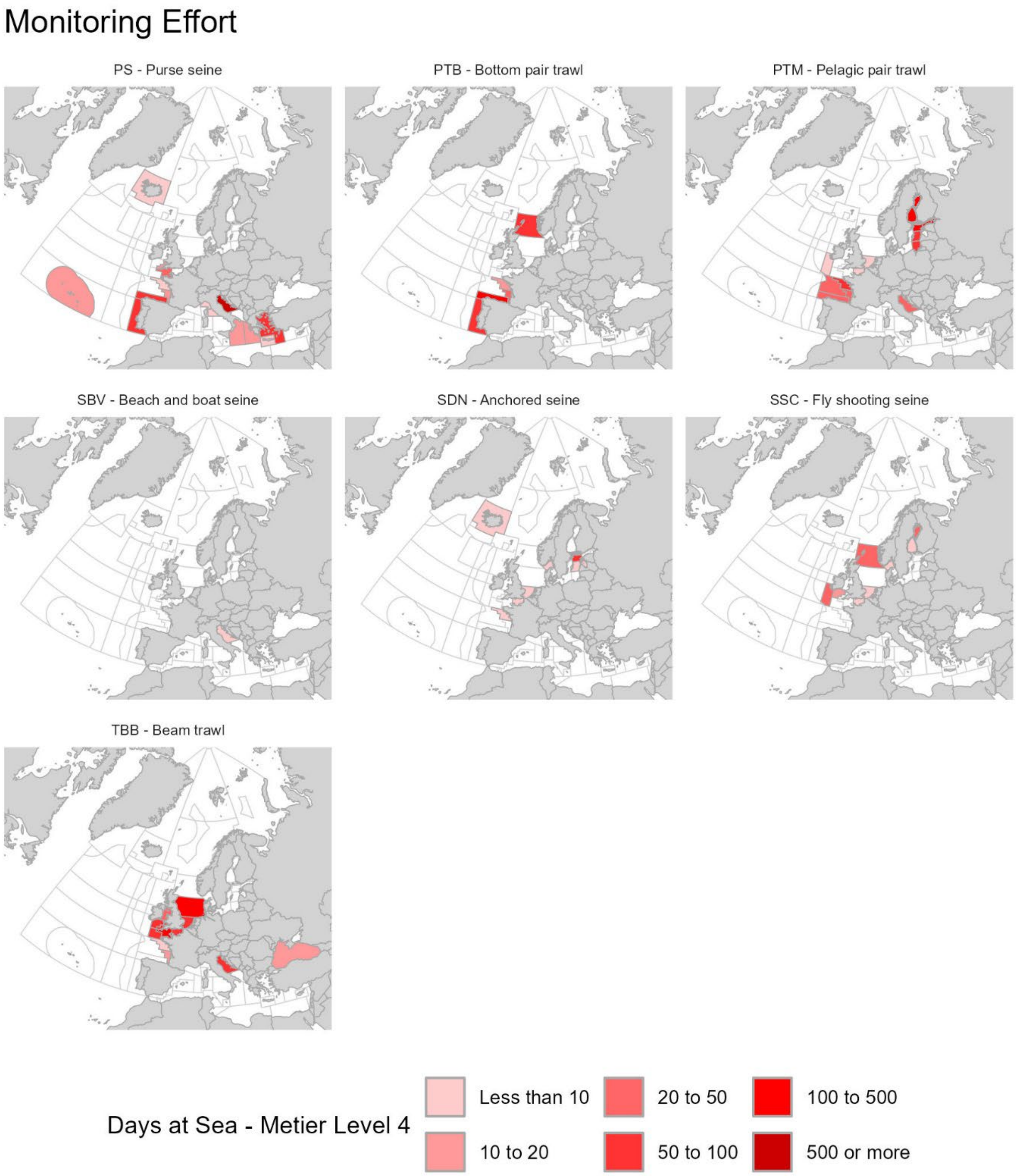

Fishing Effort
GTR - Trammel nets
HMD - Mechanised/suction dredge
LA - Lampara nets
LH - Hand and pole lines
LHM - Hand and pole lines
LHP - Hand and pole lines (hand-operated)
LLD - Drifting longlines
LLS - Set longlines
LTL - Trolling lines
Days at Sea - Metier Level 4
Less than 1 000
1 000 to 3 000
3 000 to 10 000
10 000 to 25 000
25 000 to 50 000
50 000 or more

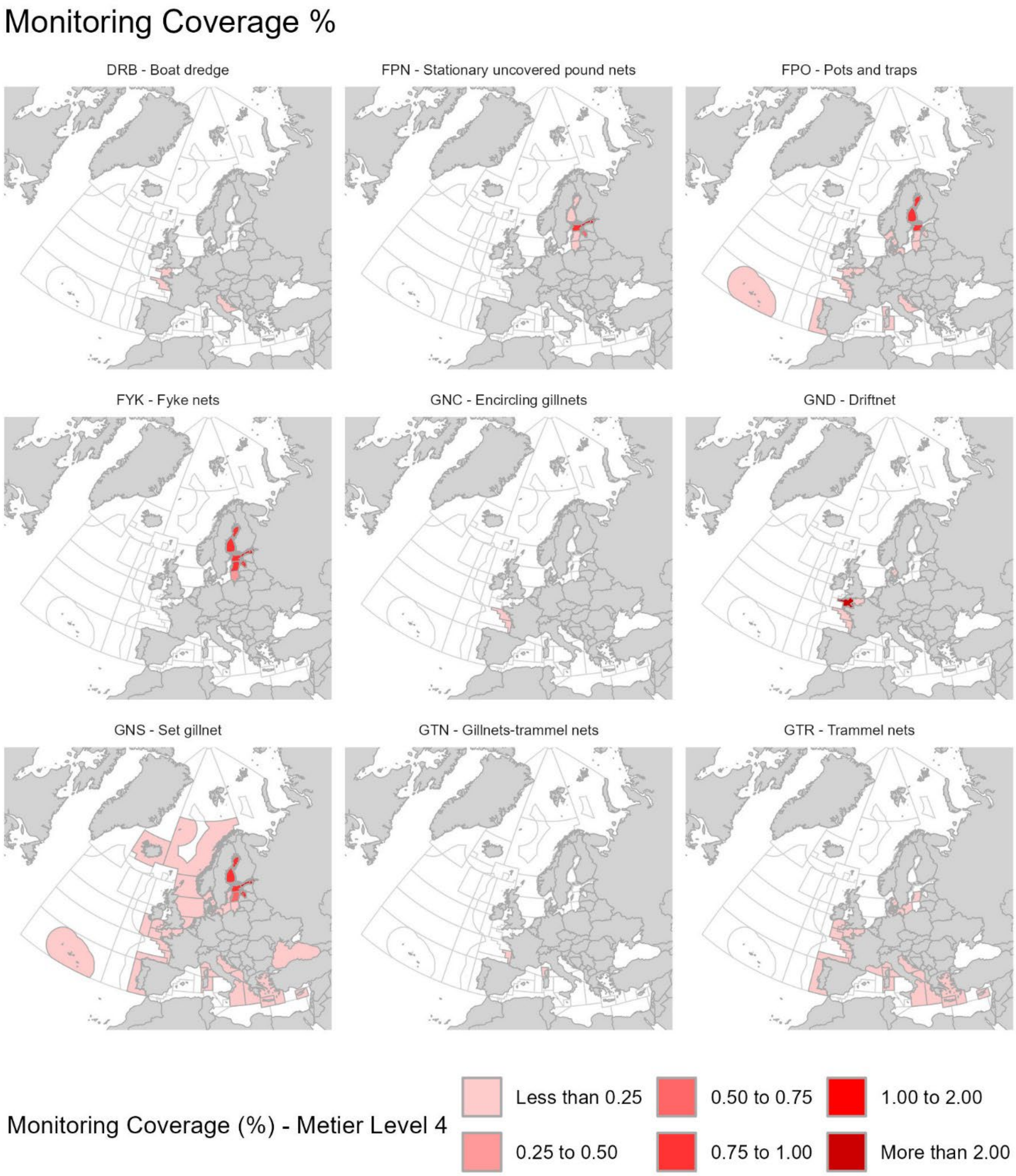

Fishing Effort
MIS - Gear nei.
OTB - Bottom otter trawl
OTM - Midwater otter trawl
OTT - Milti-rig otter trawl
PS - Purse seine
PTB - Bottom pair trawl
PTM - Pelagic pair trawl
SB - Beach Seine
SBV - Beach and boat seine
Days at Sea - Metier Level 4
Less than 1 000
1 000 to 3 000
3 000 to 10 000
10 000 to 25 000
25 000 to 50 000
50 000 or more

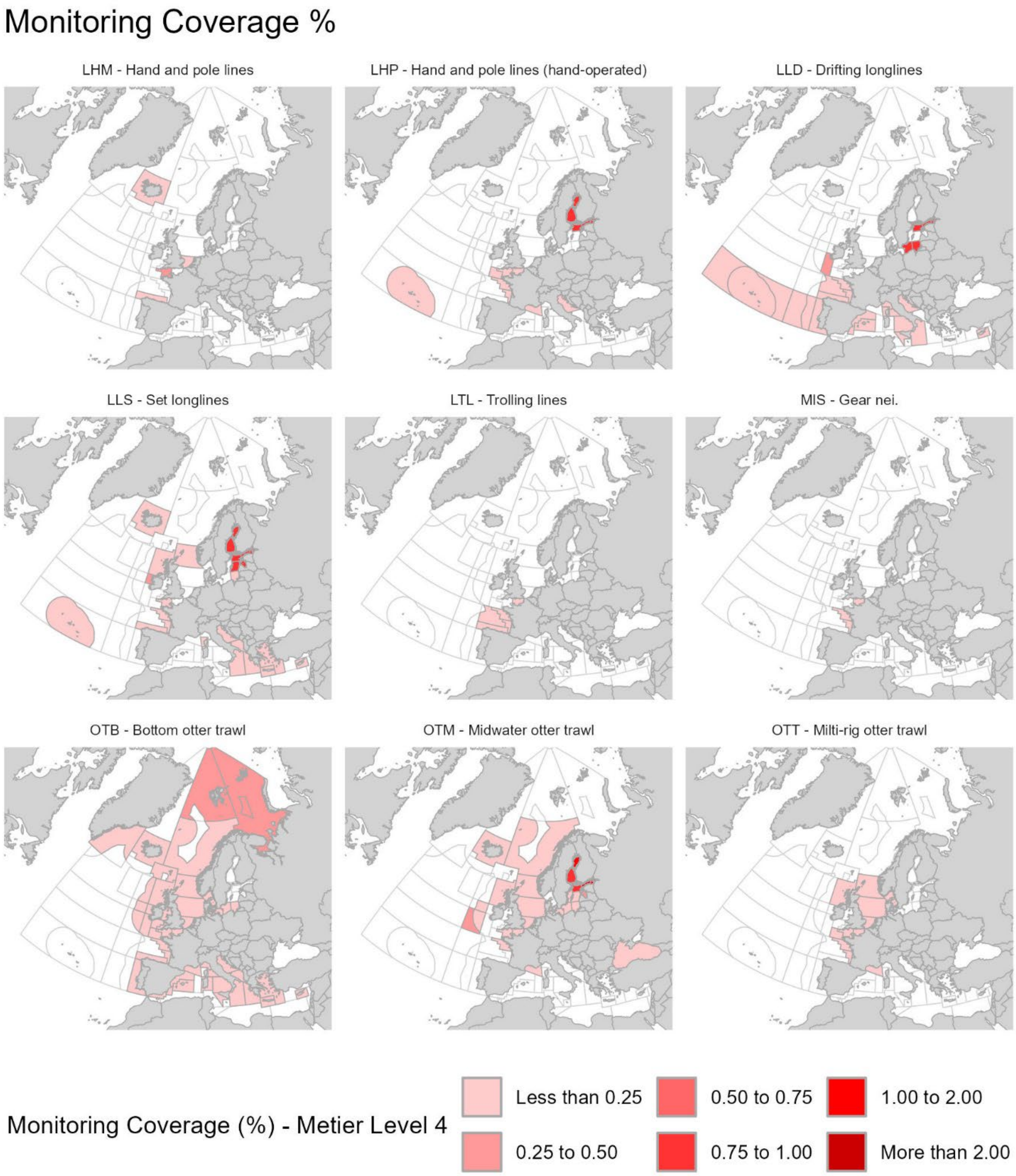

Fishing Effort
SDN - Anchored seine
SPR - Pair seine
SSC - Fly shooting seine
TBB - Beam trawl
Days at Sea - Metier Level 4
Less than 1 000
1 000 to 3 000
3 000 to 10 000
10 000 to 25 000
25 000 to 50 000
50 000 or more


Monitoring Effort
DRB - Boat dredge
FPN - Stationary uncovered pound nets
FPO - Pots and traps
FYK - Fyke nets
GNC - Encircling gillnets
GND - Driftnet
GNS - Set gillnet
GTN - Gillnets-trammel nets
GTR - Trammel nets
Days at Sea - Metier Level 4
Less than 10
10 to 20
20 to 50
50 to 100
100 to 500
500 or more


Monitoring Effort
LHM - Hand and pole lines
LHP - Hand and pole lines (hand-operated)
LLD - Drifting longlines
LLS - Set longlines
LTL - Trolling lines
MIS - Gear nei.
OTB - Bottom otter trawl
OTM - Midwater otter trawl
OTT - Milti-rig otter trawl
Days at Sea - Metier Level 4
Less than 10
10 to 20
20 to 50
50 to 100
100 to 500
500 or more


Monitoring Effort
PS - Purse seine
PTB - Bottom pair trawl
PTM - Pelagic pair trawl
SBV - Beach and boat seine
SDN - Anchored seine
SSC - Fly shooting seine
TBB - Beam trawl
Days at Sea - Metier Level 4
Less than 10
10 to 20
20 to 50
50 to 100
100 to 500
500 or more


Monitoring Coverage %
DRB - Boat dredge
FPN - Stationary uncovered pound nets
FPO - Pots and traps
FYK - Fyke nets
GNC - Encircling gillnets
GND - Driftnet
GNS - Set gillnet
GTN - Gillnets-trammel nets
GTR - Trammel nets
Monitoring Coverage (%) - Metier Level 4
Less than 0.25
0.25 to 0.50
0.50 to 0.75
0.75 to 1.00
1.00 to 2.00
More than 2.00


Monitoring Coverage %
LHM - Hand and pole lines
LHP - Hand and pole lines (hand-operated)
LLD - Drifting longlines
LLS - Set longlines
LTL - Trolling lines
MIS - Gear nei.
OTB - Bottom otter trawl
OTM - Midwater otter trawl
OTT - Milti-rig otter trawl
Monitoring Coverage (%) - Metier Level 4
Less than 0.25
0.25 to 0.50
0.50 to 0.75
0.75 to 1.00
1.00 to 2.00
More than 2.00


Monitoring Coverage %
PS - Purse seine
PTB - Bottom pair trawl
PTM - Pelagic pair trawl
SBV - Beach and boat seine
SDN - Anchored seine
SSC - Fly shooting seine
TBB - Beam trawl
Monitoring Coverage (%) - Metier Level 4
Less than 0.25
0.25 to 0.50
0.50 to 0.75
0.75 to 1.00
1.00 to 2.00
More than 2.00

Annex 10: fishPi scores (ToR E)

Download table in Excel format from the ICES library:
https://doi.org/10.17895/ices.pub.27762723

Annex 11: Reviewers report

Review Report – WGBYC 2024

The following is a combination of the comments of the 3 reviewers:

Stephanie Tachoires - Office for French biodiversity, OFB

Roberto Carlucci – Department of Biosciences, Biotechnology and Environment, University of Bari, Italy

Valentina Melli – DTU Aqua, Denmark

In order of priority, we have listed the comments as follows:

To be improved: Small actions to modify the text and make it more readable

To be checked: check for errors (sometimes perhaps resolved)

Advice for next year work: suggestion for Advice for next year work

Comment: just a comment, check whether or not action is needed

General Comments

- The overall summary of the report is well appreciated to summarize the essential ideas and results obtained during the WG. However, the summary could be more explicit on the key recommendations and conclusions of the WG.
- The report is very long, and many concepts, technical terms and acronyms are only understood by experts in the field or after a thorough reading. Thus, the integration of a Glossary is strongly suggested to report concepts and technical terms in clear manner to the readers. This could be added at the beginning of each ToR.
- A summary table of all gears (name and code) included in the Metier levels cited in the text should be added as Annex.
- The captions of most tables need to be checked, and the detail of the information given needs to be improved, by specifying the column headings
- The report is well detailed and the method explained correctly (even if some of them are a bit complex). The extent of the work conducted is commendable.
- Part of the work done in ToR D is based on an analysis from WGMME, the time given to reviewers for analyze the WGBYC report hasn't permitted to have a look of WGMME report to do a complete analysis of this ToR D.
- The methods developed and results obtained are very encouraging to improve comprehensive for ETPS bycatch. The analysis and recommendations should be helpful for managers even lack of data is still a big constraint for the analysis. The BEAM analysis was significantly improved since last year.
- The new ToR F wich is supposed to give recommendations concerning coordinating sampling plans remains a first approach. Recommendations should be more precise to be useful for managers, deeper reflection and a gear*area level recommendation could be useful.

ToR A: Review and summarize information submitted through the annual bycatch data call and other means for assessment of protected/sensitive species bycatch (ToR A)

This ToR included a review of bycatch legislation and a summary of information received from 23 countries ICES member states and 8 EU non-ICES states through the 2023 data call > improvement since last year.

To be improved:

- In 1.1, Birds directive should also be mentioned among the environmental regulations which implies protection of species and is one support of the EC Actions plan for reducing incidental catches of seabird in fishing gear (EU-POA).
- Part 1.3: Figure 4: the scale used doesn't permit to see all the monitored methods used when the proportion of annual days at sea is small. To be improved
- Section 1.3: "In the Adriatic Sea ecoregion, 1 mammal, 3 birds (1 species), 136 turtles (1 species), and 497 elasmobranchs (6 species)". It would be important to clarify ahead of this point if commercial species were excluded from the data call as some areas (e.g. the Adriatic Sea) have targeted elasmobranchs fisheries (e.g. *Mustelus* spp.) (To be improved)
- Pag. 11: What does "stratum" mean? A brief explanation o example of the term is suggested. What are the levels of strata considered? (To be improved)
- Table 3: I recommend to indicate under this table that strandings data and fishers interviews are not mentioned here because not included in the data call [perhaps because of the data format] but they are analyzed in a other section later. To be improved
- Figure 6: possible to better explain the chart legend : difference from DCF and EU-MAP?... To be improved
- Page 18: A definition of the term "electronic monitoring" should be added, as this is a broad term that typically encompass multiple technologies, including electronic logbooks.
- Part 1.4: Electronic monitoring – page 24: A link to the ICES poster Dubroca *and al*. could be added? To be improved
- page 25: (ex: 21% of bycatch for marine mammals in gillnet fisheries, Vignard, Tachoires, 2023) > as I am the author could we precise the quote "(for example 21% of bycatch for marine mammals on a preliminary estimation in gillnet fisheries on voluntary vessels in the bay of Biscay, Vignard, Tachoires, 2023)" To be improved
- page 25: several project are mentioned, it could be useful to indicate which countries are involved in each project. To be improved
- Figure 5: the label of the figure and the titles of the plots are not aligned (e.g. birds vs Aves); if the only Reptiles included are sea turtles, the latter would be a more intuitive term. In addition, Comment: Wouldn't the standardized number of reported bycatch be more relevant to discuss trends?
- Table 3 (or in the text): add a short sentence to justify why a monitoring method is not considered reliable for ETPs (e.g. port observers)
- Part 1.5 Other monitoring programmes: 1.5.1 page 28: A recommendation is formulated "it could be effective to draw up a regulation at European level establishing a general obligation for Member states to use EM technology as a control tool, whose images could later be reused for scientific purposes" > could you

clarify if it is a recommendation from the members of the WGBYC or if it is a recommendation from the project described on this section from Spain? To be improved

- Table 4: The estimate column should be standardized or, if not possible, a unit of reference should be pro-vided. E.g. 282 ind/year
- Concerning the clean catch app and the use of EM, I haven't understand the link between the both > could you clarify this link? How many vessels are equipped in this project of EM system and how many contribute to the app? To be improved

To be checked:

- In 1.2, could you confirm if the data presented are only data of observers or also Electronic monitoring (EM) sources, and mandatory declaration (as marine mammals in France? No double counting (even the declaration is often low…), just to clarify.
- Page 28: United states of America, it is surprised that USA don't provide EM data. Is it an oversight in writing?
- Section 1.3 Data call did not find (https://ices-li-brary.figshare.com/articles/re-port/WGBYC_Data_call_2024_Bycatch_of_protected_species_for_ICES_advi-sory_work/26124430). To check the link. (To be checked)
- In Fig. 4, the increase in the electronic monitoring seem to occur only for 2 countries (Sweden and Denmark), while in Fig.7 is also reported for France. Likely, there is problem of visualization due to the scale adopted in Fig.4. (To be checked).
- Figure 7: there seems to be a discrepancy with respect to Fig. 4 regarding France
- In Table 2: there's a discrepancy between the DAS for the Baltic Sea here and in the text (just one day). Check full table/relative text for errors.

Comment:

- Page 29: No mention of the different working group on bycatches: joint bycatch ASCOBANS and ACCOBAMS, also ICES/ASCOBANS working group held just before the European Conference society on marine mammals example: https://www.ascobans.org/en/meeting/1st-meeting-joint-bycatch-working-group-accobams-and-ascobans and ICES / Possible to add these references? Or if more suitable added those WG references in the ToR B
- Part 1.7 Auxiliary data:Page 36: The evolution of the strandings in French coast is mentioned with an unprecedent record number in 2023. Do we have also the evolution for harbor porpoise in Portuguese coast and Iberian peninsula, the same evolution or not? Page 37: the estimation done in the Cetambicion project on harbour porpoise in Iberian peninsula (work done by Pelagis, Université de la Rochelle and project lead CSIC) is not mentioned > is there any reason?
- In the Conclusion section, "Data checks should be performed by data submitters in advance to avoid delays during the WG." Would it be possible to establish automated checking routines giving errors during submission of the data?
- "Some countries have restricted data collection via EM for certain taxa, such as marine mammals. We encourage the collection and reporting of data for all species when the ability of EM to detect and identify them has been demonstrated."

Consider adding a comment/recommendation regarding level of taxonomic classification and use of AI.

Advice for next year work:

- Page 10: "In the Ionian Sea and the Central Mediterran Sea ecoregion, 1147 elasmobranchs (19 species) and 12 holocephalians (1 species) were reported from 557 days monitored at sea (Table 2)." I find the lack of sea turtle bycatch suspicious, it would be worth strengthening the reach of the dissemination of the data call in the Mediterranean as many countries there may be less actively involved with ICES (and thus used to submit data).
    - In the Conclusion section, information from stranding data on bycatch impact in Mediterranean Sea region could be acquired by "*CIBRA - Banca Dati Spiaggiamenti*" of University of Pavia. (http://mammiferimarini.unipv.it/index_en.php).

ToR B: Collate and review information from WGFTB national reports, other WG and recent published documents

To be improved:

- As already underlined last year by the reviewer S.T.: A glossary would be practical. Ex: TFE: Tom"s Fisheye > a short description of the system could help – also BRD : Bycath reduction device for example (and not RDB: regional data base… for this ToR)

Comment:

- The country-by-country summary is an intensive exercise to make and read. Wouldn't a sum-mary figure or table showing which countries are working on what taxa and fishery be more useful? The table format could be a simple matrix of métiers and taxa, with links to specific project descriptions/website when available.
- Part 2.1.19 UK: Concerning clean catch project, approximately 1.733 days of data have been collated as of April 2024 > those days concern both the app and the EM? Moreover in the treatment of the app data, how is the situation handled when the fisherman doesn't declare when they doesn't have any bycatches? Total effort of each vessel involved of the project is it available for analysis? Are we confident with the declaration?
- Part 2.3 Conclusion: Concerning the conclusion on pearl nets, to my knowledge, one of the problems was the method of mounting the beads, its industrialization and the associated cost. Do you have information about this topic?
- In Conclusions: WGBYC deemed this reviewing exercise very useful but I struggle to see how (despite finding it a worthy effort!). It would be beneficial to define the objective of this exercise with respect to the rest of the work of WGBYC.

Advice for next year work:

- Section 2.1: the routine described to search the WGFTFB report seems unnecessary, as each project described in the report has the following two qualifiers with respect to ETPs:

Is the project directly addressing bycatch of PETS? Yes/No
Could this project indirectly decrease bycatch of PETS? Yes/No
Therefore, it would be sufficient to search for those that have "Yes" for either question.

- I recommend separating the summary of projects that are directly and indirectly addressing ETPs bycatch. There is a substantial difference in timeline of potential implementation for a technology that has a documented effect on ETP bycatch with respect to one that is developed for other species and may have an unquantifiable benefit on reducing ETPs as well.
- Part 2.2: Mitigation strategies - Page 53: Could you precise if the literature search has or not concerned the amphihalines fishes such as sturgeon or salmon? And If not, could you explain the choice of priority?
- Table p. 54: Useful to add the countries concerned by the scientific paper and the principal author's organization > add two columns next year?
- The INTERREG project in the Adriatic region *"SAMESEA: SustainAble ManagEment of marine Sentinel spEcies under cumulative human activities"* (IPA-ADRION00096) is addressed to develop a strategy for monitoring some PET sentinel species (e.g. *Caretta caretta*, *Tursiops truncatus*, *Monachus monachus*). Several outputs of SAMESEA project will perform the multi-hazard susceptibility maps for sentinel species, and to develop a transnational strategy for their monitoring based on a cooperative model that can harmonize and standardize practices, encouraging cross-sectoral and multi-stakeholder cooperation at the local level. The project is started on 09/01/2024 with a duration of 30 months. Future outputs could be useful to inform some activities of several ToRs.

ToR C: Consider the quality of data available for use in the estimation pf bycatch rates of ETP species (BEAM)

To be improved:

- Here and throughout the report, the species Latin name needs to be corrected, with capital letter for the genus (mostly an issue in Figures and Tables).
    - ToR C section is very complex and difficult to read. An homogenization of terminology is required
    - Page 71: "The number of bycaught individuals in a fishing event was calculated as the sum of individuals caught in gear with and without pingers." It would be beneficial to clarify what a "fishing event" is depending on the metier.
    - "Fishing events where no individuals of a species were bycaught do not appear in this data set, however, monitored effort with zero bycatch is available." I do not understand this sentence.
    - Criteria 1: "ii) if so, whether this heterogeneity in variance could be explained by factors attributable to the design of monitoring programmes and the distribution of monitoring effort." Consider adding a sentence to explain why this is a "desirable" outcome
    - Part 3.3: page 72 it would be useful to explain in the text the métier level 4 even with example (= gear level GNS, GTR…)
    - Page 3.4.1 – figure 2.2 the range of species should be better organized to find easier information by genus for example and with an alphabetic order then

- Table 2.1: The explanations of the statistical analysis done for criteria 1 is a bit hard. To improve the understanding in the table, I suggest to have a small explanation of the reason of no calculation (example quoted page 73 for example “five nations were monitored but only three of those repored fishing effort, we could not estimate total bycatch”). In this manner, we better understand for each ecoregions*species*gears the reason of the no calculation and the effort member states have to be done. For example: Bay of Biscaye PTB Delphinus delphis > total bycatch is calculated 744 with a spatial variability in BPUE but it is not the case for common guillemot in the same area also with a spatial variability in BPUE. It should be useful to have a sentence (under the line concerned in the table for example) to explain why calculation is not possible
- Bm is estimated as a Total Bycatch. To clarify the use of terminology adopted for the same concept. In addition, in the estimation of Bm is required the bycatch mortality rate (BMR), which could be estimated from data on survival rate of species catch/release. It is difficult to estimate this parameter for several species, as marine mammals. Thus, in the BEAM approach seems that the BMR is assumed equal to 1 (all bycatch individuals die). This condition should be detailed in the Criteria 3. Of course, if BMR data are available for some PET species, should be correct to implement this aspect in the estimation of final Bm.)
- Criteria 6: Bycatch Mortality > Bycatch Reference Point: What is the range of values to define the vicinity to the BRP? A quantification of the values range adopted for the traffic light can be useful to better understand the evaluation.
- In the Tables 2.3-2.4, captions are not clear, and it required an improvement in the description of each head column.
- Figure 2.6: Label for Y axis should reflect the categories order Species, Area, and Metier

To be checked:

- Figure 2.2: I’m confused by the presence of commercial species in this table (e.g. *Merlangius merlangus, Lophius piscatorius).* If it is not an error, please clarify this in the text.
- Table 2.4: The value of 0.7 for the Reference Point of harbor porpoise (GTR, Baltic Sea) is strange. I understand that Bycatch Reference Point represents Number of Individuals identified as target levels in the assessment of bycatch impact on a species. The value reported for other taxa seem to be the Number of individuals, which can be compared with Total Bycatch (Bycatch mortality, see Criteria 6). I think 0.7 could be an uncorrected value.

Comment:

- If the BPUE is seasonal is there a way to establish if the DaS are homogenously distributed over the 4 Qs? To my knowledge there are often uneven distributions of the monitoring efforts in the Mediterranean (due to e.g. observers contract having to be re-activated every year).
- Criteria 3: “For example, if there is between-country heterogeneity and four nations report monitoring, but six nations are identified as contributing to fishing effort, then a total bycatch cannot be estimated.” Wouldn’t it be more conservative to assign equal BPUE to the un-reporting countries as the reporting ones?

Advice for next year work:

- Criteria 7: based on this an action for WGBYC could be to seek these expertise out in preparation for the following year

ToR D: Continue to develop and refine methodology > data poor species

To be improved:

- Section 4.2, Risk Table 1: clarify that this table is produced for each region individually; also, in the example table provided, clarify the symble "PA".
- Part 4.3.3: Precise in the legend of the table used that it is table from WGMME report (in my comprehension) and give the reference of the report page for each table. To be improved
- *"The specific meanings of the risk and confidence categories used are not currently defined."*. I think that this sentence should be reconsidered. Although the meanings of the term "risk" could be not fully defined, a logic framework in the classification and assignation of confidence levels (*) should be applied, and this procedure can be detailed in the text. For instance, when *"no specific knowledge is available in an ecoregion for a particular species/population about the direct risk of bycatch in the fishing gear…"*, you could consider that this condition represents a low (or medium) confidence level. Similarly, the confidence rating could be associated to different sources of information (literature, external datasets, WGBYC database, or expert judgement) used in the classification. Which category of information (literature, external datasets, WGBYC database, or expert judgement) is more confident? Therefore, I think that a specific meaning of the confidence levels is defined, and it should be explained in the text with some examples. (To be improved)
- Table 2 and 3: for a clear and coherent readability blank cells (no overlap) should be replaced with zero value. (To be improved)

To be checked:

- Part 4.5.1.3 : Loggerhead turtle (*Caretta caretta*), "not scored" is mentioned in the table for TBB but the justification globally concern Bottoms trawls. Other bottom trawls are assessed high. Could you explain why TBB is not scored? To be checked
- Part 4.5.1.4 page 145 and 146: The risk concerning bottom trawling is medium for *Squatina* probably because the are only bycatches reported in literature (not in bycatch records > to be checked…). This species is considered depleted so it's not surprising to find no catches (or a very low level), given the limited observation efforts. This point should also be taken into account in the evaluations. A comment on this point could be added in the report. To be improved and further investigation would be interesting on this point next year Advice for next year work
- Page 144, Drift nets: "The risk is evaluated as high, 3, with medium confidence in the Mediterranean (**) and low confidence in the Atlantic (*). The use of this gear is currently limited to coastal waters (not targeting pelagic species), and it is totally banned in some regions. Therefore, there are no bycatch records of loggerheads in GND in the ICES bycatch database." Shouldn't it be n/a?

Comment:

- As reviewer has not enough time to also analyze the WGMME report, the analysis of WGBYC review of the WGMME work could not be carried out in depth by the reviewers. Even WGBYC made some criticisms and very valuable recommendations to consolidate the reliability of the assessment, the format proposed in table 1 with score and asterisk to the level of confident could be very useful for managers > The improvement of the process and assessment will be very useful (page 134). Comment
- Section 4.5.1: The level of confidence seems easily quantifiable based on data availability but the level of risk especially between moderate and high seems very arbitrary. The examples provided were very useful in showing that some experts weighted more the capture method of the gear and the documentation of bycatch rather than the life history traits and ecology of the species.

Advice for next year work:

- Section 4.5.1: why are illegal gears (e.g drift nets) included? They cannot be assessed the same way as the other gears as there would not be any bycatch records
- Part 4.5.2 Discussion: Concerning survival rate, the WGBYC (or other relevant ICES WG) would produce a synthesis on survival rate of PETS species in order to complete the analysis. At a first level, a footnote under the table could be added when information are available on a possible survival bycatch rate. Advice for next year work
- Discussion: Consider including the survival rate (when known) in Table 3 rather than 1, as it can play a role into the impact on the population rather than the risk of bycatch.
- The meaning of bycatch risks could be linked to an assessment of degree of impact (injured/lethal) by gears. Some examples of methodologies used to estimate confidence levels and risks of bycatch impact for cetaceans are reported in Carlucci et al. (2021) (https://www.sciencedirect.com/science/article/pii/S0301479721003029). (Advice for next year work)

ToR E: Review on going monitoring of different taxonomic groups in relation to spatial bycatch risk and fishin effort ton inform coordinated sampling plans

To be improved:

- *"Each functional group gets a risk score (1-3, where 3 is the highest) for each metier (level 4) based on data or knowledge from any ecoregion"*. Is the score 3 referred to the highest bycatch risk? To clarify this detail in the sentence. (To be improved)

To be checked:

- Section 5.2. The concept of risk-score is also used in the ToR D. Is the same concept? The text reports the term "*perceived risk of bycatch*", which could induce confusion. To better detail the meaning of the term "risk" in this approach is strongly suggested. (To be checked)

- Page 165: "For each combination of métier level 4 and Division, Table XXX shows fishPi scores (scaled to range from 0 to 100), fishing effort (scaled to range from 0 to 100), monitoring coverage (%) as well as a combined risk score which results from the multiplication of scaled fishPi risk score and scaled fishing effort." I cannot match the values in the Table if I follow this description, please check.

Comment:

- Section 5.1: can the data for the monitoring effort (in days at sea) requested for each Quarter? That could be interesting to overlap with bycatch rates by Q.
- It is worth remembering in this section that if projects do not cover all species, this can cause difficulties in aggregating information on monitoring coverage. This situation is underlined in Tor A concerning EM project. Comment
- Table xxxx – Top 5 risk métier page 165 and following: Is it possible to add an estimation of the % coverage of the métier level 4 for each risk métier? Comment - Are those information (i.e same table) available by functional groups? Comment
- Discussion – Fishing effort: I don't think using swept area for effort of active gears would benefit your analyses. And even if it were, there's too much variability within métier in terms of rigging (e.g. sweeps length)

Advice for next year work:

- *"… lampreys, turtles, diving birds, surface birds, seals, dolphins, harbour porpoise, large whales, deep water sharks, demersal sharks, pelagic sharks, skates and rays."*. The division of functional group of skates and rays in two groups (deep, and shallow) could be considered in the future because the impact of several fishing gears (e.g. OTB) change along the bathymetric gradient with a different bycatch risk between the shallow and deep species. (Advice for next year work)
- The component inherent to the species/functional groups in the calculation of final *fishPi* score seem to consider any quantitative elements (e.g., abundance or biomass of a species/functional groups in the ecoregions). In contrast, other components of the calculation (e.g. fishing effort) turn out to be quantitative elements. For the future, the abundance of species in the area in addition to mere presence/absence should be considered when calculating the score. (Advice for next year work)

Tor F: For data deficient situations as highlighted in Tor C, propose measures necessary to obtain the required information

To be improved:

- It should be more explanation of what table 6.1 represents. Are the taxa found in the table on line the taxa not concerned by the aim of the sampling/protocol? To be improved
- Section 6.2: explain acronym CV
- Part 6.3: Page 182 and 183 > details of factors influencing BPUE- i.e ? Relisting the factors could be useful. To be improved
- 6.4: a bit more concrete conclusions would be strongly beneficial to the managers

Comment:

- Section 6.1: the exclusion of data due to the main objective of the protocol being different taxa seems like a very conservative approach. These were deemed ad-hoc observations but in the previous ToRs "other" monitoring methods (which often related to specific research projects) were considered reliable. Perhaps the problem lies with the definition of the monitoring protocol? For example, if these are observer data and they are trained to identify other taxa/species than the main objective of the monitoring program than why should these data be excluded?

Advice for next year work:

- The recommendations are general (and useful) but a recommendation at each gear*métier level 4)*area level should be useful (added a table an annex to better help managers?) Advice for next year work – and the same at a gear*métier level 4*area*functional groups.
- *"This highlights the need for clearer specifications on how the monitored effort can be applied in assessments. For example, if turtles are reported even though the monitoring protocol is for marine mammals, can this data still be used in turtle assessments?"*. In this regard, the use of bycatch data obtained for species through different monitoring protocols needs to be revaluated. The detection of bycatch for species with similar habitats (e.g. turtles and dolphins) detected with different protocols, but often with similar observation methodology, is valuable information to consider when counting the BPUE and BEAM of individual species. In the future, at least two estimates with/without data from monitoring protocols could be evaluated to provide even more conservative values. A consideration on this aspect in the Conclusion section could be reported (Advice for next year work)
- Table 6.3: It would be interesting to explore if the inclusion of the data excluded due to the focus taxa of the monitoring protocol would resolve some of these insufficiencies.

Tor G : Continue , in cooperation …

No particular comments but useful to understand the quality check data process and identify some limits of the data process.