Exploring possibilities for an indicator on fishing activities' impact on sensitive species

On opportunities and challenges for risk-based approaches attributing potential risk for bycatch interaction between certain fisheries and marine mammals, birds and turtles

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METHODOLOGICAL REPORT

Introduction

One of the measures under the Common Market Organisation of fishery and aquaculture products (hereafter, CMO) was the establishment of regulatory marketing standards for Fishery and Aquaculture Products (hereafter, fisheries products), laying down uniform quality characteristics for products sold in the EU, regardless of their origin (EU, 2013). A recent evaluation of the current CMO however concluded that the current standards do not sufficiently contribute to supply the market with sustainable products (SWD, 2019). Consequently, the revision of the marketing standards is included as an initiative under the Farm to Fork Strategy for a fair, healthy, and environmentally friendly food system (COM 2020/381 final).

In May 2021, the Scientific, Technical and Economic Committee for Fisheries (hereafter, STECF) released a report on "Criteria and indicators to incorporate sustainability aspects for seafood products in the marketing standards under the CMO" (STECF 20-05). This report proposed transparent methods of measuring and communicating some sustainability aspects of fisheries products along the supply chain, using simple indicators based on scientifically sound and verifiable criteria. Furthermore, it was suggested that a scoring system should be developed step by step. This should start with a System 1-scoring that could be communicated for all products on the market based on simple indicators. Products with more data at hand could benefit from a System 2-scoring in the form of a more specific assessment.

In 2022, STECF released a follow-up report on "Validation of selected sustainability indicators and underlying methodologies for the revision of the EU marketing standards for fisheries products" (STECF 22-12). One of the three key criteria for fishery products considered in this report was the potential fishing activities' "impact on sensitive species". The incidental catch of sensitive species (hereafter, bycatch) is a major issue for marine biodiversity and may have unexpected impacts on the functioning and resilience of entire ecosystems (Komoroske and Lewison, 2015; ICES, 2022).

Bycatch is of particular concern for long-lived species with comparatively low productivity, a category of species that includes all marine mammals, seabirds, and turtles, together with some finfish and cartilaginous fish (Lewison et al., 2014). Additionally, the increase in public awareness for a healthy environment in the last decades has reduced the social acceptance for unsustainable practices in economic activities. Especially, the negative impact of fishing activities on so-called 'charismatic species' like marine mammals, seabirds, and turtles has been a growing focus in the last decades (Mazzoldi et al., 2019). The problem of bycatch of sensitive species in fisheries has now become a major area of research in fisheries and ecological science but is also a topic with clear expectations for positive changes in the civil society. Based on the above, the accidental catch of sensitive species needs to be considered as a top priority in the recognition of what a sustainable fishery entails.

However, STECF 22-12 raised doubts about what would be required to develop and operationalise a meaningful indicator for attributing the potential impact of fishing for a certain product on sensitive species. The expert working group (EWG) preparing the STECF 22-12 report concluded that further work was required to define and test the feasibility of such an indicator. It was therefore advised to issue a limited ad-hoc contract, similar to the two ad-hoc contracts issued in preparation of the EWG behind the STECF 22-12 report for the two other selected indicators (*i.e.*, "impact on target species" and "impact on seabed"). Furthermore, it was advised that the scoring approach for system 1 should apply a precautionary approach for data-limited fishery products and assign the highest impact score if uncertainties existed. In a system 2, scoring may be refined to eliminate false positives if a higher level of detail on the origin and fishing method is available that may allow for use of existing information related to the fishery, and if no information is available, encourage more data collection. The work undertaken in this ad-hoc-contract should further examine the possible options for a sensitive species indicator as discussed in STECF 22-12, and to test its outcomes with relevant case studies.

Objectives, scope, and approach of the ad hoc contract

Overall, the ad-hoc contract should progress the understanding on the opportunities and challenges related to an indicator for fishing activities' "impact on sensitive species" through:

- Assess the ***feasibility*** of developing a single indicator and grading method for fishing activities' impact on sensitive species within a given time horizon of 2 years. The approach suggested by the EWG behind STECF 22-12 could be tested with a strictly reduced scope for that purpose, *i.e.*, on a selection of species or groups of species and on a selection of the major fishing areas present on the EU market. However, the feasibility assessment should also

consider that the final indicator should need to cover both domestic and imported fishery products on the EU market.

- In case practical feasibility of the final indicator is only possible by significantly reducing the list of sensitive species established in STECF 22-12, define, and apply a suitable ***scope*** through using a restricted set of priority species. For EU waters, the set of species referred to in the EU marine action plan (COM/2023/102) should be prioritised. The final selection could be further restricted if needed, as long as it still results in a meaningful final indicator and application. For non-EU waters, a similar set should be defined.
- In case of a positive feasibility assessment, the report of the ad-hoc team should describe a potential ***approach*** for finalising a graded indicator (aggregating into a combined impact of sensitive species) over the agreed time horizon. This should take into account the learnings of testing the approach proposed in EWG 22-12, as described above. The proposed process will be further discussed in a STECF EWG in December 2023.

Specific tasks of the ad hoc contract

1. Initiate the structure of a database including the most important commercial species on the EU market linked with all possible combinations of CMO gears and fishing areas. The task could potentially build on the gathered data and features of the other two indicators described above as well as EUMOFA data and the commercial designation database. The task should indicate the number of combinations that would need to be assessed in the following steps.
2. Gather existing information on the risk of interaction between sensitive species and fishing gears. Input sources could be (i) the work of well-established scientific bodies on bycatch, *e.g.*, ICES WGBYC, and (ii) existing Productivity and Susceptibility Analysis (PSA) for combinations of sensitive species, gear(s), and area(s). As described in the objectives, the list of sensitive species should be narrowed down, in case it is deemed necessary for the feasibility of the indicator.
3. Identify available information for performing (new) dedicated PSAs beyond the existing ones gathered in task 2. Performing new PSAs will not be feasible for all the fishing products on the EU market within the timeframe of the ad hoc contract, so this task should focus on potential PSAs for the most important fishing areas (possibly one or a limited number of ICES areas) and some of the most charismatic sensitive species groups. It should summarise future opportunities for performing PSAs, if more efforts were to be undertaken for this indicator.

4. Apply the available combinations on risks for sensitive species (stemming from (i) bycatch initiatives and (ii) PSAs as described above) to the database of the most important commercial species established under task 1 to evaluate data gaps and the additionally required effort. This task includes assigning low/medium/high risk values at a sensitive species level that can be linked with a target species captured by a given gear and area, based on available information.
5. Based on the previous tasks – and in particular critical decision elements, such as the coverage of products and additional effort needed – assess the feasibility of a robust indicator grading the impact on sensitive species. The already developed indicator on the state of the targeted stock should serve as a benchmark in this context in terms of comprehensiveness and practicality. Determine whether an indicator on sensitive species is realistic for all fisheries products on the EU market, and hence whether the work on this indicator should be further pursued. In the positive case, provide guidance on which further work would be required to finalise the indicator in a follow-up EWG.

Materials, methods, and outcome of the ad hoc contract

Task 1: initiate the structure of a database on commercial species

Selection of commercial species (fisheries products in the CMO)

A total of 150 marine species was selected (Table 1), excluding fisheries products from fresh- and brackish water systems (*e.g.*, perch *Perca fluviatilis*, pike *Esox lucius*, sander *Sander lucioperca* and most cyprinids). These species were identified on the basis of a list of EU landings and commercial seafood categories found in the EUMOFA database. These species represented around 90% in biomass of all seafood landed and imported in the EU market (excluding aquaculture products). However, some of the species contribute with large volumes but are not necessarily found on the market as they are exclusively or to a large extent utilized as feed, such as sandeel *Ammodytes tobianus* and sprat *Sprattus sprattus*. Thus, the 90% coverage in terms of volume is to a large extent also supported by species that consumers not necessarily find on the market. Including these species does not affect the structure of the database, only the percentage coverage of fisheries products in volume that consumers actually find (which could be higher or lower depending on which total volume is compared to, *i.e.*, including landings for feed or not). Therefore, we are still quite confident that the species considered in the present study includes the vast majority of seafood species landed and imported in EU from marine waters.

Table 1. List of the 150 commercial marine species selected for this study.

Acanthocardia tuberculata	*Engraulis encrasicolus*	*Melanogrammus aeglefinus*	*Palinurus elephas*	*Scyliorhinus stellaris*
Ammodytes tobianus	*Engraulis ringens*	*Merlangius merlangus*	*Palinurus mauritanicus*	*Sebastes marinus*
Aphanopus carbo	*Euthynnus affinis*	*Merluccius bilinearis*	*Pandalus borealis*	*Sebastes norvegicus*
Argentina silus	*Euthynnus alletteratus*	*Merluccius capensis*	*Pandalus montagui*	*Sepia officinalis*
Argentina sphyraena	*Gadus macrocephalus*	*Merluccius gayi*	*Paracentrotus lividus*	*Sepiola rondeleti*
Argopecten purpuratus	*Gadus morhua*	*Merluccius hubbsi*	*Parapenaeus longirostris*	*Seriola dumerili*
Argyrosomus regius	*Genypterus blacodes*	*Merluccius merluccius*	*Pecten jacobaeus*	*Solea solea*
Aristaeomorpha foliacea	*Glycymeris glycymeris*	*Merluccius paradoxus*	*Pecten maximus*	*Sparus aurata*
Aristeus antennatus	*Haliotis tubercolata*	*Merluccius polli*	*Penaeus kerathurus*	*Spicara smaris*
Aristeus varidens	*Hippoglossus hippoglossus*	*Merluccius productus*	*Placopecten magellanicus*	*Spisula solida*
Auxis rochei	*Homarus americanus*	*Merluccius senegalensis*	*Pleoticus muelleri*	*Spondyliosoma cantharus*
Auxis thazard	*Homarus gammarus*	*Micromesistius poutassou*	*Pleuronectes platessa*	*Sprattus sprattus*
Bolinus brandaris	*Illex argentinus*	*Molva dypterygia*	*Pollachius pollachius*	*Squalus acanthias*
Boops boops	*Illex coindetii*	*Molva macrophthalma*	*Pollachius virens*	*Squilla mantis*
Callinectes sapidus	*Isurus oxyrinchus*	*Molva molva*	*Prionace glauca*	*Theragra chalcogramma*
Callista chione	*Katsuwonus pelamis*	*Mullus barbatus*	*Raja asterias*	*Thunnus alalunga*
Cancer pagurus	*Laminaria digitata*	*Mullus surmuletus*	*Raja clavata*	*Thunnus albacares*
Cerastoderma edule	*Laminaria hyperborea*	*Mustelus mustelus*	*Rapana venosa*	*Thunnus obesus*
Chamelea gallina	*Lepidopus caudatus*	*Mytilus edulis*	*Reinhardtius hippoglossoide*	*Thunnus thynnus*
Chelidonichthys lucerna	*Lepidorhombus boscii*	*Mytilus galloprovincialis*	*Rossia macrosoma*	*Todarodes sagittatus*
Clupea harengus	*Lepidorhombus whiffiagonis*	*Neogobius melanostomus*	*Salilota australis*	*Trachurus mediterraneus*
Coryphaena hippurus	*Littorina littorea*	*Nephrops norvegicus*	*Sarda sarda*	*Trachurus murphyi*
Crangon crangon	*Loligo gahi*	*Octopus dollfusi*	*Sardina pilchardus*	*Trachurus picturatus*
Dicentrarchus labrax	*Loligo vulgaris*	*Octopus salutii*	*Sardinella aurita*	*Trachurus trachurus*
Dicologlossa cuneata	*Lophius americanus*	*Octopus vulgaris*	*Sardinella maderensis*	*Trisopterus esmarkii*
Diplodus sargus	*Lophius budegassa*	*Oncorhynchus nerka*	*Sarpa salpa*	*Trisopterus luscus*
Dissostichus eleginoides	*Lophius piscatorius*	*Osmerus eperlanus*	*Scomber colias*	*Trisopterus minutus*
Donax trunculus	*Lophius vaillanti*	*Pagellus acarne*	*Scomber scombrus*	*Tritia mutabilis*
Dosidicus gigas	*Macruronus magellanicus*	*Pagellus erythrinus*	*Scophthalmus maximus*	*Xiphias gladius*
Eledone cirrhosa	*Macruronus novaezelandiae*	*Pagrus pagrus*	*Scyliorhinus canicula*	*Zygochlamys patagonica*

Selection of fishing gears

In the absence of available information linking specific fishing gear type(s) with fisheries products on the EU market, an initial step of this ad-hoc work was to infer the most likely fishing gear(s) that is used to catch each species in Table 1 based on existing knowledge. The identification of the fishing gears which are most likely used to target the selected species was carried out following two approaches. For the EU landings, Table A (catches) of the Fisheries Dependent Information (hereafter, FDI) for the reference year 2021 was used, and the specific gear was selected in the column "gear type". For the remaining species, a bibliographic search was conducted (*e.g.*, fishbase.org, sealifebase.org, fishsource.org, scientific publications, and technical reports) to link the commercial species with gear type.

In this report, direct use of the list of fishing gear categories in Annex III of the CMO Regulation under the "Mandatory information on the category of fishing gears" (EU 1379/2013) was seen as being too generic as a basis for assessing the risk for bycatch interaction that these gears represent for sensitive species. This list includes only seven gear categories (seines, trawls, gillnets and similar nets, surrounding nets and lift nets, hooks and lines, dredges, and pots and traps) – pooling together fishing gears which are set on the bottom and in the water column (*e.g.*, bottom trawling and pelagic trawling, set gillnets and drift gillnets, set longlines and drift longlines). On the other hand, Annex III also lists gears at a finer level (under "More detailed information on corresponding gears and codes, in accordance with Commission Regulation (EC) No 26/2004 and Commission Implementing Regulation (EU) No 404/2011"). This list includes 28 fishing gears – which was deemed too detailed for the purpose of this ad-hoc contract.

To derive at a suitable level of detail for gear categories, the ad-hoc team built a database to distinguish bottom- and pelagic-fishing techniques that may still be linked to the existing CMO gear categories (Table 2). This allows for assessing potential risk of bycatch, while making it possible to attribute risk scores to the gear categories at different level of detail in the CMO. Overall, for the purpose of this ad-hoc work, we grouped fishing gears into 12 categories: seines, bottom trawls, pelagic trawls, set nets, driftnets, purse seines, hooks and lines, set longlines, drifting longlines, dredges, pots and traps, and hand implements.

Table 2. Fishing gears categories as reported by CMO Regulation with the list of fishing gears selected for this study.

Mandatory CMO information on the category of fishing gear	**More detailed information than CMO for the corresponding fishing gears**	**Fishing gear categories selected in this study**
Seines	Beach seines	Seine
Seines	Danish seines	
Seines	Scottish seines	
Seines	Pair seines*	
Trawls	Beam trawls	Bottom trawl
Trawls	Bottom otter trawls	
Trawls	Bottom pair trawls	
Trawls	Midwater otter trawls	Pelagic trawl
Trawls	Pelagic pair trawls	
Trawls	Otter twin trawls	
Gillnets and similar nets	Set (anchored) gillnets	Set net
Gillnets and similar nets	Encircling gillnets	
Gillnets and similar nets	Trammel nets	

Mandatory CMO information on the category of fishing gear	More detailed information than CMO for the corresponding fishing gears	Fishing gear categories selected in this study
Gillnets and similar nets	Combined trammel and gillnets	
Gillnets and similar nets	Driftnets	Driftnet
Surrounding nets and lift nets	Purse seines	Purse seine
Surrounding nets and lift nets	Lampara nets	
Surrounding nets and lift nets	Boat operated lift nets	
Surrounding nets and lift nets	Shore-operated stationary lift nets	
Hooks and lines	Hand lines and pole lines (hand operated)	
Hooks and lines	Hand lines and pole lines (mechanised)	Hook and line
Hooks and lines	Troll lines	
Hooks and lines	Set longlines	Set longline
Hooks and lines	Longlines (drifting)	Longline (drifting)
Dredges	Boat dredges	
Dredges	Hand dredges used on board a vessel	Dredge
Dredges	Mechanised dredges including suction dredges	
Pots and traps	Pots (traps)	Pot and trap
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*listed in the CMO under seines but unclear what it refers to. The definition of "pair seine" is more resembling a demersal trawl, and there is no reporting code for this gear in fisheries.

Selection of fishing areas

The identification of the catch areas for EU landings was carried out by analysing FDI data on catches for the commercial species (Table 1) for the reference year 2021 (*i.e.*, column "sub region"). For imported species, a bibliographic search was conducted to identify catch areas, combining general information on species range and ecology from specialised, recognised online sources (*e.g.*, fishbase.org, sealifebase.org), scientific publications, and grey literature. A total of 16 FAO fishing areas were considered (Table 3).

Table 3. FAO fishing areas considered in the study.

FAO fishing areas	
18	Arctic Sea
21	Atlantic, Northwest
27	Atlantic, Northeast
31	Atlantic, Western Central
34	Atlantic, Eastern Central
37	Mediterranean and Black Sea
41	Atlantic, Southwest
47	Atlantic, Southeast
51	Indian Ocean, Western
57	Indian Ocean, Eastern
61	Pacific, Northwest
67	Pacific, Northeast
71	Pacific, Western Central
77	Pacific, Eastern Central
81	Pacific, Southwest
87	Pacific, Southeast

Combining species, fishing areas and fishing gears

The combination of the selected commercial species (Table 1) with the fishing gears (Table 2) and fishing area (Table 3) provided what the EWG 20-05 defined as a "pseudo-métier". This combination was used as a proxy to estimate the risk that each combination of fishing area x gear x target species poses to sensitive species in terms of bycatch. In the resulting database, a filtering function enables to choose between a low level of detail (only mandatory CMO information is available) or a higher level of detail (more precise information than the mandatory CMO information is available). Following the reasoning of the EWG in STECF 20-05 of a scoring system that evaluates the fisheries products differently depending on the level of information available, a fishery product should not be able to obtain the lowest (that is, the best) score in case only the mandatory CMO information is available. Exceptions exist, however, if it is absolutely certain that the fishing technique employed (due to technical properties of fishing gears or their mode of use), or the fishing area considered presents no risk for a certain group of sensitive species. For instance, the risk of bycatch of sea turtles is null in the Arctic and Antarctic, while bycatches of either sea turtles, marine mammals, or seabirds when hand-harvesting a fisheries product can also safely be assumed to be inexistant. In both cases, this will translate to the lowest risk score (1), even if only the mandatory CMO information is available. For all gear categories, following the precautionary principle, the group chose to assign the highest risk score that was estimated for all the gears included in the corresponding gear category.

Sensitive species considered in this report

To evaluate if a robust approach for developing an indicator for the "impact on sensitive species" from fisheries products is at all feasible given data and resources at hand, the ad-hoc group decided to narrow the scope and focus on airbreathing species only, as suggested by EWG 22-12. In most fisheries around the world, catches of sea turtles, marine mammals, and seabirds are only incidental and should be avoided. Initially, elasmobranchs were also considered as an additional candidate species group because of *inter alia* the general low productivity of large sharks and rays, making many species in this group sensitive to fishing. However, some elasmobranch species are locally also targeted intentionally and landed, and the data to support fisheries management and species conservation are largely lacking for chondrichthyans in general and for elasmobranchs in particular (Gillman et al., 2023). In addition, from the restricted scope of and time allocated to this contract, the ad-hoc team considered that it was unfeasible to identify which species are protected (or commercially prohibited) in the different areas, according to the regional, national, or local legislations. A next step of the development could entail identifying a process to inform on potential bycatch risks for all sensitive species including those of commercial value.

Given the broad approach required, as well as the data and resources at hand, the group identified early-on that an indicator on "impact on sensitive species" could not be performed at species level but had to be performed at taxa level (marine mammals, seabirds, sea turtles). Ideally, a species-based approach would be applied here instead, accounting for species-specific risk of interaction with fisheries and considering the conservation status of the species – the most common approach in risk assessments. The relatively coarse approach taken by the ad-hoc group was motivated by the need for developing a valid precautionary approach in the relatively short period allocated to the project that could account for the general paucity of data on bycatch in most fisheries worldwide. Furthermore, although the indicator is called "impact on sensitive species", it is of vital importance for the communication of the results of this ad-hoc work that ***the risk scores stemming from this approach are to be considered as assessments of potential risks of negative interactions between a fishery targeting a certain species with a certain gear type and a group sensitive species*** (here, marine mammals, sea turtles and seabirds). Being a taxa level assessment, a precautionary approach is also needed that assigns generic risks to groups of species, based on the most vulnerable species if information exists, and not specific risk to a certain species. This may call for alternative wording of the indicator, as impact cannot be assessed from a commercial product perspective. In total, this approach yielded 2,530 combinations (see Table 4 as an example of the dataset; full table in Annex 1).

Table 4. Example extract of the database listing the combinations found for the Atlantic herring Clupea harengus.

Target species	**Origin**	**FAO area**	**Sea Basin**	**Gear**	**Sensitive species group**
Clupea harengus	EU landings	27	Atlantic, Northeast	Pelagic trawl	Mammals
Clupea harengus	EU landings	27	Atlantic, Northeast	Pelagic trawl	Turtles
Clupea harengus	EU landings	27	Atlantic, Northeast	Pelagic trawl	Seabirds
Clupea harengus	Imports	27	Atlantic, Northeast	Drift net	Mammals
Clupea harengus	Imports	27	Atlantic, Northeast	Drift net	Turtles
Clupea harengus	Imports	27	Atlantic, Northeast	Drift net	Seabirds
Clupea harengus	Imports	27	Atlantic, Northeast	Pelagic trawl	Mammals
Clupea harengus	Imports	27	Atlantic, Northeast	Pelagic trawl	Turtles
Clupea harengus	Imports	27	Atlantic, Northeast	Pelagic trawl	Seabirds
Clupea harengus	Imports	27	Atlantic, Northeast	Purse seine	Mammals
Clupea harengus	Imports	27	Atlantic, Northeast	Purse seine	Turtles
Clupea harengus	Imports	27	Atlantic, Northeast	Purse seine	Seabirds
Clupea harengus	Imports	27	Atlantic, Northeast	Pelagic trawl	Mammals
Clupea harengus	Imports	27	Atlantic, Northeast	Pelagic trawl	Turtles
Clupea harengus	Imports	27	Atlantic, Northeast	Pelagic trawl	Seabirds
Clupea harengus	Imports	27	Atlantic, Northeast	Purse seine	Mammals
Clupea harengus	Imports	27	Atlantic, Northeast	Purse seine	Turtles
Clupea harengus	Imports	27	Atlantic, Northeast	Purse seine	Seabirds
Clupea harengus	Imports	27	Atlantic, Northeast	Pelagic trawl	Mammals
Clupea harengus	Imports	27	Atlantic, Northeast	Pelagic trawl	Turtles
Clupea harengus	Imports	27	Atlantic, Northeast	Pelagic trawl	Seabirds
Clupea harengus	Imports	27	Atlantic, Northeast	Purse seine	Mammals
Clupea harengus	Imports	27	Atlantic, Northeast	Purse seine	Turtles
Clupea harengus	Imports	27	Atlantic, Northeast	Purse seine	Seabirds

Task 2: gathering of existing information on the risk of interaction

We performed a systematic literature review in August 2023 to identify and list scientific publications on bycatch risk assessments related to interactions between fisheries and marine mammals, seabirds, and sea turtles, both globally and at a regional and local scale. The goal of this systematic review was to inform a risk database from the literature (Annex 2), compiling existing information worldwide related to potential risks for interaction between different fishing activities and sensitive species. The search string in Scopus is shown below:

(TITLE-ABS-KEY (bycatch OR by-catch) AND TITLE-ABS-KEY (mammal OR cetacean OR *bird OR seabird OR turtle OR chelonian) AND TITLE-ABS-KEY (assessment OR risk OR psa) AND NOT TITLE-ABS-KEY (mitigati*)) AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "re") OR LIMIT-TO (DOCTYPE , "ch") OR LIMIT-TO (DOCTYPE , "bk")) AND (EXCLUDE (SUBJAREA , "NEUR") OR EXCLUDE (SUBJAREA , "IMMU") OR EXCLUDE (SUBJAREA , "BUSI") OR EXCLUDE (SUBJAREA , "ENER") OR EXCLUDE (SUBJAREA , "MEDI") OR EXCLUDE (SUBJAREA , "PHAR") OR EXCLUDE (SUBJAREA , "ARTS") OR EXCLUDE (SUBJAREA , "COMP") OR EXCLUDE (SUBJAREA , "NURS") OR EXCLUDE (SUBJAREA , "VETE") OR EXCLUDE (SUBJAREA , "BIOC")) AND (LIMIT-TO (LANGUAGE , "English") OR LIMIT-TO (LANGUAGE , "French") OR LIMIT-TO (LANGUAGE , "Swedish") OR LIMIT-TO (LANGUAGE , "Italian") OR LIMIT-TO (LANGUAGE , "Danish")) AND (LIMIT-TO (PUBYEAR , 2003) OR LIMIT-TO (PUBYEAR , 2004) OR LIMIT-TO (PUBYEAR , 2005) OR LIMIT-TO (PUBYEAR , 2006) OR LIMIT-TO (PUBYEAR , 2007) OR LIMIT-TO (PUBYEAR , 2008) OR LIMIT-TO (PUBYEAR , 2009) OR LIMIT-TO (PUBYEAR , 2010) OR LIMIT-TO (PUBYEAR , 2011) OR LIMIT-TO (PUBYEAR , 2012) OR LIMIT-TO (PUBYEAR , 2013) OR LIMIT-TO (PUBYEAR , 2014) OR LIMIT-TO (PUBYEAR , 2015) OR LIMIT-TO (PUBYEAR , 2016) OR LIMIT-TO (PUBYEAR , 2017) OR LIMIT-TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2019) OR LIMIT-TO (PUBYEAR , 2020) OR LIMIT-TO (PUBYEAR , 2021) OR LIMIT-TO (PUBYEAR , 2022) OR LIMIT-TO (PUBYEAR , 2023)

The search resulted in 363 peer-reviewed papers and included, among others, quantitative bycatch estimates for certain regions, gear types or taxa (*e.g.*, rates, magnitudes) together with different forms of quantitative, semi-quantitative, and qualitative bycatch risk assessments (*e.g.*, relative risks between species/gears/areas, absolute risks to populations). The documents identified were screened for information of potential value for both for a system 1 and system 2 approach to build an Annex 2 that could be matched in the form of a “lookup table" to commercial species, gear type, and/or fishing area, following the coverage and classifications described above. Risk-related information collected included:

- assessment type (quantitative, semi-quantitative, qualitative, or NA),
- gear type(s),
- target species or target species assemblages of the listed fishery(ies),

- risk score (low, medium, high, or NA when no score was provided or more in-depth analysis of the study was needed to be able to assign a score by expert judgment; more details described below),
- sensitive species (if any) and sensitive species group (marine mammal, seabird, and/or sea turtle) studied,
- temporal coverage,
- potential additional comments for the interpretation/understanding of the risk score.

Although the sample of publications in scientific journals related to risk assessments identified in the systematic literature search could not cover every combination listed in the Annex 1, complementary information exists from scientific papers not identified in our search and from grey literature (*e.g.*, national, or regional bodies scientific reports, Marine Stewardship Council (MSC) reports, Regional Fisheries Management Organisation (RFMO) reports, etc.). The ad-hoc group identified and additional 31 peer-reviewed publications and scientific reports of interest to this work that were added to the RD, ending up in 394 documents.

These additional sources represent only a small subset of the grey literature published on the subject of interaction between protected species and fisheries that the experts behind this report thought were pertinent to include or refer to. More publications may exist that are either not readily available online and/or written in a language not understood by the experts. Therefore, the work done in this report can be considered preliminary to provide an initial assessment, but can be further detailed in the future, likely to provide a more precise – and possibly better – score for a particular fish product. The full list of publications reviewed by the ad-hoc team is accessible as supporting information of this report and includes the entire list of hits from the search in Scopus and findings, together with a list of additional sources of interest identified by the ad-hoc team. A comprehensive summary of the information extracted from these sources is presented below.

Going through the documents, it was clear that risk assessments are often performed at sensitive species level and/or are restricted to small geographical areas. This limited their applicability for this ad-hoc work, where potential bycatch risks are addressed at taxa level (*i.e.*, marine mammals, seabirds, and sea turtles) and for wide geographical areas. Furthermore, the methodological choices in different studies to address bycatch risks hindered direct comparison across studies if no further processing was done. This is for example highly relevant for PSAs, further described below. However, the literature identified could help to identify which data are currently available for different fisheries, regions, and taxa, and could also highlight the caveats that exist with communicating simple indicators on fishing interaction with sensitive species for certain products (both informing Task 5). Additionally, the systematic review could also form the basis of an approach

for a risk-based process that may be tested (Task 4) and identify information needed for performing new PSAs (Task 3).

When consulting the scientific publications and reports in Annex 2, most studies referred to marine mammals (201), followed by seabirds (150), and turtles (150, both freshwater and marine). Figure 1 summarises the yearly distribution of the publications identified in the RD per year and species group.

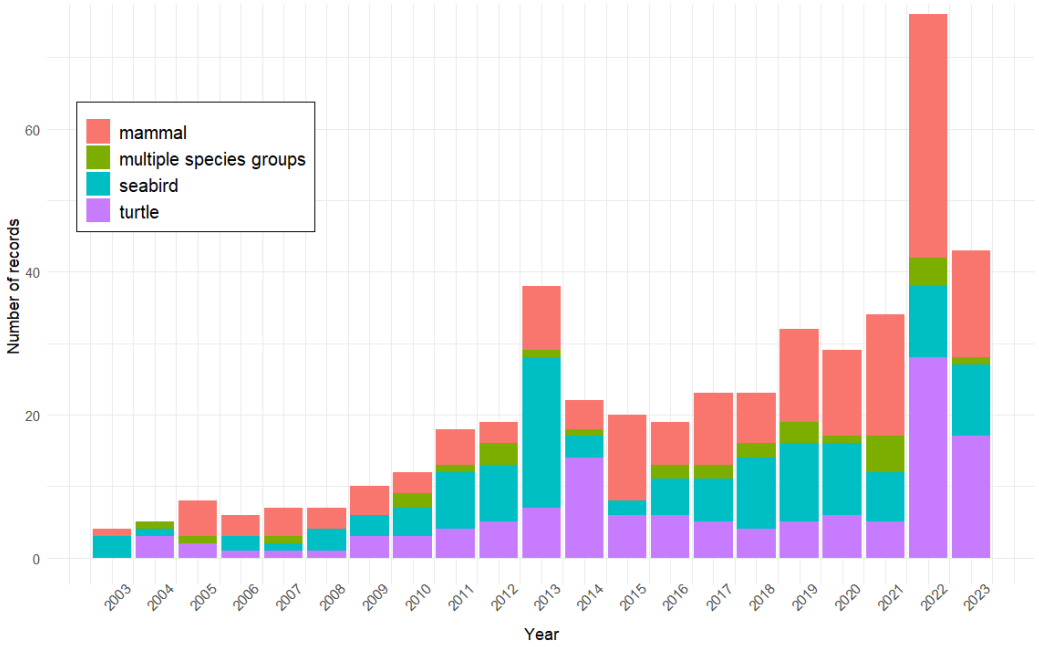

Figure 1. Number of publications in Annex 2 related to species groups (marine mammals, seabirds, and turtles) interactions with fisheries. Multiple species indicate publications that focus on more than 1 species group.

The geographical distribution of the studies identified in the RD is summarised in Figure 2.

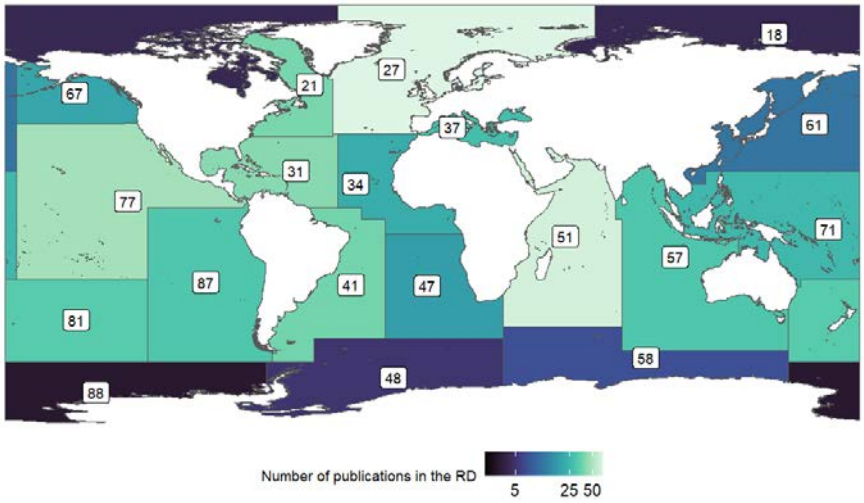

Figure 2. Number of publications in the RD related to species groups interactions with fisheries per FAO Major Fishing Area. The labels indicate FAO area codes.

Relative risk was usually represented in the papers on a scale of low to high, or 1 to 3, where 1 was low risk and 3 was high risk. In many papers, however, only bycatch estimates were present; in these cases, a value was entered on the basis of what was reported in the paper and expert judgement. Looking at these scores that could be assigned directly based on the study (around 40% of the papers), low risk was identified in 23 studies, medium risk in 29, whereas high risk in 95 publications, respectively. There is thus a tendency to report high risk scores, which could be seen as an effect of bias in research – it is likely that there is a tendency in risk assessments to focus on the fisheries and sensitive species that are of concern. Furthermore, it was found that the low-medium-high risk scores could be assigned across all gear categories, *i.e.*, the full range of risk scores was found for the same gear type. This depends on, among others, the fishery assessed, the sensitive species studied, and the methodological approach chosen. Year of publication may also be relevant, as effective by-catch mitigation measures may have been implemented for certain regions or specific fisheries. In this study, a precautionary approach was taken, leading to the selection of the worst score.

The systematic review identified only a few Productivity Susceptibility Analyses (PSA) assessing risks for marine mammals, seabirds, and turtles. These were included in the RD to indicate general risk level (low-medium-high) to mammals, seabirds, and turtles for a certain fishery, but they were patchy in terms of fishing areas and species. Several drawbacks also exist for using existing PSA studies for the purpose of the communicating risks to sensitive species/taxa from different commercial products. A PSA assigns relative risk levels for the individual species (or groups of species) that are within the scope of the study (Stobutzki et al., 2001). Moreover, various PSA approaches exist that are linked to specific limitations and uncertainties, particularly for species categorized with medium risk levels (Hordyk and Carruthers, 2018). Using existing PSA thus introduces issues with comparability of results across studies, when the different methodological choices made in each study affect *e.g.*, the cut-offs between high, medium, and low risks and in the end outcome. This implies that risk levels identified in different PSAs are not necessarily equivalent and comparable between studies, *i.e.*, that the scores from PSA studies should not be considered as a measure of absolute risk of bycatch. Another challenge is that a PSA applies relative risk levels to the species assessed, whereas the approach chosen in this report is based on risk levels for entire taxa. Furthermore, PSAs use in general a precautionary and conservative approach, as lack of data or data uncertainty tend to result in higher perceived risks, potentially leading to false positives.

The findings from the literature review highlight the difficulty in assigning a generic risk score on "impacts on sensitive species" for a product based on coarse data. As an example, the vast majority of the fisheries in the eastern, central Pacific (FAO 77), a fishing area of 48 100 100 km^2 (13.3% of the global marine areas), have no overlap with the distribution of the vaquita *Phocoena*

sinus in the north-eastern part of the Gulf of California, where the handful of individuals of the rarest cetacean in the world still survive (Rojas-Bracho et al., 2006). Even so, based on the information at hand for the commercial product on the EU market, all products originating from FAO 77 and using a gear susceptible to interact with marine mammals are, following the precautionary principle, posing a high risk to *all* marine mammals in the *entire* FAO 77 area.

Another challenge related to developing an indicator to communicate the "impact on sensitive species" from a fisheries product from fisheries is to highlight what the relative difference between commercial products actually indicates – or to put it in another way, what does a certain level of risk imply and how does it compare to the other levels? A ranking between gear categories may be used – such as considering that gillnets are worse in terms of potential risks for sensitive species compared to trap fisheries – but the actual impact is very context dependent. For example, trap fisheries are often seen as representing a low risk of bycatch of sensitive species. Yet, in the American lobster *Homarus americanus* pot fishery along the east coast of North America, entanglement of whales in the ropes linking the traps to the surface marking buoys is not uncommon, including entanglement of North-Atlantic right whale *Eubalaena glacialis*, one of the most endangered whales in the world (Johnson et al., 2005). It is clear from this simple example that **there may be large discrepancies between general risks for some gear categories in the large geographical areas as given in the CMO mandatory information** (here, trap fisheries in FAO 21) and the actual risks for certain species in specific fisheries (here, high risk of whale entanglement in the lobster trap fishery in the north-eastern US). Furthermore, the effect of fisheries on sensitive species is not limited to direct mortality from incidental captures. **Other important issues may also negatively affect sensitive species that is not accounted for in this ad-hoc work may play a major role in the sustainability of some species or groups of species**. Among those is the reduction of prey availability for predatory seabirds and mammals from fishing activities. For instance, the depletion of prey fish in some areas is known to affect the breeding success of some seabirds like the Atlantic puffin *Fratercula arctica* or the black-legged kittiwake *Rissa tridactyla* (Cury et al., 2011; Fayet et al., 2021).

Noting all these caveats, a suggested workflow to allow for utilizing different sources of information in the best possible manner for the intended purpose was therefore needed (described under task 4). The intention was to be able to score commercial products and discuss the feasibility and robustness, and if an indicator related to "impact on sensitive species" from different fisheries products is at all realistic (task 5).

Task 3: on performing new Productivity Susceptibility Analyses (PSAs)

PSAs may assist in identifying potential risks in data-limited circumstances and by this aid in prioritizing actions to mitigate those risks, such as data collection or management measures. It can thus serve as a decision-making tool for progressively enhancing the sustainability of seafood products in the European market. It is however unclear where utilizing PSAs would be most effective; perhaps it is better applied in a fishery management context as it is done in Australia (Hobday et al., 2011). However, PSAs are also used by the eco-certification Marine Stewardship Council (MSC) in their assessment and applying a similar approach to non-certified commercial products from fisheries may allow for comparability and offer an opportunity to cover all products on the EU market.

To develop dedicated PSAs for assessing the effect of fishing on sensitive species for all the fisheries products present on the EU market, the following efforts would be needed:

1. To collate the different approaches used to assess Productivity and Susceptibility attributes for different taxa and to harmonize them using an appropriate methodology (*e.g.*, which attributes and cut-off values between low-medium-high risk to use), including the approach applied by MSC, guided by the data at hand.
2. To collate species lists with data on different species' productivity (life history parameters) and susceptibility (geographical range, post-capture mortality) attributes.
3. To collate a list of fishing fleets targeting the commercial species sold on the EU market, including susceptibility attributes (*e.g.*, depth range, spatial distribution).
4. Based on the information collated in 1, 2, and 3, to perform PSAs for all the combinations of sensitive species and fleets (combination of gear and target species following CMO information) identified from the PSAs sold on the EU market.

The first three bullet points above are probably the most time-consuming tasks and could require a relatively large, dedicated expert group but could perhaps be streamlined through collaboration with experts in *e.g.*, Australia that have developed databases and regularly applies the tool. Once the attributes are collated, performing the PSAs would be relatively simple and quick. However, the output will be in the form of relative risks for individual species to different fleets. The following step is likely the most challenging and will consist of interpreting and merging the findings of the PSAs into a single, interpretable score that would be the core of a strong, science-backed system 1 for the indicator for "impact on sensitive species".

Task 4: approaches for combining risks for sensitive species to the most important commercial species

Risk assessments can take many forms, from very simple qualitative assessments to much more complex population modelling predictions. For example, while a PSA would assess a relative risk between the different species included in the assessment, a Population Viability Analysis (PVA) would predict the sustainability of a population or a species under varying scenarios, which would correspond to assessing an absolute risk of *e.g.*, extinction. As already motivated in task 2, the terminology for the indicator, "impact on sensitive species", is problematic. To truly evaluate the different degrees of impact on a sensitive species (or group of species) from a fishery or fisheries behind a certain commercial product would imply that one could estimate the mortality on this sensitive species (or group of species) from the specific fishery(ies) and estimate whether this mortality from this fishing poses a threat to the long-term viability of that species (or group of species). Given the data at hand during the elaboration of this report, it is clear that it was not feasible to inform on the actual 'impact' on sensitive species from a certain commercial product. **We simply cannot say anything on the impact, but we may address potential risks for impact on a species in different ways, *e.g.*, estimated bycatch rates, likely outcome from interaction between a fishery and a species, etc. Therefore, if this indicator should be operationalised, it is crucial to carefully consider the correct terminology to use and the message the indicator is meant to convey.**

The workflows suggested below (and scores obtained) are thus, most importantly, hereby defined as assessing the 'potential risk for negative interaction(s) between the fishery from which the fisheries product originates and the most sensitive species in each of the sensitive species' groups considered'. Furthermore, the approach estimates risk independently for each actual fisheries product, as it is informed by the gear category used and the fishing area and not the specific fishery(ies), and separately for each of the three sensitive species groups (marine mammals, seabirds, and sea turtle). This implies that there will be issues with scores attributing risk levels to certain products using this definition as *e.g.*, bycatch rates may differ between fleets/regions landing the same commercial species. Furthermore, the degree of risk for a species due to fishing activities may differ between species within the sensitive species group, and also between different sub-areas within larger fishing area (Table 3). With these caveats in mind, suggested approaches for an indicator for ***risks*** to sensitive species follows. **To handle all these caveats, a precautionary approach was taken, assigning the worst risk scores for gears and species groups if different risk levels have been identified or the information on the fisheries product is not enough to allow for more specific assessment in terms of *e.g.*, gear category of resolution of fishing area.**

Additionally, to align the indicator on fishing activities' impact on sensitive species with the other two indicators for fisheries products proposed in STECF-22-12 (*i.e.*, fishing pressure and seabed impact), we used a risk scale ranging from 1 to 5 (Table 5). These scores are evaluated independently for each of the sensitive species' groups considered by the ad-hoc team (here, marine mammals, seabirds, and sea turtles). A score of 1 corresponds to a high certainty of very low likelihood of negative interaction(s) between the fishery from which the considered fisheries product originates and the most sensitive species in a sensitive species group, while conversely, a score of 5 corresponds to a very high risk with high certainty or a very high uncertainty in the risk of interaction(s) for the considered combination of gear-area and sensitive species group. The intermediate values on the scale allow adjusting the scores in terms of likelihood of interaction and level of confidence (*i.e.*, certainty), based on the information available for specific fisheries products, from the scientific literature, or from expert judgement, where appropriate.

Table 5. Score system adopted in the study.

Final score	
1	Very low
2	Low
3	Medium
4	High
5	Very high

The ad-hoc team suggests that the recommendations listed above are carefully discussed during the upcoming EWG in December 2023.

System 0: generic approach

The risk database revealed that information on risks to sensitive species are patchy in coverage. Therefore, to be able to assign risk scores for as many commercial products as possible, a generic approach for determining potential risk for sensitive species only based on fishing gears was developed. This rating can assign a basic, precautionary rating for all products on the market, even if no detailed information is available. Using a precautionary principle, the scores stemming from this System 0 approach will tend to be towards the highest levels of risk identified, unless clear and unambiguous evidence that the assessed fishing gear category is not posing a threat to the sensitive species groups considered. The intention here is to encourage the fishing industry to provide more detailed data to demonstrate that the evaluated seafood product poses less of a risk than one defined using the System 0 approach, resulting in a likely reduction of the risk score for that product.

Essentially, more specific data related to the fisheries products (gear used, fishing area) and available information on by-catch interactions with sensitive species, would qualify the evaluated fisheries products for a scoring under a System 1 or System 2 approach instead.

The System 0 approach rates the **general potential risk posed by a specific fishing gear to marine mammals, seabirds, and sea turtles.** System 0 scores were assessed based on the input from a restricted set of key documents (both peer-reviewed papers and grey literature) that apply generic approaches, cover global fisheries or vast geographical regions, and which findings are consequently **applicable to all fisheries products** on the EU market (Wade et al., 2021; Wallace et al., 2013; Lewison et al., 2014; Dias et al., 2019; Good, 2019; Carpentieri et al., 2021; Chuenpagdee et al., 2003). If we could not find information on bycatch risk relating to a specific gear category, a risk score was informed by PSA-thinking, where attributes indicating susceptibility to fisheries include degree of overlap of a species and the fishery, selectivity, and post-capture mortality. This approach scored *e.g.*, fishing practices based on hand-picking as being low risk. In cases where multiple sources of information corresponding to different risk ratings were available for combinations of gear category and sensitive species group, a precautionary approach was applied. That is, for a given combination of gear category and sensitive species group, the highest score identified in that gear category was applied. Furthermore, most of the scientific and grey literature that we reviewed for System 0 scoring measures risk levels on a scale from 1 to 3. To align the System 0 indicator with the other two indicators for fisheries products proposed in STECF-22-12 (*i.e.*, fishing pressure and seabed impact), we rescaled the scores to range from 1 to 5 (Table 5). That is, we rescaled a 3-level score (1, 2 and 3) to a 5-level score (1=1; 2=3; 3=5). In addition, the scores in System 0 are by design conservative and must reflect the worst risk for each gear category. System 0 scores could lead to unfair scoring of fishing fleets that use effective mitigation measures to reduce bycatch rates, or which effort distribution does not overlap with the most at-risk species in each sensitive species group. Consequently, a score in System 0 for a given gear category could be at best equal or above the worst score in that same gear category using a System 1 or a System 2 approach. The method developed in System 0 produces a majority of “very high” risk, as shown in Figure 3.

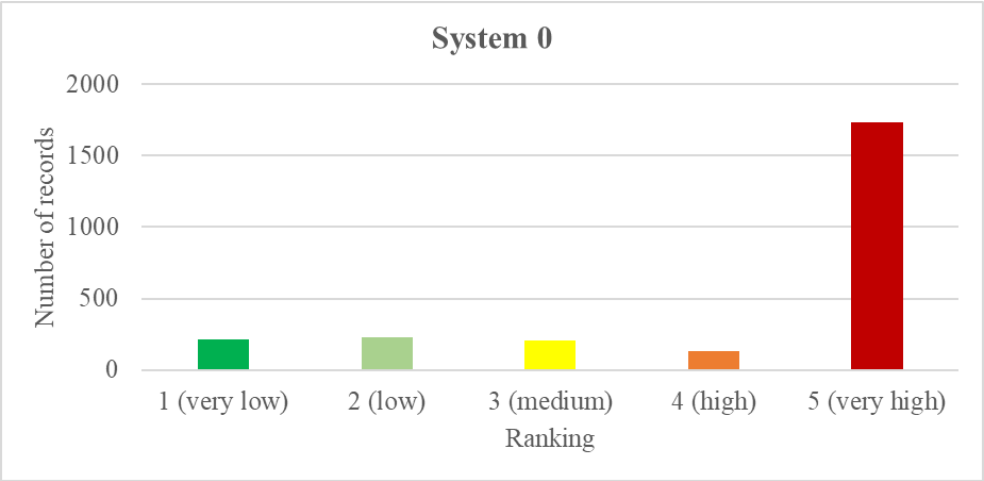

*Figure 3. Number of records for each combination of Target species * Origin * FAO area * Sea Basin * Gear * Sensitive species group using a System 0 scoring approach.*

System 1: mandatory information in the current CMO

The System 1 approach assigns a risk level to sensitive species based on the mandatory CMO information provided for all fisheries products found on the EU market (*i.e.*, commercial species name, fishing gear, and fishing area). Unlike System 0, the System 1 approach considers not only the general risk for each gear category but assigns a **risk for each combination of gear category and fishing area, and for each sensitive species group** (marine mammal, seabird, and sea turtle). In a System 1, available information on bycatch from identified peer-reviewed and grey literature is used to adjust risk scores from the system 0 approach (Annex 1).

Following the precautionary approach, the System 1 approach assigns scores for each combination of gear category and area (and for each sensitive species group) based on the most at-risk species within each sensitive species group, and on the gear type within the gear category that poses the highest risk. This implies that if the risk of interaction is high for at least one species in a FAO area with a given gear type, the risk score within that sensitive species group will be high in the corresponding gear category for all the fisheries using that gear type. This approach, although more refined than the previous System 0, remains very general and cannot account for the specificities of each fishery using a certain gear type in a FAO area. These specificities include, *e.g.*, different fishing depths for different commercial species or different targeting pattern of the same fishing gear (seasonal, temporal, bycatch mitigation in place). When the literature review allowed for assigning a risk score for a certain functional group (mammals, turtles, seabirds) in a certain area and for a specific gear, this value was then applied to all fish products caught in that area with that particular gear. Based on the caveats described earlier, this could lead to unfair scoring of fishing fleets that use effective mitigation measures to reduce bycatch rates, or which effort distribution does not overlap

with the most at-risk species in each sensitive species group. Nevertheless, this approach should incentivise the fishing industry to provide evidence that their fisheries products are associated with lower risks for sensitive species than what a System 1 approach can conclude based on CMO information alone. This may be done by *e.g.*, 100% observer data verification or other evidence that guarantee the use of effective bycatch mitigating measures in the assessed fishing fleets, or by indicating a finer spatial scale than FAO area for the fisheries product. The method developed in System 1 produces a majority of "very high" risk, as shown in Figure 4.

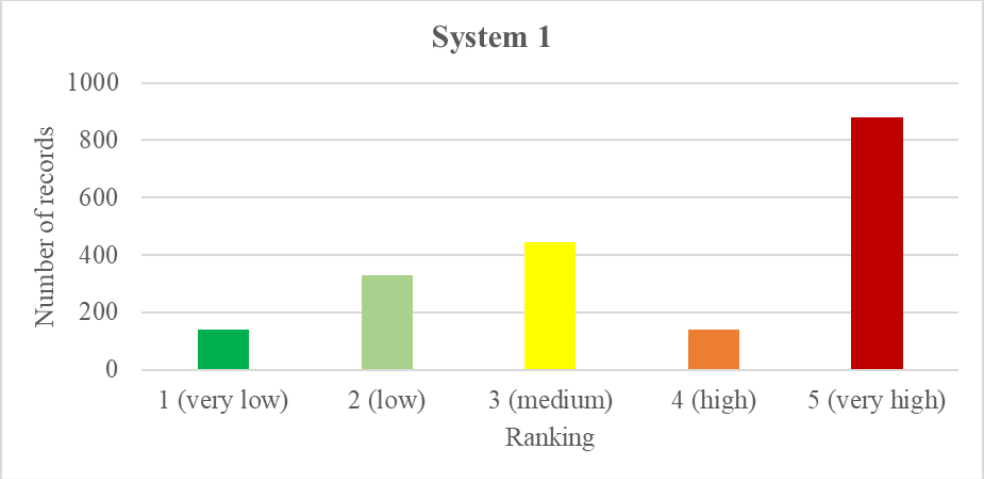

*Figure 4. Number of records for each combination of Target species * Origin * FAO area * Sea Basin * Gear * Sensitive species group using a System 1 scoring approach.*

The approach for a System 1 indicator were developed and tested during this ad-hoc work with a case study covering the fishing area FAO 27 to evaluate the pros and cons of different workflows (described below).

Case study: FAO 27, Northeast Atlantic

The major fishing area FAO 27 was chosen to demonstrate how a risk-based indicator could be developed under a System 1 approach. The FAO 27 area borders the coast of Western Europe and Scandinavia, including the Baltic Sea, and is as such one of the most important fishing areas for the EU fleet, together with FAO area 37 (the Mediterranean and Black Sea). Fisheries products originating from FAO 27 occasionally indicate more precise geographical information and/or gear type information than the mandatory CMO information, allowing for more detailed testing and analysis of outcomes. For instance, the FAO sub-areas and divisions within FAO 27 , hereafter FAO sub-areas (Figure 1), are sometimes referred to on the fisheries products sold on the EU market, either directly using the FAO sub-area code (*e.g.*, fish captured in FAO 27.IV) or using the corresponding "vernacular" name (fish captured in the North Sea). A specific workflow for FAO 27 was developed

to assign risk scores separately for marine mammals, seabirds, and sea turtles for 47 FAO sub-areas, based primarily on information from the risk database (RD), supplemented with general (*i.e.*, global) risks defined in System 0, and complemented with expert opinion for the gear-areas combinations for which direct evidence from the literature was lacking. The results of the risk scoring using a System 1 approach for the fisheries products originating from FAO 27 but providing information on FAO sub-area are shown in Table 6, Table 7, and Table 8. Evidence of gear-specific fishing effort in each FAO sub-area was taken from the FDI database for years 2020-2022. Gears were considered first at métier level 3 (*i.e.*, at gear groups level, as defined under the EU Data Collection Framework[1]), and then aggregated to gear categories as described in Table 2.

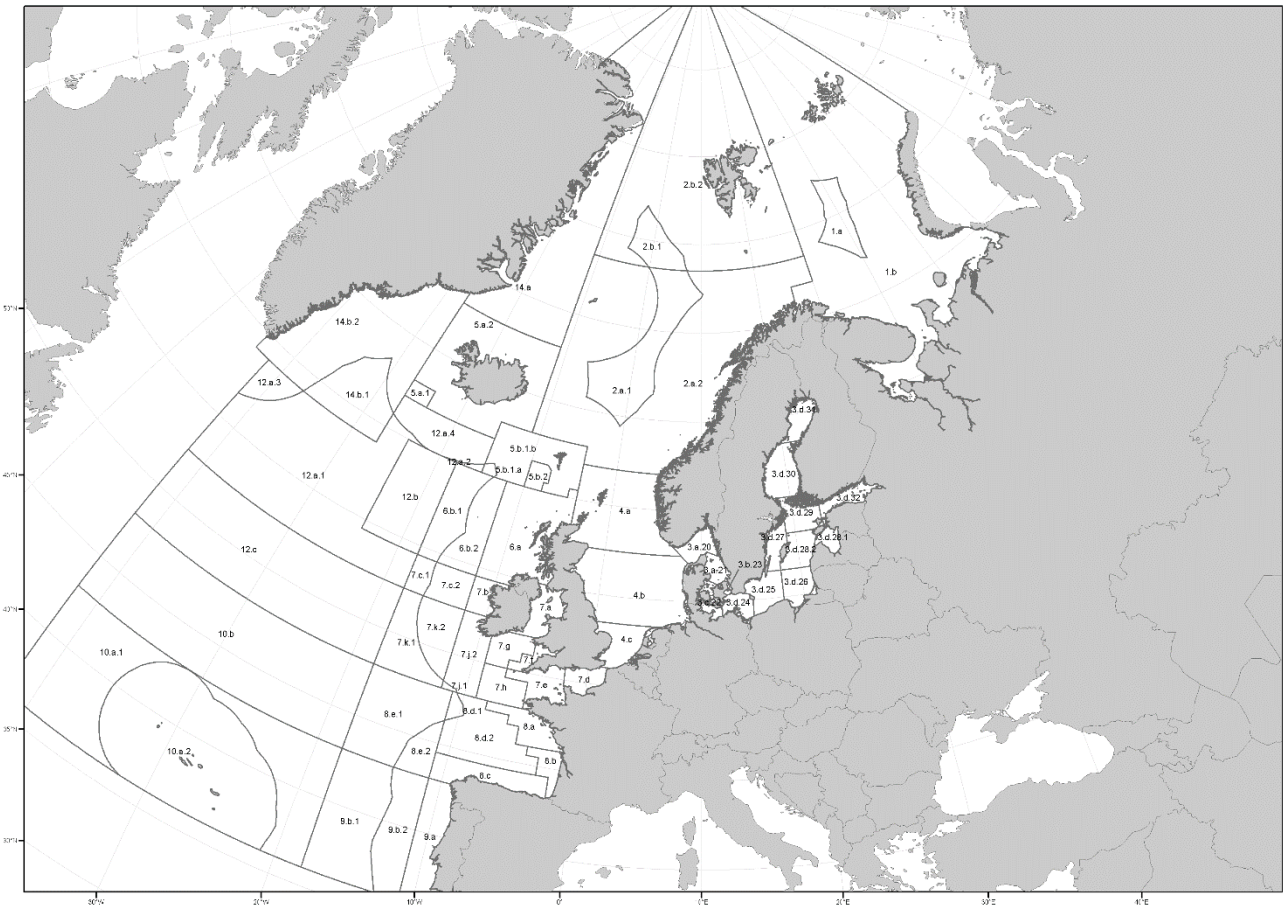

Figure 5. Map of FAO Major Fishing Area 27 divided by FAO sub-areas.

Essentially, the process assigning risk scores using a System 1 approach in FAO 27 resulted in one risk score matrix per sensitive species group and consisted of:

1. Assigning very low risk scores (*i.e.*, score 1) to FAO sub-areas with no overlap between fishing gear types and sensitive species groups. Practically, we considered the maximum

[1] https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:346:0037:0088:EN:PDF#page=16

range of the distribution of sea turtles and assumed that the risk of interaction was null outside the distribution range in the northern part of FAO 27 (for marine mammals or for seabirds, which range over the entire FAO 27, no such assumption was made).

2. Assigning risk scores for the remaining combinations of gear and area for all sensitive species groups, by filtering Annex 2 to identify scientific papers and reports that explicitly refer to the combinations of (at least one species within) sensitive species groups, fishing gear type or gear category (Table 2), and FAO sub-area (Figure 5). We then assigned risk scores based on this evidence, using a 1-to-5 scale (Table 5). If multiple recent studies were found for the same combination, the highest risk level identified within these studies was chosen for the scoring, following the precautionary approach.
3. Assigning risk scores for the combinations of taxa-gear-area for which no specific papers or report was found in the RD using the generic, global approach defined in System 0. In general, this resulted in assigning high risk scores for so-called "high-risk gears" like *e.g.*, (drift) gillnets or longlines.
4. Revising risk scores, based on expert opinion and using a precautionary approach, for a selection of combinations of taxa-gear-area when (global) scores from System 0 would differ from risk scores in FAO 27. For instance, the risk of interaction of hand-picked food products with marine mammals, seabirds, and sea turtles was generally considered very low in FAO 27, translating into a score of 1.
5. Summarising the scores by gear type and then by gear category for the entire FAO 27. That is, for each sensitive species group, a) we identified the highest risk score for each gear type in all FAO sub-areas (row "sub-total" in Table 6, Table 7, and Table 8), b) grouped the gear types per gear category, and c) identified the highest risk score within each gear category to obtain System 1 scores (row "Total" in Table 6, Table 7, and Table 8).

Table 6. Bycatch risk scores for marine mammals in FAO Major Fishing Area 27 (top), broken down by FAO sub-area and fishing gear at métier Level 3. A summary of the risk scores by fishing gear at métier Level 3 and gear category (as defined in Table 2) for the entire FAO 27 area is given at the bottom of the table, using the highest score in each column/category. NA indicates that no fishing for that gear was registered in years 2020-2021 in the FDI database. The shades of blue indicate what the scoring is based on, namely, light blue: direct evidence from literature; medium-light blue: use the global risk score (System 0) from the literature; dark blue: expert opinion using a precautionary approach.

System 1 scores in FAO 27

Gear category	Dredge			Pot and Trap			Hand harvesting			Drift net	Set net				Hook and Line			Drift longline	Set longline	Bottom trawl				Pelagic trawl		Purse seine		Seine			
Total	2			4			1			5	5				2			3	3	5				5		5		5			
Gear L3	DRB	DRH	HMD	FPN	FPO	FYK	GEF	LNB	LNS	GND	GNC	GNS	GTN	GTR	LHM	LHP	LTL	LLD	LLS	OTB	OTT	PTB	TBB	OTM	PTM	LA	PS	SB	SDN	SPR	SSC
subtotal	2	2	2	2	4	3	1	1	1	5	5	5	5	5	2	2	2	3	3	5	5	5	5	5	5	3	5	2	3	5	2

Details of risk scores per gear type in FAO 27

Gear L3	DRB	DRH	HMD	FPN	FPO	FYK	GEF	LNB	LNS	GND	GNC	GNS	GTN	GTR	LHM	LHP	LTL	LLD	LLS	OTB	OTT	PTB	TBB	OTM	PTM	LA	PS	SB	SDN	SPR	SSC
1.a	NA	NA	NA	NA	3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5	NA	NA	5	NA	NA	NA	NA	NA	NA	NA	NA
1.b	NA	NA	NA	NA	3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5	5	NA	5	NA	NA	NA	NA	NA	NA	NA	NA
10.a	NA	NA	NA	NA	3	NA	NA	1	NA	NA	NA	5	NA	5	2	2	2	3	3	5	NA	NA	NA	NA	NA	NA	5	NA	NA	NA	NA
10.b	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2	2	2	3	NA	5	5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
12	NA	NA	NA	NA	3	NA	NA	NA	NA	NA	NA	5	NA	5	NA	NA	NA	3	NA	5	5	NA	NA	5	NA	NA	5	NA	NA	NA	NA
14.a	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
14.b	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5	5	NA	NA	5	NA	NA	NA	NA	NA	NA	NA
2.a	2	NA	NA	NA	3	NA	NA	NA	NA	NA	NA	5	NA	5	NA	NA	NA	NA	NA	5	5	5	NA	5	5	NA	5	NA	2	NA	NA
2.b	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5	5	NA	5	5	NA	NA	NA	NA	NA	NA	NA
3.a.20	2	NA	NA	2	3	3	NA	NA	NA	5	NA	5	NA	5	NA	2	NA	NA	3	5	5	5	5	5	5	NA	5	2	2	NA	NA
3.a.21	2	NA	NA	2	3	3	NA	NA	NA	5	NA	5	NA	5	NA	2	NA	NA	3	5	5	5	NA	5	5	NA	5	2	2	NA	NA
3.b.23	NA	NA	NA	2	3	3	NA	NA	NA	5	NA	5	NA	5	NA	2	NA	NA	3	5	NA	NA	NA	5	NA	NA	NA	NA	NA	NA	NA
3.c.22	2	NA	NA	2	3	3	NA	NA	NA	5	NA	5	NA	5	NA	NA	NA	NA	3	5	NA	5	5	5	5	NA	5	NA	2	NA	NA
3.d.24	NA	NA	NA	2	3	3	NA	NA	NA	5	NA	5	NA	5	NA	2	NA	3	3	5	5	5	NA	5	5	NA	NA	NA	2	NA	NA
3.d.25	NA	NA	NA	2	3	3	NA	NA	NA	5	NA	5	NA	5	NA	2	NA	3	3	5	5	5	NA	5	5	NA	5	2	2	NA	NA
3.d.26	NA	NA	NA	2	3	3	NA	NA	NA	NA	NA	5	NA	NA	NA	2	NA	3	3	5	5	5	NA	5	5	NA	NA	NA	2	NA	NA
3.d.27	NA	NA	NA	2	3	3	NA	NA	NA	NA	NA	5	NA	5	NA	NA	NA	NA	NA	5	NA	NA	NA	5	5	NA	NA	NA	2	NA	NA
3.d.28.1	NA	NA	NA	2	3	3	NA	NA	NA	NA	NA	5	NA	NA	NA	NA	NA	NA	3	NA	NA	NA	NA	5	NA	NA	NA	NA	2	NA	NA
3.d.28.2	NA	NA	NA	2	3	3	NA	NA	NA	NA	NA	5	NA	5	NA	NA	NA	3	3	5	NA	5	NA	5	5	NA	NA	NA	2	NA	NA
3.d.29	NA	NA	NA	2	3	3	NA	NA	NA	NA	NA	5	NA	NA	NA	2	NA	3	3	NA	NA	NA	NA	5	5	NA	NA	NA	2	NA	NA
3.d.30	NA	NA	NA	2	3	3	NA	NA	NA	NA	NA	5	NA	NA	NA	2	NA	3	3	5	NA	5	NA	5	5	NA	NA	2	2	NA	NA
3.d.31	NA	NA	NA	2	3	3	NA	NA	NA	NA	NA	5	NA	NA	NA	2	NA	NA	3	5	NA	5	NA	5	5	NA	NA	2	NA	NA	NA
3.d.32	NA	NA	NA	2	3	3	NA	NA	NA	NA	NA	5	NA	NA	NA	2	NA	3	3	NA	NA	NA	NA	5	5	NA	NA	NA	NA	NA	NA
4.a	2	NA	2	NA	3	NA	NA	NA	NA	NA	NA	5	NA	5	2	2	NA	NA	3	5	5	5	5	5	5	NA	5	NA	2	NA	NA
4.b	2	2	2	2	3	3	NA	NA	NA	5	NA	5	5	5	2	2	NA	NA	3	5	5	5	5	5	5	NA	5	NA	2	NA	NA
4.c	2	NA	2	NA	3	3	NA	NA	NA	5	NA	5	5	5	NA	2	2	NA	3	5	5	5	5	5	5	NA	NA	NA	2	5	NA
5.a	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5	NA	NA	NA	5	NA	NA	NA	NA	NA	NA	NA
5.b	NA	NA	NA	NA	3	NA	NA	NA	NA	NA	NA	5	NA	NA	NA	2	NA	NA	1	5	5	NA	5	5	NA	NA	NA	NA	NA	NA	NA
6.a	2	NA	2	NA	3	NA	NA	NA	NA	NA	NA	5	5	5	2	2	NA	NA	3	4	5	3	5	3	3	NA	5	NA	2	5	NA
6.b	NA	NA	NA	NA	3	NA	NA	NA	NA	NA	NA	5	NA	NA	NA	NA	NA	NA	3	5	5	5	NA	5	5	NA	NA	NA	2	NA	NA
7.a	2	NA	2	NA	3	NA	NA	NA	NA	5	NA	5	NA	5	NA	2	2	NA	3	3	3	5	2	5	3	NA	NA	NA	2	NA	NA
7.b	2	NA	NA	NA	3	NA	NA	NA	NA	NA	NA	5	5	5	2	2	NA	3	3	3	3	NA	NA	3	3	NA	NA	NA	NA	5	NA
7.c	NA	NA	NA	NA	3	NA	NA	NA	NA	NA	NA	5	NA	NA	NA	2	NA	NA	3	5	5	NA	NA	5	5	NA	NA	NA	NA	NA	NA
7.d	2	2	NA	NA	3	NA	1	NA	NA	5	5	5	5	5	2	2	2	3	3	5	5	5	5	5	5	NA	5	2	2	5	2
7.e	2	NA	2	NA	4	NA	1	1	NA	5	5	5	5	5	2	2	2	3	3	5	3	5	2	3	5	NA	3	NA	2	NA	2
7.f	2	NA	2	NA	2	NA	NA	NA	NA	3	5	5	NA	5	NA	2	2	3	3	3	3	NA	2	3	5	NA	3	NA	NA	NA	NA
7.g	2	NA	NA	NA	3	NA	NA	NA	NA	5	5	5	5	5	NA	2	2	3	3	3	4	5	2	5	3	NA	NA	NA	2	NA	NA
7.h	2	NA	2	NA	3	NA	1	1	NA	NA	NA	5	5	5	2	2	2	3	3	3	4	5	2	5	3	NA	5	NA	2	NA	NA
7.j	2	NA	NA	NA	3	NA	NA	NA	NA	5	NA	5	5	5	2	2	2	3	3	5	5	5	5	5	5	NA	NA	NA	2	NA	NA
7.k	NA	NA	NA	NA	3	NA	NA	NA	NA	NA	NA	5	NA	NA	2	2	2	3	3	5	5	NA	NA	5	5	NA	NA	NA	NA	NA	NA
8.a	2	NA	2	NA	4	3	1	1	1	5	5	5	5	5	2	2	2	3	3	5	5	3	2	3	4	NA	3	NA	3	NA	NA
8.b	2	NA	NA	NA	3	3	1	1	1	5	5	5	5	5	2	2	2	3	3	4	5	3	2	5	3	NA	3	NA	3	NA	NA
8.c	2	NA	2	2	3	NA	NA	1	NA	5	5	5	5	5	2	2	2	3	3	3	5	3	5	5	3	3	4	NA	2	NA	NA
8.d	2	NA	NA	NA	3	NA	NA	NA	NA	5	5	5	5	5	2	2	2	3	3	5	5	5	5	5	5	NA	5	NA	2	NA	NA
8.e	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5	NA	NA	2	2	2	3	3	5	5	NA	NA	5	5	NA	5	NA	NA	NA	NA
9.a	2	2	2	2	4	3	NA	NA	NA	5	5	5	5	5	2	2	2	3	3	4	5	3	5	NA	NA	NA	4	2	2	NA	2
9.b	2	NA	NA	NA	3	NA	NA	NA	NA	NA	NA	5	NA	5	2	2	2	3	3	5	NA	NA	NA	NA	NA	NA	5	NA	NA	NA	NA

Table 7. Bycatch risk scores for seabirds in FAO Major Fishing Area 27 (top), broken down by FAO sub-area and fishing gear at métier Level 3. A summary of the risk scores by fishing gear at métier Level 3 and gear category (as defined in Table 2) for the entire FAO 27 area is given at the bottom of the table, using the highest score in each column/category. NA indicates that no fishing for that gear was registered in years 2020-2021 in the FDI database. The shades of blue indicate what the scoring is based on, namely, light blue: direct evidence from literature; medium-light blue: use the global risk score (System 0) from the literature; dark blue: expert opinion using a precautionary approach.

System 1 scores in FAO 27

Gear category	Dredge			Pot and Trap			Hand harvesting			Drift net	Set net				Hook and Line			Drift longline	Set longline	Bottom trawl				Pelagic trawl		Purse seine		Seine			
Total	2			2			1			5	5				3			5	5	3				3		5		3			
Gear L3	DRB	DRH	HMD	FPN	FPO	FYK	GEF	LNB	LNS	GND	GNC	GNS	GTN	GTR	LHM	LHP	LTL	LLD	LLS	OTB	OTT	PTB	TBB	OTM	PTM	LA	PS	SB	SDN	SPR	SSC
subtotal	2	2	2	2	2	2	1	1	1	5	5	5	5	5	3	3	3	5	5	3	3	3	3	3	3	5	4	3	2	3	3

Details of risk scores per gear type in FAO 27

Gear L3	DRB	DRH	HMD	FPN	FPO	FYK	GEF	LNB	LNS	GND	GNC	GNS	GTN	GTR	LHM	LHP	LTL	LLD	LLS	OTB	OTT	PTB	TBB	OTM	PTM	LA	PS	SB	SDN	SPR	SSC
1.a	NA	NA	NA	NA	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3	NA	NA	3	NA	NA	NA	NA	NA	NA	NA	NA
1.b	NA	NA	NA	NA	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3	3	NA	3	NA	NA	NA	NA	NA	NA	NA	NA
10.a	NA	NA	NA	NA	2	NA	NA	1	NA	NA	NA	5	NA	5	3	3	3	4	4	3	NA	NA	NA	NA	NA	NA	4	NA	NA	NA	NA
10.b	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3	3	3	4	NA	3	3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
12	NA	NA	NA	NA	2	NA	NA	NA	NA	NA	NA	5	NA	5	NA	NA	NA	4	NA	3	3	NA	NA	3	NA	NA	4	NA	NA	NA	NA
14.a	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
14.b	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3	3	NA	NA	3	NA	NA	NA	NA	NA	NA	NA
2.a	2	NA	NA	NA	2	NA	NA	NA	NA	NA	NA	5	NA	5	NA	NA	NA	NA	NA	3	3	3	NA	3	3	NA	4	NA	2	NA	NA
2.b	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3	3	NA	3	3	NA	NA	NA	NA	NA	NA	NA
3.a.20	2	NA	NA	2	2	2	NA	NA	NA	5	NA	5	NA	5	NA	3	NA	NA	4	3	3	3	3	3	3	NA	4	3	2	NA	3
3.a.21	2	NA	NA	2	2	2	NA	NA	NA	5	NA	5	NA	5	NA	3	NA	NA	4	3	3	3	NA	3	3	NA	4	3	2	NA	NA
3.b.23	NA	NA	NA	2	2	2	NA	NA	NA	5	NA	5	NA	5	NA	3	NA	NA	4	3	NA	NA	NA	3	NA	NA	NA	NA	NA	NA	3
3.c.22	2	NA	NA	2	2	2	NA	NA	NA	5	NA	5	NA	5	NA	NA	NA	NA	4	3	NA	3	3	3	3	NA	4	NA	2	NA	3
3.d.24	NA	NA	NA	2	2	2	NA	NA	NA	5	NA	5	NA	5	NA	3	NA	4	4	3	3	3	NA	3	3	NA	NA	NA	2	NA	3
3.d.25	NA	NA	NA	2	2	2	NA	NA	NA	5	NA	5	NA	5	NA	3	NA	4	4	3	3	3	NA	3	3	NA	4	3	2	NA	3
3.d.26	NA	NA	NA	2	2	2	NA	NA	NA	NA	NA	5	NA	NA	NA	3	NA	4	4	3	3	3	NA	3	3	NA	NA	NA	2	NA	NA
3.d.27	NA	NA	NA	2	2	2	NA	NA	NA	NA	NA	5	NA	5	NA	NA	NA	NA	NA	3	NA	NA	NA	3	3	NA	NA	NA	2	NA	NA
3.d.28.1	NA	NA	NA	2	2	2	NA	NA	NA	NA	NA	5	NA	NA	NA	NA	NA	NA	4	NA	NA	NA	NA	3	NA	NA	NA	NA	2	NA	NA
3.d.28.2	NA	NA	NA	2	2	2	NA	NA	NA	NA	NA	5	NA	5	NA	NA	NA	4	4	3	NA	3	NA	3	3	NA	NA	NA	2	NA	NA
3.d.29	NA	NA	NA	2	2	2	NA	NA	NA	NA	NA	5	NA	NA	NA	3	NA	4	4	NA	NA	NA	NA	3	3	NA	NA	NA	2	NA	3
3.d.30	NA	NA	NA	2	2	2	NA	NA	NA	NA	NA	5	NA	NA	NA	3	NA	4	4	3	NA	3	NA	3	3	NA	NA	3	2	NA	NA
3.d.31	NA	NA	NA	2	2	2	NA	NA	NA	NA	NA	5	NA	NA	NA	3	NA	NA	4	3	NA	3	NA	3	3	NA	NA	3	NA	NA	3
3.d.32	NA	NA	NA	2	2	2	NA	NA	NA	NA	NA	5	NA	NA	NA	3	NA	4	4	NA	NA	NA	NA	3	3	NA	NA	NA	NA	NA	3
4.a	2	NA	2	NA	2	NA	NA	NA	NA	NA	NA	5	NA	5	3	3	NA	NA	4	3	3	3	3	3	3	NA	4	NA	2	NA	3
4.b	2	2	2	2	2	2	NA	NA	NA	5	NA	5	5	5	3	3	NA	NA	4	3	3	3	3	3	3	NA	4	NA	2	NA	3
4.c	2	NA	2	NA	2	2	NA	NA	NA	5	NA	5	5	5	NA	3	3	NA	4	3	3	3	3	3	3	NA	NA	NA	2	3	3
5.a	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3	NA	NA	3	3	NA	NA	NA	NA	NA	NA	NA
5.b	NA	NA	NA	NA	2	NA	NA	NA	NA	NA	NA	5	NA	NA	NA	3	NA	NA	4	3	3	NA	3	3	NA	NA	NA	NA	NA	NA	NA
6.a	2	NA	2	NA	2	NA	NA	NA	NA	NA	NA	5	5	5	3	3	NA	NA	4	3	3	3	3	3	3	NA	4	NA	2	3	3
6.b	NA	NA	NA	NA	2	NA	NA	NA	NA	NA	NA	5	NA	NA	NA	NA	NA	NA	4	3	3	3	NA	3	3	NA	NA	NA	2	NA	3
7.a	2	NA	2	NA	2	NA	NA	NA	NA	5	NA	5	NA	5	NA	3	3	NA	4	3	3	3	2	3	3	NA	NA	NA	2	NA	3
7.b	2	NA	NA	NA	2	NA	NA	NA	NA	NA	NA	5	5	5	3	3	NA	4	4	3	3	NA	NA	3	3	NA	NA	NA	NA	3	3
7.c	NA	NA	NA	NA	2	NA	NA	NA	NA	NA	NA	5	NA	NA	NA	3	NA	NA	4	3	3	NA	NA	3	3	NA	NA	NA	NA	NA	NA
7.d	2	2	NA	NA	2	NA	1	NA	NA	5	5	5	5	5	3	3	3	4	4	3	3	3	3	3	3	NA	4	3	2	3	3
7.e	2	NA	2	NA	2	NA	1	1	NA	5	5	5	5	5	2	3	3	4	4	3	3	3	2	3	3	NA	4	NA	2	NA	3
7.f	2	NA	2	NA	2	NA	NA	NA	NA	5	5	5	NA	5	NA	3	3	4	4	3	3	NA	2	3	3	NA	4	NA	NA	NA	3
7.g	2	NA	NA	NA	2	NA	NA	NA	NA	5	5	5	5	5	NA	3	3	4	4	3	3	3	2	3	3	NA	NA	NA	2	NA	3
7.h	2	NA	2	NA	2	NA	1	1	NA	NA	NA	5	5	5	3	3	3	4	4	3	3	3	2	3	3	NA	4	NA	2	NA	3
7.j	2	NA	NA	NA	2	NA	NA	NA	NA	5	NA	5	5	5	3	3	3	4	4	3	3	3	3	3	3	NA	NA	NA	2	NA	3
7.k	NA	NA	NA	NA	2	NA	NA	NA	NA	NA	NA	5	NA	NA	3	3	3	4	4	3	3	NA	NA	3	3	NA	NA	NA	NA	NA	NA
8.a	2	NA	2	NA	2	2	1	1	1	5	5	5	5	5	3	3	3	3	3	3	3	3	2	3	3	NA	4	NA	2	NA	NA
8.b	2	NA	NA	NA	2	2	1	1	1	5	5	5	5	5	3	3	3	3	3	3	3	3	2	3	3	NA	4	NA	2	NA	3
8.c	2	NA	2	1	2	NA	NA	1	NA	5	5	5	5	5	2	3	3	3	3	3	3	3	3	3	3	5	4	NA	2	NA	NA
8.d	2	NA	NA	NA	2	NA	NA	NA	NA	5	5	5	5	5	3	3	3	3	3	3	3	3	3	3	3	NA	4	NA	2	NA	NA
8.e	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5	NA	NA	3	3	3	4	4	3	3	NA	NA	3	3	NA	4	NA	NA	NA	NA
9.a	2	2	2	2	2	2	NA	NA	NA	5	5	5	5	5	3	3	3	5	5	2	3	2	2	NA	NA	NA	4	3	2	NA	2
9.b	2	NA	NA	NA	2	NA	NA	NA	NA	NA	NA	5	NA	5	3	3	3	4	4	3	NA	NA	NA	NA	NA	NA	4	NA	NA	NA	NA

Table 8. Bycatch risk scores for sea turtles in FAO Major Fishing Area 27 (top), broken down by FAO sub-area and fishing gear at métier Level 3. A summary of the risk scores by fishing gear at métier Level 3 and gear category (as defined in Table 2) for the entire FAO 27 area is given at the bottom of the table, using the highest score in each column/category. NA indicates that no fishing for that gear was registered in years 2020-2021 in the FDI database. The shades of blue indicate what the scoring is based on, namely, light blue: direct evidence from literature; dark blue: expert opinion using a precautionary approach. Yellow indicates the FAO sub-areas where no turtle is present.

System 1 scores in FAO 27

Gear category	Dredge			Pot and Trap			Hand harvesting			Drift net	Set net				Hook and Line			Drift longline	Set longline	Bottom trawl				Pelagic trawl		Purse seine		Seine			
Total	2			2			1			4	5				2			5	5	5				5		5		2			
Gear L3	DRB	DRH	HMD	FPN	FPO	FYK	GEF	LNB	LNS	GND	GNC	GNS	GTN	GTR	LHM	LHP	LTL	LLD	LLS	OTB	OTT	PTB	TBB	OTM	PTM	LA	PS	SB	SDN	SPR	SSC
subtotal	2	2	2	1	2	2	1	1	1	4	4	5	4	5	2	2	2	5	5	5	5	4	4	5	3	2	5	2	2	2	2

Details of risk scores per gear type in FAO 27

Gear L3	DRB	DRH	HMD	FPN	FPO	FYK	GEF	LNB	LNS	GND	GNC	GNS	GTN	GTR	LHM	LHP	LTL	LLD	LLS	OTB	OTT	PTB	TBB	OTM	PTM	LA	PS	SB	SDN	SPR	SSC
1.a	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1.b	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10.a	NA	NA	NA	NA	2	NA	NA	1	NA	NA	NA	5	NA	5	2	2	2	5	5	5	NA	NA	NA	NA	NA	NA	5	NA	NA	NA	NA
10.b	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2	2	2	5	NA	5	5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
12	NA	NA	NA	NA	2	NA	NA	NA	NA	NA	NA	5	NA	5	NA	NA	NA	5	NA	5	5	NA	NA	5	NA	NA	5	NA	NA	NA	NA
14.a	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
14.b	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2.a	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2.b	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.a.20	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.a.21	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.b.23	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.c.22	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.d.24	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.d.25	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.d.26	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.d.27	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.d.28.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.d.28.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.d.29	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.d.30	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.d.31	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3.d.32	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4.a	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4.b	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
4.c	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5.a	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5.b	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6.a	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6.b	NA	NA	NA	NA	2	NA	NA	NA	NA	NA	NA	2	NA	NA	NA	NA	NA	NA	2	2	2	2	NA	2	2	NA	NA	NA	2	NA	2
7.a	2	NA	2	NA	2	NA	NA	NA	NA	2	NA	2	NA	2	NA	2	2	NA	2	2	2	2	2	2	2	NA	NA	NA	2	NA	2
7.b	2	NA	NA	NA	2	NA	NA	NA	NA	NA	NA	2	2	2	2	2	NA	2	2	2	2	NA	NA	2	2	NA	NA	NA	NA	2	2
7.c	NA	NA	NA	NA	2	NA	NA	NA	NA	NA	NA	2	NA	NA	NA	2	NA	NA	2	2	2	NA	NA	2	2	NA	NA	NA	NA	NA	NA
7.d	2	2	NA	NA	2	NA	1	NA	NA	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	NA	2	2	2	2	2
7.e	2	NA	2	NA	2	NA	1	1	NA	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	NA	2	NA	2	NA	2
7.f	2	NA	2	NA	2	NA	NA	NA	NA	2	2	2	NA	2	NA	2	2	2	2	2	2	NA	2	2	2	NA	2	NA	NA	NA	2
7.g	2	NA	NA	NA	2	NA	NA	NA	NA	2	2	2	2	2	NA	2	2	2	2	2	2	2	2	2	2	NA	NA	NA	2	NA	2
7.h	2	NA	2	NA	2	NA	1	1	NA	NA	NA	2	2	2	2	2	2	2	2	2	2	2	2	2	2	NA	2	NA	2	NA	2
7.j	2	NA	NA	NA	2	NA	NA	NA	NA	1	NA	2	2	2	2	2	2	2	2	2	2	2	2	2	2	NA	NA	NA	2	NA	2
7.k	NA	NA	NA	NA	2	NA	NA	NA	NA	NA	NA	2	NA	NA	2	2	2	2	2	2	2	NA	NA	2	2	NA	NA	NA	NA	NA	NA
8.a	2	NA	2	NA	2	2	1	1	1	3	3	3	3	3	2	2	2	3	3	3	3	3	3	3	3	NA	3	NA	2	NA	NA
8.b	2	NA	NA	NA	2	2	1	1	1	3	3	3	3	3	2	2	2	3	3	3	3	3	3	3	3	NA	3	NA	2	NA	2
8.c	2	NA	2	1	2	NA	NA	1	NA	3	3	3	3	3	2	2	2	3	3	3	3	3	3	3	3	2	3	NA	2	NA	NA
8.d	2	NA	NA	NA	2	NA	NA	NA	NA	3	3	3	3	3	2	2	2	3	3	3	3	3	3	3	3	NA	3	NA	2	NA	NA
8.e	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3	NA	NA	2	2	2	3	3	3	3	NA	NA	3	3	NA	3	NA	NA	NA	NA
9.a	2	2	2	1	2	2	NA	NA	NA	4	4	4	4	4	2	2	2	4	4	4	4	4	4	NA	NA	NA	4	2	2	NA	2
9.b	2	NA	NA	NA	2	NA	NA	NA	NA	NA	NA	4	NA	4	2	2	2	4	4	4	NA	NA	NA	NA	NA	NA	4	NA	NA	NA	NA

System 2: based on verifiable, additional data

No specific workflow for a System 2 indicator was undertaken during this ad-hoc contract, but we provide here a short section to guide future discussions on how to define the scoring process for a System 2 approach.

A System 2 approach would characterise a risk of fishing activities' impact on sensitive species using more detailed information on specific risks of interaction than what is provided in the System 1 approach, *i.e.*, **more detailed than the mandatory CMO information**. Such information would concern for instance 1) the specific gear type utilised in the fishery from which the fisheries product to be assessed with System 2 comes from, 2) a precise spatial origin (*e.g.*, in FAO 27, at FAO sub-area level), 3) a reliable assessment of the bycatch of sensitive species associated with the use of this gear type in that area. Applying a System 2 approach to specific fisheries products sold on the EU market would require that the fishery(ies) from which these fisheries products originate provide at least one of the following:

- Robust mean bycatch rate estimates (or total bycatch rate estimates) from *e.g.*, onboard observer data or electronic monitoring;
- Evidence of effective bycatch mitigation solutions that minimise and where possible eliminate bycatch (*e.g.*, gear modification, implementation of mitigation devices like pingers or turtle excluders, spatio-temporal fisheries closures, etc.;
- Quantitative risk assessments that demonstrate that the estimated levels of bycatch do not harm significantly the long-term sustainability of the species susceptible to bycatch in this(ese) fishery(ies).

Table 6, Table 7, and Table 8 could constitute a first step toward the development of a System 2 methodology, since they provide details of risk scores by FAO sub-area and by gear type (at métier level 3) for all 3 sensitive species group considered in this ad-hoc work. Nevertheless, it can be emphasised here that a System 2 approach would ideally account for the target species and use a much more detailed definition of fishing gear. This could be done by enforcing that fisheries products candidating for being assessed using a System 2 approach would have to report gear type at métier level 6 (<gear>_<target species>_<gear mesh size>_<selectivity device>_<selectivity device mesh size>, as defined here). The system 2 approach proposed here that considers using additional data, *e.g.*, onboard observer data on bycatch, evidence of mitigations solutions, etc. deviates significantly from the general guiding principle that has guided the work on indicators so far, which is that a scoring system for fisheries products is based solely on the data currently mandatory in the traceability chain (*i.e.*, species, area, gear). However, given the difficulty to estimate and score fisheries effects on sensitive species using only the current level of information available, the ad-hoc team urges the

regulators to consider solutions to raise the level of detail, *e.g.*, through a revision of the Control and CMO Regulation, and/or by requiring an independent, third-party certification process for the fisheries products to be scored using a System 2.

We suggest that different approaches for the development and implementation of a System 2 approach are discussed and that their feasibility is tested in a future EWG meeting.

Task 5: feasibility

General findings

Overall, when intending to communicate "impact on sensitive species" it is crucial to be transparent on what the indicator actually can address. A pivotal question in conveying sustainability messages revolves around the feasibility (clarity and comprehension) of informing consumers about the complexity of fisheries interactions with sensitive species and the significance of these pressures, all within a single and straightforward rating system. **We have shown here that 'impact' is not the appropriate terminology that can be used with current information and understanding at hand.** Assessing the "impact on sensitive species" of a certain seafood product involves multiple dimensions that are simply not feasible at the present time and may thus not be communicated. These factors encompass, *e.g.*, i) granularity – assessing risks to taxa over vast geographical areas is very different to assessing risks to certain species at different threat status; ii) actual overlap – bycatch risks are influenced by spatial and temporal components that cannot easily be considered; and iii) scales – bycatch rates in fisheries can be high or low but need to be related to the abundance of the impacted sensitive species and more generally to the "risk" that such levels of bycatch would affect the long-term viability of the species (or populations). **There is however an opportunity to communicate potential risk, although it is associated with some caveats.** From considering factors affecting risk level for a species with low productivity in the form of susceptibility to different fisheries, relative risks for different species may be estimated, but not the absolute risk to a population – *i.e.*, 'impact' – which instead requires quantitative estimates on population size, fishing effort and bycatch rates or any other risks imposed (such as cable and vessel strikes, entanglements in ropes used for trap fisheries, etc).

Given the uncertainties associated with assigning a risk score for different fisheries products and sensitive species – *i.e.*, not 'impact' – it is also of importance to consider what is intended to be achieved and potential unintended consequences. For example, with current evidence basis, some products may be assigned high risk scores because of data shortage (following the precautionary principle), even if these products are in reality posing low risks to sensitive species – while the

fisheries from which these seafood products originate may not have the financial nor legal opportunity to provide the necessary information that would demonstrate a low risk. There may also be bycatch mitigation measures in place calling for assigning a low risk score – but this should be supported by sound monitoring data to demonstrate the effectiveness of these measures. If the intention is to minimize risks to sensitive species from fisheries, reliable fisheries-dependant data and an improved understanding of the effect of observed bycatch levels on impacted populations or species are needed in the first place, rather than communicating sometimes widely uncertain or very conservative risk levels to consumers in data-deficient circumstances. However, highlighting these issues to consumers would likely contribute to focusing public awareness on bycatch issues and on bycatch mitigation solutions. Based on the stepwise approach to scoring following data availability, this would in turn incentivise the development of new or the reinforcement of existing bycatch monitoring programmes and incite fisheries where bycatch is identified as a problem to implement effective mitigation measures.

Opportunities for a scoring system

Using a combination of a System 0 and 1 approach with the presently accessible CMO data is perhaps feasible to gauge the potential risk of interactions between fisheries and sensitive species groups for all fisheries products from marine fisheries on the EU market. **However, conducting a comprehensive assessment of the impact on a sensitive species population necessitates substantially more detailed data and analyses. Unfortunately, this level of detail is presently unattainable for most marketable products.**

The results obtained by the ad-hoc group represent a starting point, yet future work will be necessary to explore the implementation of a System 0 and 1 in the EU, and how this preliminary approach can be enhanced with the development of a System 2 scoring method that would use detailed fisheries data for qualifying fisheries products – acknowledging that a usable System 2 must consider how to guarantee the customer that the provided information to support the score is verifiable. The resulting picture is a snapshot of the situation based on the literature review carried out, which was effort constrained. Starting from this initial assessment, with further refinements through *e.g.*, adding information for other FAO areas for a system 1 approach, the idea is that interested fisheries will be able to submit appropriate and updated scientific information to modify the risk score assigned at System 0 or 1, to decrease occurrence of false positives. This however calls for a strategy and at least initial resources that may support requests for risk score review by experts, for example, demonstrating that the use of bycatch reducing devices (BRDs) - gear modifications or management measures that can reduce or zero the risk of bycatch.

Following the request for this ad hoc contract, one single indicator related to the issue of sensitive species should be developed. This implies merging different taxa, *i.e.*, the combined risk for marine mammals, seabirds, and sea turtles that has been assessed separately in this work. **Given the current data at hand, and associated uncertainties as presented and discussed in this report, is it even desirable to amalgamate all these dimensions into a single category using a unified rating system? Is it scientifically sound?** Such a system should be comprehensible for consumers, equitable for the fishing industry, and encouraging of more sustainable fishing practices (particularly in terms of their influence on sensitive species). **What could such an indicator possibly achieve – and which risks may be foreseen from applying it?** Furthermore, implementing an indicator system for fisheries products on the EU market would also need some consideration of traceability systems in place to guarantee that the product holds its promise.

Future work

A future refinement could be to have a closer look on how gear categories could be further differentiated at a generic level based on *e.g.*, mesh sizes, use of bycatch mitigation devices, etc. This could inform a System 2 approach. Currently, the gear categories in the CMO, even at the most detailed level, pool together some completely different fisheries, using fishing gears that may differ widely in the risk they pose to sensitive species and/or depending on the fish species they target. For instance, two fisheries listed as using the same gear in the same area following the CMO information but targeting *e.g.*, small or large pelagics, coastal or oceanic species, will generate entirely different risks of bycatch of sensitive species.

Given the vast number of possible combinations of gear, fishing areas, and species at risk, we focused on a restricted number of sensitive species (air-breathing animals). Future work should entail including more sensitive species groups, with priority to elasmobranchs. This will be more challenging, as many species are also commercial products, but the work may benefit from collaboration with the experts developing an indicator for impact on target species.

We believe that the risk levels foreseen of utilizing the available mandatory information under System 1 (*i.e.*, the gear categories and FAO area) are too broad for scoring the potential risk of negative interaction between sensitive species and fishing activities at the scale of a given product placed on the EU market. There will be too many false positives with current data at hand. As already pointed out by the EWG in STECF 20-05, we consider that assessing any potential risks posed from a fishery to a sensitive species or species group would require the operator be able to provide data at least on the specific gear type (using for instance the list of gears proposed in this study) and on the area of catches at a finer scale than FAO areas. This may call for change in the

CMO before implementing an indicator related to sensitive species. Regarding the development of a System 2 approach, the ad-hoc team suggests that producers provide, on a voluntary basis, more detailed and accurate information for their fisheries products (including specific gear details, precise spatial origin, or data on bycatch) than the mandatory data presently required. The question of the traceability and verifiability of the additional information necessary in a System 2 approach is fundamental and might require third-party certification. Because of this, implementing a System 2 approach as described in this report would likely require important revisions of the current CMO and Control Regulations. The ad-hoc team proposes that this question is discussed in a subsequent EWG, based on the input from this report.

Furthermore, to further the understanding of the risks posed from different fisheries to sensitive species, we believe that even though PSAs might not represent the ultimate method for evaluating fisheries' sustainability concerning their impact on sensitive species from a commercial product perspective, new PSAs, based on a consistent approach for the purpose of supporting the discussed indicator' could provide an attainable and manageable means to inform the sensitive species indicator until more comprehensive bycatch data for specific fisheries becomes widely accessible. This will however require a considerable effort at start.

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