WORKSHOP ON SEA BIRD BYCATCH MONITORING IN THE NEAFC REGULATORY AREAS (WKBB)

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WORKSHOP ON SEA BIRD BYCATCH MONITORING IN THE NEAFC REGULATORY AREAS (WKBB)

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International Council for the Exploration of the Sea

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i Executive summary

In 2021, ICES received a special request for advice from the North-East Atlantic Fisheries Commission (NEAFC) on seabird bycatch in the NEAFC regulatory areas (RAs). Data scoping exercises conducted in 2021, 2022, and 2023 on the availability of bycatch data in the region on the one hand and on the availability of fisheries data on the other hand concluded of important shortages both in terms of quality and quantity that prevented in-depth analyses of the magnitude and the scale of the seabird bycatch problem in the NEAFC RAs.

The Workshop on seabird Bycatch monitoring in the NEAFC regulatory areas (WKBB) was the next step in the NEAFC special request. This report describes the work undertaken at the WKBB workshop that took place in Copenhagen and online in May 2023, presents a synthesis of the analytical outputs (including conclusions), and provides some recommendations for the scope and implementation of a pilot monitoring programme which will significantly improve the evidence base related to the incidental bycatch of seabirds in commercial fisheries operating in the NEAFC RAs.

The data at hand for the workshop – fisheries effort and two complementary seabird tracking datasets – were used to estimate the spatiotemporal overlap between seabirds and fishing activities in the period 2018-2022. Following this, a bycatch risk assessment method originally developed for marine mammal bycatch (called ByRA) was adapted to estimate risk scores and to map high-risk areas for 20 seabird species susceptible to bycatch in the NEAFC RAs. The results are discussed, including the uncertainty in the data used during the workshop. Based on the results from the ByRA, the last part of the report presents recommendations for a pilot monitoring study to increase the understanding of the scale and of the magnitude of seabirds-fisheries interactions in the NEAFC RAs.

ii Expert group information

Expert group name	Workshop on sea Bird Bycatch monitoring in the NEAFC regulatory areas (WKBB))
Expert group cycle	Annual
Year cycle started	2022
Reporting year in cycle	1/1
Chairs	Gildas Glemarec, Denmark
	Kim Magnus Bærum, Norway
Meeting venue and dates	1–4 May 2023, Copenhagen, Denmark (16 participants)

1 Introduction

In 2021, the International Council for the Exploration of the Sea (ICES) received a special request from the North-East Atlantic Fisheries Commission (NEAFC) for advice on seabird bycatch in the NEAFC regulatory areas (NEAFC RAs; Figure 1).

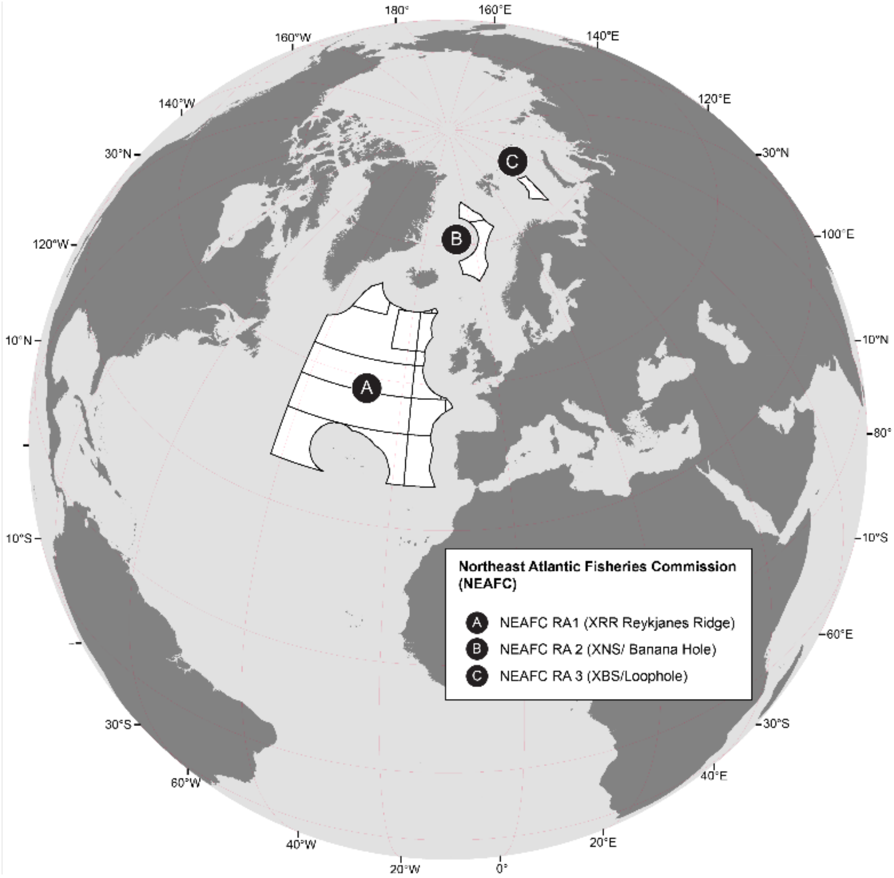


Figure 1. Locator map showing the three NEAFC regulatory areas.

An initial data scoping exercise was carried out by the ICES Working Group of Bycatch of Protected Species (WGBYC) at their 2021 meeting, using fishing effort and monitoring data submitted to ICES/WGBYC through an annual data call (ICES, 2021). The WG concluded that the existing data were insufficient to permit a quantitative assessment of seabird bycatch for the area and that at-sea monitoring should be established as soon as possible.

During 2022, the ICES Working Group on Spatial Fisheries Data (WGSFD) analysed VMS fishing effort and logbook catch data to provide an overview of patterns of fishing activity by vessels from NEAFC contracting parties in the NEAFC RAs. The work indicated that by using a combination of vessel speeds (derived from the VMS data) and associated catch data it was generally possible to allocate fishing activity to specific fisheries (ICES, 2023a).

Following these two scoping exercises, ICES concluded that it would be possible to use available fishing effort distribution data and seabird distribution data from tracking studies to produce preliminary bycatch risk maps and help identify candidate gear types and areas for the development of a pilot monitoring programme (ICES, 2023a).

The Workshop on seabird Bycatch monitoring in the NEAFC regulatory areas (WKBB) was the next step in the NEAFC special request. The present report describes the work undertaken at the

WKBB workshop that took place in Copenhagen and online in May 2023, presents a synthesis of the analytical outputs (including conclusions), and provides some recommendations for the scope and implementation of a pilot monitoring programme which will significantly improve the evidence base related to the incidental bycatch of seabirds in commercial fisheries operating in the NEAFC RAs.

2 WKPETSAMP2 relevance to WKBB

Prior to the WKBB meeting, another meeting of relevance took place in early 2023 in Copenhagen, namely the Workshop on appropriate sampling schemes for Protected Endangered and Threatened Species bycatch (WKPETSAMP2). The tasks addressed during that workshop were deemed relevant to WKBB (ToR a), and the main outcomes from the WKPETSAMP2 meeting are outlined below.

The workshop WKPETSAMP2 focussed on sharing experiences in setting up monitoring programmes for protected species from the different countries represented at the meeting. Examples were given of how national sampling programmes prioritise specific fisheries (métiers) and regions with highest risk of having known or suspected bycatch issues using different types of sampling methods (e.g. electronic monitoring, onboard observer, or reference fleet). Discussions led to multiple important questions concerning the design of a bycatch monitoring programme that can minimise bias in bycatch rate estimations across multiple types of fisheries and species. For instance, in an ideal randomised sampling situation, should the sampling unit be vessel, trip, or fishing operation in order to maximise the outcomes of the allocatable sampling effort? To address these questions quantitatively, the group worked on developing simulation tools to generate (virtual) data from a fictive fleet and evaluate the best sampling options. These simulation tools were designed to be generic, so that multiple types of fisheries and/or sampling designs could be simulated. For example, a tool developed during the WKPETSAMP2 workshop simulates a shift of fishery effort in time and space during a year while allowing the monitoring effort to shift accordingly or stay constant across time and space. Through this, it is possible to explore the effect of mismatches between sampling and fishery effort.

Despite the interest of the WKPETSAMP2 workshop for future design of bycatch monitoring programmes, its direct relevance to WKBB was limited, as the tools developed in WKPETSAMP2 were not finalized nor directly applicable to the data at hand for the timing and purpose of WKBB. Therefore, the chairs decided to recommend a monitoring programme for assessing seabird bycatch in the NEAFC RAs based on the data available to the group, namely fisheries effort data and seabird distribution data. Combining these data to predict the regions, times of the year, and species most at risk of bycatch for each métiers was deemed more practical.

3 Overlap between seabird species and fishing activities in the NEAFC regulatory areas

3.1 NEAFC fisheries data analysis

NEAFC VMS and logbook fisheries data

The VMS data used in this report to characterise the fishing activity were received from NEAFC, via the ICES Secretariat, alongside catch information from logbooks, authorisation details, and vessel information from the NEAFC fleet registry, stemming from contracting parties fleets (Denmark, including the Faroe Islands and Greenland, the European Union, Iceland, Norway, the Russian Federation, and the United Kingdom), and covered the period 2018-2022 (Figure 2).

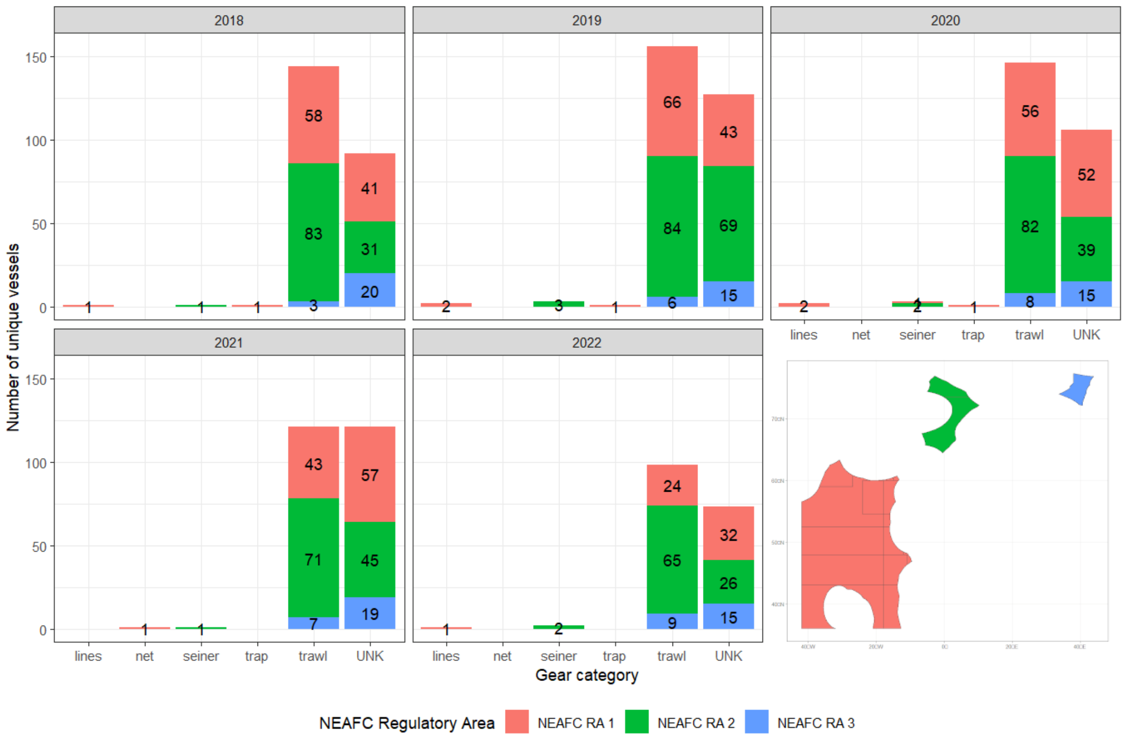


Figure 2. Number of unique vessels operating in the NEAFC regulatory areas by gear type and year (data from 2018 to 2022). UNK refers to 'unknown gear' and represents the vessels with no associated gear information (see section 4 of this report on data caveats).

These data are received annually by ICES and data from the years 2018 to 2022 had been analysed in advance of the WKBB meeting (ICES, 2023a) to support the NEAFC request to ICES to identify the areas of spatio-temporal overlap of different seabird species and fishing activities in the RAs, and estimate the level of the area/season interaction for relevant combinations of seabird species and fisheries.

The VMS and logbook data were linked using a unique identifier (the "RID" field) which now changes on an annual basis to protect the anonymity of vessels rather than the previous six-month basis. ICES received information on the catch date and the catches were linked to vessels on the date of operation (ICES, 2022b). The VMS data were filtered in R (R Core Team, 2021) to keep only records from 2018 to 2022, and exclude all duplicate reports and messages denoting entry and exit to the NEAFC regulatory areas ("ENT" and "EXT" reports). The time interval (difference) between consecutive pings for each vessel was calculated and assigned to each position. Any interval values greater than four hours were truncated to this duration, as it is the minimum reporting frequency specified in the Article 11 of the NEAFC Scheme of Control and Enforcement (https://www.neafc.org/scheme/Chapter3/article11). Such a scenario could occur when a vessel leaves an NEAFC regulatory area or has issues with its transmission system. Examination of the speed field of the VMS data showed that the speed data, which have been problematic in previous years (ICES, 2022b), were of usable quality. Fishing effort was inferred from VMS data based on speed, with pings at slower speeds deemed to represent fishing activity, and those at faster speeds to represent steaming and/or searching. In this instance, a speed of 6 knots or lower was used to demarcate fishing from non-fishing pings for bottom trawl gears. Visual examination of speed profile histograms for vessels without a registered gear type (unknown, UKN) suggests that this demarcation is appropriate for these too (Figure 3). For vessels recorded as using static gears, a speed of 4 knots or less was used to signify fishing activity, although care needs to be taken in the interpretation of these results, as the time spent at these speeds represents the recovery of gears and does not directly translate into a measure of effort (ICES, 2022b).

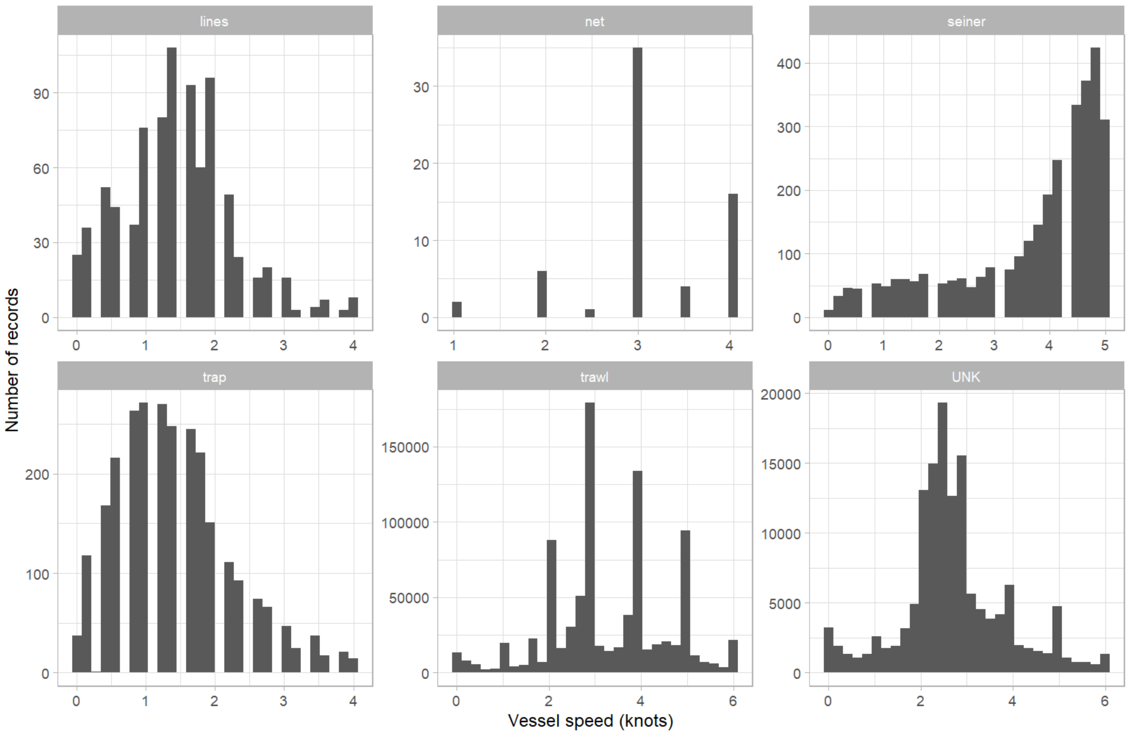


Figure 3. Histograms of vessel speed for each gear category in the NEAFC RAs between 2018 and 2022. UNK: Unknown fishing gear.

Fishing activity effort

The linked VMS and logbook data were aggregated into a spatial grid to obtain the spatial and temporal distribution of the fishing activity indicators and the fishery footprint within the NEAFC RAs. A high-resolution grid of 0.05x0.05-degree was initially used for fishing analysis purposes only, based on the 30 mins meantime interval between consecutive VMS positions. However, this resolution was not suitable to integrate the coarser resolution of the seabirds' distribution data from the Seabird Tracking and SEATRACK databases (section 3.2). The group decided to use a spatial grid of 0.25 x 0.25-degree cell size instead (approx. area of 490 km^2), i.e., the highest resolution available for the two seabirds' distribution datasets, which was judged to be appropriate to analyse the interactions between fishing activities and seabirds in the NEAFC RAs. A unique C-Square geocode was assigned to each cell grid cell to facilitate data integration and data analysis (C-Squares geocoding method in WKBB GitHub repository).

Using the selected spatial grid, the fishing footprint intensity in the NEAFC RAs was estimated as the total number of fishing hours in each grid cell. This metric represents with accuracy the actual number of hours fished for vessels using mobile gears (trawl and seine), whereas for vessel using passive gears (net, longlines, and traps) it only informs on the intensity of fishing operations (sets and hauls), but not on other important parameters as e.g. for how long these gears were deployed (soak time), or the number of hooks, type of bait, etc. These additional parameters were not available for passive gears in the fisheries data the WKBB group had access to (ICES, 2018).

Derived fisheries data products

Once raw fishing activity data had been integrated into the spatial grid, the group produced a set of derived fisheries data products for the initial analysis and exploration of the spatiotemporal trends in fishing activity within the NEAFC RAs. This initial exploration was required to discuss and investigate the categories of aggregation of fishing indicators most suitable for the risk analysis of interactions with seabirds. Figure 4 summarises the mean monthly fishing hours by gear for each of the three NEAFC RAs. For the calculation of fishing indicators (e.g. number of days fishing, number of vessels, etc.), different combinations of aggregation groups were explored, including spatial categories (e.g. spatial grid cell size), temporal categories (e.g. year, month, quarter), and fleet categories (e.g. gear, métier level) derived from fishers reported data. For reference, a complete list of the fisheries data products created and evaluated during the WKBB workshop is available on the GitHub repository.

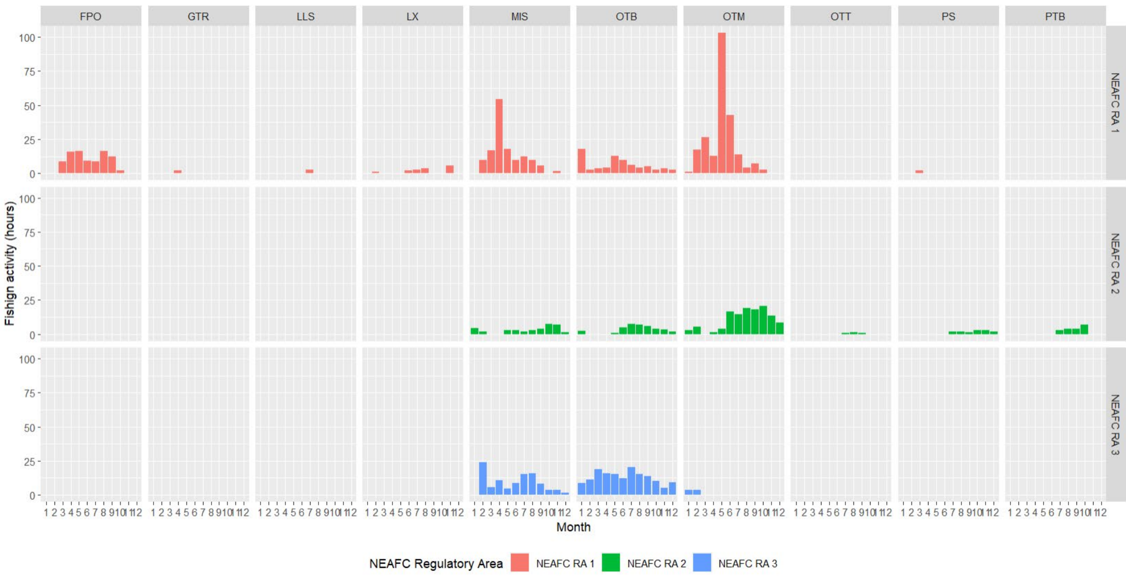


Figure 4. Fishing activity per gear (as mean number of hours fished per month) in each NEAFC RA. The fishing activity indicator represents fishing hours for mobile gears (e.g. OTB, OTM) and hours of fishing operations for passive gears (e.g. FPO). FPO = pots, GTR = gillnet/trammel net , LLS/LX: longlines, OTB = bottom trawl, OTM = pelagic trawl, OTT = twin-rig trawl, PS = purse seine, PTB = pair bottom trawl. The miscellaneous gear category (MIS) comprises all the records of fishing activities with no assigned fishing gear.

Fishing patterns varied slightly between years, so the mean value of fishing effort in the 2018-2022 period was used to obtain a so-called “fishing opportunities” layer. This layer was then used to examine the potential interactions between fisheries and seabirds as the group assumed that any fishing event has a non-zero risk of interacting with seabirds when both active vessels and seabirds were concomitantly present in the same NEAFC region (as seabird can see fishing activity from afar). The assessment of the level of interaction between fisheries and seabirds (see section 3.3 of this report on risk assessment) required that the fishing intensity was defined as the mean number of fishing hours across the years 2018 to 2022 and aggregated at 0.25 x 0.25-degree grid cell by month, for each gear category defined by WKBB experts (Table 1).

Table 1. Equivalence between the WKBB Gear Group category and Gear Type (Métier Level 4) category used for the bycatch risk assessment. As an indicator of gear occurrences, it provides the sum of VMS records over the period 2018 to 2022.

WKBB Gear Group	Gear Type (métier level 4)		Sum of VMS records
UNK	MIS	Miscellaneous	139346
lines	LX	Hooks and lines	841
lines	LLS	Set longlines	16
net	GTR	Trammel nets	64
seiner	PS	Purse seines	3160
trap	FPO	Pots	2714
trawl	OTM	Midwater otter trawls	721388
trawl	OTB	Bottom otter trawls	170551
trawl	PTB	Bottom pair trawls	1166
trawl	OTT	Twin bottom otter trawls	238

Figure 5 exemplifies the fishing opportunities layer concept and presents the seasonal variability in fishing effort intensity for the trawl gear group for the four most representative months of fishing activity (March, May, July, and November). Maps with the monthly fishing activity for all gear types are included in Annex (Figure 28 to Figure 32).

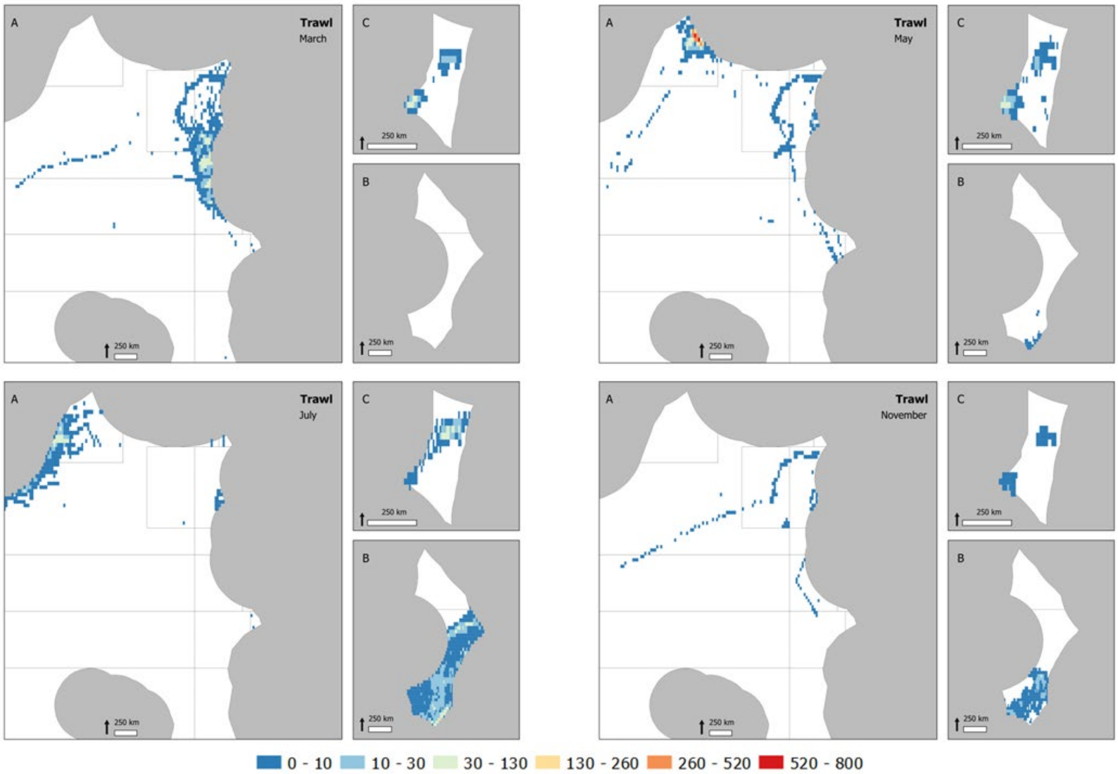


Figure 5. Seasonal variability in trawl fishing footprint intensity (mean number of fishing hours across the years 2018 to 2022 per grid cell) in the three NEAFC areas (A. NEAFC RA 1 [XRR Reykjanes Ridge]; B. NEAFC RA 2 [XNS/ Banana Hole]; C. NEAFC RA 3 [XBS/Loophole]).

3.2 Seabird data analysis

The group established a short list of seabird species susceptible to interacting with fishing gears in the NEAFC RAs (Table 2, at the end of this section). This list of species was thought as a representative sample of the species and of the species groups present in the NEAFC RAs. In order to estimate the risk of interaction between seabirds and fisheries, we collated information on the spatio-temporal distribution of these species within the NEAFC RAs. Data on seabird distribution were obtained from two distinct large-scale tracking projects, SEATRACK (https://seapop.no/en/seatrack/about-seatrack/) and BirdLife International's Seabird Tracking Database (www.seabirdtracking.org/), which differ both in terms of species that have been tracked and of the spatiotemporal coverage/resolution. In addition, for some of the considered seabird species, no tracking data were available to the group in either of the above-mentioned databases. For these species, we checked the BirdLife DataZone and/or the IUCN range maps; if the distribution of one of the species overlapped with one of the NEAFC RA, we assumed that this species could be potentially present in that RA, i.e., we assumed a uniform distribution of that species in that NEAFC RA.*

SEATRACK's Northeast-Atlantic Seabird Distribution dataset

SEATRACK's Northeast-Atlantic Seabird distribution (hereafter "NEAS") dataset relies on the processing and analysis of positional data from six species of Arctic-breeding pelagic seabirds: northern fulmar *Fulmarus glacialis*, black-legged kittiwake *Rissa tridactyla*, common murre *Uria*

* Paragraph updated based on reviewers' comments.

aalge, thick-billed murre *Uria lomvia*, little auk *Alle alle*, and Atlantic puffin *Fratercula arctica*. These species represent the most numerous seabird species breeding in the Northeast Atlantic (Barrett *et al.*, 2006; Frederiksen, 2010). Positional data for these species were obtained from light-loggers (geolocators) outfitted to individual birds at various colonies across the North Atlantic (Fauchald *et al.*, 2021). The tracking data covered several years, from 2006 to 2019. The NEAS dataset was derived by applying species distribution models separately for each species, colony, and month and then weighing the model predictions with the population abundance estimates for each colony (details in Fauchald *et al.* [2021]). The resulting outputs provided distribution maps showing the predicted average number of individual birds in each pixel for each month. The absolute predicted abundance (N birds/cell) was converted into density (number of bird/km^2), to allow for further geographical transformation and projection. For this work the distribution maps for each species were aggregated across all colonies. The processed NEAS dataset was thus composed of 6 species x 12 months = 36 data layers (rasters). To match the fisheries data, we averaged the values of all the points falling in each 0.25 x 0.25-degree grid cell in the standard spatial grid of the project and appended the c-square label.

BirdLife International's Seabird Tracking Database

BirdLife International's Seabird Tracking Database (www.seabirdtracking.org, hereafter "STDB") is the world's largest store and a website portal for browsing seabird tracking data. BirdLife provides a system for requesting data from the owners, which facilitates large collaborative analysis such as Davies *et al.* (2021). The data owners that contributed with their data to the current analysis are acknowledged in Table 2 . Prior to the WKBB meeting, the STDB was searched for seabird distribution data collected using Global Positioning System (GPS) loggers, Platform Terminal Transmitters (PTTs), and Global Location Sensor (GLS) loggers. Data were requested via the system and approval received for 6 shearwater species, the Razorbill and Long-tailed Jaeger *Stercorarius longicaudus*. Distributions for species that are in the STDB, but not in SEATRACK, were mapped using a method similar to Carneiro *et al.* (2020) but adapted for poorer data coverage. Equinox periods were omitted (March equinox: -21, +7 days; September equinox: -7, +21 days) for GLS data as these periods produce unreliable locations(Hill and Braun, 2001). All locations were pooled by month for all individuals across all years for each species. For each month with five or more bird locations, coordinates of the locations were projected onto a custom Lambert azimuthal equal area projection centred around the geometric mean of the Northeast Atlantic NEAFC region. We used kernel density estimation to compute a 95% utilisation distribution (UD) using the '*adehabitatHR*' R package (Calenge, 2006) in 5 x 5 km cells with a 200 km smoothing factor based on estimated error in for GLS data (Carneiro *et al.*, 2020). Each grid cell contained a value of relative probability of tracked birds occurring in that cell combining information on the proportion of tracked individuals using each cell and the relative time spent in each cell. We reprojected the UD rasters to WGS84 projection and converted them to spatial points. To match the fisheries data, we averaged the values of all the points falling in each 0.25 x 0.25-degree grid cell in the standard spatial grid of the project and appended the c-square label.

Table 2. Species that occur in the NEAFC regulatory areas. "Data quantity" refers to the amount of data that exists and the relative coverage of the areas by visual inspection. "Data approved" relates to the proportion of data that exists and which use in this project was approved by data owners (not all data requests were approved).

Species	Data Quantity	Data Approved	Data owners (dataset IDs)
Cory's Shearwater	Large	Most	Jacob González-Solís (506, 974-975, 983, 1691, 1696-1698, 1710-1712), Vitor Paiva (511, 1032-1033, 1056, 1060-1061), Ivan Ramirez

Species	Data Quantity	Data Approved	Data owners (dataset IDs)
Calonectris borealis			(511), Jaime Ramos (1032-1033, 1056, 1060-1061), Ewan Wakefield (1586)
Scopoli's Shearwater *Calonectris diomedea*	Large	Most	Jacob González-Solís (507, 1690, 1714-1717)
Audubon's Shearwater *Puffinus lherminieri*	Large	Most	Jacob González-Solís (684, 980-981), Veronica Neves (684), Vitor Paiva (1023, 1029)
Manx Shearwater *Puffinus puffinus*	Large	Some	Jacob González-Solís (1083), Mark Jessopp (1481-1482), John Quinn (1481-1482)
Great Shearwater *Ardenna gravis*	Medium	Some	Jacob González-Solís (982), Peter Ryan (982)
Sooty Shearwater *Ardenna grisea*	Medium	Some	April Hedd (628), William Montevecchi (628), Richard Phillips (628), Ewan Wakefield (1587)
Balearic Shearwater *Puffinus mauretanicus*	None	-	-
Long-tailed Jaeger *Stercorarius longicaudus*	Large	Some	Rob van Bemmelen (1093), Olivier Gilg (1093), Johannes Lang (1098)
Pomarine Jaeger *Stercorarius pomarinus*	None	-	-
Great Skua *Catharacta skua*	Medium	None	-
Razorbill *Alca torda*	Medium	Some	Thorkell Lindberg Thorarinsson (1075-1077), Yann Kolbeinsson (1075-1077) in Linnebjerg *et al.* (2018)
Ring-billed Gull *Larus delawarensis*	None	-	-
Northern Gannet *Morus bassanus*	None	-	-
Black guillemot *Cepphus grylle*	None	-	-
Little auk *Alle alle*	Large	All	Fauchald *et al.* (2021) / SEATRACK
Northern fulmar *Fulmarus glacialis*	Large	All	Fauchald *et al.* (2021) / SEATRACK
Black-legged kittiwake *Rissa tridactyla*	Large	All	Fauchald *et al.* (2021) / SEATRACK

Species	Data Quantity	Data Approved	Data owners (dataset IDs)
Common guillemot *Uria aalge*	Large	All	Fauchald *et al.* (2021) / SEATRACK
Thick-billed murre *Uria lomvia*	Large	All	Fauchald *et al.* (2021) / SEATRACK
Atlantic puffin *Fratercula arctica*	Large	All	Fauchald *et al.* (2021) / SEATRACK

†

† Added after the report was reviewed.

3.3 Risk assessment

Ecological risk assessments (ERA) are useful tools for progressing ecosystem approach to management of fisheries by offering decision-support that allows for cost-effective prioritization of species and actions, e.g. Hobday *et al.* (2011). For seabirds, many fisheries bodies (e.g. CCAMLR, ICCAT, and WCPFC) apply different approaches to conduct ERAs of the effects of fishing on seabirds, including purely expert-based, semi-quantitative, or more quantitative approaches (Small, Waugh and Phillips, 2013).

Productivity Susceptibility Analysis (PSA)

The group initially considered utilizing Productivity Susceptibility Analysis (PSA), a semi-quantitative method originally developed to assess potential risks from fishing for data-deficient bycatch species in an Australian trawl fishery (Stobutzki, Miller and Brewer, 2001). A PSA combines attributes of productivity of a species (e.g. age at maturity) with attributes for its susceptibility to a certain fishery (e.g. overlap between the species' distribution and the fishery(ies) susceptible to capture these species) to estimate a potential vulnerability score for the species to the fishery(ies). The general objective of a PSA is to identify the most high-risk species in a fishery in order to prioritize monitoring, conservation, or mitigation actions. Although this approach offers many benefits in data-deficient situations, there are nonetheless constraints that ought to be considered before using it. Many different approaches exist, varying in e.g. the attributes used for productivity and susceptibility and cut-offs for low-medium-high risk they use, as well as their robustness to assess different risk levels (Hordyk and Carruthers, 2018). For instance, the vulnerability score is a measure of potential relative risks between different species, not absolute risks (of bycatch) to a species or a population. Furthermore, PSA applies a precautionary approach, which will assign a high-risk score where there are knowledge gaps, thereby being prone to false positives.

The group discussed which information and analysis were needed to be able to provide recommendations related to bird bycatch monitoring and assessment, informed by the current data at hand, and the effort required to run this analysis. The group concluded that, in order to recommend adequate monitoring in the NEAFC RAs, priority should be given to identifying potential bycatch hotspot areas within the three NEAFC RAs (both spatially and temporally) and to flag out the fisheries for which the risk of interactions with seabirds is high. A PSA was not the preferred option as it would rather provide relative risks between different bird species. Moreover, due to the different approaches available to run a PSA, this work would require additional effort in evaluating which methodological approach would be most suitable. Therefore, the group considered alternatives to estimate seabird bycatch risk in the NEAFC RAs (see below).

ByRA (Bycatch Risk Assessment)

ByRA is a newly developed tool building on PSA, which offers a convenient framework to evaluate bycatch risks spatially and temporally. This method evaluates a relative bycatch risk score for each grid cell of predefined dimensions in the study area, building upon all the fisheries and species distribution data available and complementing the knowledge gaps with expert opinion (Verutes *et al.*, 2020).

The ByRA "toolbox" was initially developed to estimate bycatch risks for populations of marine mammals. The original criteria – fitted to marine mammals – needed to be adjusted to seabirds for WKBB. During the workshop, experts on bird ecology and on interaction between seabirds and fisheries reassessed the pre-existing criteria in ByRA. They informed cut-off values to assign nominal categories from published PSAs on seabirds and amended some criteria to be better suited to seabirds. This work included adding and removing criteria for exposure and consequence and re-evaluating the cut-off values used for low-medium-high risks (Table 3). Some species were already known to be highly susceptible to bycatch and/or in conservation need from previous work (Table 4 in Annex), while for other species, knowledge was scarcer, e.g. on their distribution, or their gear-specific susceptibility to bycatch. The group established a list of 20 seabird species for which bycatch in the NEAFC RAs was potentially occurring based on evidence from other geographical areas or from expert knowledge and the ByRA criteria were evaluated for each of these species (Table 6 to in Annex). Arguably, this selection may have excluded other co-occurring and bycatch-prone species. The primary intention of this work, however, was to map the differences in bycatch risks spatially and temporally in the NEAFC RAs so that this work could inform fisheries managers which combination of areas, seasons, and gears are the most problematic in terms of seabird bycatch or require attention. Risk levels were assigned based on the available information, applying a precautionary approach, i.e., when in doubt, a higher risk score was assigned to the criterion.

Table 3. Description of the criteria and risk scores used for the ByRA analysis to estimate bycatch risks for populations of seabirds in the NEAFC regulatory areas.

Criterion name	High risk	Medium risk	Low risk	Description
Resilience (species specific)				
Age at maturity	> 7 years	2-7 years	< 2 years	Age of which most of the adult birds in the population are likely to become mature (produce fledglings).
Reproductive strategy	Biannual breeding and/or high mate fidelity	Annual breeding, one fledgling	Annual breeding, multiple fledglings	A combination of breeding frequency, clutch size, and tendency of mate fidelity within the species.
Population trends	Decreasing	Stable	Increasing	Observed or modelled population trends in Europe, or worldwide.
IUCN status	DD, CR or EN	VU or NT	LC	IUCN Red List status specific for Europe, or global status if not specified for Europe.
Exposure (fishery-species specific)				
Spatial overlap	>30% of species overlaps with gear	10-30% of species overlaps with gear	<10% of species overlaps with gear	The overlap by grid cell between spatial distribution of each species and gear is calculated in GIS.
Temporal overlap	Gear and species interact all year (12 months)	Gear and species interact most of year (4- 11 months)	Gear and species interact occasionally (1-3 months)	The geographical overlap of modelled seabird density and fishery effort.
Probability of bycatch mortality following	Probable (bycatch is likely lethal)	Possible (bycatch is likely sub-lethal)	Unlikely (mortality/injury from bycatch is negligeable)	The severity (direct effect) of gear on mortality rate of a species.

Criterion name	High risk	Medium risk	Low risk	Description
interaction with fishery				
Probability of unaccounted mortality	Probable	Possible	Unlikely	Based on expert opinion. Expected probability of bycatch mortality when species interact with fishing operation.
Intensity of gear use	High	Medium	Low	Based on expert opinion. Expected probability of mortality related to the fishing operation, besides direct bycatch in gear (e.g. cable strikes)
Status of management	No management strategy identified	Management strategy identified, but not fully implemented	Management strategy identified and fully implemented	Management strategies (e.g. monitoring of bird populations and fisheries, enforcement of regulations, etc.)
Behavioural susceptibility to interaction	Attracted to fishing vessels	Not attracted to fishing vessel, but feeding on bait or target species for fishery	Neither attracted to vessel nor overlap	Behavioural response of the animals to fishing activities or specific gears

Results

The ByRA was applied for 20 seabird species in the three NEAFC RAs and the ICES statistical areas within. Findings indicate four distinct bycatch risk hotspots across the study area (Figure 6). Within RA 1 (Reykjanes Ridge), there are two areas (ICES fishing areas 27.6.b.1 and 27.7.k.1) where levels for 17 of the 20 species fall into the highest risk category. Notably, levels of highest risk in this RA vary temporally. For individual species bycatch risk maps, coupled with summaries of the gear categories driving risk during each month of the year, see Figure 8 to Figure 26 in Annex. Within RA 2 (Banana Hole), a clear risk hotspot covers most of the southern portion of ICES fishing area 27.2.a.1. This exposure is driven largely by seiners, trawls, and undetermined fishing gears operating south of the 70th parallel north. Here, the ByRA detected highest relative levels of risk for 13 of the 20 species evaluated. Finally, there is a smaller risk hotspot in RA 3 (Loophole, 27.1.a), just north of the 75th parallel north and between 35 and 45 degrees east. This trend in high bycatch risk, driven predominately by trawls and undetermined fishing gears was observed for 11 of the 20 species evaluated and year-round. For convenience, a table with the description of the ICES areas within the NEAFC RAs is presented in Annex (Table 26).

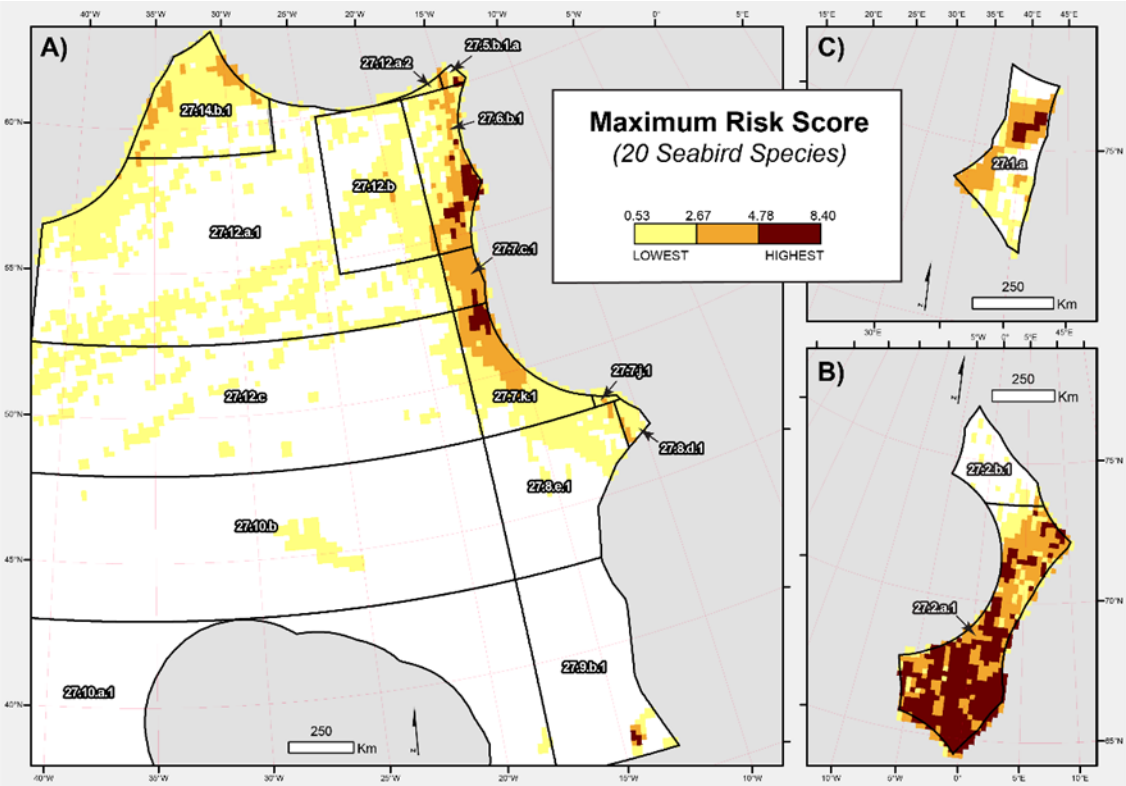
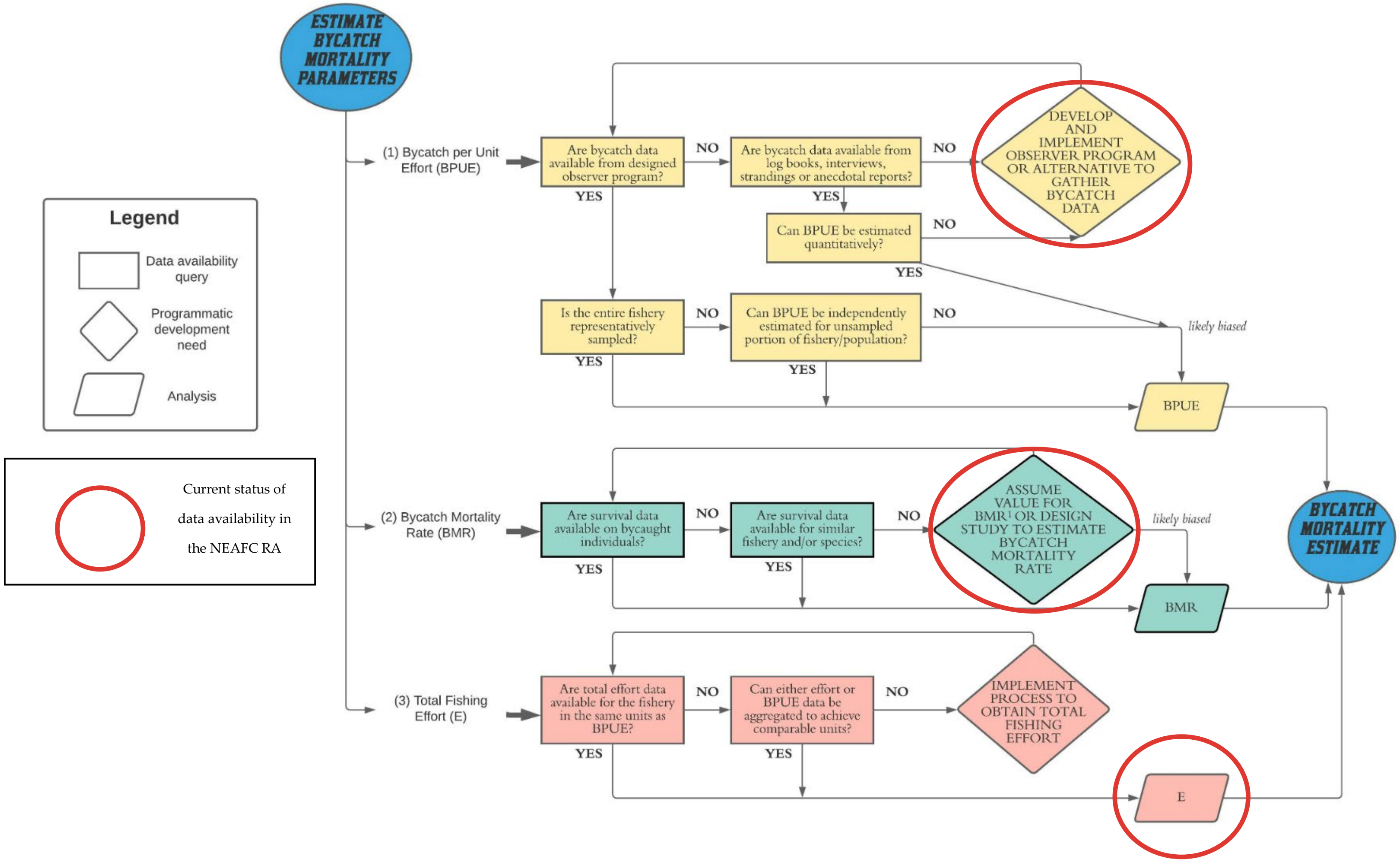


Figure 6. Composite map showing maximum bycatch risk scores across the 20 seabird species evaluated with the ByRA in the three NEAFC RAs and the ICES statistical areas within. White-coloured areas indicate limited bycatch occurrence based on existing data to assess species-fishing gear co-occurrence with the ByRA.

4 Caveats and deficiencies of fisheries data from the NEAFC regulatory areas

The group discussed the needs in terms of quality and quantity of data necessary for estimating seabird bycatch in the NEAFC RAs reliably. Establishing best practices for assessing protected species bycatch in fisheries has received increased attention in recent years following a number of international, regional, and national initiatives worldwide, including e.g. work on bycatch indicator taken up by OSPAR in the north-east Atlantic (Dierschke, Christensen-Dalsgaard and Koschinski, 2023) and HELCOM in the Baltic Sea (HELCOM, 2023), both linked to the EU Marine Strategy Framework Directive (MSFD) criteria D1C1 Incidental by-catch rate (EC, 2008; Palialexis *et al.*, 2019). In addition, in the United States (US) – a major market for fisheries products – the implementation of the Import Provisions of the United States Marine Mammal Protection Act Fisheries now requires fisheries operating outside the US which products target the US market to have or develop specific marine mammal protection standards that are of equivalent effectiveness to the standards implemented for commercial fisheries in the US (Moore *et al.*, 2021). This means that all these fisheries must guarantee that the levels of bycatch marine mammal populations are exposed to are within sustainable limits. Managing marine mammal bycatch and seabird bycatch is similar in its principles and Wade *et al.* (2021) provided guidance to implement comprehensive (marine mammal) bycatch assessments that is also applicable to seabird species. The very first step of this framework is to identify the fisheries that pose a threat to populations, by describing both the fisheries characteristics and the characteristics of the species/populations affected by these fisheries, in order to help prioritise bycatch and effort data collection. This initial phase is fundamental to effectively quantify bycatch mortality, assess the impact of fisheries on the populations, and eventually decide on appropriate mitigation measures to reduce and where possible eliminate bycatch (Wade *et al.*, 2021).

In the NEAFC RAs, comprehensive fisheries data are scarce and lack important information to understand the characteristics of the fishing effort in terms of spatio-temporal distribution and intensity of the fishing effort at gear level (see ICES [2023a] and Section 3.1 for details). In parallel, our knowledge of the seabird species/populations present in the NEAFC RAs has considerably increased in the last decade with projects using tracking data to identify the seasonal distribution of dozens of marine species, e.g. SeaTrack and BirdLife Seabird Tracking databases (see Section 3.2 for details). In addition, seabird populations abundance is known from regular count surveys at colonies and population modelling. Nonetheless, because of the highly migratory nature of all the seabird species found in the NEAFC RAs, these animals are subject to a wide array of threats from fisheries across their range. In the absence of reliable bycatch estimates in most of their distribution range, it is not currently possible to assess the impact of fishing on these seabirds, i.e., whether fishing poses a threat to the long-term survival of these species/populations or is within acceptable levels. Moore *et al.* (2021) describes the necessary components for estimating bycatch mortality in a fishery, which can then be compared to reference points, i.e., threshold values or tipping points above which bycatch mortality becomes unsustainable for the impacted species/population. Although developed for marine mammal species, the framework reproduced here in Figure 7 is also applicable to seabird bycatch in the NEAFC RAs.



1. Use a precautionary value, typically 1.0.

Figure 7. Decision tree for estimating the components of bycatch mortality. The data availability in the NEAFC RAs in each category is highlighted (red circles). Adapted from Moore *et al.* (2021).

Figure 7 emphasises that three main elements are necessary to estimate bycatch mortality: i) an estimate of bycatch per unit effort (BPUE), ii) of total fishing effort, and iii) of bycatch mortality rates. The latter can be assumed to be 100% for seabirds, i.e., all seabird/gear interactions result in direct death or in injury that will more likely than not result in mortality. With regards to the two other components, namely bycatch per unit effort and total fishing effort, the data currently available in the NEAFC RAs are insufficient to reliably estimate the magnitude of seabird bycatch mortality in the region (ICES, 2023a). The information at-hand for the workshop consisted of positional data (VMS), coupled with vessels' e-logs and port sampling data, with no recordings of incidental captures of seabirds in the region. Moreover, there is a wide uncertainty on the gear types used in the NEAFC RAs, as many fishing operations are registered or classified as MIS. Since bycatch risks and rates are highly dependent on gear types and on the corresponding intensity of the effort, estimating the number of seabird bycatches in the NEAFC RAs would require much finer-scale, detailed information on the fleet(s) characteristics. Fishing vessels should therefore report effort at haul level, indicating at least the gear category and ideally métier L6. Effort intensity must be reported at a level that is meaningful to raise mean bycatch rates and reduce uncertainty, e.g. as number of hooks per km for longline fisheries, or as soak time * net length for gillnet vessels. What is more, no seabird bycatch or any other interactions between seabirds and fisheries – for example, cable strikes, i.e., birds' collisions with trawling cables, or the third-wire/monitoring cable – are reported in the NEAFC RAs currently, despite strong suspicions that they occur for at least some combinations of gear/species/season, as shown in the ByRA analysis in the previous section. It is thus necessary that the fleets engaged in fishing activities in the NEAFC RAs agree to participate in a monitoring programme dedicated to the collection of data on seabird-fisheries interactions in the region. In the likely case a census of the fishing activity cannot be collected, monitoring data must be representative of the entire fleet, so that the bycatch rates estimated from a sample of the fleet can be extrapolated to produce robust, certain raised total seabird bycatch mortality estimates at regional level.‡

‡ Sentence modified after the report was reviewed.

5 Monitoring seabird bycatch in the NEAFC regulatory areas

Through a dedicated yearly data call, ICES collects information on fishing effort and bycatch records from all ICES member states (ICES, 2023b). Within this data call, ICES also has an ongoing special request for data appraisal and advice development from NEAFC to assess seabird bycatch rates in the NEAFC RAs. Although these data are currently too scarce to provide a clear understanding of the potential effects of fisheries in the NEAFC RAs on seabird populations, it will have to increase in quality in the years to come and provide a reliable source of information. For now and based on the analytical work presented in the previous sections, the group was able to create bycatch risk maps, establishing which combinations of area/season/species/métier were the most problematic with regards to seabird bycatch in the NEAFC RAs, but no quantifiable estimate of seabird bycatch and other seabirds-fisheries interactions (e.g. cable strikes) was possible given the fisheries data at-hand for this workshop.

In this section, we discuss the needs for a realistic monitoring programme aiming at assessing seabird-fisheries interactions in the three NEAFC RAs. Generally speaking, monitoring the occurrence of rare events like bycatch of seabirds in fisheries in order to obtain unbiased event rate estimates requires a relatively high sampling coverage both spatially (to account for spatial variations in bycatch rates) and temporally (to account for seasonality in effort and seabird distribution). A wide range of methods and tools exist to collect fisheries-dependant data that could meet the needs of a seabird bycatch monitoring programme in the NEAFC RAs. The main options and their interest in monitoring seabird bycatch in NEAFC RA fisheries are succinctly described below.

5.1 Monitoring options in the NEAFC RAs

Fisheries observers

Fisheries observers are a cornerstone of most monitoring programmes in Northern Atlantic countries. Observers working onboard fishing vessels can collect a range of high-quality data, including biological samples and occurrence of bycatch of seabirds during fishing operations. Observers are however not omniscient and need to be present in strategic places and times to be able to detect and record seabird bycatches or other types of detrimental interactions (e.g. cable strikes). When taken by other duties (e.g., measuring fish catches), observers may easily miss bycatches or interactions events. Moreover, a regional observer programme focussing on bycatch of seabirds in the NEAFC RAs should be set up using experiences from other RFMOs where some gear categories are covered up to 100% (see e.g., https://www.bmis-bycatch.org/sites/default/files/inline-files/2021-ISSF-March-CMMs-summary.pdf).§

Electronic monitoring

Electronic monitoring (EM) or remote electronic monitoring (REM) are tools widely used across countries in the North Atlantic to monitor fisheries (ICES, 2023c). In Europe and in the US,

§ Paragraph edited after the report was reviewed.

bycatch monitoring programmes using EM exist that are already integrated to national data collection programmes, demonstrating the maturity of EM to monitor fisheries bycatch. Simply put, an EM system consists of a set of hardware (cameras, various sensors, and a central computer unit) installed onboard a fishing vessel that can record the entirety of the fishing activity of that vessel for immediate or later review. An associate EM analysing software links recorded videos, vessel position, and other information collected by EM systems to enable reviewers to mark the points of interest (fishing operations, individual target catches or bycatches, etc.). Video reviewing is often the most time-consuming and expensive part of an EM programme. In some situation, reviewing a subset of the recorded EM data can considerably reduce costs, while still achieving monitoring goals, but in the case of seabird bycatches, the probability to miss rare events may be high. Nonetheless, a seabird bycatch monitoring programme using EM would be comparatively cheaper than an observer-based programme for an equivalent sampling coverage, or would provide a more representative coverage of the fleet than any observer programme (van Helmond *et al.*, 2020). Moreover, the ping frequency of EM systems is much higher than any VMS, offering a much finer registration of the spatial distribution of the fishing activity. What is more, in the latest years, EM providers and users of EM systems alike have started to develop solutions to automatise EM data reviewing processes using machine learning (ML) algorithms (sometimes referred to as artificial intelligence or AI) in order to detect e.g. fishing operations and estimate effort, or to automatise the detection and identification of (by)catch species. The implementation of these AI tools is underway in at least some fisheries (van Helmond *et al.*, 2020; ICES, 2023c). This will likely result in reducing the overall cost of EM data analysis and/or allow EM analysts to review more data in the same time span, thus increasing the sampling coverage for the same cost. It can be stressed however that automatising bycatch detection/identification requires a large quantity of annotated images to train a model that can achieve acceptable levels of accuracy, and that the development of these models necessitates high computational power, which will (at least initially) increase the cost of the monitoring programme (ICES, 2022a).

Self-sampling

Self-sampling could constitute a simple and cost-effective solution to collect seabird bycatch data in the NEAFC RAs. This would require training crews to record all seabird/gear interactions observed onboard and to couple this information with that from electronic logbooks (gear type, position, time, effort metric, target species catches, etc.). Additionally, the crew could also collect dead specimen for later identification by scientists. Nevertheless, beside the safety hazard of manipulating and storing carcasses of dead birds onboard fishing vessels (dead animals could be carrying contagious diseases like the bird flu), self-sampling programmes raise legitimate concerns about the reliability of such data, where failure to adhere to sampling protocols, lack of expertise for species identification, and possible falsification of the data cannot be excluded. There is clear evidence in the literature that the quality of self-sampling for estimating protected, endangered, and threatened (PET) species bycatch is questionable and ought to be compared and validated with other more reliable data sources from e.g. observer or electronic monitoring (EM) programmes. Basran & Sigurðsson (2021) notes for instance that "Overall, (…) bycatch recorded by observers was higher than that from fisher logbooks by an average of 774% in trawls, 7348% in nets, and 1725% in hook and line gears. When combining all years of data available, fisher logbook [by]catch per unit effort or average number of individuals caught were significantly less than those from observer data for all gear types that could be examined in all countries". Other examples of the poor quality of self-reported data for monitoring PET species bycatch were described in US fisheries where "approximately 98% of marine mammal takes, […] were not reported as required by law" in the California swordfish drift gillnet fishery (Enticknap, B., Shester, G., and Brock, T., 2021 based on the work from Carretta, 2021). Likewise, PET species bycatch rates reported by inspectors in the lumpsucker fishery in Iceland were five times higher when compared to self-reporting logbooks (Pálsson, Gunnlaugsson and Ólafsdóttir, 2015) and equally five times higher when compared to Norwegian and Danish lumpsucker fisheries (Christensen-Dalsgaard *et al.*, 2019).

Self-sampling, although simple and cost-effective, currently appears to provide limited applicability for monitoring seabird bycatch in the NEAFC RAs by itself, and although all seabird bycatches should be reported by law, a significant amount of independent data collection is critical to obtain unbiased bycatch estimates.

Reference fleet

Alternatively, bycatch rate estimates can be raised from the data collected by a reference fleet, as is already done in Norwegian fisheries. This type of sampling differs from the self-sampling described above in that it usually consists of a small group of vessels/fishers that receive dedicated training in reporting catches and bycatch and is closely followed up by dedicated contact persons. For example, between 2016 and 2020, 15 vessels operating in high seas were part of the Norwegian reference fleet, but none of these vessels reported to operate in the NEAFC RAs (Clegg and Williams, 2020; Tom Clegg, pers. comm.). In the NEAFC RAs, a reference fleet should be sufficiently representative of the métiers and the fishing activities occurring in the region to infer unbiased bycatch estimates. Like self-sampling however, data from reference fleets are also potentially biased if the scientific monitoring protocols are not strictly followed. The bias in a reference fleet is generally assumed to be lesser than the bias in a self-sampling programme, thanks to a better training and closer follow up of the participating fishers. Yet, a specific issue with reference fleets (and self-sampling) to monitor seabird bycatch is that this method will likely not account for cryptic mortality or for bycatches that are not brought onboard. For instance, in the case of trawlers, cable strikes are a growing concern and can cause injuries or the death of seabirds roaming around the deployed gear. A fishing crew, even if properly trained will likely not have the capacity to monitor cable strikes when busy working on other parts of the deck. Since the carcasses are not brought on board in the case of cable strikes, this mortality will likely go unreported. Furthermore, the reference fleet may not be representative of the entire fleet due to the relatively low numbers of vessels usually involved. Reference fleet data thus also require validation using other monitoring methods (e.g. onboard observers, or EM) to ensure quality and reliability. For instance, in their paper studying cetacean bycatch in countries with reporting legislations, Basran & Sigurðsson (2021) state that "bycatch reported in the fisher logbook data in the seine, trawl, and trap gear categories (…) were not detected by the [Norwegian] reference fleet, though the fleet [was] covering these gear categories". As was the case with self-sampling, a seabird bycatch monitoring programme using a reference fleet in the NEAFC RAs would therefore also require sufficient independent data collection (from observers and/or EM data) to reach an acceptable level of reliability.

5.2 Recommendation for a seabird bycatch monitoring programme – Pilot study

The workshop collated and analysed data from fisheries and from seabird distribution datasets, which could be used to identify areas of gear- and species-specific high-risks of seabird bycatch in the three NEAFC RAs. Nevertheless, these datasets are currently insufficient both in quantity (no seabird bycatch rate estimate for any of the gears) and in quality (high uncertainty in gear-specific effort) to quantify the magnitude of seabird bycatch in the NEAFC RAs. The work done by the WKBB group and presented in this report highlights the areas, the seasons, and the gears where seabird bycatch risks are potentially the highest, showing an important variability in seabird species expected bycatch mortalities (Figure 6; Figure 8 to Figure 26 in Annex). Likewise, reports from the scientific literature strongly suggests that seabird bycatch is non-evenly distributed in time and space, but rather occasional with both seasonal and spatial patterns in frequency of bycatch events (Bull, 2007; Bærum *et al.*, 2019; Zhou, Jiao and Browder, 2019). The results of this workshop should nonetheless be corroborated with factual data from an independent monitoring programme to fill in data gaps in the NEAFC RAs and permit to estimate seabird mortality from fisheries interactions in the future. To achieve this, it is necessary to set up a monitoring programme that will collect information at a finer scale than what is currently reported in the NEAFC RAs on the characteristics of the fleet (to reduce the uncertainty in gear usage), on the fishing effort intensity and distribution (to allocate fishing effort at a finer-scale than currently possible), and on the bycatch rates associated with the different gears (to estimate gear- and species-specific average bycatch rates that can be scaled up to the entire fleet). From a single vessel viewpoint, we can probably assume that seabird bycatch events are rare in the NEAFC RAs. Therefore, to obtain as unbiased as possible bycatch rate estimates in the different gear categories, the sampling effort would need to cover a large proportion of the fleet both in terms of number of vessels and in terms of fishing effort. The European Commission recommends for instance a minimum of 10% observer coverage to estimate bycatch of protected species accurately (EC, 2012), but this implies that the monitored vessels are representative of the entire fleet. In the NEAFC RAs, seabird bycatch risk remains very uncertain for a large proportion of the fleet for which the gears are not well defined (the MIS and UNK categories). In addition, long-term monitoring of the same vessels might be preferable than spreading the monitoring effort on many more vessels. The reason for this is that seabird bycatch may be rare (few events) but may involve occasionally large numbers of individuals. Missing these mass bycatch events would therefore under-estimate seabird bycatch rate and ultimately seabird bycatch mortality, as demonstrated in e.g. Glemarec *et al.* (2020).

In view of the above, the group recommends that a pilot study is initially conducted in the NEAFC RAs before engaging into a wider monitoring effort of a larger proportion of the fleet. The main aims of the pilot study would be to obtain reliable information on i) seabird bycatch frequency in the main gears used in the NEAFC RAs, ii) the frequency of collision between seabirds and cables for all gears, iii) gear-specific fleet effort within the areas where bycatch risk is highest as defined by the ByRA (see section 3.3). The data collected during this pilot trial will help validate the findings of this workshop, i.e., the areas, gears, and seasons that pose the highest risk to seabirds, and guide the design of a larger-scale monitoring programme to collect data on interactions between seabirds and fisheries that could be used for estimating total seabird mortality and population effect of fisheries on seabirds. Such pilot study is therefore meant to be a precursor to gather knowledge on implementing a full-scale monitoring programme which will cover a much larger percentage of the overall fishing effort within each of the three regulatory areas for each of the gear types identified in section 3.1.

Designing an effective seabird bycatch monitoring programme that balances the costs of sampling with the representativeness of the whole fishing fleet requires at least some basic knowledge of the expected frequency and distribution of the bycatch events. This is essential to designate a sufficient number of vessels to monitor, which métiers, and which area and season the sampling effort must focus on. In the NEAFC RAs, most of the fishing effort is driven by trawlers, which are often viewed as less dangerous for seabirds than passive gears, especially static and drift-nets, or longlines (Lewison *et al.*, 2014; Dias *et al.*, 2019). Cable strikes (or warp strikes) however, can pose a serious threat to some species attracted by fishing activities (Sullivan *et al.*, 2006; Melvin *et al.*, 2011; Hickcox and MacKenzie, 2023), so that the assumption that trawl fisheries in the NEAFC RAs are seabird-safe should be verified with a dedicated monitoring programme. Seabird bycatch rates and seabird collision rates should be estimated for all the species present in the NEAFC RAs. This means that all incidents ought to be reported, but also that the absence of incident needs to be reported, as recommended by WGBYC (ICES, 2021). Reporting true zeros is essential to reliably estimate spatio-temporal variations seabird-fisheries interaction rates. Concomitantly, gear usage should ideally be reported at haul level and include fine-scale information on fishing activities, including GPS positions of each haul (at least start and end), haul duration, number of hooks per km for longline fisheries, soak time and mesh sizes for net fisheries, etc. to allow more reliable estimation of the fishing effort distribution for each gear type.

To achieve these goals, the group recommends that:

1. A pilot study is implemented to monitor seabird-fisheries interactions (including bycatch and cable strikes) in all three NEAFC RAs.
2. The sampling in the pilot study is based on a mixture of electronic monitoring and trained fisheries observers.
3. The pilot study focuses in priority on the high-risk areas and time periods highlighted by the ByRA.
4. The pilot study represents an adequate sample of the most prominent métiers in terms of effort and risk in the NEAFC RAs.**
5. All the vessels operating in the NEAFC RAs report fishing activity data at a fine-scale and ideally at haul level.

The rationale behind the second recommendation is that, while EM would produce relatively cheap yet reliable bycatch information over time, thus being the preferred main sampling method, onboard fisheries observers will supply the EM generated data with information or observation that might be outside the detection capabilities of an EM system. The latter could be for instance if camera placement or video quality does not allow to observe or to identify some bycaught individuals. Generally, it is essential when starting a new monitoring programme with EM to validate and calibrate EM data with onboard observers' data to verify that the information from EM data streams is valid and can be extrapolated. Observers would also collect additional information on local environmental changes (e.g. sudden wind bursts), changes in bird behaviour, or deviation in how the fishing gear is operated that could affect the likelihood of seabird bycatch. Moreover, while EM systems are able to record the entirety of the fishing activity of a vessel over extended periods, it might be necessary to sub-sample the EM data for practical and/or economic reasons. Information collected by observers could help define the most adequate assessment of EM footage, e.g. by focusing on specific periods during the hauling process where the risk of seabird interaction is highest. It can be noted here that while EM systems installed onboard vessel are usually similar in their general principles, the camera placement and the review process is highly dependent on the type of monitoring data that has to be collected. The Working Group on Technology Integration for Fishery-Dependent Data (WGTIFD) has developed informative guidelines to implement monitoring programmes using EM, including templates for Vessel Monitoring Plans and Calls for Tenders that would help define and describe the needs for such EM programme (ICES, 2019, 2023c). What is more, the review process of data collected with EM requires a specific training. In the present case, EM data analysts will need to record as a minimum information on fishing effort at a fine scale and any observed seabird interactions (bycatch and cable strikes). The group recommends externalising the review process as is done in other fisheries monitored with EM (ICES, 2023c), for instance by leaving the task of EM data analysis to the EM provider. This would simplify the implementation of the EM programme by reducing the need for hiring and training EM data

** Goal edited after the report was reviewed.

analysts. Moreover fisheries data collected with EM usually belongs to vessel owners and are often reviewed by the national authorities or monitoring agencies of the vessel's flag. In the case of monitoring seabird bycatch in the NEAFC RAs, it is advisable that the same reviewing team does the review process to ensure that the EM data collected on vessels with different national flags are treated in the same way.

Ideally, the sampling effort for both EM and external observers should be representative for the total fishing activity within the NEAFC RAs. However, as there are three types of métiers (OTM, OTB and MIS) that stand out with considerably higher effort registered (Table 1), the group recommends focusing the sampling effort in the pilot study on these métiers, at least initially. Nevertheless, it should be stressed that the likelihood of seabird bycatch might be much higher in other métiers, particularly in longlines, and that these should not be ignored. Still, the risk (i.e., likelihood times consequence) is assumed to be higher for the high effort métiers due to the higher number of fishing events for these métiers. Consequently, prior to the pilot study, it is important to define which métiers are encompassed in the MIS-category to ensure that the OTM and OTB métiers represent indeed the bulk of the fishing activity of the fleet (i.e., fishing activity is correctly registered in the data available for analyses). For the OTM- and OTB-métier, recording both potential seabird bycatch within the trawls and cable strikes should be prioritised.

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Annex 1: List of participants

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Allen Kingston (part-time attendance)	University of St Andrews	United Kingdom	ark10@st-andrews.ac.uk
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Gildas Glemarec (chair)	National Institute of Aquatic Resources (DTU Aqua)	Denmark	ggle@aqua.dtu.dk
Gregg Verutes	Blue Forest Conservation	United States	gverutes@gmail.com
Kim Magnus Bærum (chair)	Norwegian Institute for Nature Research (NINA)	Norway	kim.barum@nina.no
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Pauline Delalain (part-time attendance)	Comité National des Pêches (CNPMEM)	France	pdelalain@comite-peches.fr
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Ruth Fernandez	ICES	Denmark	ruth.fernandez@ices.dk
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Yann Rouxel	RSPB/BirdLife International	United Kingdom	yann.rouxel@rspb.org.uk

Annex 2: Additional figures and tables

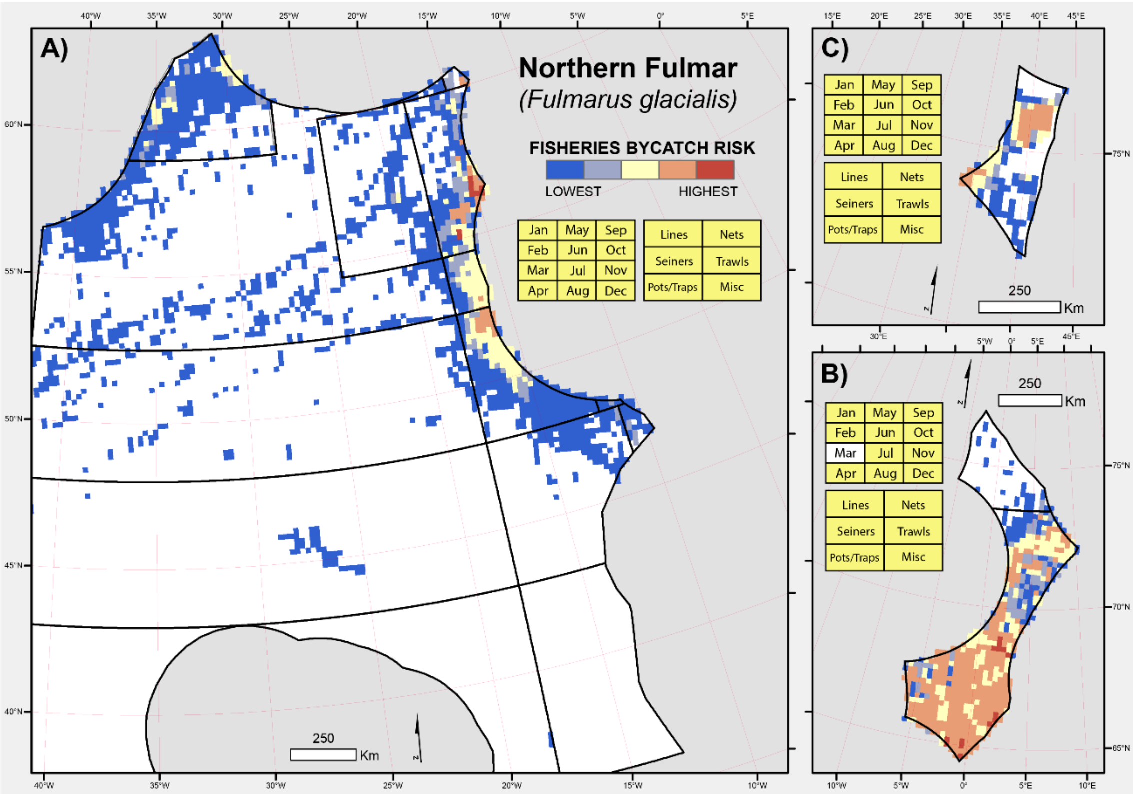

Figure 8. Bycatch risk scores for the northern fulmar (*Fulmarus glacialis*) evaluated with the ByRA in the three NEAFC RAs and the ICES statistical areas within. Yellow-coloured boxes indicate months and gear categories for which the bycatch risk scores apply. White-coloured areas indicate limited bycatch occurrence based on existing data to assess species-fishing gear co-occurrence with the ByRA. Seabird distribution data derived from SEATRACK.[††]

[††] Data source added following reviewers comments.

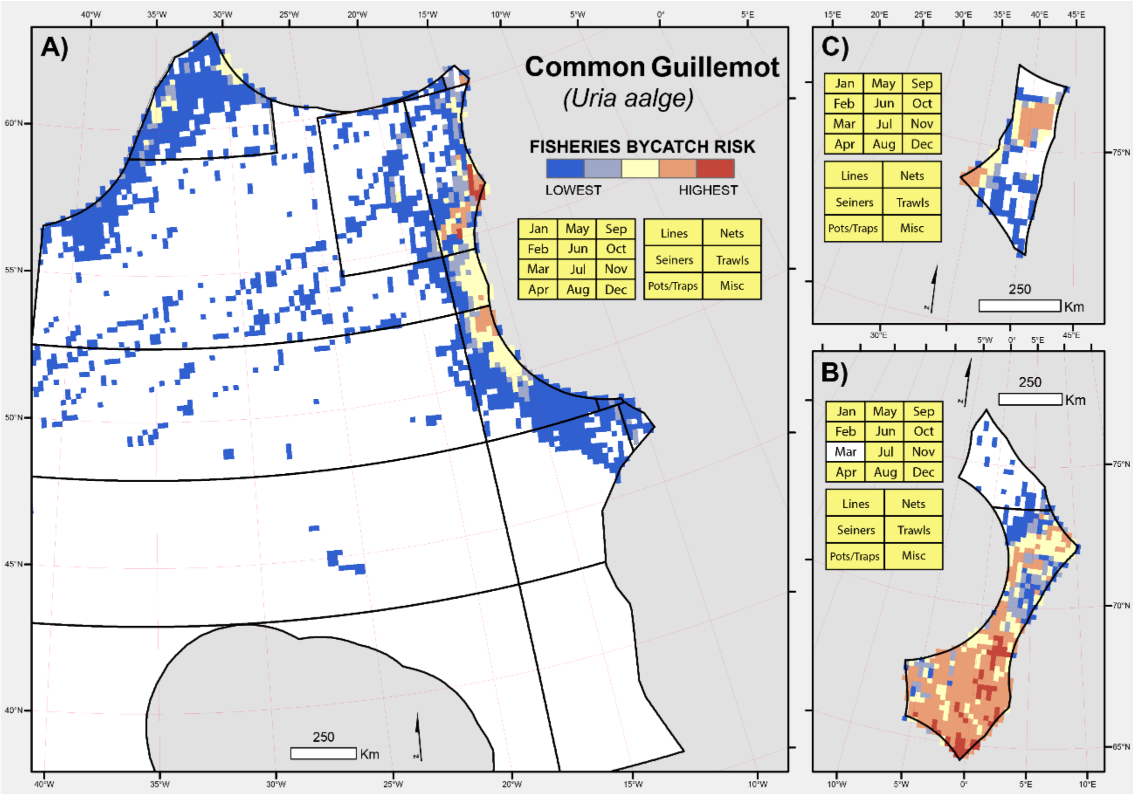

Figure 9. Bycatch risk scores for the common guillemot (*Uria aalge*) evaluated with the ByRA in the three NEAFC RAs and the ICES statistical areas within. Yellow-coloured boxes indicate months and gear categories for which the bycatch risk scores apply. White-coloured areas indicate limited bycatch occurrence based on existing data to assess species-fishing gear co-occurrence with the ByRA. Seabird distribution data derived from SEATRACK.‡‡

‡‡ Data source added following reviewers comments.

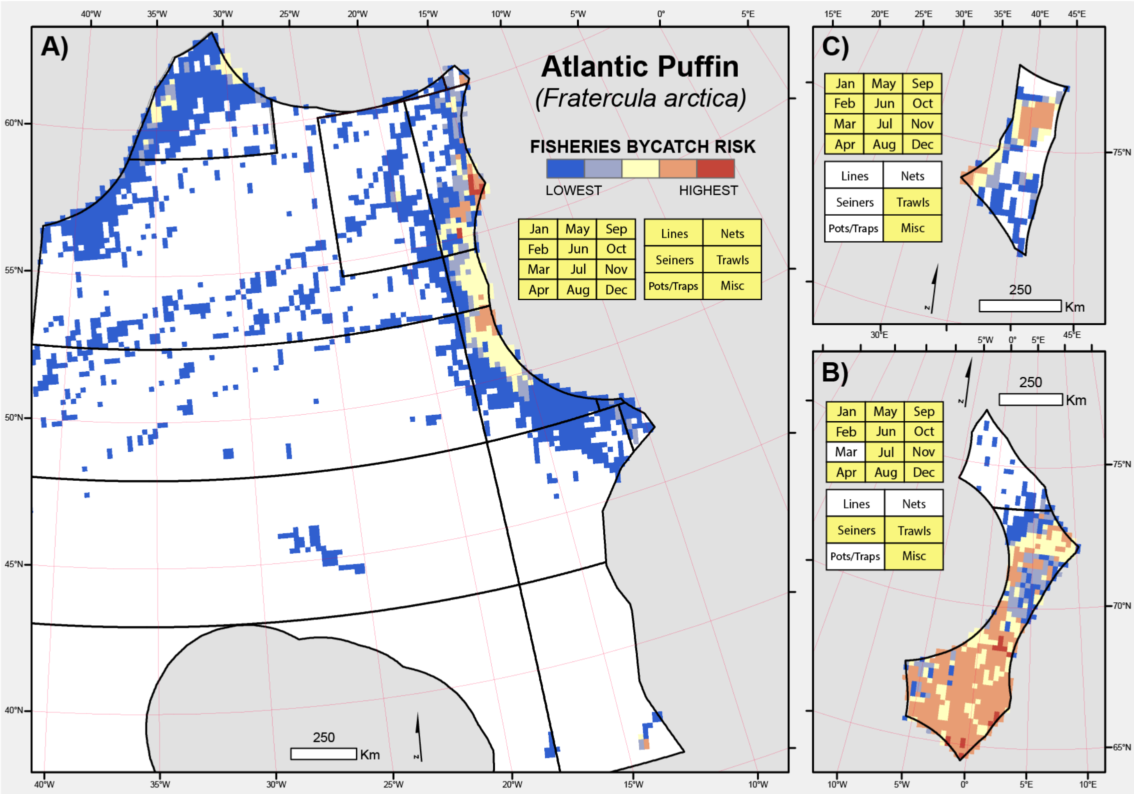

Figure 10. Bycatch risk scores for the Atlantic puffin (*Fratercula arctica*) evaluated with the ByRA in the three NEAFC RAs and the ICES statistical areas within. Yellow-coloured boxes indicate months and gear categories for which the bycatch risk scores apply. White-coloured areas indicate limited bycatch occurrence based on existing data to assess species-fishing gear co-occurrence with the ByRA. Seabird distribution data derived from SEATRACK.[§§]

[§§] Data source added following reviewers comments.

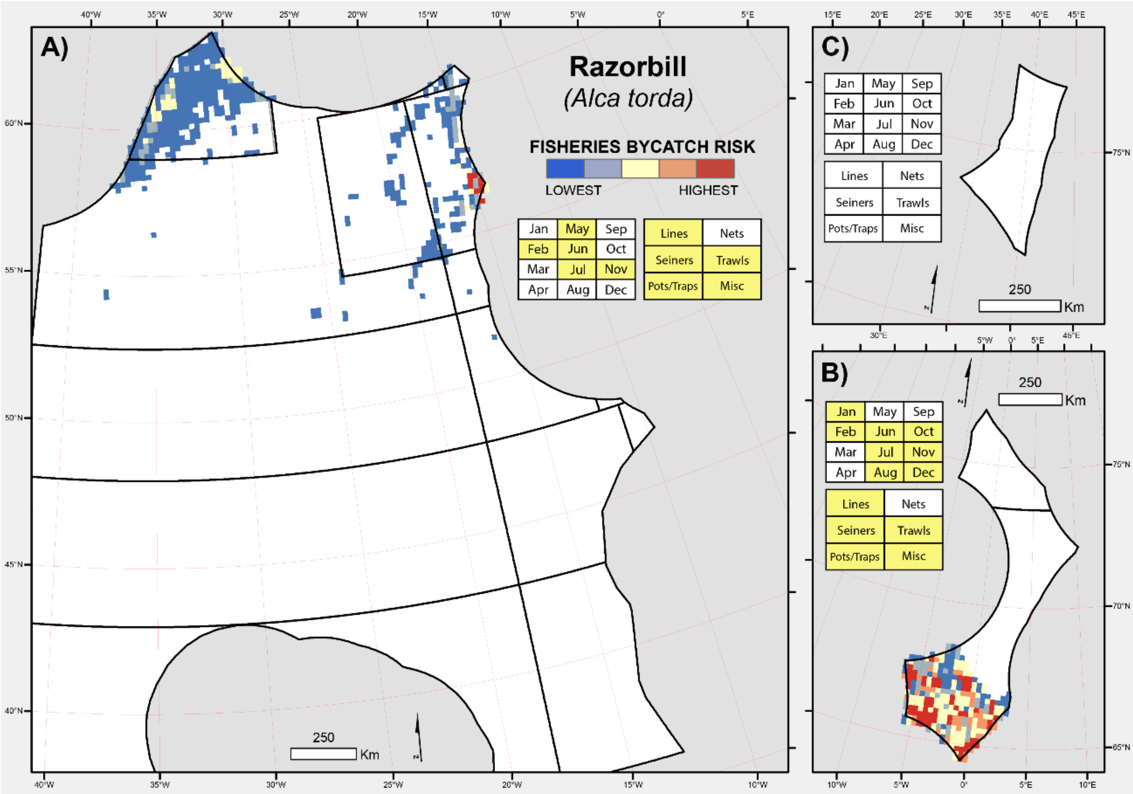

Figure 11. Bycatch risk scores for the razorbill (*Alca torda*) evaluated with the ByRA in the three NEAFC RAs and the ICES statistical areas within. Yellow-coloured boxes indicate months and gear categories for which the bycatch risk scores apply. White-coloured areas indicate limited bycatch occurrence based on existing data to assess species-fishing gear co-occurrence with the ByRA. Seabird distribution data derived from BirdLife International's Seabird Tracking Database.[***]

[***] Data source added following reviewers comments.

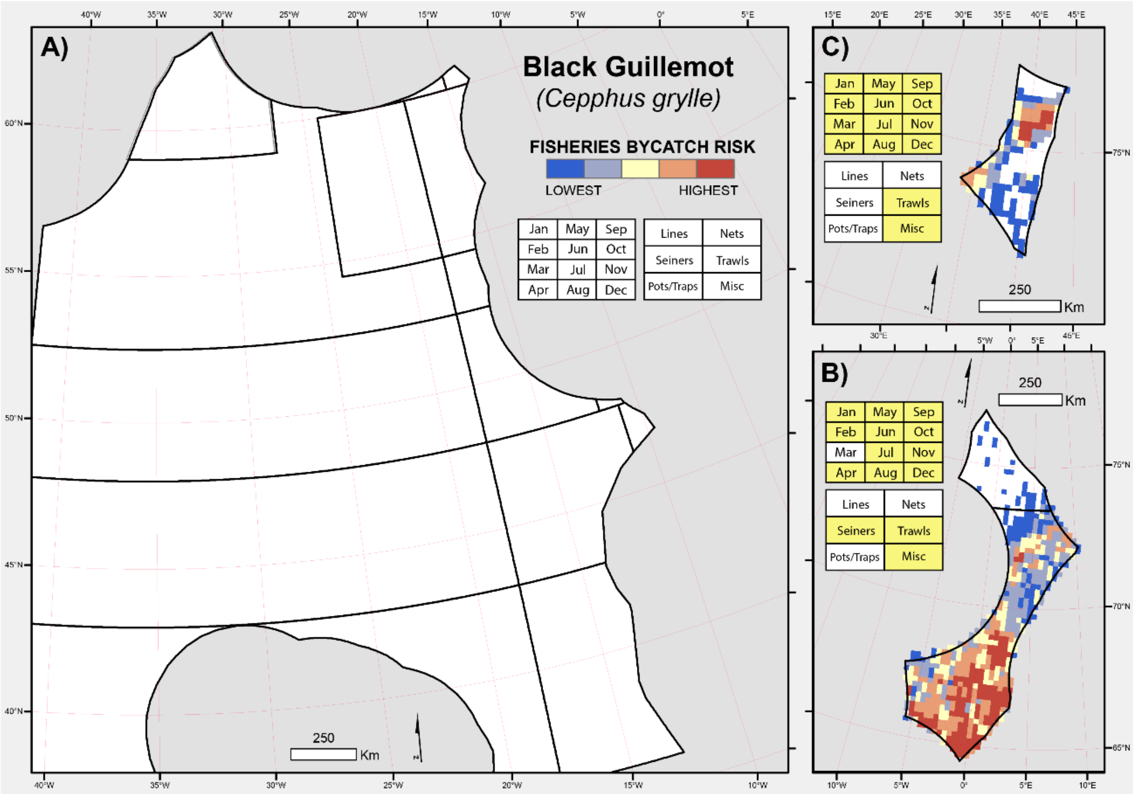

Figure 12. Bycatch risk scores for the black guillemot (*Cepphus grylle*) evaluated with the ByRA in the three NEAFC RAs and the ICES statistical areas within. Yellow-coloured boxes indicate months and gear categories for which the bycatch risk scores apply. White-coloured areas indicate limited bycatch occurrence based on existing data to assess species-fishing gear co-occurrence with the ByRA. Seabird distribution data derived from BirdLife and/or IUCN range maps.[†††]

[†††] Data source added following reviewers comments.

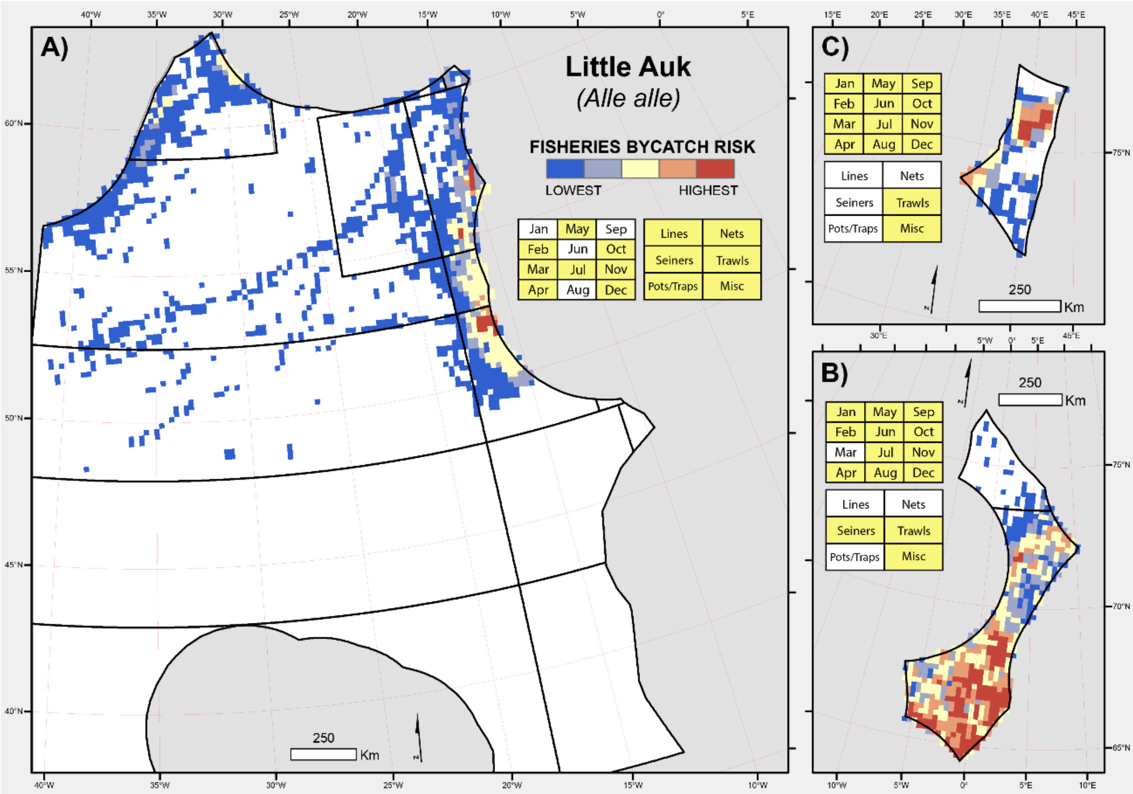

Figure 13. Bycatch risk scores for the little auk (*Alle alle*) evaluated with the ByRA in the three NEAFC RAs and the ICES statistical areas within. Yellow-coloured boxes indicate months and gear categories for which the bycatch risk scores apply. White-coloured areas indicate limited bycatch occurrence based on existing data to assess species-fishing gear co-occurrence with the ByRA. Seabird distribution data derived from SEATRACK.‡‡‡

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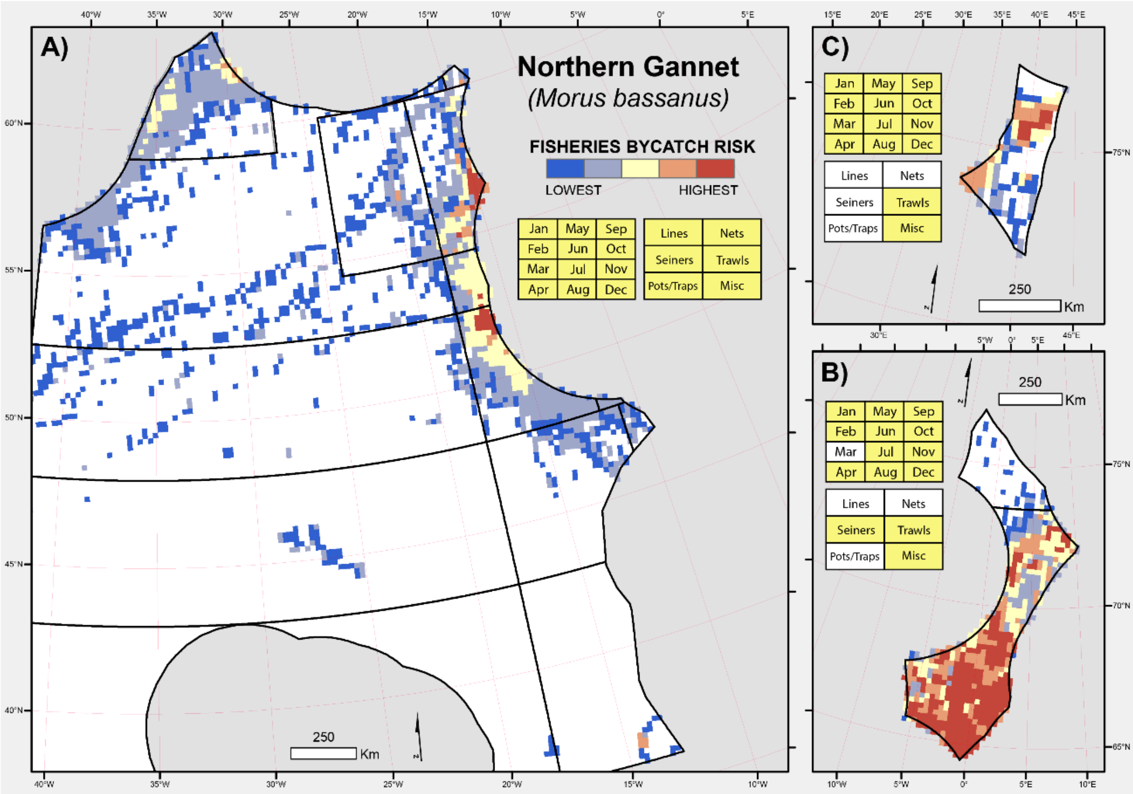

Figure 14. Bycatch risk scores for the northern gannet (*Morus bassanus*) evaluated with the ByRA in the three NEAFC RAs and the ICES statistical areas within. Yellow-coloured boxes indicate months and gear categories for which the bycatch risk scores apply. White-coloured areas indicate limited bycatch occurrence based on existing data to assess species-fishing gear co-occurrence with the ByRA. Seabird distribution data derived from BirdLife and/or IUCN range maps.§§§

§§§ Data source added following reviewers comments.

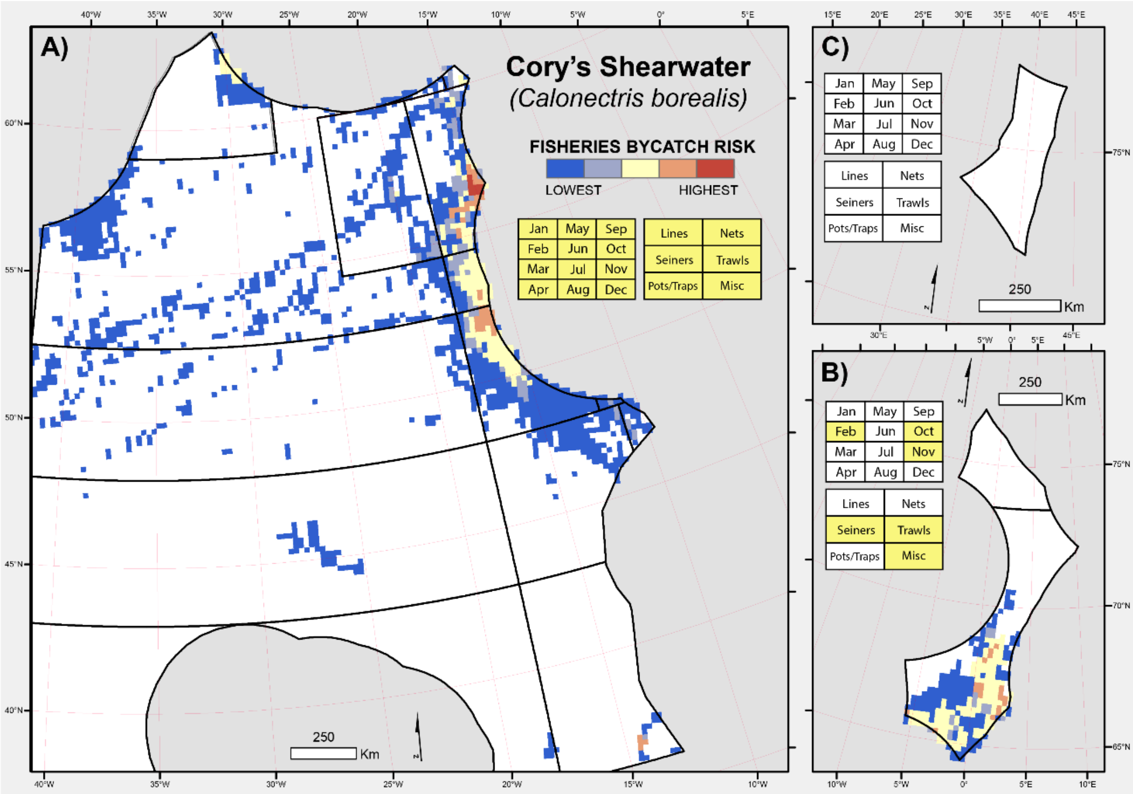

Figure 15. Bycatch risk scores for the Cory's shearwater (*Calonectris borealis*) evaluated with the ByRA in the three NEAFC RAs and the ICES statistical areas within. Yellow-coloured boxes indicate months and gear categories for which the bycatch risk scores apply. White-coloured areas indicate limited bycatch occurrence based on existing data to assess species-fishing gear co-occurrence with the ByRA. Seabird distribution data derived from BirdLife International's Seabird Tracking Database.[****]

[****] Data source added following reviewers comments.

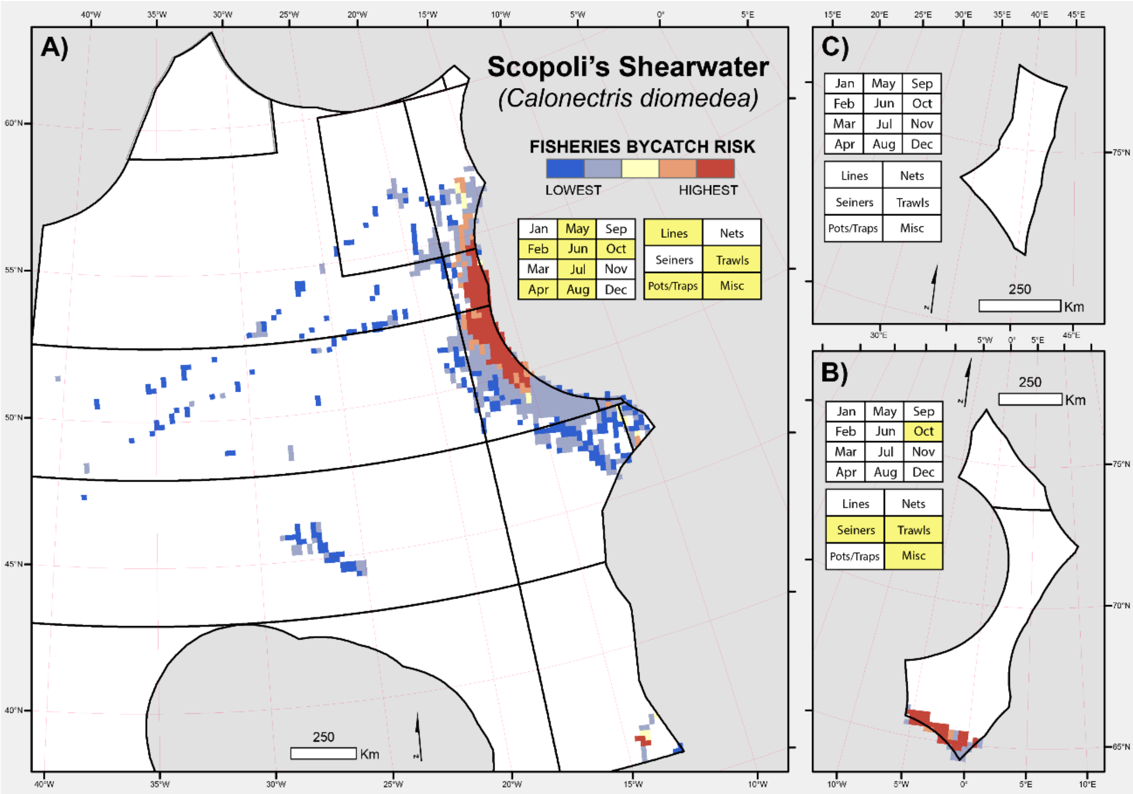

Figure 16. Bycatch risk scores for the Scopoli's shearwater (*Calonectris diomedea*) evaluated with the ByRA in the three NEAFC RAs and the ICES statistical areas within. Yellow-coloured boxes indicate months and gear categories for which the bycatch risk scores apply. White-coloured areas indicate limited bycatch occurrence based on existing data to assess species-fishing gear co-occurrence with the ByRA. Seabird distribution data derived from BirdLife International's Seabird Tracking Database.††††

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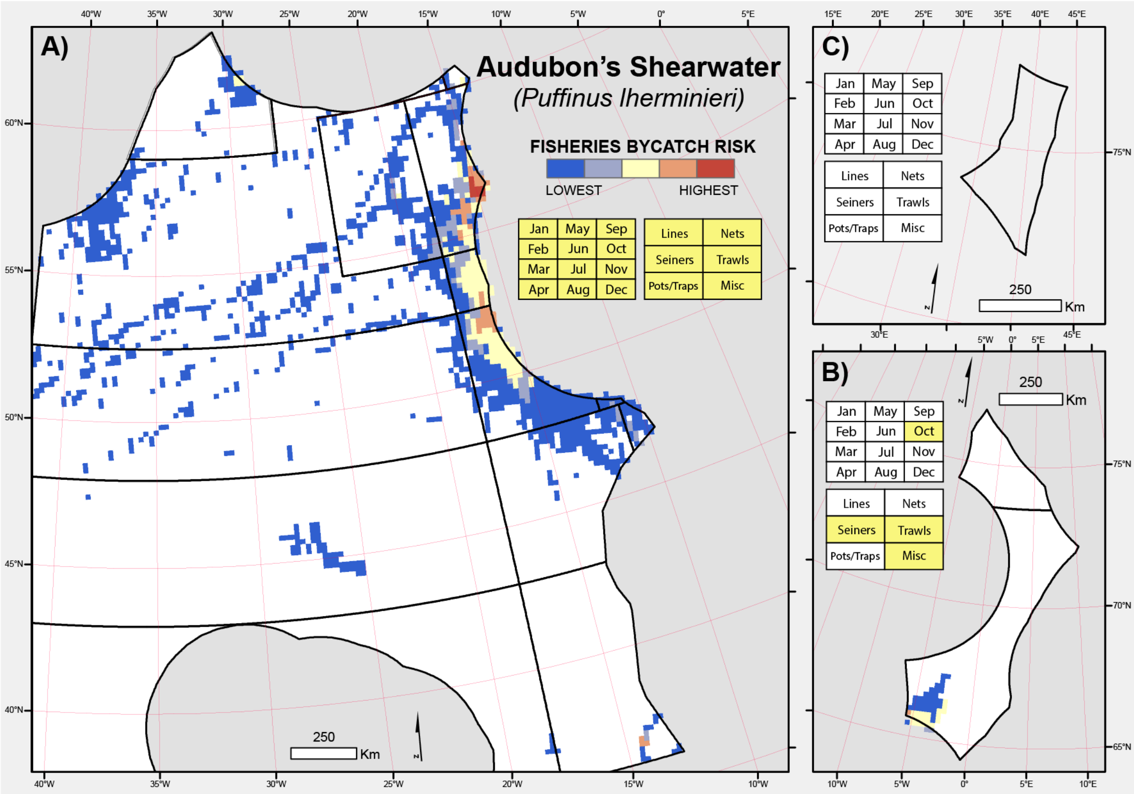

Figure 17. Bycatch risk scores for the Audubon's shearwater (*Puffinus lherminieri*) evaluated with the ByRA in the three NEAFC RAs and the ICES statistical areas within. Yellow-coloured boxes indicate months and gear categories for which the bycatch risk scores apply. White-coloured areas indicate limited bycatch occurrence based on existing data to assess species-fishing gear co-occurrence with the ByRA. Seabird distribution data derived from BirdLife International's Seabird Tracking Database.‡‡‡‡

‡‡‡‡ Data source added following reviewers comments.

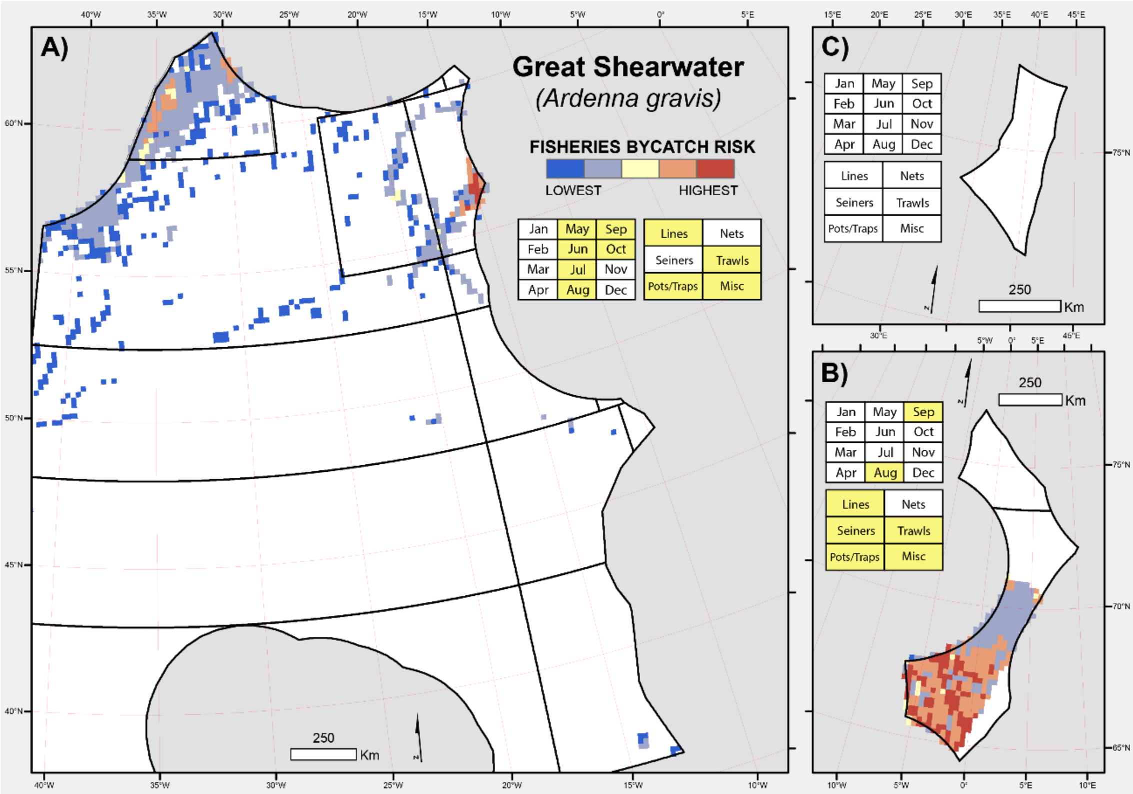

Figure 18. Bycatch risk scores for the great shearwater (*Ardenna gravis*) evaluated with the ByRA in the three NEAFC RAs and the ICES statistical areas within. Yellow-coloured boxes indicate months and gear categories for which the bycatch risk scores apply. White-coloured areas indicate limited bycatch occurrence based on existing data to assess species-fishing gear co-occurrence with the ByRA. Seabird distribution data derived from BirdLife International's Seabird Tracking Database.[§§§§]

[§§§§] Data source added following reviewers comments.

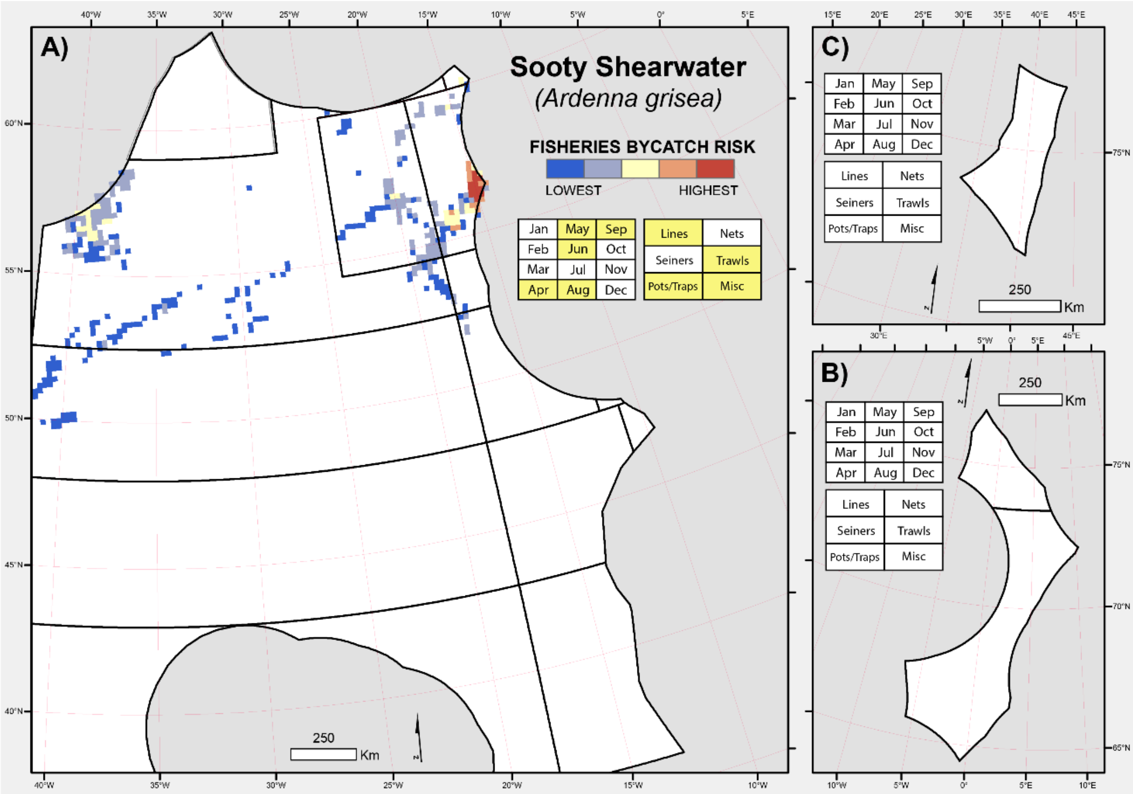

Figure 19. Bycatch risk scores for the sooty shearwater (*Ardenna grisea*) evaluated with the ByRA in the three NEAFC RAs and the ICES statistical areas within. Yellow-coloured boxes indicate months and gear categories for which the bycatch risk scores apply. White-coloured areas indicate limited bycatch occurrence based on existing data to assess species-fishing gear co-occurrence with the ByRA. Seabird distribution data derived from BirdLife International's Seabird Tracking Database.***

***** Data source added following reviewers comments.

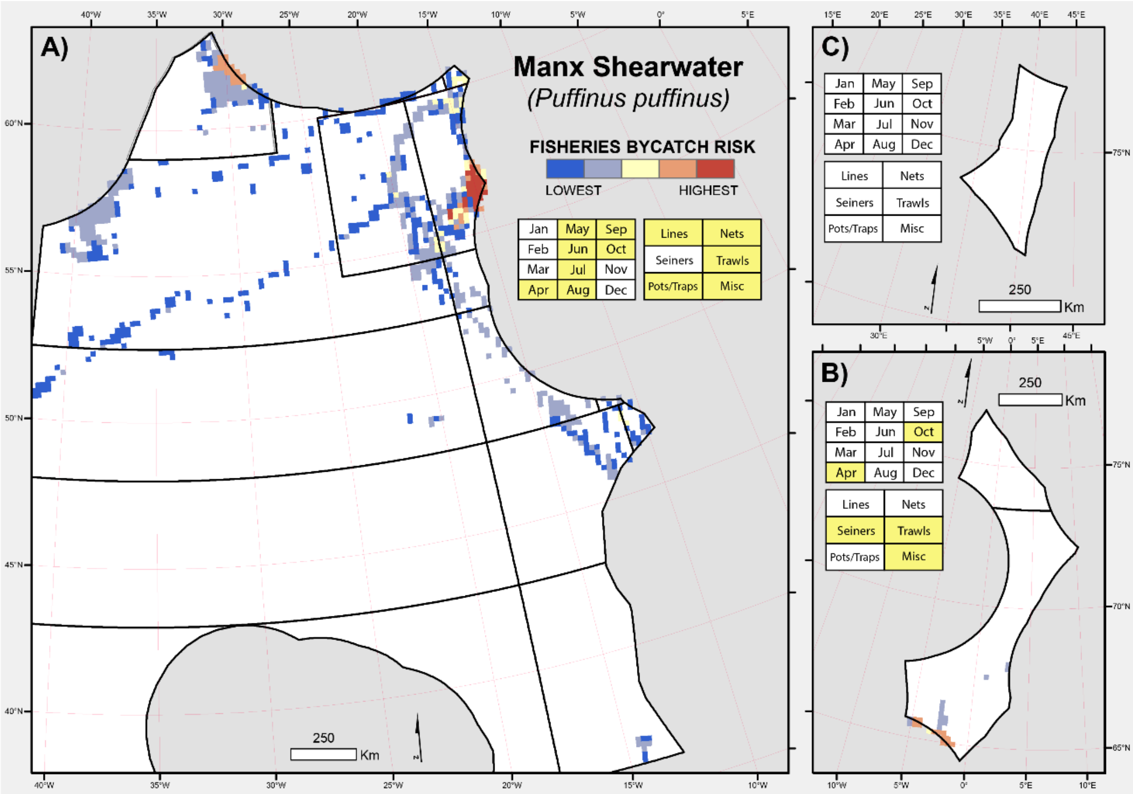

Figure 20. Bycatch risk scores for the Manx shearwater (*Puffinus puffinus*) evaluated with the ByRA in the three NEAFC RAs and the ICES statistical areas within. Yellow-coloured boxes indicate months and gear categories for which the bycatch risk scores apply. White-coloured areas indicate limited bycatch occurrence based on existing data to assess species-fishing gear co-occurrence with the ByRA. Seabird distribution data derived from BirdLife International's Seabird Tracking Database.†††††

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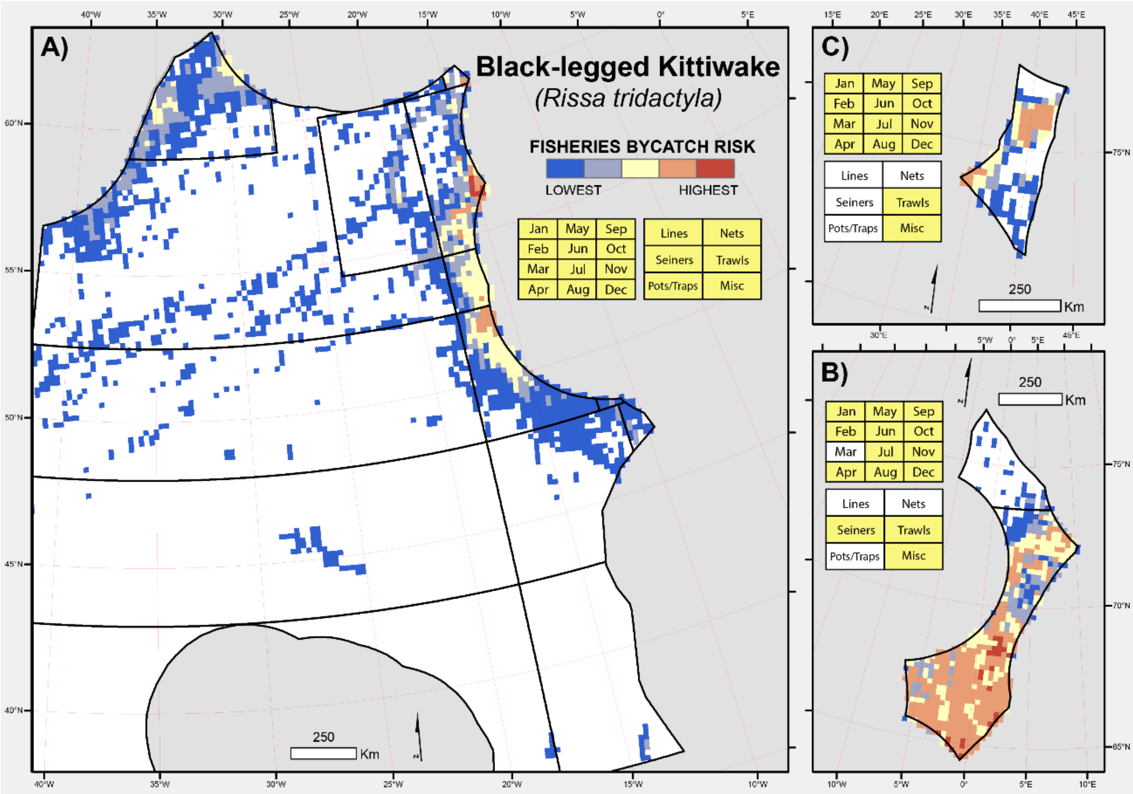

Figure 21. Bycatch risk scores for the black-legged kittiwake (*Rissa tridactyla*) evaluated with the ByRA in the three NEAFC RAs and the ICES statistical areas within. Yellow-coloured boxes indicate months and gear categories for which the bycatch risk scores apply. White-coloured areas indicate limited bycatch occurrence based on existing data to assess species-fishing gear co-occurrence with the ByRA. Seabird distribution data derived from SEATRACK.‡‡‡‡‡

‡‡‡‡‡ Data source added following reviewers comments.

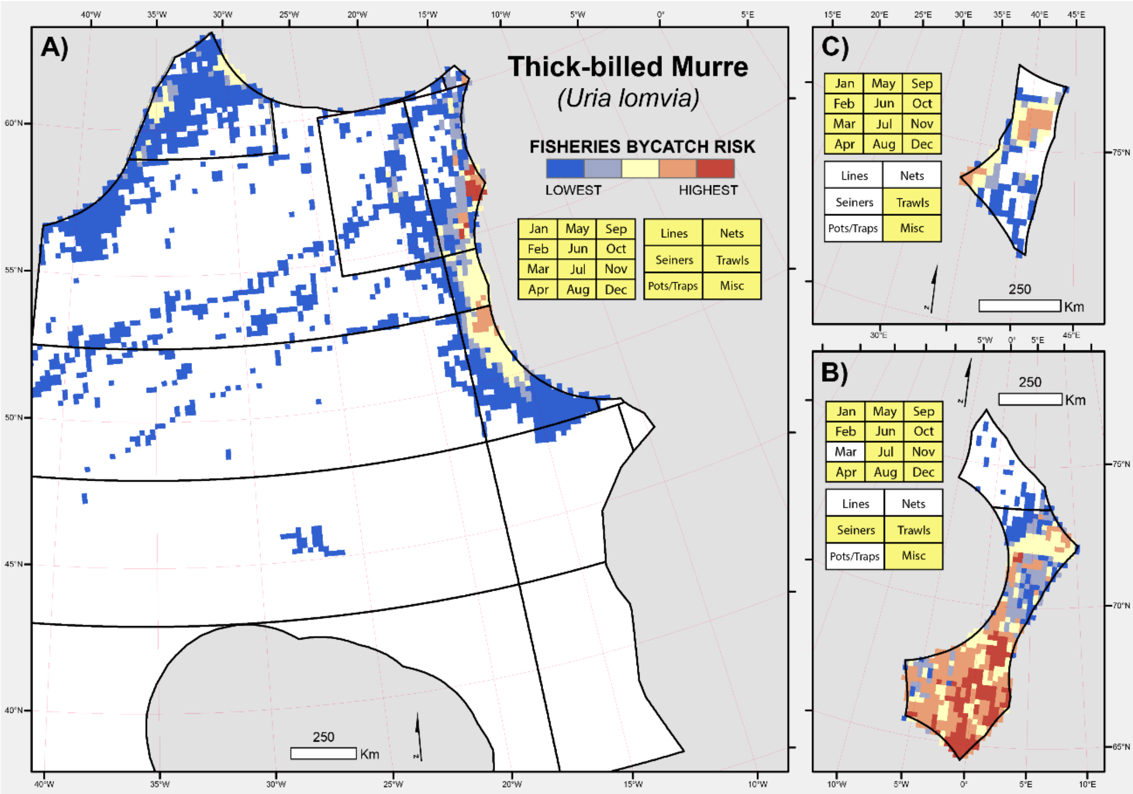

Figure 22. Bycatch risk scores for the thick-billed murre (*Uria lomvia*) evaluated with the ByRA in the three NEAFC RAs and the ICES statistical areas within. Yellow-coloured boxes indicate months and gear categories for which the bycatch risk scores apply. White-coloured areas indicate limited bycatch occurrence based on existing data to assess species-fishing gear co-occurrence with the ByRA. Seabird distribution data derived from SEATRACK.[§§§§§]

§§§§§ Data source added following reviewers comments.

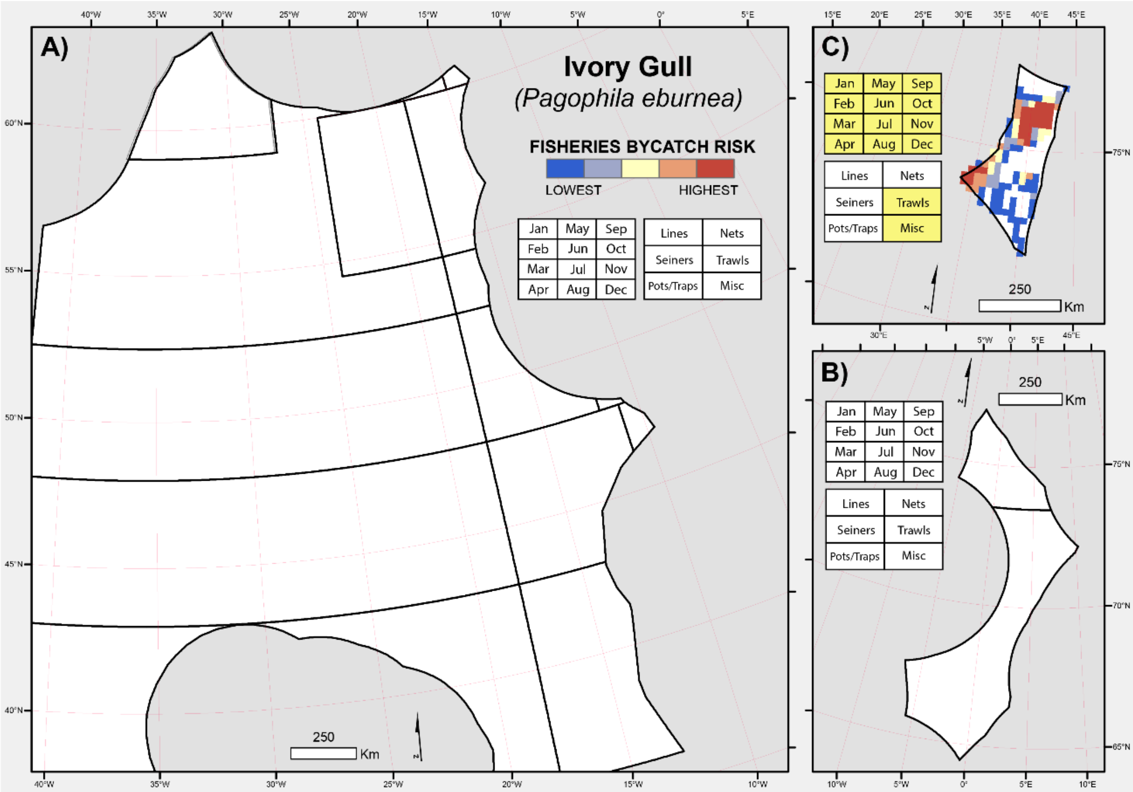

Figure 23. Bycatch risk scores for the ivory gull (*Pagophila eburnea*) evaluated with the ByRA in the three NEAFC RAs and the ICES statistical areas within. Yellow-coloured boxes indicate months and gear categories for which the bycatch risk scores apply. White-coloured areas indicate limited bycatch occurrence based on existing data to assess species-fishing gear co-occurrence with the ByRA. Seabird distribution data derived from BirdLife and/or IUCN range maps.******

****** Data source added following reviewers comments.

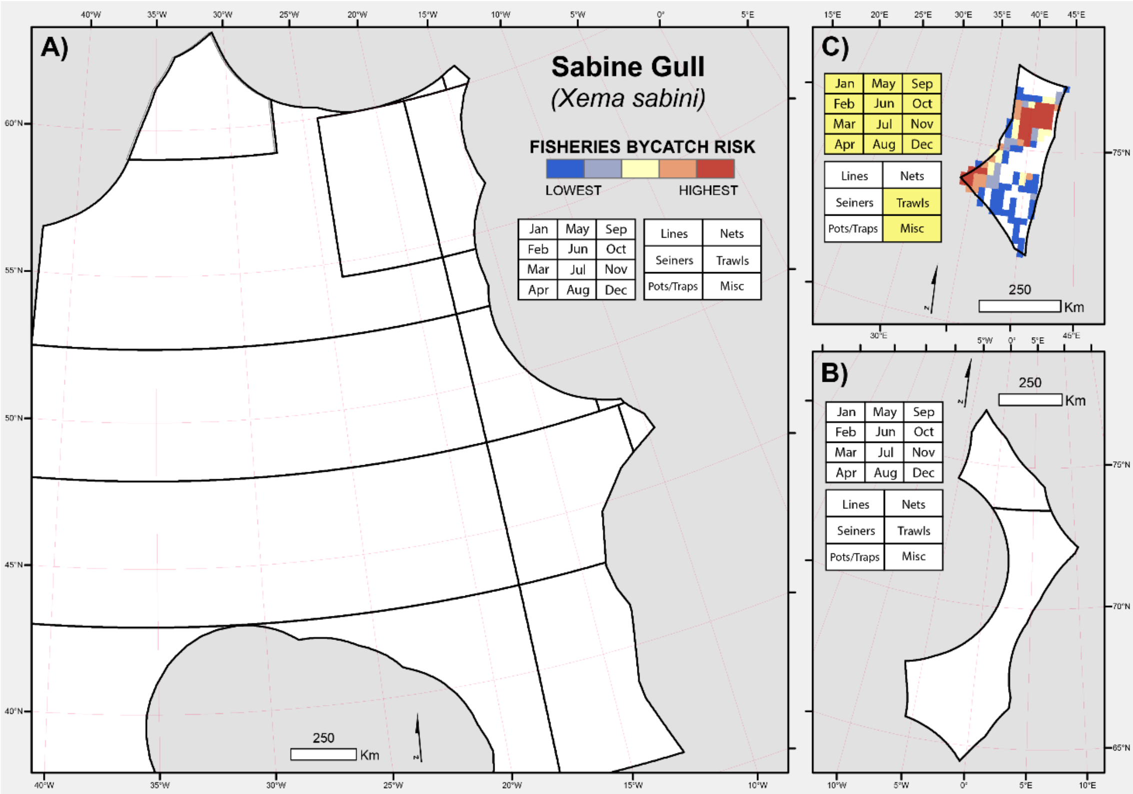

Figure 24. Bycatch risk scores for the Sabine gull (*Xema sabini*) evaluated with the ByRA in the three NEAFC RAs and the ICES statistical areas within. Yellow-coloured boxes indicate months and gear categories for which the bycatch risk scores apply. White-coloured areas indicate limited bycatch occurrence based on existing data to assess species-fishing gear co-occurrence with the ByRA. Seabird distribution data derived from BirdLife and/or IUCN range maps.[††††††]

[††††††] Data source added following reviewers comments.

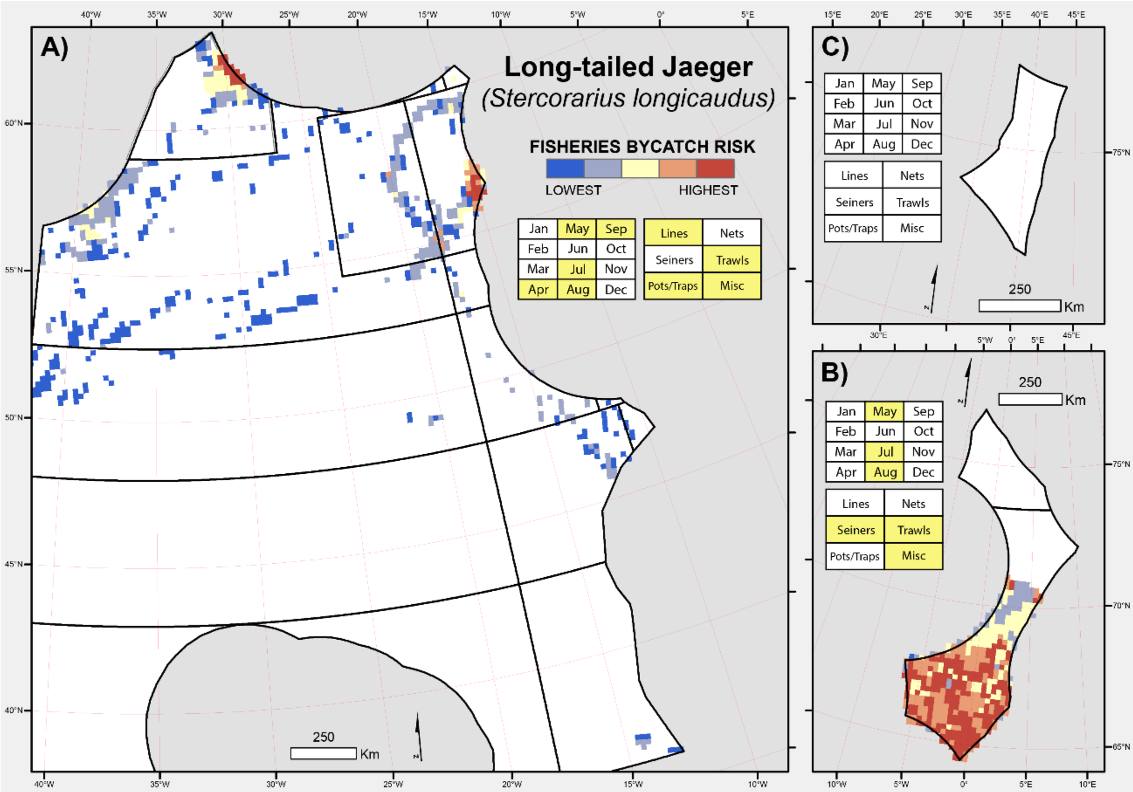

Figure 25. Bycatch risk scores for the long-tailed jaeger (*Stercorarius longicaudus*) evaluated with the ByRA in the three NEAFC RAs and the ICES statistical areas within. Yellow-coloured boxes indicate months and gear categories for which the bycatch risk scores apply. White-coloured areas indicate limited bycatch occurrence based on existing data to assess species-fishing gear co-occurrence with the ByRA. Seabird distribution data derived from BirdLife International's Seabird Tracking Database.‡‡‡‡‡‡

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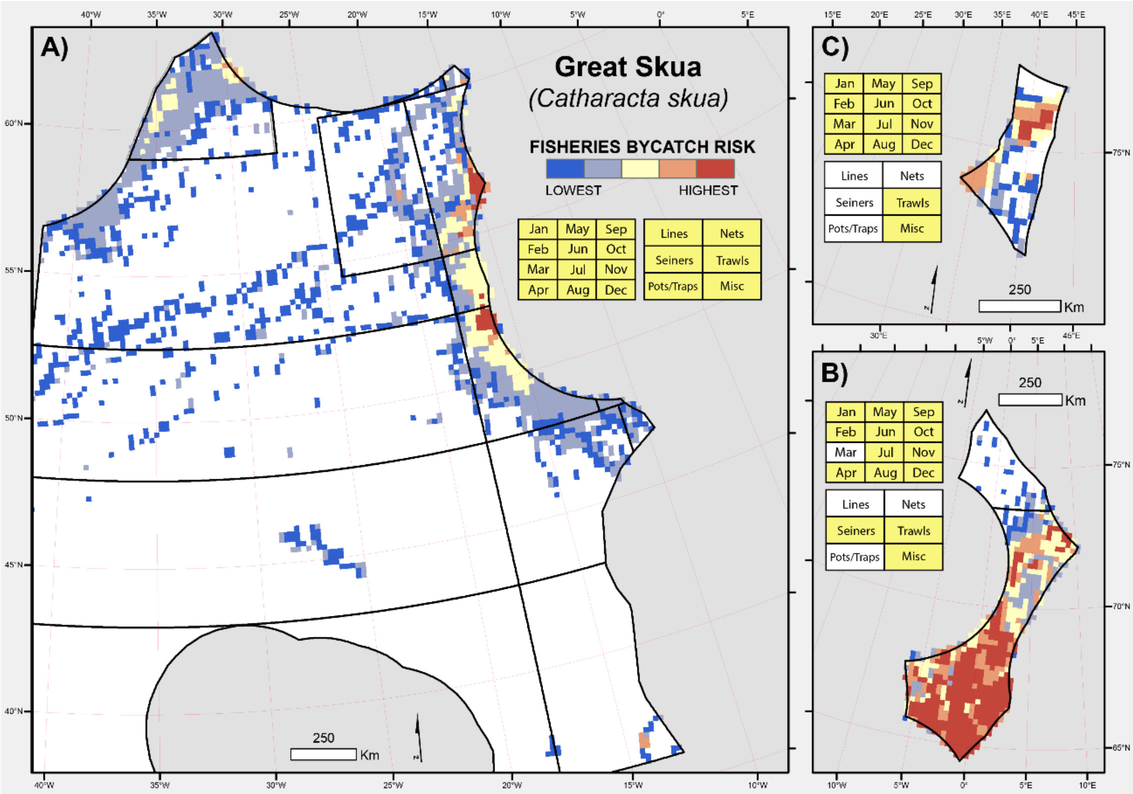

Figure 26. Bycatch risk scores for the great skua (*Catharacta skua*) evaluated with the ByRA in the three NEAFC RAs and the ICES statistical areas within. Yellow-coloured boxes indicate months and gear categories for which the bycatch risk scores apply. White-coloured areas indicate limited bycatch occurrence based on existing data to assess species-fishing gear co-occurrence with the ByRA. Seabird distribution data derived from BirdLife and/or IUCN range maps.[§§§§§§]

[§§§§§§] Data source added following reviewers comments.

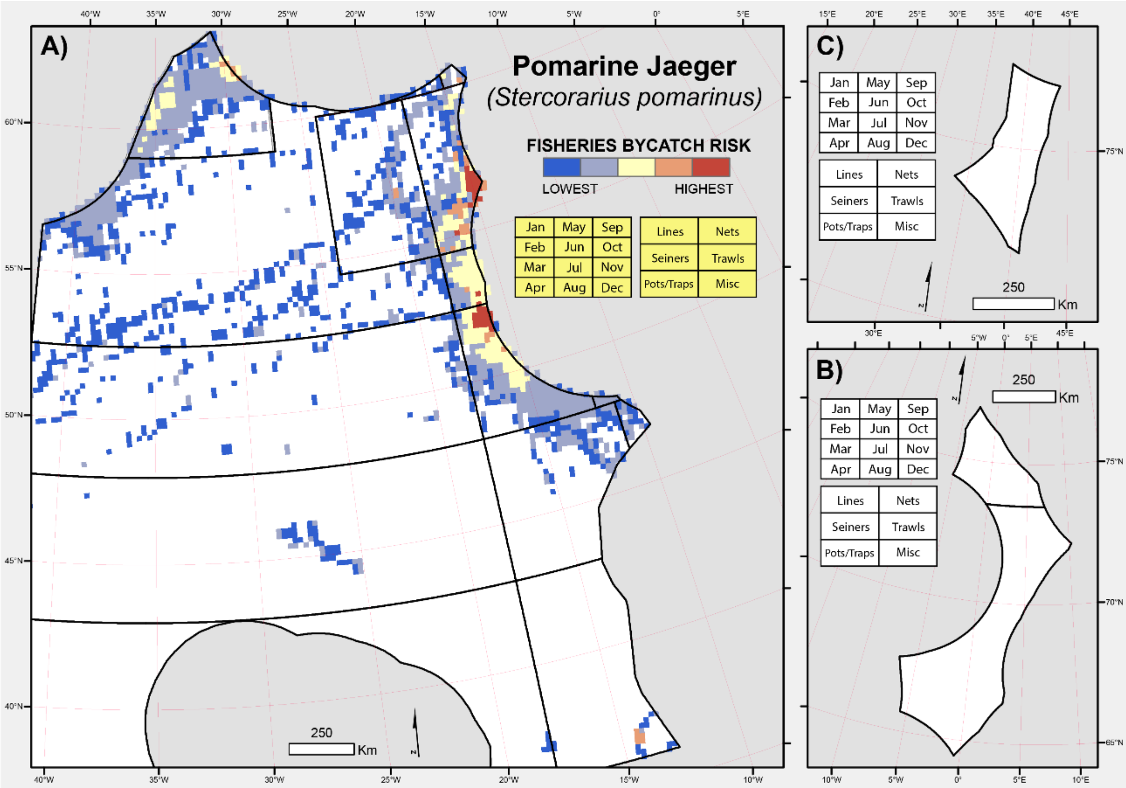

Figure 27. Bycatch risk scores for the pomarine jaeger (*Stercoranius pomarinus*) evaluated with the ByRA in the three NEAFC RAs and the ICES statistical areas within. Yellow-coloured boxes indicate months and gear categories for which the bycatch risk scores apply. White-coloured areas indicate limited bycatch occurrence based on existing data to assess species-fishing gear co-occurrence with the ByRA. Seabird distribution data derived from BirdLife and/or IUCN range maps.*****

******* Data source added following reviewers comments.

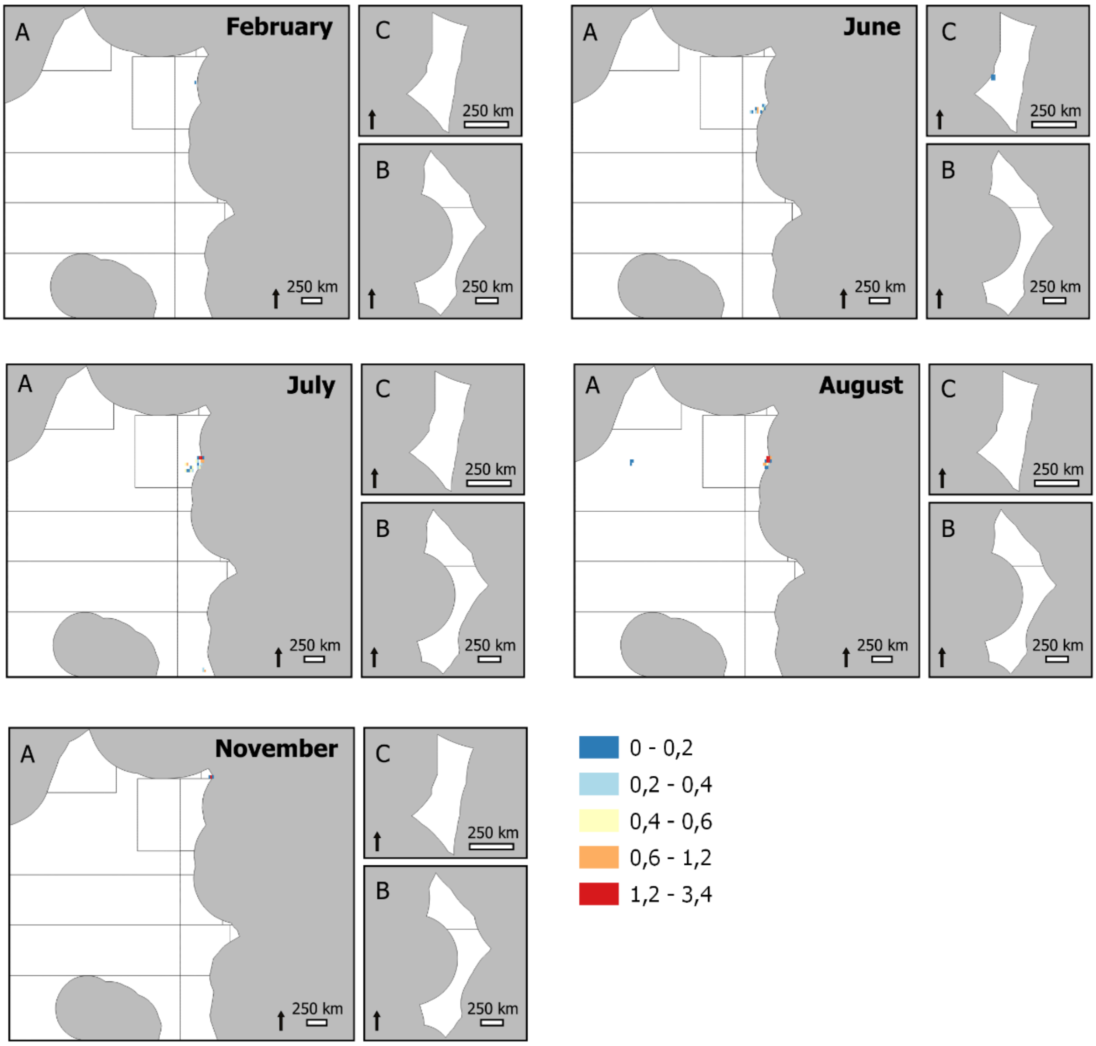

Figure 28. Monthly variations in longline fishing footprint intensity (mean fishing hours per grid cell per month) for the period 2018-2022. The NEAFC regulatory areas: A. NEAFC RA 1 (XRR Reykjanes Ridge) B. NEAFC RA 2 (XNS/ Banana Hole) C. NEAFC RA 3 (XBS/Loophole).

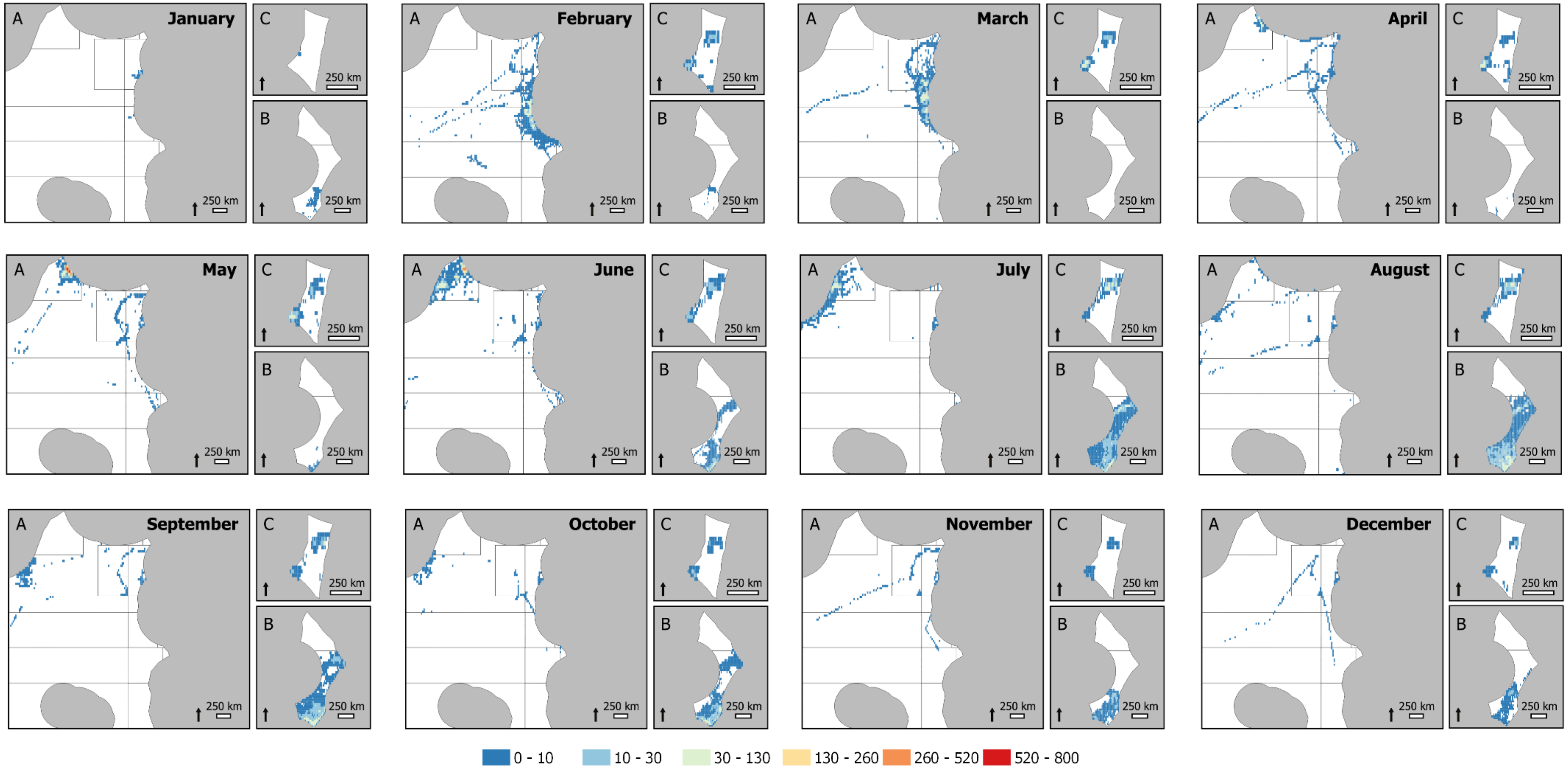

Figure 29. Monthly variations in trawl fishing footprint intensity (mean fishing hours per grid cell per month) for the period 2018-2022. The NEAFC regulatory areas: A. NEAFC RA 1 (XRR Reykjanes Ridge) B. NEAFC RA 2 (XNS/ Banana Hole) C. NEAFC RA 3 (XBS/Loophole).

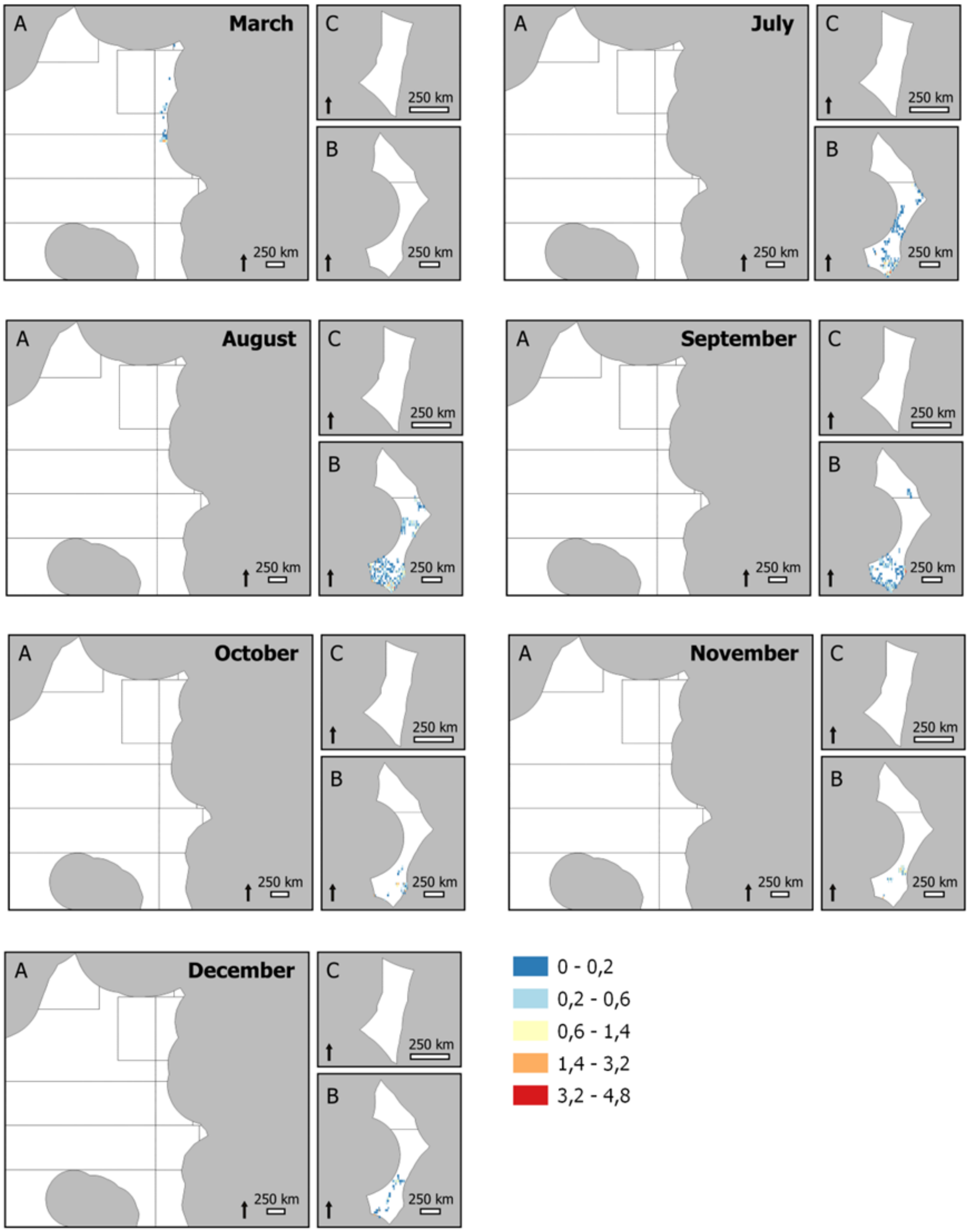

Figure 30. Monthly variations in seine fishing footprint intensity (mean fishing hours per grid cell per month) for the period 2018-2022. The NEAFC regulatory areas: A. NEAFC RA 1 (XRR Reykjanes Ridge) B. NEAFC RA 2 (XNS/ Banana Hole) C. NEAFC RA 3 (XBS/Loophole).

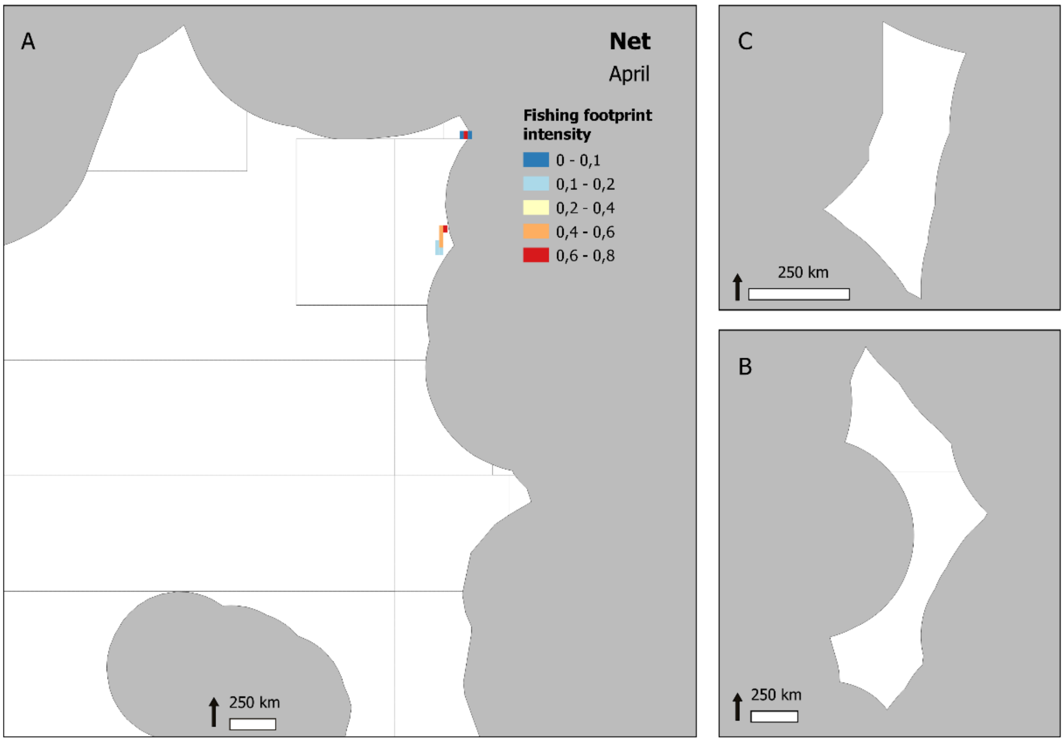

Figure 31. Net fishing footprint intensity (mean fishing hours per grid cell per month) for the month of April (the only month with fishing effort data for that gear) for the period 2018-2022. The NEAFC regulatory areas: A. NEAFC RA 1 (XRR Reykjanes Ridge) B. NEAFC RA 2 (XNS/ Banana Hole) C. NEAFC RA 3 (XBS/Loophole).

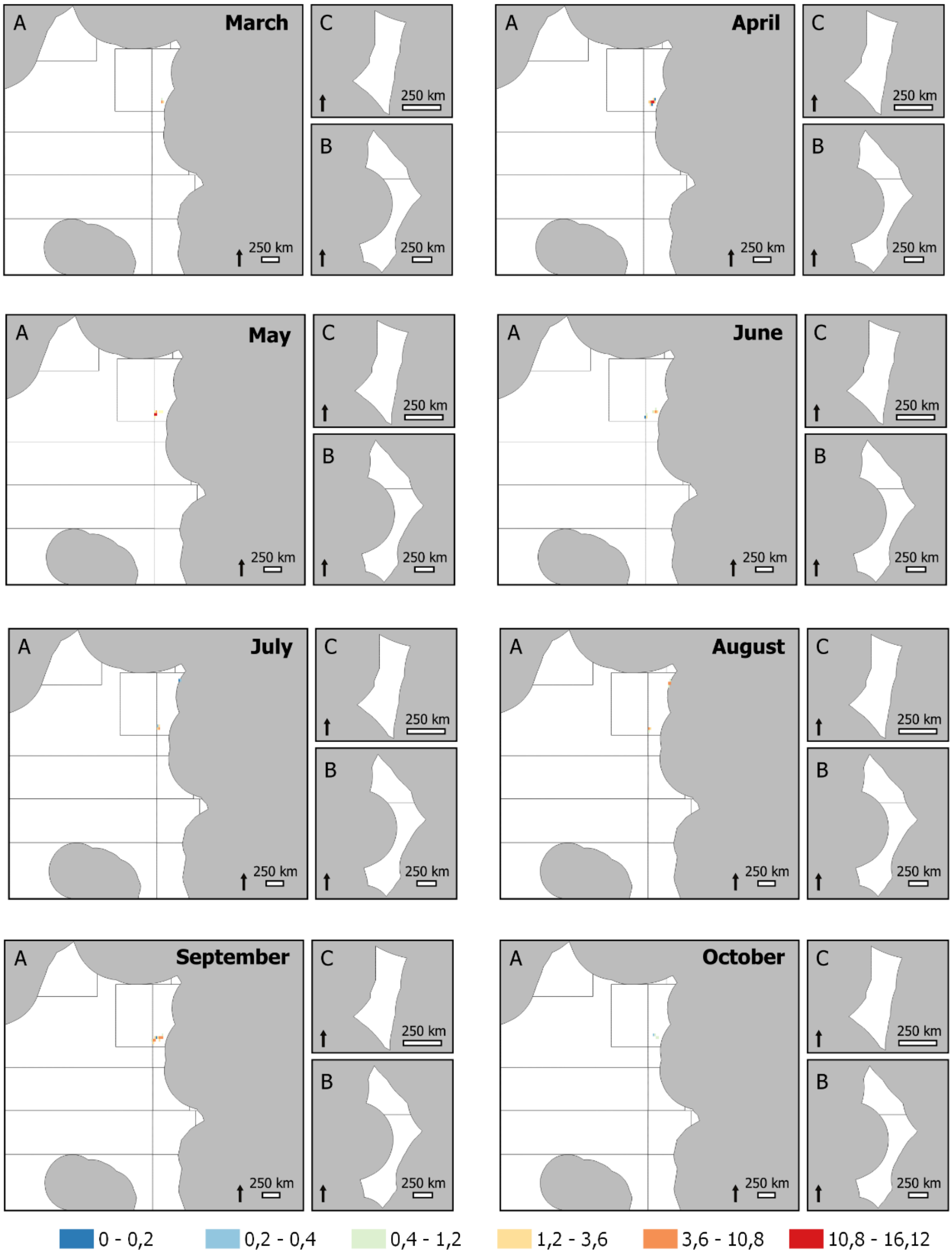

Figure 32. Monthly variations in pots and traps fishing footprint intensity (mean fishing hours per grid cell per month) for the period 2018-2022. The NEAFC regulatory areas: A. NEAFC RA 1 (XRR Reykjanes Ridge) B. NEAFC RA 2 (XNS/ Banana Hole) C. NEAFC RA 3 (XBS/Loophole).

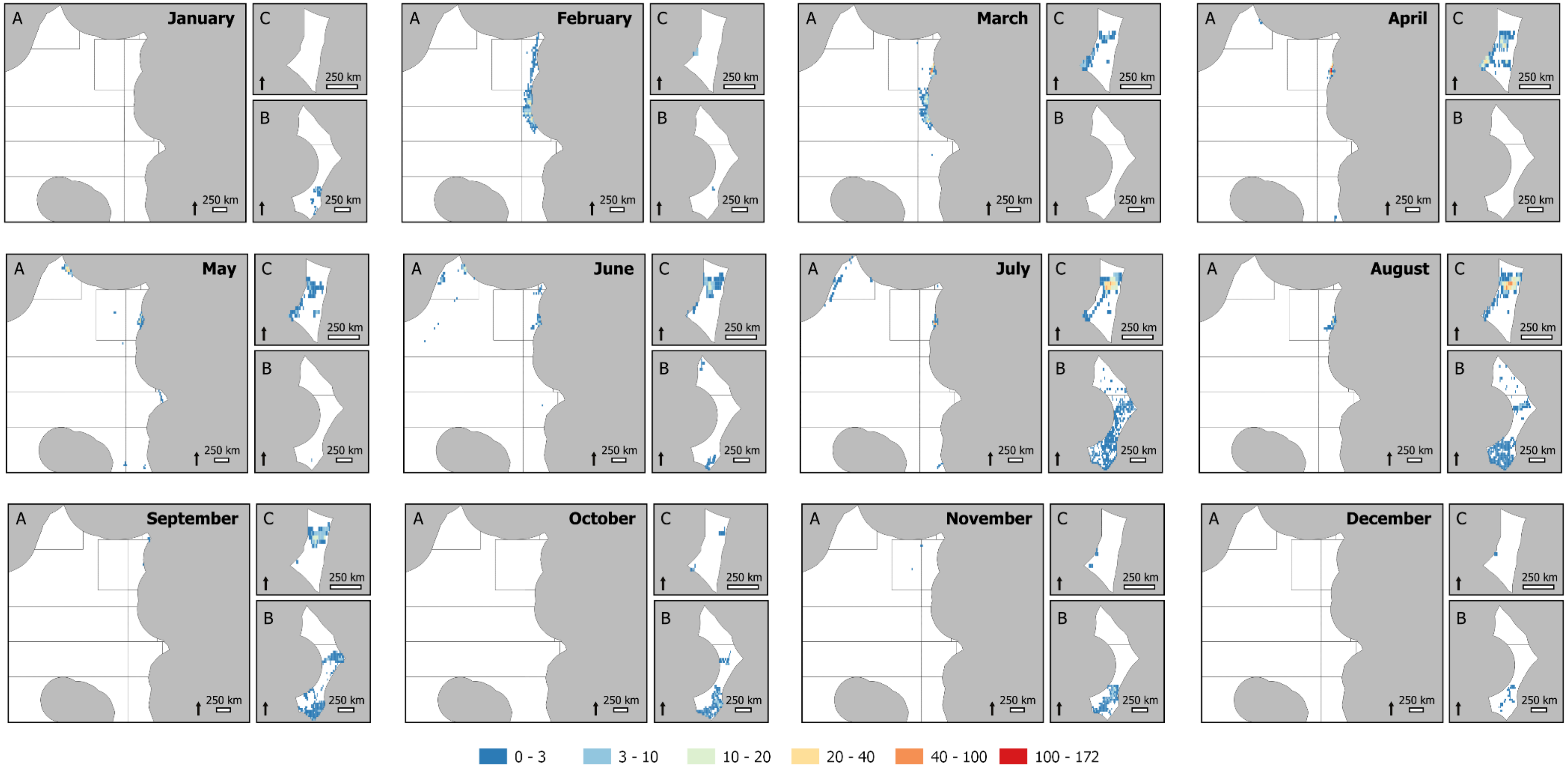

Figure 33. Monthly variations for all other unclassified (UNK) fishing gears footprint intensity (mean fishing hours per grid cell per month) for the period 2018-2022. The NEAFC regulatory areas: A. NEAFC RA 1 (XRR Reykjanes Ridge) B. NEAFC RA 2 (XNS/ Banana Hole) C. NEAFC RA 3 (XBS/Loophole).

Table 4. List of seabirds relevant to NEAFC with sources for information on species distribution and evidence of bycatch.

Aphia ID	Species Scientific name	Previous Scientific Name	Vernacular name English	Ecoregion	Relevant to NEAFC	NEAFC Area	Sources for distribution	Sources for bycatch evidence (irrespective of gear & region)	Link/DOI
137128	*Alca torda*	*Alca torda*	Razorbill	Barents Sea	Y	3	BirdLife DataZone	Northridge, S., Kingston, A. and Coram, A., 2020. Preliminary estimates of seabird bycatch by UK vessels in UK and adjacent waters. *Report prepared for the Department for Environment Food and Rural Affairs (Project Code ME6024).*	https://randd.defra.gov.uk/ProjectDetails?ProjectID=20461&FromSearch=Y&Publisher=1&SearchText=ME6024&SortString=ProjectCode&SortOrder=Asc&Paging=10#Description
137128	*Alca torda*	*Alca torda*	Razorbill	Norwegian Sea	Y	2	BirdLife DataZone	Northridge, S., Kingston, A. and Coram, A., 2020. Preliminary estimates of seabird bycatch by UK vessels in UK and adjacent waters. *Report prepared for the Department for Environment Food and Rural Affairs (Project Code ME6024).*	https://randd.defra.gov.uk/ProjectDetails?ProjectID=20461&FromSearch=Y&Publisher=1&SearchText=ME6024&SortString=ProjectCode&SortOrder=Asc&Paging=10#Description
137128	*Alca torda*	*Alca torda*	Razorbill	Oceanic Northeast Atlantic	Y	1	Expert opinion	Northridge, S., Kingston, A. and Coram, A., 2020. Preliminary estimates of seabird bycatch by UK vessels in UK and adjacent waters. Report prepared for the Department for Environment Food and Rural Affairs (Project Code ME6024). https://randd.defra.gov.uk/ProjectDetails?ProjectID=20461&FromSearch=Y&Publisher=1&SearchText=ME6024&SortString=ProjectCode&SortOrder=Asc&Paging=10#Description	https://randd.defra.gov.uk/ProjectDetails?ProjectID=20461&FromSearch=Y&Publisher=1&SearchText=ME6024&SortString=ProjectCode&SortOrder=Asc&Paging=10#Description

Aphia ID	Species Scientific name	Previous Scientific Name	Vernacular name English	Ecoregion	Relevant to NEAFC	NEAFC Area	Sources for distribution	Sources for bycatch evidence (irrespective of gear & region)	Link/DOI
137129	*Alle alle*	*Alle alle*	Little auk	Barents Sea	Y	3	SeaTrack Data	Merkel, F.R. 2011. Gillnet bycatch of seabirds in Southwest Greenland, 2003 - 2008. Technical Report No. 85, Pinngortitaleriffik, Greenland Institute of Natural Resources	https://natur.gl/wp-content/uploads/2010/01/85-Gillnet-bycatch-of-seabirds-in-Southwest-Greenland-2003-2008.pdf
137129	*Alle alle*	*Alle alle*	Little auk	Norwegian Sea	Y	2	SeaTrack Data	Merkel, F.R. 2011. Gillnet bycatch of seabirds in Southwest Greenland, 2003 - 2008. Technical Report No. 85, Pinngortitaleriffik, Greenland Institute of Natural Resources	https://natur.gl/wp-content/uploads/2010/01/85-Gillnet-bycatch-of-seabirds-in-Southwest-Greenland-2003-2008.pdf
137129	*Alle alle*	*Alle alle*	Little auk	Oceanic Northeast Atlantic	Y	1	SeaTrack Data	Merkel, F.R. 2011. Gillnet bycatch of seabirds in Southwest Greenland, 2003 - 2008. Technical Report No. 85, Pinngortitaleriffik, Greenland Institute of Natural Resources https://natur.gl/wp-content/uploads/2010/01/85-Gillnet-bycatch-of-seabirds-in-Southwest-Greenland-2003-2008.pdf	https://natur.gl/wp-content/uploads/2010/01/85-Gillnet-bycatch-of-seabirds-in-Southwest-Greenland-2003-2008.pdf
137201	*Ardenna gravis*	*Puffinus gravis*	Great shearwater	Norwegian Sea	N	2	Seabird Tracking Data	POWERS, K.D., Wiley, D.N., Robuck, A.R., Olson, Z.H., Welch, L.J., Thompson, M.A. and Kaufman, L., 2020. Spatiotemporal characterization of non-breeding Great Shearwaters Ardenna gravis within their wintering range. *Marine Ornithology*, *48*, pp.215-229.	http://www.marineornithology.org/PDF/48_2/48_2_215-229.pdf

Aphia ID	Species Scientific name	Previous Scientific Name	Vernacular name English	Ecoregion	Relevant to NEAFC	NEAFC Area	Sources for distribution	Sources for bycatch evidence (irrespective of gear & region)	Link/DOI
137201	*Ardenna gravis*	*Puffinus gravis*	Great shearwater	Oceanic Northeast Atlantic	Y	1	Seabird Tracking Data	Sigourney, D.B., Orphanides, C.D. and Hatch, J.M., 2019. Estimates of Seabird Bycatch in Commercial Fisheries off the East Coast of the United States from 2015 to 2016.	https://www.researchgate.net/publication/332970662_Estimates_of_Seabird_Bycatch_in_Commercial_Fisheries_off_the_East_Coast_of_the_United_States_from_2015_to_2016
137202	*Ardenna griseus*	*Puffinus griseus*	Sooty shearwater	Norwegian Sea	N	2	Seabird Tracking Data	Uhlmann, S., 2003. *Fisheries bycatch mortalities of sooty shearwaters (Puffinus griseus) and short-tailed shearwaters (P. tenuirostris)* (p. 52). Wellington, New Zealand: Department of Conservation.	https://www.researchgate.net/publication/238683533_Fisheries_bycatch_mortalities_of_sooty_shearwaters_Puffinus_griseus_and_short-tailed_shearwaters_P_tenuirostris
137202	*Ardenna griseus*	*Puffinus griseus*	Sooty shearwater	Oceanic Northeast Atlantic	Y	1	Seabird Tracking Data	Sigourney, D.B., Orphanides, C.D. and Hatch, J.M., 2019. Estimates of Seabird Bycatch in Commercial Fisheries off the East Coast of the United States from 2015 to 2016.	https://www.researchgate.net/publication/332970662_Estimates_of_Seabird_Bycatch_in_Commercial_Fisheries_off_the_East_Coast_of_the_United_States_from_2015_to_2016
232037	*Aythya ferina*	*Aythya ferina*	Common Pochard	Norwegian Sea	N	2	BirdLife DataZone		
159164	*Aythya fuligula*	*Aythya fuligula*	Tufted Duck	Barents Sea	N	3	BirdLife DataZone		
159164	*Aythya fuligula*	*Aythya fuligula*	Tufted Duck	Norwegian Sea	N	2	BirdLife DataZone		

Aphia ID	Species Scientific name	Previous Scientific Name	Vernacular name English	Ecoregion	Relevant to NEAFC	NEAFC Area	Sources for distribution	Sources for bycatch evidence (irrespective of gear & region)	Link/DOI
159172	*Aythya marila*	*Aythya marila*	Greater scaup	Barents Sea	N	3	BirdLife DataZone		
159172	*Aythya marila*	*Aythya marila*	Greater scaup	Norwegian Sea	N	2	BirdLife DataZone		
159197	*Bucephala clangula*	*Bucephala clangula*	Common Goldeneye	Barents Sea	N	3	BirdLife DataZone		
159197	*Bucephala clangula*	*Bucephala clangula*	Common Goldeneye	Norwegian Sea	N	2	BirdLife DataZone		
1348497	*Calonectris borealis*	*Calonectris borealis*	Cory's shearwater	Oceanic Northeast Atlantic	Y	1	Seabird Tracking Data	Báez, J.C., García-Barcelona, S., Mendoza, M., Ortiz de Urbina, J.M., Real, R. and Macías, D., 2014. Cory's shearwater by-catch in the Mediterranean Spanish commercial longline fishery: implications for management. *Biodiversity and conservation*, *23*(3), pp.661-681.	https://doi.org/10.1007/s10531-014-0625-6
137194	*Calonectris diomedea*	*Calonectris diomedea*	Scopoli's shearwater	Oceanic Northeast Atlantic	Y	1	Seabird Tracking Data	Bugoni, L., Mancini, P.L., Monteiro, D.S., Nascimento, L. and Neves, T.S., 2008. Seabird bycatch in the Brazilian pelagic longline fishery and a review of capture rates in the southwestern Atlantic Ocean. Endangered Species Research, 5(2-3), pp.137-147.	10.3354/esr00115

Aphia ID	Species Scientific name	Previous Scientific Name	Vernacular name English	Ecoregion	Relevant to NEAFC	NEAFC Area	Sources for distribution	Sources for bycatch evidence (irrespective of gear & region)	Link/DOI
137174	*Catharacta skua*	*Stercorarius skua*	Great skua	Barents Sea	Y	3	BirdLife DataZone	Bugoni, L., Mancini, P.L., Monteiro, D.S., Nascimento, L. and Neves, T.S., 2008. Seabird bycatch in the Brazilian pelagic longline fishery and a review of capture rates in the southwestern Atlantic Ocean. *Endangered Species Research*, *5*(2-3), pp.137-147.	https://www.int-res.com/articles/esr2008/5/n005p137.pdf
137174	*Catharacta skua*	*Stercorarius skua*	Great skua	Norwegian Sea	Y	2	BirdLife DataZone	Bugoni, L., Mancini, P.L., Monteiro, D.S., Nascimento, L. and Neves, T.S., 2008. Seabird bycatch in the Brazilian pelagic longline fishery and a review of capture rates in the southwestern Atlantic Ocean. *Endangered Species Research*, *5*(2-3), pp.137-147.	https://www.int-res.com/articles/esr2008/5/n005p137.pdf
137174	*Catharacta skua*	*Stercorarius skua*	Great skua	Oceanic Northeast Atlantic	Y	1	Seabird Tracking Data	Bugoni, L., Mancini, P.L., Monteiro, D.S., Nascimento, L. and Neves, T.S., 2008. Seabird bycatch in the Brazilian pelagic longline fishery and a review of capture rates in the southwestern Atlantic Ocean. *Endangered Species Research*, *5*(2-3), pp.137-147.	https://www.int-res.com/articles/esr2008/5/n005p137.pdf

Aphia ID	Species Scientific name	Previous Scientific Name	Vernacular name English	Ecoregion	Relevant to NEAFC	NEAFC Area	Sources for distribution	Sources for bycatch evidence (irrespective of gear & region)	Link/DOI
137130	*Cepphus grylle*	*Cepphus grylle*	Black guillemot	Barents Sea	Y	3	BirdLife DataZone	Fangel, K., Aas, Ø., Vølstad, J.H., Bærum, K.M., Christensen-Dalsgaard, S., Nedreaas, K., Overvik, M., Wold, L.C. and Anker-Nilssen, T., 2015. Assessing incidental bycatch of seabirds in Norwegian coastal commercial fisheries: empirical and methodological lessons. Global Ecology and Conservation, 4, pp.127-136.	https://www.sciencedirect.com/science/article/pii/S2351989415000621
137130	*Cepphus grylle*	*Cepphus grylle*	Black guillemot	Norwegian Sea	Y	2	Expert opinion	Fangel, K., Aas, Ø., Vølstad, J.H., Bærum, K.M., Christensen-Dalsgaard, S., Nedreaas, K., Overvik, M., Wold, L.C. and Anker-Nilssen, T., 2015. Assessing incidental bycatch of seabirds in Norwegian coastal commercial fisheries: empirical and methodological lessons. Global Ecology and Conservation, 4, pp.127-136. https://www.sciencedirect.com/science/article/pii/S2351989415000621	https://www.sciencedirect.com/science/article/pii/S2351989415000621
137071	*Clangula hyemalis*	*Clangula hyemalis*	Long-tailed duck	Barents Sea	N	3	BirdLife DataZone		
137071	*Clangula hyemalis*	*Clangula hyemalis*	Long-tailed duck	Norwegian Sea	N	2	BirdLife DataZone		

Aphia ID	Species Scientific name	Previous Scientific Name	Vernacular name English	Ecoregion	Relevant to NEAFC	NEAFC Area	Sources for distribution	Sources for bycatch evidence (irrespective of gear & region)	Link/DOI
137131	*Fratercula arctica*	*Fratercula arctica*	Atlantic puffin	Barents Sea	Y	3	SeaTrack Data	Hedd, A., Regular, P.M., Wilhelm, S.I., Rail, J.F., Drolet, B., Fowler, M., Pekarik, C. and Robertson, G.J., 2016. Characterization of seabird bycatch in eastern Canadian waters, 1998–2011, assessed from onboard fisheries observer data. *Aquatic Conservation: Marine and Freshwater Ecosystems*, *26*(3), pp.530-548.	https://doi.org/10.1002/aqc.2551
137131	*Fratercula arctica*	*Fratercula arctica*	Atlantic puffin	Norwegian Sea	Y	2	SeaTrack Data	Hedd, A., Regular, P.M., Wilhelm, S.I., Rail, J.F., Drolet, B., Fowler, M., Pekarik, C. and Robertson, G.J., 2016. Characterization of seabird bycatch in eastern Canadian waters, 1998–2011, assessed from onboard fisheries observer data. *Aquatic Conservation: Marine and Freshwater Ecosystems*, *26*(3), pp.530-548.	https://doi.org/10.1002/aqc.2551
137131	*Fratercula arctica*	*Fratercula arctica*	Atlantic puffin	Oceanic Northeast Atlantic	Y	1	SeaTrack Data	Hedd, A., Regular, P.M., Wilhelm, S.I., Rail, J.F., Drolet, B., Fowler, M., Pekarik, C. and Robertson, G.J., 2016. Characterization of seabird bycatch in eastern Canadian waters, 1998–2011, assessed from onboard fisheries observer data. *Aquatic Conservation: Marine and Freshwater Ecosystems*, *26*(3), pp.530-548.	https://doi.org/10.1002/aqc.2551

Aphia ID	Species Scientific name	Previous Scientific Name	Vernacular name English	Ecoregion	Relevant to NEAFC	NEAFC Area	Sources for distribution	Sources for bycatch evidence (irrespective of gear & region)	Link/DOI
232054	*Fulica atra*	*Fulica atra*	Eurasian Coot	Norwegian Sea	N	2	BirdLife DataZone		
137195	*Fulmarus glacialis*	*Fulmarus glacialis*	Northern fulmar	Barents Sea	Y	3	SeaTrack Data	Northridge, S., Kingston, A. and Coram, A., 2020. Preliminary estimates of seabird bycatch by UK vessels in UK and adjacent waters. *Report prepared for the Department for Environment Food and Rural Affairs (Project Code ME6024).*	https://randd.defra.gov.uk/ProjectDetails?ProjectID=20461&FromSearch=Y&Publisher=1&SearchText=ME6024&SortString=ProjectCode&SortOrder=Asc&Paging=10#Description
137195	*Fulmarus glacialis*	*Fulmarus glacialis*	Northern fulmar	Norwegian Sea	Y	2	SeaTrack Data	Northridge, S., Kingston, A. and Coram, A., 2020. Preliminary estimates of seabird bycatch by UK vessels in UK and adjacent waters. *Report prepared for the Department for Environment Food and Rural Affairs (Project Code ME6024).*	https://randd.defra.gov.uk/ProjectDetails?ProjectID=20461&FromSearch=Y&Publisher=1&SearchText=ME6024&SortString=ProjectCode&SortOrder=Asc&Paging=10#Description
137195	*Fulmarus glacialis*	*Fulmarus glacialis*	Northern fulmar	Oceanic Northeast Atlantic	Y	1	SeaTrack Data	Northridge, S., Kingston, A. and Coram, A., 2020. Preliminary estimates of seabird bycatch by UK vessels in UK and adjacent waters. *Report prepared for the Department for Environment Food and Rural Affairs (Project Code ME6024).*	https://randd.defra.gov.uk/ProjectDetails?ProjectID=20461&FromSearch=Y&Publisher=1&SearchText=ME6024&SortString=ProjectCode&SortOrder=Asc&Paging=10#Description
137185	*Gavia adamsii*	*Gavia adamsii*	Yellow-billed Loon	Barents Sea	N	3	BirdLife DataZone		
137185	*Gavia adamsii*	*Gavia adamsii*	Yellow-billed Loon	Norwegian Sea	N	2	BirdLife DataZone		

Aphia ID	Species Scientific name	Previous Scientific Name	Vernacular name English	Ecoregion	Relevant to NEAFC	NEAFC Area	Sources for distribution	Sources for bycatch evidence (irrespective of gear & region)	Link/DOI
137186	*Gavia arctica*	*Gavia arctica*	Black-throated Loon	Barents Sea	N	3	BirdLife DataZone		
137186	*Gavia arctica*	*Gavia arctica*	Black-throated Loon	Norwegian Sea	N	2	BirdLife DataZone		
137187	*Gavia immer*	*Gavia immer*	Common loon	Barents Sea	N	3	BirdLife DataZone		
137187	*Gavia immer*	*Gavia immer*	Common loon	Norwegian Sea	N	2	BirdLife DataZone		
137188	*Gavia stellata*	*Gavia stellata*	Red-throated Loon	Barents Sea	N	3	BirdLife DataZone		
137188	*Gavia stellata*	*Gavia stellata*	Red-throated Loon	Norwegian Sea	N	2	BirdLife DataZone		
137178	*Gulosus aristotelis*	*Phalacrocorax aristotelis*	European shag	Barents Sea	N	3	BirdLife DataZone		
137178	*Gulosus aristotelis*	*Phalacrocorax aristotelis*	European shag	Norwegian Sea	N	2	BirdLife DataZone		
137138	*Larus argentatus*	*Larus argentatus*	Herring gull	Barents Sea	N	3	SeaTrack Data		
137138	*Larus argentatus*	*Larus argentatus*	Herring seagull	Norwegian Sea	N	2	SeaTrack Data		
137141	*Larus canus*	*Larus canus*	Common gull	Barents Sea	N	3	BirdLife DataZone		
137141	*Larus canus*	*Larus canus*	Common gull	Norwegian Sea	N	2	BirdLife DataZone		

Aphia ID	Species Scientific name	Previous Scientific Name	Vernacular name English	Ecoregion	Relevant to NEAFC	NEAFC Area	Sources for distribution	Sources for bycatch evidence (irrespective of gear & region)	Link/DOI
148797	*Larus delawarensis*	*Larus delawarensis*	Ring-billed gull	Oceanic Northeast Atlantic	N	1	BirdLife DataZone		
137142	*Larus fuscus*	*Larus fuscus*	Lesser black-backed gull	Barents Sea	N	3	BirdLife DataZone		
137142	*Larus fuscus*	*Larus fuscus*	Lesser black-backed gull	Norwegian Sea	N	2	BirdLife DataZone		
137144	*Larus glaucoides*	*Larus glaucoides*	Iceland gull	Barents Sea	N	3	BirdLife DataZone		
137144	*Larus glaucoides*	*Larus glaucoides*	Iceland gull	Norwegian Sea	N	2	BirdLife DataZone		
137145	*Larus hyperboreus*	*Larus hyperboreus*	Glaucous gull	Barents Sea	Y	3	SeaTrack Data	Petersen, A., Irons, D.B., Gilchrist, H.G., Robertson, G.J., Boertmann, D., Strøm, H., Gavrilo, M., Artukhin, Y., Clausen, D.S., Kuletz, K.J. and Mallory, M.L., 2015. The status of Glaucous Gulls Larus hyperboreus in the circumpolar Arctic. *Arctic*, pp.107-120.	10.14430/arctic4462
137145	*Larus hyperboreus*	*Larus hyperboreus*	Glaucous gull	Norwegian Sea	Y	2	SeaTrack Data	Petersen, A., Irons, D.B., Gilchrist, H.G., Robertson, G.J., Boertmann, D., Strøm, H., Gavrilo, M., Artukhin, Y., Clausen, D.S., Kuletz, K.J. and Mallory, M.L., 2015. The status of Glaucous Gulls Larus hyperboreus in the circumpolar Arctic. *Arctic*, pp.107-120.	10.14430/arctic4462

<u>Aphia ID</u>	Species Scientific name	Previous Scientific Name	Vernacular name English	Ecoregion	Relevant to NEAFC	NEAFC Area	Sources for distribution	Sources for bycatch evidence (irrespective of gear & region)	Link/DOI
137146	*Larus marinus*	*Larus marinus*	Greater black-backed gull	Barents Sea	N	3	Expert opinion		
137146	*Larus marinus*	*Larus marinus*	Greater black-backed gull	Norwegian Sea	N	2	Expert opinion		
232052	*Larus michahellis*	*Larus michahellis*	Yellow-legged gull	Oceanic Northeast Atlantic	N	1	BirdLife DataZone		
137149	*Larus ridibundus*	*Larus ridibundus*	Black-headed gull	Barents Sea	N	3	BirdLife DataZone		
137149	*Larus ridibundus*	*Larus ridibundus*	Black-headed gull	Norwegian Sea	N	2	BirdLife DataZone		
137072	*Melanitta fusca*	*Melanitta fusca*	Velvet scoter	Barents Sea	N	3	BirdLife DataZone		
137072	*Melanitta fusca*	*Melanitta fusca*	Velvet scoter	Norwegian Sea	N	2	BirdLife DataZone		
137073	*Melanitta nigra*	*Melanitta nigra*	Common scoter	Barents Sea	N	3	BirdLife DataZone		
137073	*Melanitta nigra*	*Melanitta nigra*	Common scoter	Norwegian Sea	N	2	BirdLife DataZone		
232039	*Mergellus albellus*	*Mergellus albellus*	Smew	Barents Sea	N	3	BirdLife DataZone		
232039	*Mergellus albellus*	*Mergellus albellus*	Smew	Norwegian Sea	N	2	BirdLife DataZone		

Aphia ID	Species Scientific name	Previous Scientific Name	Vernacular name English	Ecoregion	Relevant to NEAFC	NEAFC Area	Sources for distribution	Sources for bycatch evidence (irrespective of gear & region)	Link/DOI
159097	*Mergus merganser*	*Mergus merganser*	Common merganser	Barents Sea	N	3	BirdLife DataZone		
159097	*Mergus merganser*	*Mergus merganser*	Common merganser	Norwegian Sea	N	2	BirdLife DataZone		
159098	*Mergus serrator*	*Mergus serrator*	Red-breasted merganser	Barents Sea	N	3	BirdLife DataZone		
159098	*Mergus serrator*	*Mergus serrator*	Red-breasted merganser	Norwegian Sea	N	2	BirdLife DataZone		
148776	*Morus bassanus*	*Morus bassanus*	Northern gannet	Barents Sea	Y	3	BirdLife DataZone	Northridge, S., Kingston, A. and Coram, A., 2020. Preliminary estimates of seabird bycatch by UK vessels in UK and adjacent waters. *Report prepared for the Department for Environment Food and Rural Affairs (Project Code ME6024)*.	https://randd.defra.gov.uk/ProjectDetails?ProjectID=20461&FromSearch=Y&Publisher=1&SearchText=ME6024&SortString=ProjectCode&SortOrder=Asc&Paging=10#Description
148776	*Morus bassanus*	*Morus bassanus*	Northern gannet	Norwegian Sea	Y	2	BirdLife DataZone	Northridge, S., Kingston, A. and Coram, A., 2020. Preliminary estimates of seabird bycatch by UK vessels in UK and adjacent waters. *Report prepared for the Department for Environment Food and Rural Affairs (Project Code ME6024)*.	https://randd.defra.gov.uk/ProjectDetails?ProjectID=20461&FromSearch=Y&Publisher=1&SearchText=ME6024&SortString=ProjectCode&SortOrder=Asc&Paging=10#Description

Aphia ID	Species Scientific name	Previous Scientific Name	Vernacular name English	Ecoregion	Relevant to NEAFC	NEAFC Area	Sources for distribution	Sources for bycatch evidence (irrespective of gear & region)	Link/DOI
148776	*Morus bassanus*	*Morus bassanus*	Northern gannet	Oceanic Northeast Atlantic	Y	1	BirdLife DataZone	Northridge, S., Kingston, A. and Coram, A., 2020. Preliminary estimates of seabird bycatch by UK vessels in UK and adjacent waters. *Report prepared for the Department for Environment Food and Rural Affairs (Project Code ME6024).*	https://randd.defra.gov.uk/ProjectDetails?ProjectID=20461&FromSearch=Y&Publisher=1&SearchText=ME6024&SortString=ProjectCode&SortOrder=Asc&Paging=10#Description
137154	*Pagophila eburnea*	*Pagophila eburnea*	Ivory gull	Barents Sea	Y	3	BirdLife DataZone		
137179	*Phalacrocora x carbo*	*Phalacrocora x carbo*	Great cormorant	Barents Sea	N	3	BirdLife DataZone		
137179	*Phalacrocora x carbo*	*Phalacrocora x carbo*	Great cormorant	Norwegian Sea	N	2	BirdLife DataZone		
137181	*Podiceps auritus*	*Podiceps auritus*	Horned Grebe	Norwegian Sea	N	2	BirdLife DataZone		
137182	*Podiceps cristatus*	*Podiceps cristatus*	Great crested grebe	Norwegian Sea	N	2	BirdLife DataZone		
137183	*Podiceps grisegena*	*Podiceps grisegena*	Red-necked grebe	Barents Sea	N	3	BirdLife DataZone		
137183	*Podiceps grisegena*	*Podiceps grisegena*	Red-necked grebe	Norwegian Sea	N	2	BirdLife DataZone		
232041	*Polysticta stelleri*	*Polysticta stelleri*	Steller's eider	Barents Sea	N	3	BirdLife DataZone		

Aphia ID	Species Scientific name	Previous Scientific Name	Vernacular name English	Ecoregion	Relevant to NEAFC	NEAFC Area	Sources for distribution	Sources for bycatch evidence (irrespective of gear & region)	Link/DOI
232041	*Polysticta stelleri*	*Polysticta stelleri*	Steller's eider	Norwegian Sea	N	2	BirdLife DataZone		
514084	*Puffinus lherminieri*	*Puffinus baroli*	Audubon's Shearwater	Oceanic Northeast Atlantic	Y	1	Seabird Tracking Data		
445503	*Puffinus mauretanicus*	*Puffinus mauretanicus*	Balearic Shearwater	Oceanic Northeast Atlantic	?	1	Expert opinion	Oliveira, N., Henriques, A., Miodonski, J., Pereira, J., Marujo, D., Almeida, A., Barros, N., Andrade, J., Marçalo, A., Santos, J. and Oliveira, I.B., 2015. Seabird bycatch in Portuguese mainland coastal fisheries: An assessment through on-board observations and fishermen interviews. *Global Ecology and Conservation*, *3*, pp.51-61.	https://doi.org/10.1016/j.gecco.2014.11.006
137203	*Puffinus puffinus*	*Puffinus puffinus*	Manx shearwater	Norwegian Sea	Y	2	BirdLife DataZone	Bonnet-Lebrun, A.S., Catry, P., Clark, T.J., Campioni, L., Kuepfer, A., Tierny, M., Kilbride, E. and Wakefield, E.D., 2020. Habitat preferences, foraging behaviour and bycatch risk among breeding sooty shearwaters Ardenna grisea in the Southwest Atlantic. *Marine Ecology Progress Series*, *651*, pp.163-181.	https://doi.org/10.3354/meps13439

Aphia ID	Species Scientific name	Previous Scientific Name	Vernacular name English	Ecoregion	Relevant to NEAFC	NEAFC Area	Sources for distribution	Sources for bycatch evidence (irrespective of gear & region)	Link/DOI
137203	*Puffinus puffinus*	*Puffinus puffinus*	Manx shearwater	Oceanic Northeast Atlantic	Y	1	Seabird Tracking Data	Bonnet-Lebrun, A.S., Catry, P., Clark, T.J., Campioni, L., Kuepfer, A., Tierny, M., Kilbride, E. and Wakefield, E.D., 2020. Habitat preferences, foraging behaviour and bycatch risk among breeding sooty shearwaters Ardenna grisea in the Southwest Atlantic. *Marine Ecology Progress Series*, *651*, pp.163-181.	https://doi.org/10.3354/meps13439
137155	*Rhodostethia rosea*	*Rhodostethia rosea*	Ross's gull	Barents Sea	N	3	BirdLife DataZone		
137156	*Rissa tridactyla*	*Rissa tridactyla*	Black-legged kittiwake	Barents Sea	Y	3	SeaTrack Data	Northridge, S., Kingston, A. and Coram, A., 2020. Preliminary estimates of seabird bycatch by UK vessels in UK and adjacent waters. *Report prepared for the Department for Environment Food and Rural Affairs (Project Code ME6024)*.	https://randd.defra.gov.uk/ProjectDetails?ProjectID=20461&FromSearch=Y&Publisher=1&SearchText=ME6024&SortString=ProjectCode&SortOrder=Asc&Paging=10#Description
137156	*Rissa tridactyla*	*Rissa tridactyla*	Black-legged kittiwake	Norwegian Sea	Y	2	SeaTrack Data	Northridge, S., Kingston, A. and Coram, A., 2020. Preliminary estimates of seabird bycatch by UK vessels in UK and adjacent waters. *Report prepared for the Department for Environment Food and Rural Affairs (Project Code ME6024)*.	https://randd.defra.gov.uk/ProjectDetails?ProjectID=20461&FromSearch=Y&Publisher=1&SearchText=ME6024&SortString=ProjectCode&SortOrder=Asc&Paging=10#Description

Aphia ID	Species Scientific name	Previous Scientific Name	Vernacular name English	Ecoregion	Relevant to NEAFC	NEAFC Area	Sources for distribution	Sources for bycatch evidence (irrespective of gear & region)	Link/DOI
137156	*Rissa tridactyla*	*Rissa tridactyla*	Black-legged kittiwake	Oceanic Northeast Atlantic	Y	1	SeaTrack Data	Northridge, S., Kingston, A. and Coram, A., 2020. Preliminary estimates of seabird bycatch by UK vessels in UK and adjacent waters. *Report prepared for the Department for Environment Food and Rural Affairs (Project Code ME6024).*	https://randd.defra.gov.uk/ProjectDetails?ProjectID=20461&FromSearch=Y&Publisher=1&SearchText=ME6024&SortString=ProjectCode&SortOrder=Asc&Paging=10#Description
137074	*Somateria mollissima*	*Somateria mollissima*	Common eider	Barents Sea	N	3	BirdLife DataZone		
137074	*Somateria mollissima*	*Somateria mollissima*	Common eider	Norwegian Sea	N	2	BirdLife DataZone		
137075	*Somateria spectabilis*	*Somateria spectabilis*	King eider	Barents Sea	N	3	BirdLife DataZone		
137075	*Somateria spectabilis*	*Somateria spectabilis*	King eider	Norwegian Sea	N	2	BirdLife DataZone		
137171	*Stercorarius longicaudus*	*Stercorarius longicaudus*	Long-tailed jaeger	Barents Sea	N	3	BirdLife DataZone		
137171	*Stercorarius longicaudus*	*Stercorarius longicaudus*	Long-tailed jaeger	Norwegian Sea	N	2	BirdLife DataZone		
137171	*Stercorarius longicaudus*	*Stercorarius longicaudus*	Long-tailed jaeger	Oceanic Northeast Atlantic	Y	1	Seabird Tracking Data		
137172	*Stercorarius parasiticus*	*Stercorarius parasiticus*	Parasitic jaeger	Barents Sea	N	3	BirdLife DataZone		

Aphia ID	Species Scientific name	Previous Scientific Name	Vernacular name English	Ecoregion	Relevant to NEAFC	NEAFC Area	Sources for distribution	Sources for bycatch evidence (irrespective of gear & region)	Link/DOI
137172	*Stercorarius parasiticus*	*Stercorarius parasiticus*	Parasitic jaeger	Norwegian Sea	N	2	BirdLife DataZone		
137172	*Stercorarius parasiticus*	*Stercorarius parasiticus*	Parasitic jaeger	Oceanic Northeast Atlantic	Y	1	Seabird Tracking Data	Benaka, L.R., D. Bullock, A.L. Hoover, and N.A. Olsen (editors). U.S. National Bycatch Report First Edition Update 3. 2019. U.S. Dept. of Commerce, NOAA. NOAA Technical Memorandum NMFS-F/SPO-190, 95 p	https://media.fisheries.noaa.gov/dam-migration/nbr_update_3.pdf
137173	*Stercorarius pomarinus*	*Stercorarius pomarinus*	Pomarine skua	Barents Sea	N	3	BirdLife DataZone		
137173	*Stercorarius pomarinus*	*Stercorarius pomarinus*	Pomarine skua	Norwegian Sea	N	2	BirdLife DataZone		
137173	*Stercorarius pomarinus*	*Stercorarius pomarinus*	Pomarine skua	Oceanic Northeast Atlantic	Y	1	BirdLife DataZone		
137133	*Uria aalge*	*Uria aalge*	Common guillemot (or common murre)	Barents Sea	Y	3	SeaTrack Data	Northridge, S., Kingston, A. and Coram, A., 2020. Preliminary estimates of seabird bycatch by UK vessels in UK and adjacent waters. *Report prepared for the Department for Environment Food and Rural Affairs (Project Code ME6024).*	https://randd.defra.gov.uk/ProjectDetails?ProjectID=20461&FromSearch=Y&Publisher=1&SearchText=ME6024&SortString=ProjectCode&SortOrder=Asc&Paging=10#Description

Aphia ID	Species Scientific name	Previous Scientific Name	Vernacular name English	Ecoregion	Relevant to NEAFC	NEAFC Area	Sources for distribution	Sources for bycatch evidence (irrespective of gear & region)	Link/DOI
137133	*Uria aalge*	*Uria aalge*	Common guillemot (or common murre)	Norwegian Sea	Y	2	SeaTrack Data	Northridge, S., Kingston, A. and Coram, A., 2020. Preliminary estimates of seabird bycatch by UK vessels in UK and adjacent waters. *Report prepared for the Department for Environment Food and Rural Affairs (Project Code ME6024).*	https://randd.defra.gov.uk/ProjectDetails?ProjectID=20461&FromSearch=Y&Publisher=1&SearchText=ME6024&SortString=ProjectCode&SortOrder=Asc&Paging=10#Description
137133	*Uria aalge*	*Uria aalge*	Common guillemot	Oceanic Northeast Atlantic	Y	1	SeaTrack Data	Northridge, S., Kingston, A. and Coram, A., 2020. Preliminary estimates of seabird bycatch by UK vessels in UK and adjacent waters. *Report prepared for the Department for Environment Food and Rural Affairs (Project Code ME6024).*	https://randd.defra.gov.uk/ProjectDetails?ProjectID=20461&FromSearch=Y&Publisher=1&SearchText=ME6024&SortString=ProjectCode&SortOrder=Asc&Paging=10#Description
137134	*Uria lomvia*	*Uria lomvia*	Thick-billed Murre (or Brünnich's guillemot)	Barents Sea	Y	3	SeaTrack Data	Christensen-Dalsgaard, S., Anker-Nilssen, T., Crawford, R., Bond, A., Sigurðsson, G.M., Glemarec, G., Hansen, E.S., Kadin, M., Kindt-Larsen, L., Mallory, M. and Merkel, F.R., 2019. What's the catch with lumpsuckers? A North Atlantic study of seabird bycatch in lumpsucker gillnet fisheries. Biological Conservation, 240, p.108278.	https://doi.org/10.1016/j.biocon.2019.108278
137134	*Uria lomvia*	*Uria lomvia*	Thick-billed Murre (or Brünnich's guillemot)	Norwegian Sea	Y		SeaTrack Data	Christensen-Dalsgaard, S., Anker-Nilssen, T., Crawford, R., Bond, A.,	

Aphia ID	Species Scientific name	Previous Scientific Name	Vernacular name English	Ecoregion	Relevant to NEAFC	NEAFC Area	Sources for distribution	Sources for bycatch evidence (irrespective of gear & region)	Link/DOI
								Sigurðsson, G.M., Glemarec, G., Hansen, E.S., Kadin, M., Kindt-Larsen, L., Mallory, M. and Merkel, F.R., 2019. What's the catch with lumpsuckers? A North Atlantic study of seabird bycatch in lumpsucker gillnet fisheries. Biological Conservation, 240, p.108278. https://doi.org/10.1016/j.biocon.2019.108278	
137167	*Xema sabini*	*Xema sabini*	Sabine's gull	Barents Sea	Y	3	BirdLife DataZone		

Table 5: Rating instructions for the exposure-consequence criteria in Tables 5–19. Each criterion is associated to a *Data Quality* (DQ) score ranging from 1 (high) to 2 (medium) and 3 (low). A parameter *Weight* is needed in ByRA assessments and was fixed to 2 for all the criteria for all species. See also Table 3 for a more detailed information on the criteria and scoring.

Species name		
SPECIES RESILIENCE ATTRIBUTES		**RATING INSTRUCTION**
	age of maturity	(3) 7 years, (2) 2-7 years, (1) < 2 years, or (0) no score
	reproductive strategy	(3) biannual breeding or mate fidelity, (2) annual breeding + 1 fledgling, (1) annual breeding + multiple fledglings (0) no score
	population trend	(3) decreasing, (2) stable, (1) increasing, or (0) no score
	IUCN status	(3) DD or CR or EN, (2) VU or NT, (1) LC, or (0) no score
	proportion of tagged distribution utilising area	(3) > x%, (2) x - x%, (1) < x%, or (0) no score; based on Percentiles
SPECIES STRESSOR OVERLAP PROPERTIES		**RATING INSTRUCTION**
Gear Category(ies)	mortality following interaction	(3) probable, (2) possible, (1) unlikely, (0) no score
	unaccounted mortality	(3) probable, (2) possible, (1) unlikely, (0) no score
	intensity of gear use	(3) high, (2) medium, (1) low, (0) no score
	temporal overlap	(3) gear and species interact all year (12 months), (2) most of year (4- 11 months), (1) occasional (1-3 months), (0) no score
	current status of management	(3) no strategy identified, (2) management strategy identified, (1) management strategy identified and implemented, (0) no score
	behavioural susceptibility to interaction	(3) high, (2) medium, (1) low, (0) no score

Table 6: Table exposure-consequence criteria (*Fulmarus glacialis*) – Rating instructions described in Table 5. DQ (Data Quality) ranging from 1 (high) to 2 (medium) and 3 (low). Weight fixed to 2.

Fulmarus glacialis				
SPECIES RESILIENCE ATTRIBUTES		**RATING**	**DQ**	**WEIGHT**
	age of maturity	3	1	2
	reproductive strategy	2	1	2
	population trend	3	1	2
	IUCN status	2	1	2
	proportion of tagged distribution utilising area	0	2	2

SPECIES STRESSOR OVERLAP PROPERTIES		**RATING**	**DQ**	**WEIGHT**
Trawls (OTB + OTM)	mortality following interaction	2	3	2
	unaccounted mortality	3	3	2
	intensity of gear use	2	2	2
	temporal overlap	2	2	2
	current status of management	3	1	2
	behavioural susceptibility to interaction	3	2	2
Purse seine (PS)	mortality following interaction	2	2	2
	unaccounted mortality	1	3	2
	intensity of gear use	2	2	2
	temporal overlap	2	2	2
	current status of management	3	1	2
	behavioural susceptibility to interaction	3	2	2
Longlines (LX + LLS)	mortality following interaction	3	1	2
	unaccounted mortality	1	3	2
	intensity of gear use	2	2	2
	temporal overlap	2	2	2
	current status of management	3	1	2
	behavioural susceptibility to interaction	3	2	2

SPECIES STRESSOR OVERLAP PROPERTIES		**RATING**	**DQ**	**WEIGHT**
Pots and traps (FPO)	mortality following interaction	1	2	2
	unaccounted mortality	1	2	2
	intensity of gear use	2	2	2
	temporal overlap	2	2	2
	current status of management	3	1	2
	behavioural susceptibility to interaction	1	2	2
Gillnets (GN)	mortality following interaction	2	2	2
	unaccounted mortality	1	1	2
	intensity of gear use	2	2	2
	temporal overlap	2	2	2
	current status of management	3	1	2
	behavioural susceptibility to interaction	2	3	2
Miscellaneous (MIS)	mortality following interaction	3	3	2
	unaccounted mortality	3	3	2
	intensity of gear use	2	2	2
	temporal overlap	2	2	2
	current status of management	3	3	2
	behavioural susceptibility to interaction	3	3	2

Table 7: Table exposure-consequence criteria (*Uria aalge*) – Rating instructions described in Table 5. DQ (Data Quality) ranging from 1 (high) to 2 (medium) and 3 (low). Weight fixed to 2.

Uria aalge									
SPECIES RESILIENCE ATTRIBUTES		**RATING**	**DQ**	**WEIGHT**					
	age of maturity	3	2	2					
	reproductive strategy	2	1	2					
	population trend	1	1	2					
	IUCN status	1	1	2					
	proportion of tagged distribution utilising area	0	2	2					
SPECIES STRESSOR OVERLAP PROPERTIES		**RATING**	**DQ**	**WEIGHT**	**SPECIES STRESSOR OVERLAP PROPERTIES**		**RATING**	**DQ**	**WEIGHT**
Trawls (OTB + OTM)	mortality following interaction	1	2	2	**Pots and traps (FPO)**	mortality following interaction	1	2	2
	unaccounted mortality	1	2	2		unaccounted mortality	1	2	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	2	2	2		temporal overlap	2	2	2
	current status of management	3	1	2		current status of management	3	1	2
	behavioural susceptibility to interaction	1	1	2		behavioural susceptibility to interaction	1	1	2
Purse seine (PS)	mortality following interaction	1	2	2	**Gillnets (GN)**	mortality following interaction	3	2	2
	unaccounted mortality	1	2	2		unaccounted mortality	1	1	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	2	2	2		temporal overlap	2	2	2
	current status of management	3	1	2		current status of management	3	1	2
	behavioural susceptibility to interaction	1	1	2		behavioural susceptibility to interaction	1	2	2
Longlines (LX + LLS)	mortality following interaction	2	3	2	**Miscellaneous (MIS)**	mortality following interaction	2	3	2
	unaccounted mortality	1	2	2		unaccounted mortality	1	3	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	2	2	2		temporal overlap	2	2	2
	current status of management	3	1	2		current status of management	3	3	2
	behavioural susceptibility to interaction	1	1	2		behavioural susceptibility to interaction	1	3	2

Table 8: Table exposure-consequence criteria (*Fratercula arctica*) – Rating instructions described in Table 5. DQ (Data Quality) ranging from 1 (high) to 2 (medium) and 3 (low). Weight fixed to 2.

Fratercula arctica				
SPECIES RESILIENCE ATTRIBUTES		**RATING**	**DQ**	**WEIGHT**
	age of maturity	2	2	2
	reproductive strategy	2	1	2
	population trend	3	1	2
	IUCN status	3	1	2
	proportion of tagged distribution utilising area	0	2	2
SPECIES STRESSOR OVERLAP PROPERTIES		**RATING**	**DQ**	**WEIGHT**
Trawls (OTB + OTM)	mortality following interaction	1	2	2
	unaccounted mortality	1	2	2
	intensity of gear use	2	2	2
	temporal overlap	2	2	2
	current status of management	3	1	2
	behavioural susceptibility to interaction	2	1	2
Purse seine (PS)	mortality following interaction	1	2	2
	unaccounted mortality	1	2	2
	intensity of gear use	2	2	2
	temporal overlap	2	2	2
	current status of management	3	1	2
	behavioural susceptibility to interaction	1	1	2
Longlines (LX + LLS)	mortality following interaction	2	3	2
	unaccounted mortality	1	2	2
	intensity of gear use	2	2	2
	temporal overlap	2	2	2
	current status of management	3	1	2
	behavioural susceptibility to interaction	1	1	2

SPECIES STRESSOR OVERLAP PROPERTIES		**RATING**	**DQ**	**WEIGHT**
Pots and traps (FPO)	mortality following interaction	1	2	2
	unaccounted mortality	1	2	2
	intensity of gear use	2	2	2
	temporal overlap	2	2	2
	current status of management	3	1	2
	behavioural susceptibility to interaction	1	1	2
Gillnets (GN)	mortality following interaction	3	2	2
	unaccounted mortality	1	1	2
	intensity of gear use	2	2	2
	temporal overlap	2	2	2
	current status of management	3	1	2
	behavioural susceptibility to interaction	1	2	2
Miscellaneous (MIS)	mortality following interaction	2	3	2
	unaccounted mortality	1	3	2
	intensity of gear use	2	2	2
	temporal overlap	2	2	2
	current status of management	3	3	2
	behavioural susceptibility to interaction	1	3	2

Table 9: Table exposure-consequence criteria (*Alca torda*) – Rating instructions described in Table 5. DQ (Data Quality) ranging from 1 (high) to 2 (medium) and 3 (low). Weight fixed to 2.

Alca torda

SPECIES RESILIENCE ATTRIBUTES		RATING	DQ	WEIGHT
	age of maturity	2	2	2
	reproductive strategy	2	1	2
	population trend	1	1	2
	IUCN status	1	1	2
	proportion of tagged distribution utilising area	0	2	2

SPECIES STRESSOR OVERLAP PROPERTIES		RATING	DQ	WEIGHT	SPECIES STRESSOR OVERLAP PROPERTIES		RATING	DQ	WEIGHT
Trawls (OTB + OTM)	mortality following interaction	1	2	2	Pots and traps (FPO)	mortality following interaction	1	2	2
	unaccounted mortality	1	2	2		unaccounted mortality	1	2	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	0	2	2		temporal overlap	0	2	2
	current status of management	3	1	2		current status of management	3	1	2
	behavioural susceptibility to interaction	1	1	2		behavioural susceptibility to interaction	1	1	2
Purse seine (PS)	mortality following interaction	1	2	2	Gillnets (GN)	mortality following interaction	3	2	2
	unaccounted mortality	1	2	2		unaccounted mortality	1	1	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	0	2	2		temporal overlap	0	2	2
	current status of management	3	1	2		current status of management	3	1	2
	behavioural susceptibility to interaction	1	1	2		behavioural susceptibility to interaction	1	2	2
Longlines (LX + LLS)	mortality following interaction	2	3	2	Miscellaneous (MIS)	mortality following interaction	2	3	2
	unaccounted mortality	1	2	2		unaccounted mortality	1	3	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	0	2	2		temporal overlap	0	2	2
	current status of management	3	1	2		current status of management	3	3	2
	behavioural susceptibility to interaction	1	1	2		behavioural susceptibility to interaction	1	3	2

Table 10: Table exposure-consequence criteria (*Cepphus grylle*) – Rating instructions described in Table 5. DQ (Data Quality) ranging from 1 (high) to 2 (medium) and 3 (low). Weight fixed to 2.

Cepphus grylle				
SPECIES RESILIENCE ATTRIBUTES		**RATING**	**DQ**	**WEIGHT**
	age of maturity	2	2	2
	reproductive strategy	2	1	2
	population trend	0	1	2
	IUCN status	1	1	2
	proportion of tagged distribution utilising area	0	2	2

SPECIES STRESSOR OVERLAP PROPERTIES		**RATING**	**DQ**	**WEIGHT**
Trawls (OTB + OTM)	mortality following interaction	1	2	2
	unaccounted mortality	1	2	2
	intensity of gear use	2	2	2
	temporal overlap	0	2	2
	current status of management	3	1	2
	behavioural susceptibility to interaction	1	1	2
Purse seine (PS)	mortality following interaction	1	2	2
	unaccounted mortality	1	2	2
	intensity of gear use	2	2	2
	temporal overlap	0	2	2
	current status of management	3	1	2
	behavioural susceptibility to interaction	1	1	2
Longlines (LX + LLS)	mortality following interaction	2	3	2
	unaccounted mortality	1	2	2
	intensity of gear use	2	2	2
	temporal overlap	0	2	2
	current status of management	3	1	2
	behavioural susceptibility to interaction	1	1	2

SPECIES STRESSOR OVERLAP PROPERTIES		**RATING**	**DQ**	**WEIGHT**
Pots and traps (FPO)	mortality following interaction	1	2	2
	unaccounted mortality	1	2	2
	intensity of gear use	2	2	2
	temporal overlap	0	2	2
	current status of management	3	1	2
	behavioural susceptibility to interaction	1	1	2
Gillnets (GN)	mortality following interaction	3	2	2
	unaccounted mortality	1	1	2
	intensity of gear use	2	2	2
	temporal overlap	0	2	2
	current status of management	3	1	2
	behavioural susceptibility to interaction	1	2	2
Miscellaneous (MIS)	mortality following interaction	2	3	2
	unaccounted mortality	1	3	2
	intensity of gear use	2	2	2
	temporal overlap	2	2	2
	current status of management	3	3	2
	behavioural susceptibility to interaction	1	3	2

Table 11: Table exposure-consequence criteria (*Alle alle*) – Rating instructions described in Table 5. DQ (Data Quality) ranging from 1 (high) to 2 (medium) and 3 (low). Weight fixed to 2.

Alle alle				
SPECIES RESILIENCE ATTRIBUTES		**RATING**	**DQ**	**WEIGHT**
	age of maturity	2	2	2
	reproductive strategy	2	1	2
	population trend	0	1	2
	IUCN status	1	1	2
	proportion of tagged distribution utilising area	0	2	2

SPECIES STRESSOR OVERLAP PROPERTIES		RATING	DQ	WEIGHT	SPECIES STRESSOR OVERLAP PROPERTIES		RATING	DQ	WEIGHT
Trawls (OTB + OTM)	mortality following interaction	1	1	2	**Pots and traps (FPO)**	mortality following interaction	1	1	2
	unaccounted mortality	1	1	2		unaccounted mortality	1	1	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	2	2	2		temporal overlap	2	2	2
	current status of management	3	1	2		current status of management	3	1	2
	behavioural susceptibility to interaction	1	1	2		behavioural susceptibility to interaction	1	1	2
Purse seine (PS)	mortality following interaction	1	1	2	**Gillnets (GN)**	mortality following interaction	3	2	2
	unaccounted mortality	1	1	2		unaccounted mortality	1	1	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	2	2	2		temporal overlap	2	2	2
	current status of management	3	1	2		current status of management	3	1	2
	behavioural susceptibility to interaction	1	1	2		behavioural susceptibility to interaction	1	2	2
Longlines (LX + LLS)	mortality following interaction	1	1	2	**Miscellaneous (MIS)**	mortality following interaction	1	3	2
	unaccounted mortality	1	1	2		unaccounted mortality	1	3	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	2	2	2		temporal overlap	2	2	2
	current status of management	3	1	2		current status of management	3	3	2
	behavioural susceptibility to interaction	1	1	2		behavioural susceptibility to interaction	1	2	2

Table 12: Table exposure-consequence criteria (*Morus bassanus*) – Rating instructions described in Table 5. DQ (Data Quality) ranging from 1 (high) to 2 (medium) and 3 (low). Weight fixed to 2.

Morus bassanus				
SPECIES RESILIENCE ATTRIBUTES		**RATING**	**DQ**	**WEIGHT**
	age of maturity	2	2	2
	reproductive strategy	2	1	2
	population trend	1	1	2
	IUCN status	1	1	2
	proportion of tagged distribution utilising area	0	2	2

SPECIES STRESSOR OVERLAP PROPERTIES		**RATING**	**DQ**	**WEIGHT**	**SPECIES STRESSOR OVERLAP PROPERTIES**		**RATING**	**DQ**	**WEIGHT**
Trawls (OTB + OTM)	mortality following interaction	2	2	2	**Pots and traps (FPO)**	mortality following interaction	1	1	2
	unaccounted mortality	2	3	2		unaccounted mortality	1	1	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	0	2	2		temporal overlap	0	2	2
	current status of management	3	1	2		current status of management	3	1	2
	behavioural susceptibility to interaction	3	1	2		behavioural susceptibility to interaction	1	1	2
Purse seine (PS)	mortality following interaction	2	2	2	**Gillnets (GN)**	mortality following interaction	3	3	2
	unaccounted mortality	1	2	2		unaccounted mortality	1	2	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	0	2	2		temporal overlap	0	2	2
	current status of management	3	1	2		current status of management	3	1	2
	behavioural susceptibility to interaction	3	1	2		behavioural susceptibility to interaction	2	2	2
Longlines (LX + LLS)	mortality following interaction	2	3	2	**Miscellaneous (MIS)**	mortality following interaction	2	3	2
	unaccounted mortality	1	1	2		unaccounted mortality	1	3	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	0	2	2		temporal overlap	0	2	2
	current status of management	3	1	2		current status of management	3	3	2
	behavioural susceptibility to interaction	2	1	2		behavioural susceptibility to interaction	3	3	2

Table 13: Table exposure-consequence criteria (*Calonectris borealis*) – Rating instructions described in Table 5. DQ (Data Quality) ranging from 1 (high) to 2 (medium) and 3 (low). Weight fixed to 2.

Calonectris borealis									
SPECIES RESILIENCE ATTRIBUTES		**RATING**	**DQ**	**WEIGHT**					
	age of maturity	2	1	2					
	reproductive strategy	2	1	2					
	population trend	3	3	2					
	IUCN status	1	1	2					
	proportion of tagged distribution utilising area	0	2	2					
SPECIES STRESSOR OVERLAP PROPERTIES		**RATING**	**DQ**	**WEIGHT**	**SPECIES STRESSOR OVERLAP PROPERTIES**		**RATING**	**DQ**	**WEIGHT**
Trawls (OTB + OTM)	mortality following interaction	2	3	2	**Pots and traps (FPO)**	mortality following interaction	1	2	2
	unaccounted mortality	2	3	2		unaccounted mortality	1	2	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	2	2	2		temporal overlap	2	2	2
	current status of management	3	1	2		current status of management	3	2	2
	behavioural susceptibility to interaction	3	2	2		behavioural susceptibility to interaction	1	2	2
Purse seine (PS)	mortality following interaction	2	3	2	**Gillnets (GN)**	mortality following interaction	2	2	2
	unaccounted mortality	2	3	2		unaccounted mortality	1	1	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	2	2	2		temporal overlap	2	2	2
	current status of management	3	2	2		current status of management	3	1	2
	behavioural susceptibility to interaction	2	2	2		behavioural susceptibility to interaction	2	3	2
Longlines (LX + LLS)	mortality following interaction	3	2	2	**Miscellaneous (MIS)**	mortality following interaction	3	3	2
	unaccounted mortality	2	2	2		unaccounted mortality	2	3	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	2	2	2		temporal overlap	2	2	2
	current status of management	3	1	2		current status of management	3	3	2
	behavioural susceptibility to interaction	3	2	2		behavioural susceptibility to interaction	3	3	2

Table 14: Table exposure-consequence criteria (*Calonectris diomedea*) – Rating instructions described in Table 5. DQ (Data Quality) ranging from 1 (high) to 2 (medium) and 3 (low). Weight fixed to 2.

Calonectris diomedea				
SPECIES RESILIENCE ATTRIBUTES		**RATING**	**DQ**	**WEIGHT**
	age of maturity	2	1	2
	reproductive strategy	2	1	2
	population trend	3	3	2
	IUCN status	1	1	2
	proportion of tagged distribution utilising area	0	2	2

SPECIES STRESSOR OVERLAP PROPERTIES		**RATING**	**DQ**	**WEIGHT**	**SPECIES STRESSOR OVERLAP PROPERTIES**		**RATING**	**DQ**	**WEIGHT**
Trawls (OTB + OTM)	mortality following interaction	2	3	2	**Pots and traps (FPO)**	mortality following interaction	1	2	2
	unaccounted mortality	2	3	2		unaccounted mortality	1	2	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	2	2	2		temporal overlap	2	2	2
	current status of management	3	3	2		current status of management	3	2	2
	behavioural susceptibility to interaction	3	2	2		behavioural susceptibility to interaction	1	2	2
Purse seine (PS)	mortality following interaction	2	3	2	**Gillnets (GN)**	mortality following interaction	2	2	2
	unaccounted mortality	2	3	2		unaccounted mortality	1	1	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	2	2	2		temporal overlap	2	2	2
	current status of management	3	2	2		current status of management	3	1	2
	behavioural susceptibility to interaction	2	2	2		behavioural susceptibility to interaction	2	3	2
Longlines (LX + LLS)	mortality following interaction	3	2	2	**Miscellaneous (MIS)**	mortality following interaction	3	3	2
	unaccounted mortality	2	2	2		unaccounted mortality	2	3	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	2	2	2		temporal overlap	2	2	2
	current status of management	3	1	2		current status of management	3	3	2
	behavioural susceptibility to interaction	3	2	2		behavioural susceptibility to interaction	3	3	2

Table 15: Table exposure-consequence criteria (*Puffinus lherminieri*) – Rating instructions described in Table 5. DQ (Data Quality) ranging from 1 (high) to 2 (medium) and 3 (low). Weight fixed to 2.

Puffinus lherminieri									
SPECIES RESILIENCE ATTRIBUTES		**RATING**	**DQ**	**WEIGHT**					
	age of maturity	2	1	2					
	reproductive strategy	2	1	2					
	population trend	3	1	2					
	IUCN status	2	1	2					
	proportion of tagged distribution utilising area	0	2	2					
SPECIES STRESSOR OVERLAP PROPERTIES		**RATING**	**DQ**	**WEIGHT**	**SPECIES STRESSOR OVERLAP PROPERTIES**		**RATING**	**DQ**	**WEIGHT**
Trawls (OTB + OTM)	mortality following interaction	2	3	2	**Pots and traps (FPO)**	mortality following interaction	1	2	2
	unaccounted mortality	2	3	2		unaccounted mortality	1	2	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	2	2	2		temporal overlap	2	2	2
	current status of management	3	1	2		current status of management	3	2	2
	behavioural susceptibility to interaction	3	2	2		behavioural susceptibility to interaction	1	2	2
Purse seine (PS)	mortality following interaction	2	3	2	**Gillnets (GN)**	mortality following interaction	2	2	2
	unaccounted mortality	2	3	2		unaccounted mortality	1	1	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	2	2	2		temporal overlap	2	2	2
	current status of management	3	2	2		current status of management	3	1	2
	behavioural susceptibility to interaction	2	2	2		behavioural susceptibility to interaction	2	3	2
Longlines (LX + LLS)	mortality following interaction	3	2	2	**Miscellaneous (MIS)**	mortality following interaction	3	3	2
	unaccounted mortality	2	2	2		unaccounted mortality	2	3	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	2	2	2		temporal overlap	2	2	2
	current status of management	3	1	2		current status of management	3	3	2
	behavioural susceptibility to interaction	3	2	2		behavioural susceptibility to interaction	3	3	2

Table 16: Table exposure-consequence criteria (*Ardenna gravis*) – Rating instructions described in Table 5. DQ (Data Quality) ranging from 1 (high) to 2 (medium) and 3 (low). Weight fixed to 2.

Ardenna gravis									
SPECIES RESILIENCE ATTRIBUTES		**RATING**	**DQ**	**WEIGHT**					
	age of maturity	2	1	2					
	reproductive strategy	2	1	2					
	population trend	2	1	2					
	IUCN status	1	1	2					
	proportion of tagged distribution utilising area	0	2	2					
SPECIES STRESSOR OVERLAP PROPERTIES		**RATING**	**DQ**	**WEIGHT**	**SPECIES STRESSOR OVERLAP PROPERTIES**		**RATING**	**DQ**	**WEIGHT**
Trawls (OTB + OTM)	mortality following interaction	2	3	2	**Pots and traps (FPO)**	mortality following interaction	1	2	2
	unaccounted mortality	2	3	2		unaccounted mortality	1	2	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	2	2	2		temporal overlap	2	2	2
	current status of management	1	3	2		current status of management	3	2	2
	behavioural susceptibility to interaction	3	2	2		behavioural susceptibility to interaction	1	2	2
Purse seine (PS)	mortality following interaction	2	3	2	**Gillnets (GN)**	mortality following interaction	2	2	2
	unaccounted mortality	2	3	2		unaccounted mortality	1	1	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	2	2	2		temporal overlap	2	2	2
	current status of management	3	2	2		current status of management	3	1	2
	behavioural susceptibility to interaction	2	2	2		behavioural susceptibility to interaction	2	3	2
Longlines (LX + LLS)	mortality following interaction	3	2	2	**Miscellaneous (MIS)**	mortality following interaction	3	3	2
	unaccounted mortality	2	2	2		unaccounted mortality	2	3	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	2	2	2		temporal overlap	2	2	2
	current status of management	3	1	2		current status of management	3	3	2
	behavioural susceptibility to interaction	3	2	2		behavioural susceptibility to interaction	3	3	2

Table 17: Table exposure-consequence criteria (*Ardenna grisea*) – Rating instructions described in Table 5. DQ (Data Quality) ranging from 1 (high) to 2 (medium) and 3 (low). Weight fixed to 2.

Ardenna grisea				
SPECIES RESILIENCE ATTRIBUTES		**RATING**	**DQ**	**WEIGHT**
	age of maturity	2	1	2
	reproductive strategy	2	1	2
	population trend	3	1	2
	IUCN status	3	1	2
	proportion of tagged distribution utilising area	0	2	2

SPECIES STRESSOR OVERLAP PROPERTIES		**RATING**	**DQ**	**WEIGHT**
Trawls (OTB + OTM)	mortality following interaction	2	3	2
	unaccounted mortality	2	3	2
	intensity of gear use	2	2	2
	temporal overlap	2	2	2
	current status of management	3	1	2
	behavioural susceptibility to interaction	3	2	2
Purse seine (PS)	mortality following interaction	2	3	2
	unaccounted mortality	2	3	2
	intensity of gear use	2	2	2
	temporal overlap	2	2	2
	current status of management	3	2	2
	behavioural susceptibility to interaction	2	2	2
Longlines (LX + LLS)	mortality following interaction	3	2	2
	unaccounted mortality	2	2	2
	intensity of gear use	2	2	2
	temporal overlap	2	2	2
	current status of management	3	1	2
	behavioural susceptibility to interaction	3	2	2

SPECIES STRESSOR OVERLAP PROPERTIES		**RATING**	**DQ**	**WEIGHT**
Pots and traps (FPO)	mortality following interaction	1	2	2
	unaccounted mortality	1	2	2
	intensity of gear use	2	2	2
	temporal overlap	2	2	2
	current status of management	3	2	2
	behavioural susceptibility to interaction	1	2	2
Gillnets (GN)	mortality following interaction	2	2	2
	unaccounted mortality	1	1	2
	intensity of gear use	2	2	2
	temporal overlap	2	2	2
	current status of management	3	1	2
	behavioural susceptibility to interaction	2	3	2
Miscellaneous (MIS)	mortality following interaction	3	3	2
	unaccounted mortality	2	3	2
	intensity of gear use	2	2	2
	temporal overlap	2	2	2
	current status of management	3	3	2
	behavioural susceptibility to interaction	3	3	2

Table 18: Table exposure-consequence criteria (*Puffinus Puffinus*) – Rating instructions described in Table 5. DQ (Data Quality) ranging from 1 (high) to 2 (medium) and 3 (low). Weight fixed to 2.

Puffinus Puffinus									
SPECIES RESILIENCE ATTRIBUTES		**RATING**	**DQ**	**WEIGHT**					
	age of maturity	2	1	2					
	reproductive strategy	2	1	2					
	population trend	3	3	2					
	IUCN status	1	1	2					
	proportion of tagged distribution utilising area	0	2	2					
SPECIES STRESSOR OVERLAP PROPERTIES		**RATING**	**DQ**	**WEIGHT**	**SPECIES STRESSOR OVERLAP PROPERTIES**		**RATING**	**DQ**	**WEIGHT**
Trawls (OTB + OTM)	mortality following interaction	2	3	2	**Pots and traps (FPO)**	mortality following interaction	1	2	2
	unaccounted mortality	2	3	2		unaccounted mortality	1	2	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	2	2	2		temporal overlap	2	2	2
	current status of management	3	1	2		current status of management	3	2	2
	behavioural susceptibility to interaction	3	2	2		behavioural susceptibility to interaction	1	2	2
Purse seine (PS)	mortality following interaction	2	3	2	**Gillnets (GN)**	mortality following interaction	2	2	2
	unaccounted mortality	2	3	2		unaccounted mortality	1	1	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	2	2	2		temporal overlap	2	2	2
	current status of management	3	2	2		current status of management	3	1	2
	behavioural susceptibility to interaction	2	2	2		behavioural susceptibility to interaction	2	3	2
Longlines (LX + LLS)	mortality following interaction	3	2	2	**Miscellaneous (MIS)**	mortality following interaction	3	3	2
	unaccounted mortality	2	2	2		unaccounted mortality	2	3	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	2	2	2		temporal overlap	2	2	2
	current status of management	3	1	2		current status of management	3	3	2
	behavioural susceptibility to interaction	3	2	2		behavioural susceptibility to interaction	3	3	2

Table 19: Table exposure-consequence criteria (*Rissa tridactyla*) – Rating instructions described in Table 5. DQ (Data Quality) ranging from 1 (high) to 2 (medium) and 3 (low). Weight fixed to 2.

Rissa tridactyla									
SPECIES RESILIENCE ATTRIBUTES		**RATING**	**DQ**	**WEIGHT**					
	age of maturity	2	1	2					
	reproductive strategy	1	1	2					
	population trend	3	1	2					
	IUCN status	2	1	2					
	proportion of tagged distribution utilising area	0	2	2					
SPECIES STRESSOR OVERLAP PROPERTIES		**RATING**	**DQ**	**WEIGHT**	**SPECIES STRESSOR OVERLAP PROPERTIES**		**RATING**	**DQ**	**WEIGHT**
Trawls (OTB + OTM)	mortality following interaction	2	3	2	Pots and traps (FPO)	mortality following interaction	1	2	2
	unaccounted mortality	1	3	2		unaccounted mortality	1	2	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	2	2	2		temporal overlap	2	2	2
	current status of management	3	1	2		current status of management	3	2	2
	behavioural susceptibility to interaction	1	2	2		behavioural susceptibility to interaction	1	2	2
Purse seine (PS)	mortality following interaction	2	3	2	Gillnets (GN)	mortality following interaction	2	2	2
	unaccounted mortality	1	3	2		unaccounted mortality	1	1	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	2	2	2		temporal overlap	2	2	2
	current status of management	3	1	2		current status of management	3	1	2
	behavioural susceptibility to interaction	1	2	2		behavioural susceptibility to interaction	1	3	2
Longlines (LX + LLS)	mortality following interaction	2	3	2	Miscellaneous (MIS)	mortality following interaction	2	3	2
	unaccounted mortality	1	3	2		unaccounted mortality	1	3	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	2	2	2		temporal overlap	2	2	2
	current status of management	3	1	2		current status of management	3	3	2
	behavioural susceptibility to interaction	1	2	2		behavioural susceptibility to interaction	1	3	2

Table 20: Table exposure-consequence criteria (*Uria lomvia*) – Rating instructions described in Table 5. DQ (Data Quality) ranging from 1 (high) to 2 (medium) and 3 (low). Weight fixed to 2.

Uria lomvia									
SPECIES RESILIENCE ATTRIBUTES		**RATING**	**DQ**	**WEIGHT**					
	age of maturity	2	1	2					
	reproductive strategy	2	1	2					
	population trend	3	1	2					
	IUCN status	1	1	2					
	proportion of tagged distribution utilising area	0	2	2					
SPECIES STRESSOR OVERLAP PROPERTIES		**RATING**	**DQ**	**WEIGHT**	**SPECIES STRESSOR OVERLAP PROPERTIES**		**RATING**	**DQ**	**WEIGHT**
Trawls (OTB + OTM)	mortality following interaction	1	2	2	Pots and traps (FPO)	mortality following interaction	1	2	2
	unaccounted mortality	1	2	2		unaccounted mortality	1	2	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	2	2	2		temporal overlap	2	2	2
	current status of management	3	1	2		current status of management	3	1	2
	behavioural susceptibility to interaction	1	1	2		behavioural susceptibility to interaction	1	1	2
Purse seine (PS)	mortality following interaction	1	2	2	Gillnets (GN)	mortality following interaction	3	2	2
	unaccounted mortality	1	2	2		unaccounted mortality	1	1	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	2	2	2		temporal overlap	2	2	2
	current status of management	3	1	2		current status of management	3	1	2
	behavioural susceptibility to interaction	1	1	2		behavioural susceptibility to interaction	1	2	2
Longlines (LX + LLS)	mortality following interaction	2	3	2	Miscellaneous (MIS)	mortality following interaction	2	3	2
	unaccounted mortality	1	2	2		unaccounted mortality	1	3	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	2	2	2		temporal overlap	2	2	2
	current status of management	3	1	2		current status of management	3	3	2
	behavioural susceptibility to interaction	1	1	2		behavioural susceptibility to interaction	1	3	2

Table 21: Table exposure-consequence criteria (*Pagophila eburnea*) – Rating instructions described in Table 5. DQ (Data Quality) ranging from 1 (high) to 2 (medium) and 3 (low). Weight fixed to 2.

Pagophila eburnea				
SPECIES RESILIENCE ATTRIBUTES		**RATING**	**DQ**	**WEIGHT**
	age of maturity	2	1	2
	reproductive strategy	1	1	2
	population trend	3	1	2
	IUCN status	2	1	2
	proportion of tagged distribution utilising area	0	2	2

SPECIES STRESSOR OVERLAP PROPERTIES		**RATING**	**DQ**	**WEIGHT**
Trawls (OTB + OTM)	mortality following interaction	2	3	2
	unaccounted mortality	1	3	2
	intensity of gear use	2	2	2
	temporal overlap	0	2	2
	current status of management	3	1	2
	behavioural susceptibility to interaction	1	2	2
Purse seine (PS)	mortality following interaction	2	3	2
	unaccounted mortality	1	3	2
	intensity of gear use	2	2	2
	temporal overlap	0	2	2
	current status of management	3	1	2
	behavioural susceptibility to interaction	1	2	2
Longlines (LX + LLS)	mortality following interaction	2	3	2
	unaccounted mortality	1	3	2
	intensity of gear use	2	2	2
	temporal overlap	0	2	2
	current status of management	3	1	2
	behavioural susceptibility to interaction	1	2	2

SPECIES STRESSOR OVERLAP PROPERTIES		**RATING**	**DQ**	**WEIGHT**
Pots and traps (FPO)	mortality following interaction	1	2	2
	unaccounted mortality	1	2	2
	intensity of gear use	2	2	2
	temporal overlap	0	2	2
	current status of management	3	2	2
	behavioural susceptibility to interaction	1	2	2
Gillnets (GN)	mortality following interaction	2	2	2
	unaccounted mortality	1	1	2
	intensity of gear use	2	2	2
	temporal overlap	0	2	2
	current status of management	3	1	2
	behavioural susceptibility to interaction	1	3	2
Miscellaneous (MIS)	mortality following interaction	2	3	2
	unaccounted mortality	1	3	2
	intensity of gear use	2	2	2
	temporal overlap	0	2	2
	current status of management	3	3	2
	behavioural susceptibility to interaction	1	3	2

Table 22: Table exposure-consequence criteria (*Xema sabini*) – Rating instructions described in Table 5. DQ (Data Quality) ranging from 1 (high) to 2 (medium) and 3 (low). Weight fixed to 2.

Xema sabini				
SPECIES RESILIENCE ATTRIBUTES		**RATING**	**DQ**	**WEIGHT**
	age of maturity	2	1	2
	reproductive strategy	1	1	2
	population trend	2	1	2
	IUCN status	1	1	2
	proportion of tagged distribution utilising area	0	2	2

SPECIES STRESSOR OVERLAP PROPERTIES		**RATING**	**DQ**	**WEIGHT**	**SPECIES STRESSOR OVERLAP PROPERTIES**		**RATING**	**DQ**	**WEIGHT**
Trawls (OTB + OTM)	mortality following interaction	2	3	2	Pots and traps (FPO)	mortality following interaction	1	2	2
	unaccounted mortality	1	3	2		unaccounted mortality	1	2	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	0	2	2		temporal overlap	0	2	2
	current status of management	3	1	2		current status of management	3	2	2
	behavioural susceptibility to interaction	1	2	2		behavioural susceptibility to interaction	1	2	2
Purse seine (PS)	mortality following interaction	2	3	2	Gillnets (GN)	mortality following interaction	2	2	2
	unaccounted mortality	1	3	2		unaccounted mortality	1	1	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	0	2	2		temporal overlap	0	2	2
	current status of management	3	1	2		current status of management	3	1	2
	behavioural susceptibility to interaction	1	2	2		behavioural susceptibility to interaction	1	3	2
Longlines (LX + LLS)	mortality following interaction	2	3	2	Miscellaneous (MIS)	mortality following interaction	2	3	2
	unaccounted mortality	1	3	2		unaccounted mortality	1	3	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	0	2	2		temporal overlap	0	2	2
	current status of management	3	1	2		current status of management	3	3	2
	behavioural susceptibility to interaction	1	2	2		behavioural susceptibility to interaction	1	3	2

Table 23: Table exposure-consequence criteria (*Stercorarius longicaudus*) – Rating instructions described in Table 5. DQ (Data Quality) ranging from 1 (high) to 2 (medium) and 3 (low). Weight fixed to 2.

Stercorarius longicaudus									
SPECIES RESILIENCE ATTRIBUTES		**RATING**	**DQ**	**WEIGHT**					
	age of maturity	2	1	2					
	reproductive strategy	2	1	2					
	population trend	2	1	2					
	IUCN status	1	1	2					
	proportion of tagged distribution utilising area	0	2	2					
SPECIES STRESSOR OVERLAP PROPERTIES		**RATING**	**DQ**	**WEIGHT**	**SPECIES STRESSOR OVERLAP PROPERTIES**		**RATING**	**DQ**	**WEIGHT**
Trawls (OTB + OTM)	mortality following interaction	2	2	2	**Pots and traps (FPO)**	mortality following interaction	1	1	2
	unaccounted mortality	1	2	2		unaccounted mortality	1	1	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	0	2	2		temporal overlap	0	2	2
	current status of management	3	1	2		current status of management	3	1	2
	behavioural susceptibility to interaction	0	1	2		behavioural susceptibility to interaction	1	1	2
Purse seine (PS)	mortality following interaction	2	2	2	**Gillnets (GN)**	mortality following interaction	3	3	2
	unaccounted mortality	1	2	2		unaccounted mortality	1	2	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	0	2	2		temporal overlap	0	2	2
	current status of management	3	1	2		current status of management	3	1	2
	behavioural susceptibility to interaction	3	1	2		behavioural susceptibility to interaction	2	2	2
Longlines (LX + LLS)	mortality following interaction	2	3	2	**Miscellaneous (MIS)**	mortality following interaction	2	3	2
	unaccounted mortality	1	1	2		unaccounted mortality	1	3	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	0	2	2		temporal overlap	0	2	2
	current status of management	3	1	2		current status of management	3	3	2
	behavioural susceptibility to interaction	2	1	2		behavioural susceptibility to interaction	3	3	2

Table 24: Table exposure-consequence criteria (*Catharacta skua*) – Rating instructions described in Table 5. DQ (Data Quality) ranging from 1 (high) to 2 (medium) and 3 (low). Weight fixed to 2.

Catharacta skua				
SPECIES RESILIENCE ATTRIBUTES		**RATING**	**DQ**	**WEIGHT**
	age of maturity	2	1	2
	reproductive strategy	2	1	2
	population trend	2	1	2
	IUCN status	1	1	2
	proportion of tagged distribution utilising area	0	2	2

SPECIES STRESSOR OVERLAP PROPERTIES		**RATING**	**DQ**	**WEIGHT**	**SPECIES STRESSOR OVERLAP PROPERTIES**		**RATING**	**DQ**	**WEIGHT**
Trawls (OTB + OTM)	mortality following interaction	2	2	2	**Pots and traps (FPO)**	mortality following interaction	1	1	2
	unaccounted mortality	1	2	2		unaccounted mortality	1	1	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	0	2	2		temporal overlap	0	2	2
	current status of management	3	1	2		current status of management	3	1	2
	behavioural susceptibility to interaction	0	1	2		behavioural susceptibility to interaction	1	1	2
Purse seine (PS)	mortality following interaction	2	2	2	**Gillnets (GN)**	mortality following interaction	3	3	2
	unaccounted mortality	1	2	2		unaccounted mortality	1	2	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	0	2	2		temporal overlap	0	2	2
	current status of management	3	1	2		current status of management	3	1	2
	behavioural susceptibility to interaction	3	1	2		behavioural susceptibility to interaction	2	2	2
Longlines (LX + LLS)	mortality following interaction	2	3	2	**Miscellaneous (MIS)**	mortality following interaction	2	3	2
	unaccounted mortality	1	1	2		unaccounted mortality	1	3	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	0	2	2		temporal overlap	0	2	2
	current status of management	3	1	2		current status of management	3	3	2
	behavioural susceptibility to interaction	2	1	2		behavioural susceptibility to interaction	3	3	2

Table 25: Table exposure-consequence criteria (*Stercorarius pomarinus*) – Rating instructions described in Table 5. DQ (Data Quality) ranging from 1 (high) to 2 (medium) and 3 (low). Weight fixed to 2.

Stercorarius pomarinus									
SPECIES RESILIENCE ATTRIBUTES		**RATING**	**DQ**	**WEIGHT**					
	age of maturity	2	1	2					
	reproductive strategy	2	1	2					
	population trend	2	1	2					
	IUCN status	1	1	2					
	proportion of tagged distribution utilising area	0	2	2					
SPECIES STRESSOR OVERLAP PROPERTIES		**RATING**	**DQ**	**WEIGHT**	**SPECIES STRESSOR OVERLAP PROPERTIES**		**RATING**	**DQ**	**WEIGHT**
Trawls (OTB + OTM)	mortality following interaction	2	2	2	**Pots and traps (FPO)**	mortality following interaction	1	1	2
	unaccounted mortality	1	2	2		unaccounted mortality	1	1	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	0	2	2		temporal overlap	0	2	2
	current status of management	3	1	2		current status of management	3	1	2
	behavioural susceptibility to interaction	0	1	2		behavioural susceptibility to interaction	1	1	2
Purse seine (PS)	mortality following interaction	2	2	2	**Gillnets (GN)**	mortality following interaction	3	3	2
	unaccounted mortality	1	2	2		unaccounted mortality	1	2	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	0	2	2		temporal overlap	0	2	2
	current status of management	3	1	2		current status of management	3	1	2
	behavioural susceptibility to interaction	3	1	2		behavioural susceptibility to interaction	2	2	2
Longlines (LX + LLS)	mortality following interaction	2	3	2	**Miscellaneous (MIS)**	mortality following interaction	2	3	2
	unaccounted mortality	1	1	2		unaccounted mortality	1	3	2
	intensity of gear use	2	2	2		intensity of gear use	2	2	2
	temporal overlap	0	2	2		temporal overlap	0	2	2
	current status of management	3	1	2		current status of management	3	3	2
	behavioural susceptibility to interaction	2	1	2		behavioural susceptibility to interaction	3	3	2

Table 26. ICES Areas within the NEAFC RAs.

Area	Area Description	Parent Area	Parent Area Description
27.1.a	Barents Sea - NEAFC Regulatory Area	27.1	Barents Sea
27.10.a.1	Azores Grounds - Parts of the NEAFC Regulatory Area	27.10.a	Azores Grounds
27.10.b	Northeast Atlantic South	27.1	Azores Grounds
27.12.a.1	Subdivision XIIa1 - NEAFC Regulatory Area	27.12.a	Southern mid-Atlantic Ridge (Southern Reykjanes Ridge south to Charlie-Gibbs Fracture Zone)
27.12.a.2	Subdivision XIIa2 - NEAFC Regulatory Area	27.12.a	Southern mid-Atlantic Ridge (Southern Reykjanes Ridge south to Charlie-Gibbs Fracture Zone)
27.12.b	Western Hatton Bank	27.12	North of Azores
27.12.c	Central Northeast Atlantic – South	27.12	North of Azores
27.14.b.1	Southeast Greenland - Parts of NEAFC Regulatory Area	27.14.b	South-east Greenland
27.2.a.1	Norwegian Sea - NEAFC Regulatory Area (Division IIa1)	27.2.a	Norwegian Sea
27.2.b.1	Spitzbergen and Bear Island - NEAFC Regulatory Area	27.2.b	Spitzbergen and Bear Island
27.6.b.1	Rockall - Part of NEAFC Regulatory area	27.6.b	Rockall
27.7.c.1	Porcupine Bank - NEAFC Regulatory Area	27.7.c	Porcupine Bank
27.7.j.1	Southwest of Ireland - East - Parts of NEAFC Regulatory Area	27.7.j	South-west of Ireland - East
27.7.k.1	Southwest of Ireland - West - Part of the NEAFC Area	27.7.k	South-west of Ireland - West
27.8.d.1	Bay of Biscay - Offshore - Parts in NEAFC Regulatory Area	27.8.d	Bay of Biscay - Offshore
27.8.e.1	West of Bay of Biscay - Parts in NEAFC Regulatory Area	27.8.e	West of Bay of Biscay
27.9.b.1	Portuguese Waters - West Parts in NEAFC Regulatory Area	27.9.b	Portuguese Waters - West

Annex 3: Resolution

2022/WK/HAPISG12 The **Workshop on sea Bird Bycatch monitoring in the NEAFC regulatory areas (WKBB),** chaired by Gildas Glemarec* (Denmark) and Kim Magnus Bærum* (Norway), will meet:

intersessionally in April 2023 to:

a) Review the results from WKPETSAMP2[26] to evaluate and select input data to be used by WKBB (Science Plan Codes: 3.2 and 3.3)

in Copenhagen on 1-4 May 2023 to:

b) Identify the areas of spatio-temporal overlap of different seabird species and fishing activities in the NEAFC RAs, and estimate the level of the area/season interaction for relevant combinations of seabird species and fisheries (Science Plan Codes: 4.2, 6.1);
c) Document gaps and deficiencies related to the quantity and quality of total fishing effort data affecting statistically robust bycatch mortality estimates at the fleet level in the NEAFC RAs, and identify actions required to enable such estimations (Science Plan Codes: 3.5);
d) Recommend pilot study(ies) to monitor and assess the scale and magnitude of seabird-fisheries interactions in the NEAFC RAs for high-risk seabird bycatch métiers (as identified under ToR b) (Science Plan Codes: 3.2, 3.3, 6.1)

WKBB will report by 30 June 2023 to the attention of the HAPISG and ACOM.

Supporting information

Priority	The workshop is directly linked to a special request for advice from NEAFC on ‘seabird bycatch in the NEAFC Regulatory Area.’
Scientific justification	This workshop is directly linked to the ongoing workshop on “improving protected species bycatch monitoring”, namely WKPETSAMP2 and WKPETSAMP3; both processes being related to a special request for advice from DGEnvironment. WKBB will also support the objective 4.2. of The Roadmap for ICES bycatch advice on protected, endangered, and threatened species and propose options to improve data availability and quality.

[26] Workshop on appropriate sampling schemes for Protected Endangered and Threatened Species bycatch (WKPETSAMP2)

	Relevant outcomes from the Workshop on Estimation of Rare Events (WKRARE, 2021) will be considered. In addition, conclusions from the recent report on "monitoring seabird bycatch in the NEFAC regulatory area[27]" will also be considered. Data collection methods to be considered for ToR d) include sampling programmes using at-sea observers, electronic monitoring with video, and fisher-reported data. When proposing monitoring pilot studies, experts will consider i) which gears/métiers pose the greatest risk in terms of seabird-fisheries interactions, ii) the fisheries hotspots in the area(s) of interest, and iii) the spatiotemporal distribution of the seabird species at risk of interacting with fishing gears in the area(s) of interest. To estimate the level of interaction by area/season for relevant combinations of species and fisheries, tools like e.g., Productivity-Susceptibility Analyses (PSA) may be considered.
Resource requirements	None, beyond the funding for the workshops to be provided b NEAFC.
Participants	The workshop will be attended by up to 15 experts. Th workshop requires the participation of experts with knowledg on and access to national and regional fisheries data collectio schemes to estimate fishing effort distribution and quantificatio in the area(s) of concern, experts on seabird distribution an ecology in North-East Atlantic offshore waters, and experts o seabird-fisheries interactions.
Secretariat facilities	SharePoint access and Secretariat support.
Financial	Financed through specific budget linked to a special request fc ICES advice.
Linkages to advisor committees	ACOM
Linkages to othe committees or groups	DSTSG, HAPISG, WGCATCH, WGBYC, JWGBIRD
Linkages to othe organizations	NEAFC, OSPAR

27 ICES. 2023. Monitoring seabird bycatch in the North East Atlantic Fisheries Commission Regulatory Area. ICES Business Reports, 03: 02. 11 pp. http://doi.org/10.17895/ices.pub.21908577

Annex 4: Review of Report of ICES Workshop on Seabird Bycatch Monitoring in the NEAFC Regulatory Areas (WKBB)

Context

Following a special request from NEAFC for advice on seabird bycatch rates in three offshore regions of the northern North Atlantic, a workshop was held in May 2023 to compile data on fisheries and seabird species distributions. VMS monitoring and logbook data were used to analyse fishing effort along with seabird tracking data using geolocators, GPS and other forms of positional logging from two sources (BirdLife International's seabird tracking database and SEATRACK's Northeast Atlantic seabird distribution dataset from the Norwegian research programme, SEAPOP). Fisheries data covered the years 2018-2022; seabird tracking data derived from the SEATRACK database covered the years 2006-2019, from which species distribution models had been generated. It was presumed that BirdLife international's seabird tracking database used only data from 2018-2022 but this needs clarification. A bycatch risk assessment method previously used by WGBYC on marine mammals was adapted for use on seabirds. Finally, a pilot monitoring study to improve data collection was proposed.

Executive Summary

The task that the group was set was a challenging one given the limited availability of data and so it is unsurprising that seabird species bycatch rates could not be extracted from the analyses, and instead the focus was on piloting a methodological procedure that could be used going forward. Nevertheless, the workshop participants could have identified additional available resources that were not tapped in this current assessment, and there could have been more discussion of the results and interpretation in the light of existing knowledge on the status, distribution and ecology of the species targeted. This would also better reveal potential biases or limitations. For the two northern areas, for example, the SEAPOP programme involves not only tracking of individuals of several species but also at-sea surveys, and there are other cruises in the northern North Atlantic (and Barents Sea) that have been undertaken. Some comparison of those results would help inform the maps presented here. It is important that monitoring of both fishing effort and bycatch in these offshore areas is significantly improved, and therefore strong endorsement of the proposed pilots should be a major conclusion from the workshop. Improvements should also be made as a matter of priority to the allocation of fishing activities to specific gear types (preferably at metier level 6), and the quantification of actual fishing effort (ideally, areas swept by trawls and seines, soak times and lengths of net for static gear rather than hours at sea assumed to be fishing).

Main Recommendations

1. Express strong support for NEAFC's proposal to conduct fisheries monitoring pilots to provide stronger evidence on seabird-fisheries interactions.
2. Specify explicit and measurable objectives of the proposed fisheries monitoring pilots
3. Where appropriate, stress the importance of including other data, for example, fishing effort determined using machine learning algorithms developed by Global Fishing Watch using AIS data, of improving log-books with respect to gear type (including

potential long-lining), and of setting up a dedicated monitoring programme that includes at-sea surveys (since seabird tracking data and opportunistic surveys will obviously not suffice).

4. Highlight a limitation of the risk assessment of not having provided for independent synthesis of *all* accumulated scientific information, which is a fundamental principle for developing transparent, evidence-informed regional conservation management decisions, and a research priority of addressing this deficit, including by conducting a systematic literature review to assemble a database of species-specific and gear-specific seabird catch rates in the NEAFC regulatory areas, and conducting a meta-analytic synthesis in order to produce the most robust and generalizable findings that are optimal for guiding regional bycatch management. The former could draw upon not only the work of WGBYC but other studies and reviews within the North Atlantic.
5. Identify priority next steps for designing robust monitoring pilots, including:
   - How the fisheries monitoring design will minimise sources of statistical sampling bias, such as by employing a sampling design that is randomised and balanced proportionately across fleet components, seasons, and fishing ground zones; if a probability sampling design is not employed, how under-coverage bias would be accounted for in estimated seabird species-specific catch rates; for rare-event catch rates, the requisite coverage rate to meet objectives; and approaches and limitations of the pilot design in accounting for inter-annual variability in catch risk.
   - Identifying priority data fields and data collection protocols (for both conventional human observer programmes and electronic monitoring systems) to produce robust estimates of seabird species-specific and gear-specific catch risk.
6. Amend the workshop report text that concludes that a NEAFC regional observer programme is not feasible due to issues that would prevent a randomised sampling design and would be too expensive, but instead propose that NEAFC and ICES review numerous examples of regional observer programmes under other RFMOs which can provide NEAFC and ICES with ideas for overcoming these identified issues.

1. Is the analysis technically correct: Partially. The workshop has identified possible seabird bycatch hotspots using one appropriate approach (areal overlap, which is but one of a suite of predictors of capture risk susceptibility) given data limitations. However, the approach would have been substantially more robust if expanded to assess all accumulated evidence – including through a formal systematic literature review and meta-analytical synthesis.

2. Are the scope and depth of science appropriate: Yes, however, the details for the prescribed monitoring pilot should be expanded to address the specific observer and EM system designs, data collection fields, and data collection protocols by gear type.

3. Does the analysis contain the knowledge to answer the request for advice: Yes, the analyses summarised in the workshop report provide evidence for identifying seabird bycatch hotspots in the NEAFC regulatory areas and for recommending pilot monitoring to address identified data quality/quantity deficits

Individual Reviews:

A) Peter GH Evans (School of Ocean Sciences, Bangor University)

1. Introduction

It is stated that ICES WGSFD used a combination of vessel speeds derived from VMS data and logbook catch to allocate fishing activity to specific fisheries. It would be useful here to give a little more information about how this was done and at what metier level. Are the gear types used by each vessel not registered somewhere, e.g. NEAFC fleet registry? Assuming that information was not available, could not AIS data be used to extract further information on vessel IDs and then a sample taken to determine metier information at least above level 2? A minimum of metier level 4 would be desirable. Vessel speed alone seems a fairly imprecise way to determine this level of information. Can one distinguish different types of trawling, for example? Some explanation would be good for how useful the logbook data were at identifying metiers.

2. WKPETSAMP2 relevance to WKBB

The workshop referred to in this section concerned sampling designs to optimise assessment of bycatch within high-risk fisheries (metiers) and regions, and the development of a simulation tool. However, this was not used in the current exercise so I am not sure why this section is included unless it is expanded to develop more detailed recommendations for a sampling design of sufficient extent to avoid the many potential biases that exist.

3. Overlap between seabird species and fishing activities in the NEAFC Regulatory Area

3.1 NEAFC fisheries data analysis

The identity of gear types does appear to be limited to broad categories, and there is a significant proportion that are unknown. Therefore, would this not benefit from a supplementary analysis using AIS data and collaboration with Global Fishing Watch and their machine learning algorithms to estimate fishing effort? There are many challenges with determining actual fishing effort from vessel speed data alone, particularly for certain gear types such as static gears. In those cases, might fishing effort be exaggerated as it could include slow speeds during recovery of gear which could occupy quite a lot of time?

The number of fishing hours per grid cell was thought to be an accurate representation of the fishing effort for mobile gear such as trawls and seines, whereas for passive gears such as longlines, nets and traps, it was not possible to obtain more than general fishing intensity since information on soak times (nets) and number of hooks (longlines) or type of bait was not available.

Figure 4 gives monthly data at a higher metier level (e.g. OTM, OTB, OTT) so I assume this information has come from the logbooks or the NEAFC fleet registry. It would be helpful if this was clarified.

Figure 5 shows seasonal (Mar, May, July, Nov) variability for trawls in the three NEAFC areas. These appear to show a strong summer vs winter pattern. I wonder if this is reflected across other gear types.

3.2. Seabird data analysis

Seabird tracking data from SEAPOP's SEATRACK and Bird Life's International Seabird Tracking Database were used for information on seabird species distributions.

The former (SEA) is based on six species of arctic breeding seabird over the period 2006-19, and uses geolocators.

NB should it not read ‘weighting’ rather than ‘weighing’ the model predictions?

The latter (STDB) is a global data source for several seabird species and used GPS, PTT or GLS loggers. Analysis performed on 6 shearwater species, razorbill and long-tailed skua. Kernel density estimations were performed using a 95% utilisation distribution.

Were there data sets in STDB in areas B & C that were not in SEA so that a comparative analysis could be made to test the robustness of the predictions from the data sets?

What were the sample sizes? Making predictions from a small number of individuals is always challenging and so it is important to understand the level of sampling in the three study areas. The distribution of tracked birds depends a lot upon the locations from where they were tagged. Was this fully taken into account in the analysis?

3.3. Risk assessment

The first sentence could benefit from being rewritten. It doesn’t really say anything!

Productivity Sensitivity Analysis (PSA) methods to develop vulnerability scores were reviewed but not adopted as it only uses relative risk rather than absolute risk. Instead, a Bycatch Risk Assessment (BYRa) approach, as adopted by ICES WGBYC, was used.

Table 3 is rather similar to exercises undertaken by others, e.g. in Bradbury et al. (2017) and Evans & Baines (2013). Those have included some additional life history/demographic parameters that reflect resilience, which could usefully have been considered, such as generation length, foraging niche breadth, reproductive rates.

In the results, there seems to be a verb missing from the sentence: “For individual species bycatch risk maps, coupled with summaries of the gear categories driving risk during each month of the year, see Figure 8 to Figure 26 in Annex.”

It would be useful to have summarised the winter vs summer trends for each species in relation to overlap with fishing activity. And if possible, draw comparisons between the three regions.

4. Caveats and deficiencies of fisheries data from the NEAFC Regulatory Area

There are serious limitations from the existing data: no information on bycatch, limited data on bird densities (with potential biases resulting from where and when they were tagged), and limited information on temporal variation in actual fishing effort (particularly at a minimum level of metier 4, and ideally 6).

5. Monitoring seabird bycatch in the NEAFC Regulatory Area

5.1. Monitoring options in the NEAFC RA

Fisheries observers

Maybe also worth mentioning issues if this was allocated to fisheries observers who not only would have difficulties distinguishing species within bird families (e.g. shearwaters) but also would have other duties that would take them away from spotting birds falling out of fishing gear.

Electronic monitoring

Another advantage, if cameras are strategically placed, includes coverage of the gear as it is being hauled to obtain more comprehensive bycatch estimates. As noted, machine learning tools are continually being improved increasing the potential to reduce the time required for humans to review videos. However, even without that facility, the relative cost of EM vs human observers is substantially lower (see, for example, Course, 2021).

Self-sampling

Deficiencies of self-sampling are well described.

Reference fleet

Data collected from a reference fleet have advantages over self-sampling although there remains a need for fleets with high- risk gears to be sampled, and for validation by independent means. On the other hand, this applies to all the approaches reviewed. As for missing cases of cryptic mortality and bycatches not brought aboard, these also are surely potential limitations of the other methods.

It is not clear whether the finding of Basran & Sigurdsson (2021) of fewer bycatches recorded from the reference fleet than from fisher logbook data means much when neither datasets are validated and unless both were comprehensively sampled and recorded, there could be differences by chance.

5.2. Recommendation for a seabird bycatch monitoring programme – Pilot study

There is some repetition in the first paragraph of this section which could be made more concise. Essentially, the key points are improving identification of the gear type being used by vessels and determination of actual fishing effort (ideally, areas swept by trawls and seines, soak times and lengths of net for static gear rather than hours at sea assumed to be fishing), and more monitoring. The authors suggest the latter might best be implemented by increasing the amount of monitoring effort on the same vessel since bycatches are rare events. If that is adopted, however, then it is important that the higher-risk fishing gears are each sampled. Potential for cable strikes within trawl fisheries needs further investigation. However, trawl fisheries do experience seabird bycatch and so this aspect should also be investigated further.

The term "fine-scale" is used several times but can be interpreted in different ways (spatial, temporal, gear specific at different metier levels, etc). This should be made more explicit.

Five actions are recommended by the group, all of which are relevant and important to achieve the goals. I would agree that recommendation 2 should receive particular attention.

That last paragraph is very long and could usefully be split into two or three, for example from "Information collected by observers could help define…." And then lower down "The group recommends externalising the review process…."

The group concludes that OTM and OTB should receive particular attention because of the relatively high amount of effort associated with these gear types, although earlier it was felt that bycatch might be much lower there than in longlines or static gear. There is a high proportion of fishing effort that cannot be assigned to a particular gear type.

Clearly, a priority should be to improve gear identification to better establish the amount of fishing effort that applies to each gear type. In the interim, I would recommend that longlines which have been proven to be a particular problem for shearwaters and fulmars, for example, are investigated further to ascertain whether some vessels are longlining in any of the three areas and therefore should be included in the pilot study.

References

Bradbury, G., Shackshaft, M., Scott-Hayward, L., Rexstad, E., Miller, D., and Edwards, D. (2017) *Risk assessment of seabird bycatch in UK waters*. Unpublished Report to Defra. WWT Consulting, Wildfowl & Wetlands Trust, Slimbridge, Glos, UK. 205pp.

Course, G.P. (2021) *Monitoring cetacean bycatch: an analysis of different methods aboard commercial fishing vessels*. ASCOBANS Technical Series No. 1. 74pp.

Evans, P.G.H. and Baines, M.E. (2013) *A methodology to assess the sensitivity of marine mammals to different fishing activities and intensities*. CCW Policy Research Report No 12/6. 83pp.

B) David Gremillet, CEFE-CNRS, Centre d'Ecologie Fonctionnelle et Evolutivé, Montpellier cedex

This workshop and report aimed at assessing seabird bycatch in the NEAFC Regulatory Area, and at providing guidance for improvements in the matter. Considering the world seabird community has declined by half since 1970 (Grémillet et al. Current Biology 2018), and that bycatch mortality is one of the main drivers of such drastic decline (Dias et al. Biological Conservation 2019), the workshop and reports are extremely timely and useful. Also, while historically there has been a major focus on seabird bycatch on albatrosses and petrels in the Southern Ocean (Tuck et al. Biological Conservation 2003), with considerable improvements in bycatch mitigation, areas such as the Mediterranean and the North Atlantic have been lagging far behind. Further, because of global warming, high-latitude fisheries are intensifying in the North Atlantic, an area where the seabird community is already under the cumulative stress of many threats, such as direct and indirect climate change impacts (Clairbaux et al. Current Biology 2021) or pollutions (Albert et al. Science of the Total Environment 2021).

Therefore, I applaud this essential initiative, and gratefully thank participants to the workshop for their time and efforts. Their report is generally excellent, with adequate methodology, analyses, and conclusions which logically lead to recommendations for further studies, to be performed urgently. I only have a limited number of comments, which are listed below:

- The title should be revised, as "seabirds" is now the generally used term ("sea birds" can be found in older bibliography). Also, there is no need for a capital letter in "bycatch"
- Some more information about the fishing fleet would be welcome: percentage of units per nation, average vessel size and range, targeted species, yearly catch volumes and yearly income. The latter is important in the context of my next comment.
- I must admit that I (naively) assumed that such offshore fisheries, which should be performed by units > 12 meters, would be subjected by law to a continuous, mandatory fishery observer program. Hence, the report should specify why it is not the case. Further, I disagree with the argument that observer programs are "*too expensive*". Considering the substantial incomes of these fisheries, a mandatory observer program should be funded by the fisheries themselves, and legally enforced (no observers on board, no fishing). I understand that this difficult in areas beyond national jurisdiction, but the report mentions a very interesting US initiative on page 15 "*in the United States (US) – a major market for fisheries products – the implementation of the Import Provisions of the United States Marine Mammal Protection Act Fisheries now requires fisheries operating outside the US which products target the US market to have or develop specific marine mammal protection standards that*

are of equivalent effective-ness to the standards implemented for commercial fisheries in the US (Moore et al., 2021)."

- With respect to the data sources, the methods section should mention whether adding AIS data would have strengthened the analyses.
- On page 17, the authors state "*It is thus necessary that the fleets engaged in fishing activities in the NEAFC RA agree to participate in a monitoring programme dedicated to the collection of data on seabird-fisheries interactions in the region* ". This key message should be underlined and put forward much earlier in the report, especially in the summary. This summary should clearly state that the analyses performed identified major knowledge gaps and that, as of today, it is impossible to assess the magnitude of seabird bycatch in the study area.
- Page 18: "*it will hopefully*…". I suggest revising this sentence, since hoping will not be enough when discussing bycatch issues with a fishery. The tone has to be more affirmative.

C) *Eric Gilman, Fisheries Research Group, Honolulu, USA*

Executive Summary

ES1: It would be helpful to report explicitly in the ES the workshop participants' conclusions on whether the strength of evidence from the findings from the ByRA risk assessment are adequate to inform management of seabird bycatch in the NEAFC regulatory area. "The results are discussed, including the uncertainty in the data used during the workshop" is a useful description of the process – but what were the results and management implications of any identified deficits with the data?

ES2: Similarly, "the last part of the report presents recommendations for a pilot monitoring study" – expanding this with 1 additional sentence to state the objective of the pilot and how it addresses identified data limitations would provide the reader with a much more complete understanding of the workshop conclusions.

ES3: While outside of the 3 tasks that ICES assigned to the workshop, did the workshop have advice on improvements required for fully operational fisheries monitoring programs to provide robust data needed for ICES/NEAFC evidence-informed policy on managing seabird bycatch – in other words, why are pilots needed instead of establishing permanent independent monitoring?

ES4: 2nd sentence - minor – bycatch data are a category of fisheries data, so a deficit in the former reflects a deficit in the latter. Instead of referring broadly to limited fisheries data, could you specify what categories or fields are limited?

Section 1 – Intro – no comments

Section 2 – WKPETSAMP2 – sampling

Sampling1: The summary, including descriptions of the outcomes of the WKPETSAMP2 workshop is clear and helpful. A key outcome of direct relevance to the WKBB task c is to account for the main sources of statistical sampling bias in fisheries monitoring programs when WKBB assessed the available NEAFC fisheries data. What are the contemporary sampling designs of monitoring programs –particularly those that provide for independent monitoring (i.e., not self-reported logbook data) – and for each, assess against a suite of criteria for best practice fisheries sampling designs, such as whether sampled effort is random and balanced proportionately across fleet components, and if a probability sampling design is not employed then what is the risk of undercoverage bias; and for rare-event seabird bycatch, the requisite coverage rate to meet objectives, accounting for : (1) the objectives of analysis, including required levels of accuracy and precision of catch rates, and (2) aspects of each individual fishery – such as how many vessel classes exist, how many ports are used, the spatial and temporal distribution of effort, the frequency of occurrence of catch interactions for each species of interest, the amount of fishing effort, and the spatial and temporal distribution of catch…

Section 3.1 – overlap, fishing effort

Overlap 1: It would be useful to include a brief intro to this section that synthesizes existing knowledge that areal and temporal overlap between a fishery and distribution of seabird populations is but 1 of an ensemble of attributes that explain susceptibility to seabird catch risk.

Overlap 2: A brief summary, perhaps in a table by gear type/fishery, explaining the availability of different categories of monitoring data from highest to least certain (observer & EM, VMS, port sampling, logbook) would be useful in part to understand why interpretation of VMS data was needed to estimate the amount and spatial and temporal distribution of effort.

Overlap 3: Fig 2 – number of vessels by gear category – a figure presenting effort (number of operations, or number of fishing days or hours) by gear type would be useful additional info.

Overlap 4: Could the method employed to estimate effort from analyzing VMS data be validated for any of the fisheries/gear types? Or at least estimate precision with say logbook data?

Section 3.2 – overlap, seabird distribution

Overlap 5: In addition to the 2 referenced seabird tracking databases, a systematic lit review could enable assembling a database of species-specific and gear-specific seabird catch rates in the NEAFC regulatory areas. This would complement the databases – potentially overcoming gaps in tagged species/populations.

Overlap 6: In addition to the VMS dataset, mention of whether the vessels that fish in the NEAFC RA have AIS would be useful, and whether this could be assessed such as using the ML algorithms developed by Global Fishing Watch to provide an additional approach to estimate effort.

Section 3.3 - ERAs

ERA 1: ERAs of the effects of fishing span from quantitative model-based approaches to qualitative data-limited approaches. The first sentence should be revised to specify that it is referring to semi-quantitative ERAs such as PSAs.

ERA 2: An additional caveat of PSAs is that, in assessing relative as opposed to absolute risk, they do not reflect the effect of a fishery in reducing population yield, where life history attributes (e.g., the relationship between adult biomass and recruitment) dictate how an individual population responds to fishery removals. As a result, populations of species with low fecundity, delayed maturation and other life history traits that make them vulnerable to anthropogenic mortality are always going to be ranked as higher risk than relatively productive species by PSAs – which provides limited evidence to inform fisheries management strategy development.

ERA 3: The lack of a selectivity susceptibility attribute in the ByRA method is a concern – to assess relative risk between as well as within gear types. Encounterabiliy (susceptibility from vertical overlap) is another important attribute for gear types such as demersal longline and pots.

Section 4 – caveats/deficiencies

Very useful, comprehensive section. A few minor comments follow.

Deficits 1: The recommendations would be improved through accounting for the Agreement on the Conservation of Albatrosses and Petrels (ACAP) recommendations on: (1) *Data Collection Guidelines for Observer Programmes to Improve Knowledge of Fishery Impacts on ACAP-Listed Species*. Rev. 1. (https://www.bmis-bycatch.org/system/files/zotero_attachments/library_1/IN7KIQMG%20-%20Wolfaardt%20and%20Debski%20-%20Data%20collection%20guidelines%20for%20observer%20programmes.pdf); and (2) ACAP Guidelines on Fisheries Electronic Monitoring (https://www.iattc.org/GetAttachment/2bbb73b3-305c-441f-ab0d-d3cd201e7f12/WSEMS-05-MISC_ACAP-Guidelines-on-Fisheries-Electronic-Monitoring-Systems.pdf).

Deficits 2: Not mentioned in the report, the extremely short time series length of available VMS/logbook data prevents accounting for cyclical (inter-annual and decadal) climate cycle effects and responses to outcomes of climate change effects on seabird species-specific catch risk in NEAFC fisheries.

Deficits 3: A review of issues that have been raised over the application of the US MMPA PBR should be included. Potential Biological Removal (PBR) requires minimal demographic information to estimate mortality thresholds – it has previously been applied to seabirds (e.g., see Dillingham and Fletcher 2011). There are more robust approaches available for data-limited populations to assess the magnitude of bycatch relative to biological reference points.

Deficits 4: Indirect, collateral effects should also be accounted for – for instance, for seabirds, fishing mortality of one of a breeding pair typically results in chick mortality by starvation, and the remaining adult might take several years before mating again, further reducing reproductive output, and accounting for sublethal effects.

Deficits 5: The statement that seabird bycatch mortality rates should be assumed to be 100% is not accurate across fisheries – e.g., some fisheries have high captures during gear haulback, where there is a low rate of at-vessel mortality (i.e., the fishers retrieve the birds alive) and might have a high post-release survival rate.

Deficits 6: The final sentence could be revised to clarify that, by minimizing statistical sampling bias, the objective is to produce *robust, certain* raised estimates.

Section 5 - monitoring

Mon 1: Commented on above, a summary of the contemporary monitoring framework, by gear type, in the NEAFC areas, would be very helpful. In addition, a sum of the data fields and data collection protocols of the existing monitoring programs would be helpful. Without a baseline, it is challenging to assess whether the prescribed pilot is a large improvement…

Mon 2: The opening subsection on fisheries observers concludes that a regional observer program is not feasible due to issues that would prevent a randomized sampling design and would be too expensive. There is a lack of presentation of a rationale for the basis of these conclusions. There are numerous examples of regional observer programs under other RFMOs that could be reviewed to provide NEAFC with ideas for overcoming these identified issues.

Mon 3: The EM section should be expanded to:

1. describe the very successful Australian EM audit model (where all vessels have EM systems, and random samples of imagery and sensor data are reviewed to assess the precision of logbook data. To incentivise improved logbook data quality, penalties (e.g., full review of EM imagery, assign an observer, or issue a fine) can be assigned when a vessel is found to systematically record logbook data with low precision with EM data), and

2. highlight how EM systems overcome sources of statistical sampling bias that conventional observer programs are subject to – including an observer effect, observer displacement effect, and coercion and corruption.

Mon 4: A priority recommendation on designing a pilot observer/EM program is missing. All key data fields need to be collected that enable conditioning (standardizing) effort for potentially significant explanatory predictors of species - (and length- and sex-) specific catch rates.

Mon 5: Procedures for the EM system designs and reviewing protocols are needed for each gear type. E.g., different camera fields of view will be needed for the trawl vessels than the gillnet and trap vessels…