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Executive summary

The Joint ICES/OSPAR/HELCOM Working Group on Seabirds met in Copenhagen 9–13 November 2015. The meeting was chaired by Morten Frederiksen, Ian Mitchell and Volker Dierschke, and was attended by 21 members and invited experts representing eleven countries. The objectives of the meeting were to develop and implement indicators for seabirds under the Marine Strategy Framework Directive, as well as to review and discuss seabird-related issues relevant to human uses of the sea. The meeting consisted of a series of interconnected workshops, where subgroups with floating membership discussed the group's Terms of Reference. Report chapters were drafted by Term of Reference leads and collated by the chairs.

The group discussed a proposal for a database at ICES to hold data needed for updating of OSPAR and potentially HELCOM indicators. A list of suggestions for the design and content of such a database was developed.

Due to analytical problems and lack of data, the OSPAR indicators of marine bird abundance and breeding failure were not fully updated as planned. The breeding failure indicator showed some improvement in 2013 and 2014, following a run of very poor years. Surface feeders showed higher frequency of breeding failure than water column feeders in most areas.

Seabird indicators for the HELCOM area are currently under development. These will consider the abundance of both breeding and wintering birds. The group developed a detailed suggestion for which species should be included in the indicators and how they should be assigned to functional groups. A suggested scheme for the spatial assessment units which should be used was also developed. It is critically important that species wintering far offshore also should be included in the indicator, and this will require aerial surveys. During winter 2015/2016, a coordinated aerial survey covering most of the Baltic countries will take place. The group also evaluated the feasibility of an indicator of seabird breeding success.

A lack of knowledge of the impacts of offshore windfarms on seabirds is currently limiting development of new installations. The group discussed what could be done to address this, and developed a detailed list of research questions and suggestions for how these could be answered. This list is expected to be used by both government agencies and developers when deciding on funding of research projects.

The Landing Obligation currently being phased in under the Common Fisheries Policy has been suggested to have substantial impacts on seabirds, because some species feed extensively on discarded fish. The group developed suggestions for how such impacts could be monitored, focusing on the species and biological aspects most likely to be affected. It is expected that overall the Landing Obligation will benefit the wider marine ecosystem and not seriously undermine seabird communities.

Predation from invasive mammals is an important threat to many seabird colonies. The group considered how this problem could be monitored, potentially as an indicator under the Marine Strategy Framework Directive.

Fisheries on low trophic level fish have the potential to affect seabirds directly through competition for prey. The group considered several case studies demonstrating such impacts, and discussed the implications for fisheries management. As part of ecosystem-based management, fisheries for low trophic level fish should be regulated such that sufficient amounts of fish are left to allow birds and other predators to

maintain their populations. Available evidence suggests that this equates to about one third of the historical maximum stock size.

1 Introduction

The Joint OSPAR/HELCOM/ICES Working Group on Seabirds (JWGBIRD), chaired by Ian Mitchell (OSPAR/UK), Morten Frederiksen (ICES/Denmark) and Volker Dierschke (HELCOM/Germany), met at ICES in Copenhagen 9–13 November 2015 to address the following terms of reference:

a) Conduct an assessment of the OSPAR MSFD common indicators for OSPAR Regions II, III and IV, as a contribution to the OSPAR IA2017: B1 – marine bird abundance and B3 – marine bird breeding success. Reporting should follow the format and time frame predefined by OSPAR and will ensure access to the underlying data used to produce the assessment. Where this is not possible, then these datasets should be flagged and the pathway for access to the data described.

b) Conduct an assessment of indicators B1 and B3 in OSPAR Region I, where sufficient data are made available by Contracting Parties.

c) Update the HELCOM core indicators related to seabirds as a draft contribution to the second holistic assessment. The reporting format and time frame should follow the predefined guidance given by HELCOM and as specified in the core indicator process. If time permits, further develop seabird indicators. A specific need for further development of the breeding success parameter has been identified.

d) Review and revise the monitoring guidelines drafted by the HELCOM BALSAM project, for future inclusion in the HELCOM Monitoring Manual.

e) Review strategic studies of seabird ecology in relation to offshore windfarm impacts.

f) Design a protocol (or protocols) for assessing the effects on seabirds of the new CFP Landings Obligations. This continues on from work conducted by JWGBIRD in 2014 and could include the following:

  i) Conduct sensitivity scoring of species to reduction in food from discards (and offal) using the protocol developed by JWGBIRD 2014.

  ii) Pre- and post-Obligations comparison of abundance and breeding success of those species scored as most sensitive.

  iii) Meta-analysis of diet studies of seabird species thought to depend largely on discards to seek species-specific, temporal and regional differences in such dependencies, to be able to predict where birds might be most affected.

  iv) An inventory of the seabird colonies which may be vulnerable to the changed availability of discards to 'generalist piscivores' and studies into appropriate remedial action.

g) Assessment of the current scale of the threat and measures from non-native predators at seabird colonies in the NE Atlantic. The assessment could be made using existing literature, or on the basis of a questionnaire designed by JWGBIRD in 2014 to collect information on i) characteristics of the seabird colonies and their predators, ii) potential or existing pathways of introduction and invasion, iii) measures planned or already in place, iv) animal rights issues and hunting regulations and v) legislation and conservation aims.

h) Review long-term studies on fishery-driven changes in the marine community of NW European waters that have had consequences for seabirds, to provide insights into the ecological processes underlying changes in the seabird populations. This review could be used to provide recommendations to ICES for the management of fisheries, particularly low-trophic level (LTL) fisheries.

The meeting was attended by 18 members and three invited experts, and a further nine members and the following non-members provided input via correspondence: Rowena Langston, Kees Koffijberg, Steve Votier, Tony Bicknell, Daniel Oro, Ramunas Žydelis.

2 OSPAR and HELCOM indicators

Terms of Reference

a) Conduct an assessment of the OSPAR MSFD common indicators for OSPAR Regions II, III and IV, as a contribution to the OSPAR IA2017: B1 – marine bird abundance and B3 – marine bird breeding success. Reporting should follow the format and time frame predefined by OSPAR and will ensure access to the underlying data used to produce the assessment. Where this is not possible, then these datasets should be flagged and the pathway for access to the data described.

b) Conduct an assessment of indicators B1 and B3 in OSPAR Region I, where sufficient data are made available by Contracting Parties.

c) Update the HELCOM core indicators related to seabirds as a draft contribution to the second holistic assessment. The reporting format and time frame should follow the predefined guidance given by HELCOM and as specified in the core indicator process. If time permits, further develop seabird indicators. A specific need for further development of the breeding success parameter has been identified.

d) Review and revise the monitoring guidelines drafted by the HELCOM BALSAM project, for future inclusion in the HELCOM Monitoring Manual.

Scientific justification

a,b) ICES has played a key role in supporting the development of regional indicators of bird population status in the Greater North Sea since the inception of EcoQOs in 2001. In 2013, OSPAR adopted a first set of common indicators to support the implementation of the EU MSFD including two common indicators for marine birds. The joint OSPAR/ICES Working Group was formed in 2014 in order to e.g. take forward the further development and testing of these indicators. This task under the ToR will be to review the assessments and report including recommendations on the future operation of these indicators by Contracting Parties.

c,d) HELCOM joins the group to further enhance coherence of environmental status assessments between the two RSCs. Coherence in the assessments is seen as being of particular relevance for the highly mobile seabirds migrating across the two regions.

2.1 General issues

2.1.1 Summary of discussion on the proposed OSPAR Seabird Database (Hosted by ICES)

Overview

1) JWGBIRD had previously expressed the need for a central database to feed assessments of OSPAR Common Indicators on birds. We have also proposed ICES Data Centre as a suitable host. JWGBIRD thanks JNCC, UK for collating data and temporarily storing it, but recognizes that a longer term solution is needed.

2) JWGBIRD consider the purpose of an OSPAR Bird database to be:

1.1) To collate data used in indicator assessments.

1.2) The database should NOT replace national databases or be a repository for raw data (see below).

1.3) To provide a snapshot of data used in each assessment (as required by OSPAR and HELCOM data strategies, as required of each Member State by MSFD Art. 19).

1.4) To provide an audit trail for each assessment.

3) The database should certainly hold data collected by observers on land of marine birds when they are:

1.5) Counts of adult birds and estimates of breeding success that are conducted on land at breeding colonies or sites, nesting close to the coast and using marine environment (e.g. for food); and/or

1.6) In intertidal areas or close to the shore and counted from land during migration or overwinter.

4) The database could feasibly be constructed to accommodate land-based data (see above) from both the OSPAR and HELCOM areas (i.e. NE Atlantic and Baltic Sea).

5) The database should be updated annually by online data submissions by Contracting Parties.

6) JWGBIRD is currently uncertain whether the database could or should accommodate data on the following:

1.7) Bird counts at sea that are collected by boat-based and aerial surveys. Further discussions with custodians of the European Seabirds at Sea Database (ESAS) are required.

1.8) Counts of seals and their pups, as used to construct OSPAR indicator M3 and M5.

JWGBIRD highlighted concerns that some data providers might have over the free access to data held in the database; these are detailed below.

Background

Land-based counts–our understanding

- Each row of data consists of one value per species per site per year.
- The data can include both observed counts that may have missing values in some years; or a complete time-series of values in which missing observed counts have been interpolated. The provision of observed or interpolated counts is the decision of each Contracting Party.
- The International Waterbird Census database currently holds observed counts only of wintering waterbirds and waders. The proposed OSPAR database is required because indicator assessments use data products from certain contracting parties (i.e. post-interpolated values) and we need an alternative database in which to store them.
- There is a need for separate tables for breeding counts and non-breeding counts.

Breeding success data

- Ideally, each data row should contain two values per species per site per year: a count of nests monitored, and a count of chicks fledged from those nests.
- The above are difficult to collect for remote sites and for other sites that are visited for a short period. JWGBIRD will aim to develop an alternative method for recording breeding success/failure at these sites. These alternative parameters could be included in the same database.

At-sea data

- At-sea data are currently only used for HELCOM indicators. But JWGBIRD is aiming to develop ways of including these data in the OSPAR Common Indicator on marine bird abundance (B1).
- These data are collected from type of two platforms, boat and planes. Data collected by the two methods can be stored in the same database, but some spatial standardization needs to be agreed or captured in the database.
- Observed counts only should be stored. Estimates of numbers birds not observed in transects should be carried out during subsequent analysis (e.g. using distance sampling).
- We could potentially include at-sea data and land-based data in the same database (but in separate tables). This makes sense from the point of view of both the provider and the user.
- At-sea data from the OSPAR area are currently held in the European Seabirds at Sea Database (ESAS). BALSAM has discussed a HELCOM-wide database using ESAS-based format. It is unclear if there is a need to store data anywhere other than the ESAS database. We need to ensure the existing ESAS format can be accessed by the data analysis tools used by HELCOM and OSPAR.
- JWGBIRD will approach ESAS to see if the OSPAR database should aim to include at-sea data.

Issues over data access

- We understand data will be publicly available under the relevant OSPAR/HELCOM data sharing policy.
- There will be resistance to open data access from certain providers (e.g. NGOs, individuals, commercial organizations, academic institutions).
- Data from individual sites may not be submitted by some CPs because of resistance from data providers, only data at larger scales may be available (e.g. France).

We need to accept the above reservations in order to make use of all data that are collected, i.e. we may need to compromise on certain characteristics of the data e.g. spatial resolution.

2.2 Assessments of OSPAR MSFD common indicators: B1–marine bird abundance and B3–marine bird breeding success/failure (ToRs a&b)

2.2.1 Introduction

ToRs a & b were fully completed for indicator B3-marine bird breeding success/failure, but only in OSPAR region I, using data provided by Norway (including Jan Mayen and Svalbard); in OSPAR region II, using data provided by Belgium, the Netherlands, Norway and the UK; and in OSPAR region III, using data provided by the UK, on behalf of the Republic of Ireland. No assessment of B3 in OSPAR Region IV was possible because no data were provided by France, Spain or Portugal.

ToR a was not fully completed for B1-marine bird abundance. The assessment of B1 was based on analyses that were conducted in 2014 as part of the process of testing the Indicator (see ICES, 2015). These assessments of B1 are confined to OSPAR regions II-the Greater North Sea and III-the Celtic Seas. In 2015, more recent data were submitted by some contracting parties, but unfortunately technical problems encountered by the UK lead have meant that new analyses could not be run in time. The assessment of the Greater North Sea omits all data from the Skagerrak and Kattegat submitted in 2015 by Denmark and Sweden, as well as data for the Norwegian and Danish North Sea Coasts that were submitted by Norway and Denmark in 2015 (but includes the Danish Wadden Sea). In 2014, no data were made available for OSPAR IV-Bay of Biscay and Iberian coast; France did submit breeding counts in 2015, but unfortunately these are not included in this assessment. No data on non-breeding birds have yet been submitted by France. No data on breeding or non-breeding birds have been submitted yet by Spain and Portugal (including the Azores in Region V-Macaronesia).

The analytical problems encountered by the UK lead meant that ToR b was not completed for B1, despite Norway submitting both breeding and non-breeding data from the Norwegian Sea and Barents Sea (including Svalbard and Jan Mayen).

An updated assessment that uses all available data is planned for spring 2016.

The assessments for indicators B1 and B3 are in Annex 6 and 7, respectively and were presented by the JWGBIRD OSPAR chair to OSPAR's ICG-COBAM on 1 December 2015, at their meeting in London, as papers: ICG-COBAM(3) 15/04/01 Add.10 and 15/04/01 Add.04. They will subsequently be submitted to OSPAR's Biological Diversity Committee in March 2016. These two indicators will contribute to the OSPAR Intermediate Assessment 2017 (IA2017). The results of the IA2017 will be used by EU Member States in their assessments of Good Environmental Status (GES) under Article 8 of the Marine Strategy Framework Directive (MSFD).

Annex 8 and 9 contain the technical specifications for indicators B1 and B3 respectively, which are now presented as OSPAR CEMAP Guidelines (Coordinated Environmental Monitoring and Assessment Programme). These are in a format specified by OSPAR and contain details on how each indicator will be constructed and assessed. These CEMAP Guidelines were created from previous technical specifications developed by JWGBIRD (see ICES, 2015) in order to incorporate additional information as requested by OSPAR.

The data collation and analysis underpinning the testing of each indicator were conducted by the British Trust for Ornithology (BTO) under contract to the OSPAR Commission and funded by the UK Government (Department for Environment, Fisheries and Rural affairs-DEFRA) and the Schleswig-Holstein State Government, Germany. The assessments were drafted by the OSPAR chair of JWGBIRD and amended and improved by JWGBIRD, who also designed the presentation of results.

2.2.2 Summary of assessment of indicator B1–Marine Bird Abundance

This indicator describes changes in abundance of breeding and non-breeding marine birds, i.e. birds relying on marine food resources. Birds are a highly visible component of marine ecosystems. Collectively, these species represent a variety of feeding guilds, from herbivores to top predators. Due to the long lifespan of these species, abundance changes slowly and is sensitive to a variety of pressures. The indicator and its thresholds are derived from the OSPAR EcoQO on seabird population trends as an index of seabird community health. Annual estimates of abundance of each species are compared against thresholds. For the EcoQO to be achieved, the abundance of 75% or more species needed to be above these thresholds.

The assessment was based on analyses that were conducted in 2014 as part of the process of testing the indicator (see ICES, 2015). In 2015, more recent data were submitted by some contracting parties, but unfortunately technical problems encountered by the UK lead, have meant that new analyses could not be run in time (see above). In 2014, data were submitted by CPs for the period 1980–2013. When all data from participating CPs had been collated, it became clear that variability of the quantity of data available at the beginning and end of the time-series may give an erroneous impression of species abundance in the OSPAR II subregion. For this reason, the time-series were restricted to the period 1991–2011.

In both the Celtic Seas and Greater North Sea, the proportion of species for which relative abundance was above the desired thresholds dropped below 75% in 2005 and has remained so since. Migratory and overwintering populations of waders and grazers that use intertidal areas appear to be doing relatively well. Species of seabird that breed in the two regions and can feed on fish throughout the water column are faring better than other breeding seabird species that can only feed on fish at the surface.

2.2.3 Summary of assessment of indicator B3–Marine Bird Breeding Success/failure

2.2.3.1 Background

This indicator describes changes in breeding failure rates in marine birds, defined as the failure of a colony to produce on average at least 0.1 chicks per breeding pair, clutch or nest per year. The indicator is derived from annual data on mean breeding success (number of chicks fledged per pair, clutch or nest) of marine bird species at colonies throughout the NE Atlantic.

As long-lived species with delayed maturity, changes in productivity of marine birds are expected to reflect changes in environmental conditions long before they are evident as changes in population size.

The failure rate of seabirds could be a valuable indicator of GES achievement, especially in areas where fisheries and seabirds target the same prey. The indicator could also provide evidence of other impacts, from e.g. human disturbance, contaminants and predation by invasive species.

This assessment will determine how frequently widespread breeding failures in marine birds occur. The spatial extent of failure will be assessed for each species and year by the proportion of colonies that fail. If widespread failures occur in more than three years out of six, the cumulative effect of successive failures is likely to have a significant impact on recruitment into the regional population.

Separate assessments were carried out for OSPAR regions I-the Arctic, II-the Greater North Sea and III-the Celtic Seas. (No data were provided by contracting parties in OSPAR Regions IV-Bay of Biscay and Iberian Coast, and V-Macaronesia).

2.2.3.2 Assessment thresholds for widespread breeding failure

In a given year, colony failure is considered to be ‘widespread’ if the annual colony failure rate (i.e. percentage of colonies failing in each region) of a species exceeds one of the two thresholds below, depending on the species (see Figure 1):

i) mean percentage of colonies failing per year, over the preceding 15 years;

ii) 5% of colonies failing per year.

The aim of identifying widespread breeding failures is to differentiate large-scale anthropogenic impacts from local problems, where only a small proportion of colonies fail per year. The above thresholds were taken from Cook *et al*. (2014), who tested various target thresholds on each species indicator of annual colony failure rate. A different threshold was applied to the breeding failure rate of terns because they often desert colonies, sometimes before laying, in response to local disturbances or impacts on food supply (Shealer and Kress, 1991; Holt, 1994; Cook *et al*., 2011). The threshold for terns is designed to identify years of unusually high rates of breeding colony failure.

A fixed threshold of 5% was appropriate to species, which do not tend to desert colonies *en masse* in the same way as terns use colony desertion as a life-history strategy. Years in which colony failure rate is more than 5% are much rarer in other species and therefore provide a good indicator that pressures may be impacting on the population.

Cook *et al*. (2014) proposed using the threshold used for terns (i.e. mean percentage of colonies failing per year, over the preceding 15 years) to assess breeding failure in other species if it is greater than 5%. When JWGBIRD examined the species-specific colony failure rates (e.g. Figure 1), it was apparent that for all species, except terns, no colonies would fail in most years and that failure rates of over 5% of colonies were significant events. The use of a threshold derived from mean breeding failure rates would risk assessing some years as ‘normal’, in which more than 5% of colonies have failed and were clearly not typical of ‘normal’ conditions.

JWGBIRD recommend the following application of thresholds of colony failure rate, which are included in the assessment of indicator B3 (see Annex 7) and in the CEMAP Guidelines for B3 (see Annex 9):

i) for all tern species, use the mean percentage of colonies failing per year, over the preceding 15 years;

ii) for all species (except terns), use 5% of colonies failing per year.

2.2.3.3 Results of assessment breeding failure

The proportion of species that have not experienced widespread colony failures in more than three of the previous six years declined in all three regions during 2009–2014, but improved during 2013 and 2014. The declines in the Celtic Seas and Greater North Sea were much greater for surface feeders than for water column feeders. The declines in the Arctic were similar for both functional groups.

During 2009–2014, widespread colony failures had occurred in four years or more in 44%, 40% and 22% of seabird species assessed in the Norwegian part of OSPAR I, in the Greater North Sea and in the Celtic Seas, respectively. In the North Sea and Celtic Seas these species were all surface-feeders, as opposed to water column feeders. This would suggest the availability of small forage fish species (e.g. lesser sandeel, sprat) at the surface is limiting the breeding success of some species (e.g. black-legged kittiwake). In the Norwegian Part of OSPAR I, an equal number of surface-feeders and water column feeders exhibited widespread breeding failures, suggesting that the availability of prey fish (e.g. 1-year old cod) may be low throughout the water column in some areas. Drivers of food availability are likely to be ecosystem-specific changes, possibly initiated by past and present fisheries in combination with climate change.

In all regions, breeding failure, particularly at tern and gull colonies, has been caused by predation and disturbance from avian predators (e.g. other seabirds, common raven, white-tailed eagle) and from invasive native mammals (e.g. red fox) and non-native mammals (e.g. American mink).

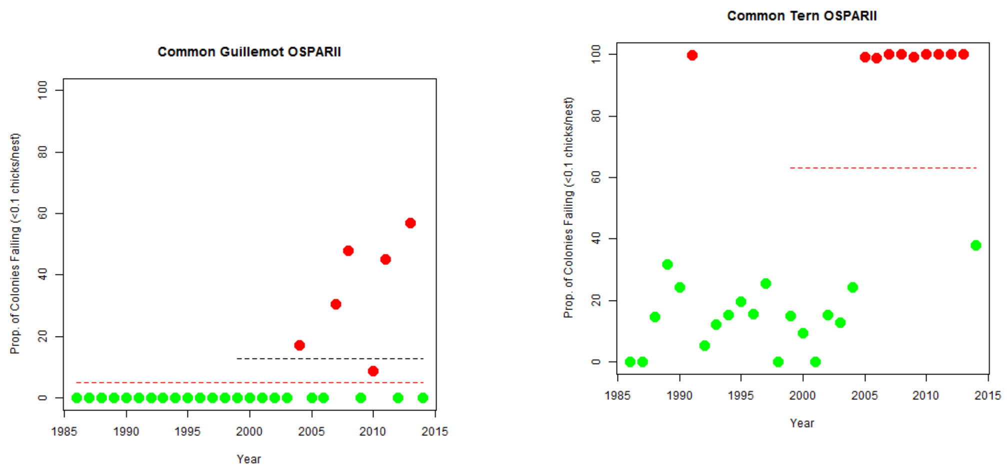

Figure 1. Examples of species-specific indicators of annual colony failure in relation to different thresholds, for a) Common guillemot and b) Common tern in the Greater North Sea 1986–2014. Thresholds are shown as red dotted lines. The threshold for tern species is the mean percentage of colonies failing per year, over the preceding 15 years. The threshold for all other species (except terns) is 5% of colonies failing per year. The black dotted line denotes the mean percentage of colonies failing per year, over the preceding 15 years, where this is not used as the threshold. All values below the threshold are coloured green and all those above are coloured red and indicate 'widespread breeding failure'.

2.3 Development of HELCOM bird abundance indicators (ToR c)

2.3.1 Introduction

Within the framework of indicators to assess the environmental status of the Baltic Sea and to be used for HELCOM Holistic Assessment 2 (HOLAS 2) and Marine Strategy Framework Direction (MSFD), two core indicators dealing with the abundance of waterbirds have been developed in HELCOM CORESET I and II. One indicator follows the abundance of breeding waterbirds, the other addresses the abundance of wintering waterbirds. By using data of coastal waterbirds from the International Waterbird Census (IWC) for the period 1991 to 2010, an assessment of the latter category has been carried out, but due to lack of available data an analysis of the abundance of breeding birds is still to be accomplished. The respective reports (HELCOM 2015a, 2015b) can be found at http://helcom.fi/baltic-sea-trends/indicators/.

However, though the structures of the indicators are nearly accomplished and widely accepted, some details regarding the concepts remained open. Discussions under this ToR were aimed at finalizing the selection of waterbird species for the two abundance indicators and their classification according to functional groups. Another conceptual issue was the geographical level on which assessments should be conducted, as so far there has been no decision about the assessment units to be used.

The ToR c session also addressed technical issues related to data and timelines. Progress made in the development of the two core indicators will be included into updated versions of the reports due 2016.

2.3.2 Indicator concepts

2.3.2.1 Species to include in the abundance indicators

As the aim of the indicators is to assess the status of the Baltic Sea, the selection of species should consider where the birds are actually foraging. For breeding birds this means that the preference should be for species foraging at sea or in habitats influenced by the sea such as beaches and coastal marshes, whereas other species (i.e. breeding coastal but foraging inland) can reflect biodiversity. For the two indicators a pragmatic approach of considering a large number of species appears to be of advantage, because the assessments are less vulnerable to outliers, and robust assessments will be possible also on the scale of countries or other subdivisions (see below). At the same time, it is ensured that from a national perspective the species information is correct and accurate. Further, if assessments are conducted for functional groups separately, the analysis of each group can be built on a relatively large number of species. Again, a split-up to subdivisions would be more critical if restricted to very few species.

For species residing in the Baltic Sea throughout the year, it is relevant to consider them in both the breeding and the wintering period. Although this type of monitoring may not provide more accurate information about the total abundance of the species, it provides relevant information about the status of the sea area where the individuals occur. For example, the population sizes of auks are preferably monitored at the few breeding colonies in summer, whereas winter abundance in given marine areas elsewhere can contribute to assess the environmental status of those areas.

Offshore areas in the Baltic Sea provide important overwintering areas for a number of waterbird species. To get representative data of these species, and thus a solid base for indicator calculations, offshore surveys are a necessary addition to the monitoring scheme. Most HELCOM Contracting Parties already carry out national offshore monitoring through aerial and/or ship-based surveys. During winter 2015/2016, these surveys will be conducted in a coordinated way (see Annex 10), serving as a test of a concept for Baltic-wide monitoring in future.

2.3.2.2 Composition of functional groups

Regarding functional groups and the allocation of species to them, the proposal made by JWGBIRD at their 2014 meeting (ICES, 2015) is followed, meaning that five functional groups are considered: wading feeders (walking or wading in shallow water), surface feeders (feeding in the surface layer of the sea, i.e. within 1–2 m below the surface), water column feeders (feeding at a broad range in the water column, including birds feeding on demersal fish), benthic feeders (feeding on invertebrates at the seabed) and grazing feeders (herbivores feeding in intertidal areas and shallow water) (see ICES, 2015 for more details). Though in general one species may belong to more than one functional group if it uses more than one foraging mode, no such case was identified in the Baltic, because gulls are wading feeders only in a restricted area (wind flats in the SW Baltic) and dabbling ducks are well suited in the grazing feeder group, though partly feeding on invertebrates.

Table 1 presents the composition of functional groups for both the breeding and wintering waterbird indicator in the Baltic. Note that no wading feeders are included in winter, and therefore no assessment for that group can be done for that season.

Table 1. Bird species assigned to functional groups as proposed for the breeding waterbird and wintering waterbird indicator, respectively.

Functional group	Breeding waterbird indicator	Wintering waterbird indicator
Wading feeder	Common shelduck Eurasian oystercatcher Pied avocet Ringed plover Dunlin	NA
Surface feeders	Arctic skua Arctic tern Common gull Great black-backed gull Herring gull Lesser black-backed gull Little tern Caspian tern Sandwich tern Common tern	Common gull Herring gull Great black-backed gull
Water column feeders	Great crested grebe Great cormorant Red-breasted merganser Razorbill Common guillemot Black guillemot Goosander	Red-throated diver Black-throated diver Great crested grebe Red-necked grebe Slavonian grebe Great cormorant Goosander Red-breasted merganser Smew Razorbill Common guillemot Black guillemot
Benthic feeders	Tufted duck Common eider Velvet scoter	Common pochard Tufted duck Greater scaup Common eider Steller's eider Long-tailed duck Common scoter Velvet scoter Common goldeneye
Grazing feeders	Mute swan Barnacle goose Greylag goose	Mute swan Whooper swan Eurasian wigeon Eurasian teal Mallard Northern pintail Common coot

2.3.2.3 Assessment units

HELCOM assessment units are defined in the HELCOM Monitoring and Assessment Strategy that was adopted at the HELCOM Ministerial Meeting in 2013. When considering all birds, the entire Baltic Sea (assessment unit scale 1) is relevant. Many marine species that feed in the marine area occur in populations that cover the entire Baltic Sea. An example of such a species is the Common Guillemot, for which the main breeding population exists on Gotland, with smaller populations for example in the Gulf of Finland and near Bornholm which are connected through immigration from the main population. For such smaller populations, evaluating breeding abundances might provide erroneous conclusions as the reason for a decline might be pressures from fishing in the Gotland Basin. Velvet Scoter and Razorbill are also examples of species for which Baltic Sea wide assessments might be relevant and could support regional assessments and conclusions.

However, when considering pressures and measures, more grouped and smaller scale results would be relevant. For bird species associated with coastal habitats, the HELCOM assessment units spanning whole sub-basins are considered somewhat problematic as different pressures may e.g. occur on the Swedish rocky coast compared to the sandy shores of the Baltic States on the opposite shore. There might be different causes for abundance declines in different areas, and necessary measures will differ accordingly. In addition, spatially more detailed results may reduce the noise in the modelling, as covariate factors need to make ecological sense (during the first analysis for the wintering bird indicator, the coastal area of each EEZ was used as the geographical unit).

In conclusion, it would be relevant to provide the large-scale key message for the whole Baltic Sea as well as more detailed regional information. The aim was to delineate areas that are of ecological relevance to wintering and breeding seabirds, respectively (e.g. regarding landscape elements such as sandy shores, deep archipelagos or rocky coasts), but likely also relate to human pressures and relevant measures. As the distributions of both waterbirds and pressures show seasonal variation, different groupings for geographical subdivisions for the wintering and breeding waterbird indicators are relevant and shown in Figure 1. Modelling exercises have to ensure that sufficient data are included in each region, meaning that the areas should not be too small. However, the proposed groupings are initial guidelines for the more detailed grouping and need national consultation to verify the borders. In this context it is worth mentioning that offshore areas have been poorly treated in part of the Baltic, meaning that some key species in the marine environment of the Baltic have failed to qualify for assessments by coastal waterbird counts alone.

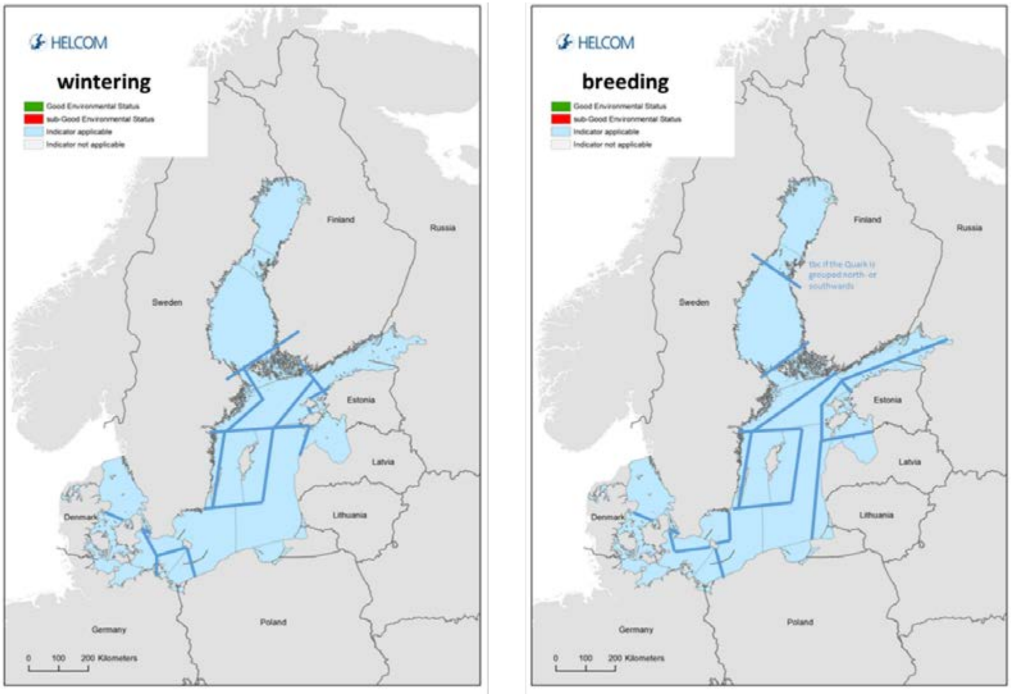

Figure 2. Proposed subdivisions for reporting the currently assessed waterbird abundance on a smaller geographical scale (blue lines) compared to the entire Baltic (light blue) as the assessment unit.

2.3.2.4 Breeding success

Following the reasoning in the OSPAR indicator B3 (Marine Bird breeding success/failure), breeding success is thought to have a high potential to indicate pressures acting on waterbirds early, while population size as measured in the abundance indicator is reacting more slowly to pressures. Since most waterbird species are long-lived, but have relatively low annual reproductive output, changes in the population size may be detected only after several years. Currently, breeding success is included as a parameter in the indicator measuring the abundance of breeding waterbirds, but in future it may appear more reasonable to develop a separate indicator.

Recently, breeding success could not contribute to the breeding bird indicator simply because there is hardly any relevant monitoring in place. Possibilities for future monitoring potentially feeding the indicator were explored in two ways. First, it was found to be useful to compile already existing studies and publications on breeding success before the next meeting of JWGBIRD in 2016. Among the few studies conducted so far, the Swedish high quality monitoring data on auks breeding on Stora Karlsö are regarded to be very important for understanding the overall bird status in the Baltic Sea as well as the links to fisheries-related pressures. Regrettably, the data are currently not available for HELCOM assessments as the monitoring has been carried out by the University of Stockholm and are not available in the national bird database. It is recommended that it should be explored whether these data can be somehow utilized in HELCOM assessments.

Second, experts present at the workshop filled in the table of information on which species in their country are already monitored, can potentially be monitored if resources are not restricting, or are impossible to be monitored. It turned out again that only few waterbirds are currently monitored with respect to breeding success, but that many appear to be suitable to serve as target species given their relevance for the assessment of pressures are identified. However, possible restrictions such as the access to breeding sites, conservation issues, bird behaviour (e.g. early dispersal of duck families) and insufficient funding have to be overcome. Table 2 shows the rating of species by country according to expected potential for breeding success monitoring.

Table 2. Waterbird species breeding in the Baltic, aggregated according to functional groups and assessed according to their potential for monitoring with respect to breeding success. A (green): monitoring already in place in part of the country; B (amber): monitoring appears possible if resources were available; C (red): monitoring not possible; blank: species not breeding in that country or no information (no data from Russia and Poland). Asterisks indicate restrictions regarding availability of data, certainty of rating and occurrence (foraging) at the coast.

	Species	DK	SE	FI	RU	EE	LV	LT	PL	DE
wading	Eurasian oystercatcher	B	B	B			B			B*
	Pied avocet	B	A			B		B*		B
	Ringed plover	B	B	B*		B	B			B
	Dunlin	C	C	C		A	B*			C
	Common shelduck	B	C	B*		B	B	B*		
surface	Arctic skua		B	B*						
	Common gull	B	B	B*		A	B*	B*		B*
	Great black-backed gull	B	B	B*		B				B*
	Herring gull	B	B	B*		B	B*	B*		B*
	Lesser black-backed gull	B	A	B*		B				B*
	Little tern	B	B	B		B	B	B*		B
	Caspian tern		A	B		B				
	Sandwich tern	B	A			B				B
	Common tern	B	B	B		B	B	B*		B
	Arctic tern	B	B	B		B	B			B
water column	Great crested grebe	B	C	B*		B		B*		
	Great cormorant	A	A	A		A	B*	B		B*
	Goosander		C	B		B	B	B*		
	Red-breasted merganser	C	C	B		C	B			C
	Razorbill	B	A	A*		C				
	Common guillemot	B	A	A*						
	Black guillemot	B	B	A*		C				
benthic	Tufted duck		B	B		B		B*		
	Common eider	B	B	B		B				B
	Velvet scoter		B	B		C				
grazing	Mute swan	B	B	B		B		B*		B*
	Greylag goose					B				
	Barnacle goose					B				

Information on breeding success could also be achieved by more general means. The Danish survey of wings from quarry species gives information on age and sex ratio for a number of waterbirds. The idea to collect more generic data by use of digital images of flocks of flying long-tailed ducks, as used in Sweden, reveals possibilities to address the breeding success question even for species that either entirely or mainly breed far from the Scandinavian countries. The image-based sexing and ageing approach could potentially be extended to inform about annual breeding success, even for species other than long-tailed duck. Though information on breeding success outside the Baltic would not give information on pressures acting in the HELCOM assessment area, it could support interpretation of results obtained from the monitoring of wintering bird abundance.

2.3.3 Technical indicator discussion

Due to currently restricted availability of data, it was not possible to provide updated results for the HELCOM waterbird abundance indicators at this time. In order to ensure timely updates for the purposes of the HOLAS II, the experts decided to focus on clarifying exactly which steps are needed to be taken in each country to make the needed data available. This includes providing older data (especially those from 1991 to 2000) needed as reference values. In general, for the breeding bird indicator the data availability issues are more severe than for the wintering coastal counts. Offshore counts of wintering birds (aerial and ship-based surveys) have so far not been considered, but are planned to be included into assessments in the near future.

Following up work in HELCOM BALSAM (see Section 2.4), data arrangements for the waterbird abundance indicators will be developed in HELCOM BalticBOOST, a project released in October 2015 in order to stimulate regional coherence of marine strategies. Breeding bird data may be held in a database similar to that of OSPAR bird indicators, and coastal waterbird data (IWC) are currently stored at Wetlands International. Regarding offshore surveys, BalticBOOST also focuses on a database structure similar to the ESAS database. An extended version of this structure has already been proposed in HELCOM BALSAM (see Annex 11, see also Table 3). It was considered whether a geo-database would be a suitable format rather than tables and shapefiles.

For discussions on general questions of data handling and data holding see Section 2.1. Experts noted that the HELCOM data and information strategy guide the work on data issues related to indicators and assessments. The strategy aims to facilitate public access to environmental data, and thus data underlying assessments should be made available. However, JWGBIRD experts highlight that problems may arise concerning the public access data sharing policy of HELCOM, because both wintering and breeding waterbird abundance indicators are based on data partially or mostly originating from volunteers and NGOs rather than publicly funded monitoring programmes. Using only data collected within state funded monitoring programmes would leave these indicators almost without data and their calculation would not be possible. Pre-processed data are not a suitable solution, because raw data are needed for the analyses. Using privately owned raw data in the indicator evaluations is therefore considered necessary from an expert point of view, and further discussions are needed on how these data are to be covered by the HELCOM data and information strategy. National considerations will be needed and discussions on an appropriate level of aggregation of data (e.g. spatially) are foreseen as necessary on this point.

2.4 HELCOM monitoring guidelines (ToR d)

Monitoring guidelines for open sea monitoring in the wintering period have been developed in HELCOM BALSAM, which included two workshops of HELCOM bird experts (May 2014, Tallinn; January 2015, Jurmala). These guidelines were presented to HELCOM State & Conservation 2-2015, and after comments by Germany and Sweden have been incorporated, the final guidelines have currently been presented to HELCOM State & Conservation 3-2015 for adoption. At the JWGBIRD 2015 meeting, no further amendments were proposed. The final version of the guidelines is included to this report as Annex 11. Development of a data model was initiated in BALSAM, and building on this experience a proposal was now presented (Table 3), discussed and supported by JWGBIRD members. It will be further developed in the HELCOM coordinated project BalticBOOST, work package 1.2.

Table 3. Extended ESAS database structure for offshore surveys as proposed in HELCOM BALSAM. Additions to the original ESAS structure are marked in red.

Trip table	Position table	Bird table	Abiotic table
Tripkey	Poskey	Species_key	Object_key
Year	Tripkey	Poskey	Poskey
Month	Time_hour	Transect	Object_type
Day	Time_minute	Euring_species_code	Number_of_objects
Base_type	Time_second	Number_of_birds	Distance_km
Platform_code	Latitude	Distance	Side_of_base
Transect_width	Longitude Transect_ID	Activity (behaviour)	Activity_of_object
Cruise_key	Area_surveyed (km²)	Age_class	Direction_of_travel
Route	km_travelled	Age_year	Direction_of_travel_type
Count_type	Seastate	Plumage	Direction_obs_plattform
Species_observed	Visibility	Sex	Ship_followers
Use_of_binoculars	Glare	Group	Notes
Behaviour_type	Sun_angle	Direction_of_travel	
Set-net_count	Cloud_cover	Prey	
Ship_count	Precipitation	Association	
Base_side	Ice	Behaviour (detailed)	
Origin	Notes	Notes	
Direction_of_travel_type			
Number_of_observers			
Observer1			
Observer2			
Observer3			
Notes			

During the work on the monitoring guidelines in BALSAM, it was agreed to establish a coordinated offshore winter survey, because a number of waterbird species so far were monitored incompletely (including key species such as long-tailed duck, common scoter, velvet scoter, divers, auks and little gull). The plan was brought forward after the BALSAM project, and the JWGBIRD meeting was used to discuss details for the survey, which will be conducted by aerial surveys in most countries (Denmark, Sweden, Finland, Estonia, Latvia, Germany) and by ship-based surveys in Poland (participation of Lithuania pending decision). The aim is to interchange available aircrafts and observers between countries in order to survey those parts of the survey area offering suitable weather conditions as efficiently as possible. More details on the coordinated survey are shown in Annex 10.

Although various national offshore monitoring schemes are in place, the aim is to carry out coordinated Baltic-wide winter surveys in future. To ensure a smooth coordination, efforts should be tied to a specified coordination platform, for example in HELCOM the Working Group State and Conservation, which is responsible for issues related to monitoring and could be supported with expert input from JWGBIRD. However, funding of surveys will come from national authorities, and it should be strived for to have all relevant national authorities connected to such a coordination platform. As the winter survey 2015/2016 provides a detailed concept, additional funding, for example by EU, should enable building up a coordinated international monitoring scheme and carrying out joint analyses of the data derived.

2.5 References

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3 Strategic studies of seabird ecology in relation to offshore windfarm impacts

Term of reference e): Review strategic studies of seabird ecology in relation to offshore windfarm impacts.

Scientific justification: There is an urgent need to fill key knowledge gaps regarding impacts of offshore wind on seabird populations, and to promote establishment of strategic monitoring studies that will quantify population-level impacts. The rapid increase in numbers of consented offshore windfarms and plans for further development make such work urgent, and important in the context of seabird conservation as well as helping to inform industry about how to reduce consenting risk and to develop in locations and with designs that minimize hazard to seabirds. The group will also have the benefit of a report prepared following the Inter-governmental Workshop in London in September 2015.

3.1 Introduction

Under ToR (e) JWGBIRD aims to identify critical knowledge gaps for key species, and research that could be commissioned to fill those knowledge gaps.

The Working Group held a plenary session on this ToR from 0900–1100 on Tuesday 10 November, a Skype meeting with experts unable to attend in person from 1400–1500 on Tuesday 10 November, and a wrap-up plenary session from 1630–1800 on Wednesday 11 November. Discussion focused primarily around a few species identified as high priority as they are known to be vulnerable to the impacts of offshore windfarms either through collision mortality (great black-backed gull, northern gannet, lesser black-backed gull, black-legged kittiwake) or through displacement effects (red-throated diver, auks). These species were used to explore issues that apply also to other species and are not the only species for which strategic research projects will ultimately be identified.

The background to this ToR has been two separate but complementary projects: Bob Furness has been reviewing key knowledge gaps for southern North Sea offshore windfarm developers with projects in UK waters, and Sue O'Brien has been working on trans-boundary issues relating to seabirds and offshore windfarms throughout the North Sea as part of ongoing Intergovernmental Workshops. Discussions at JWGBIRD will also help to shape both of those processes.

The discussions were aimed at identifying strategic ecological research projects that would add to existing evidence on the impacts of offshore windfarms on birds. The group only considered ecological work and did not consider areas that could be considered to be policy, e.g. what an acceptable change to a population impacted by offshore windfarms might be.

The group noted that offshore windfarms may also impact migrating passerines and bats, but that further consideration of this was beyond the scope of this ToR and membership of JWGBIRD.

Despite the focus of this ToR on the North Sea, delegates present made the point that offshore windfarms are likely to be developed in the Baltic Sea in future, and therefore that there is considerable interest in identifying key knowledge gaps relating to important species in the Baltic such as common scoter and long-tailed duck.

Key evidence needs relating to impacts of offshore windfarms on seabirds have previously been listed by the Intergovernmental Workshops and associated stakeholder consultations, and, as a convenient introduction to evidence needs, those are summarized in Table 1.

Table 1. High-level evidence needs and questions relating to marine birds (seabirds, divers and seaducks) and offshore windfarms, collated from and agreed by delegates at the 2nd InterGovernmental Forum workshop.

Question related to offshore wind energy development	To answer this we would need a better understanding of…	Evidence need: More information is required on…
What are transboundary cumulative impacts from offshore windfarms (OWF)?	Numbers of birds using different sea areas at different times of year and consistency in distributions across years, defining populations at a regional scale as basis for assessment of cumulative transboundary effects	More up to date information on bird distributions and numbers covering large sea areas – monitoring at scale of individual windfarm developments is too small to quantify cumulative trans-boundary impacts.
		Better quantification of impacts of offshore windfarms on birds (see below).
	Large-scale seasonal movements of birds and drivers of those movements (e.g. prey availability, weather conditions).	Movements of birds, e.g. tagging studies, stable isotope analysis, etc. but with studies carried out in a coordinated strategic manner across multiple locations.
		Concurrent information on potential covariates, e.g. sea surface temperature, prey, etc.
	Meta-population dynamics, e.g. natal dispersal, interannual movements between colonies of breeding birds.	Large-scale tagging and ringing studies at multiple locations concurrently, e.g. colour-ringing.
	(Meta) population sizes of relevant bird species, as well as estimates of (meta) population parameters such as reproductive success, mortality, life expectancy, etc.	As complete as possible data on demographic parameters of the relevant species for the populations frequenting the North Sea.
What are the impacts of OWF relative to other causes of population change, e.g. climate change?	Population-level consequences of climate change and an understanding of mechanism, e.g. change in prey availability reduces productivity.	Baseline information on population size, demographic rates and information on how these change with variables such as SST and prey.

Question related to offshore wind energy development	To answer this we would need a better understanding of...	Evidence need: More information is required on...
How many birds die from collisions with OWF?	Rate of collisions or an estimate from collision risk models.	Year-round species-specific empirical data across multiple sites and species for parameters that are used in collision risk modelling, especially those parameters that models are most sensitive to.
		Improved and tested technology to directly measure species-specific collisions as a proportion of birds using the area and to validate collision risk model estimates.
		The ability to assign collision mortalities to the appropriate relevant population exposed to collision risk.
Do displacement and barrier effects occur (not known for all species) and, where it is known to occur, what are the population level consequences of displacement? Does habituation occur and if yes, does it bring incidental benefits, e.g. increased prey availability within OWF resulting in increased survival rates?	Displacement rates, models to quantify energetics of displacement and impacts at population level.	Better quality year-round information across multiple sites and species on displacement rates plus long-term studies to quantify habituation. Studies dedicated especially to establishing possible changes in seabird abundances/densities inside and outside windfarm areas for species still considered to avoid windfarms.
		Energetic costs of displacement/barrier effects (e.g. reduced prey intake, longer foraging trips) and consequences on productivity and survival rates.
		Empirical data to reduce uncertainty in models to estimate displacement impacts (e.g. Chris Toppings' agent-based model).
		Interaction effects across industries, e.g. gulls attracted to fishing vessels that are not permitted to enter OWF resulting in apparent displacement from OWF but no change in species' energetic budget.

Discussions focused on a few species but are presented here under four themes: demography, population modelling, displacement and collision. It should be emphasized that these four themes are not mutually exclusive. For example, it would be appropriate to undertake studies that both estimate the effects of displacement and/or collision on demographic rates and construct population models using these demographic rates. The research ideas presented below are suggested research projects and do not represent a comprehensive list of future research projects. Further work will be needed to identify a complete list of potential projects for all relevant species. A process for identifying priority research is also required. In particular, the group recognized that there may be merit in developing new methods through studies focused on a common seabird species with well-known ecology, although the key issues may relate to species that are more difficult to study and lack data; this may be particularly relevant to modelling work where models may best be developed and parameterized for common species before being applied to data-deficient species.

3.2 Demography including population abundance and movements

3.2.1 General discussion

- Impacts of offshore windfarms may be especially strong where these are located close to seabird breeding colonies. However, with the focus of this project including trans-boundary effects we have particularly emphasized cases involving non-breeding seabirds, which are especially difficult to study and where there are many knowledge gaps.
- Better estimates of adult survival of northern gannet are needed and could be relatively easily obtained through colour ringing studies. If birds are ringed as chicks, with enough effort at a sufficient number of colonies, a better idea of immature survival rates and inter-colony movements would also be obtained. This information would be particularly useful for meta-population modelling, but could also permit analysis of survival rates of adults at colonies differing in exposure to collision risk. Evidence that survival was reduced at colonies where adults are assessed to be at high risk of collision compared to birds at colonies distant from offshore windfarms would provide evidence of a population-level effect, whereas no difference in adult survival among colonies differing in exposure to this risk would suggest that offshore windfarm impact on survival was unlikely to have a population-level impact on this species.
- The point was made that birds carrying devices, such as GPS tags, should ideally be ringed for mark-recapture studies to quantify survival rates. However, since birds with devices might have reduced survival rates, it is appropriate that they should be included for survival analysis in subsequent years (i.e. excluding the year(s) of device deployment until device removal). For them to be considered in survival analysis in the current year, there should be strong evidence that the device has not had any effect on the bird’s state including breeding performance. This could be the case where deployment duration is short, device size and shape small relative to the bird and the species in question responds well to handling and device attachment.
- There was discussion around the impact of geolocators on survival, and agreement was reached that individuals carrying geolocators incorporated into a ring could be included in survival analyses providing appropriate

studies of geolocator effects were carried out. Whereas there is always a chance that the ring reduces a bird's survival probability, the addition of a geolocator to a ring might reduce this probability further since the mass and drag increases. Therefore, it is recommended that parallel colour-ringing is carried out so that the survival of those carrying rings and rings plus geolocators can be compared. This would allow long-term data on an individual's movements and survival to be obtained concurrently and would be especially useful for immature life stages. Attaching colour rings and geolocators to chicks with the aim of recapture as breeding adults is most likely to work for birds that breed in relatively few places that are accessible, and show high natal philopatry, otherwise finding birds carrying tags after several years will be almost impossible. However, some success with this has been achieved with black-legged kittiwakes, despite their relatively low level of natal philopatry.

- For red-throated diver, two key questions were raised. Is the non-breeding season red-throated diver population in the southern North Sea spatially structured by breeding site origins? What are the spatio-temporal patterns in red-throated diver use of the North Sea and Baltic?
- The group discussed red-throated diver movements and ecology in detail. We identified six possible periods during a year for red-throated divers, and noted how likely birds were to be remaining in an area for most of that period or moving through an area quickly: breeding season (static), autumn passage (rapid movement), post-breeding moult (static), winter (semi-static), pre-breeding aggregation (static), spring passage (rapid movement).
- The extent to which individuals are static during a period will influence how vulnerable they are to displacement from an offshore windfarm. The group noted that away from the breeding sites, the post-breeding moult period could be the most vulnerable period of the year for this species, when birds have a reduced flight capability but have high energetic demands. At present, we have a poor understanding of where post-breeding moult occurs for this species.
- The group also discussed individual site fidelity in winter, with some limited evidence of individuals returning to the same locations on subsequent winters. This would imply there is some benefit to having local knowledge, suggesting that individuals might find foraging in novel areas more difficult.
- There was discussion around the benefits of geolocators vs. implanted GPS tags (red-throated divers are not suited to harnesses) to better understand red-throated diver movements and the origins of birds occurring in areas with many offshore windfarms. Geolocators are generally considered to be much less intrusive than GPS tags but provide less precise data on a bird's location. Additionally, the individual needs to be recaptured to retrieve the data, meaning that birds on wintering locations cannot be tagged with any realistic expectation of tag recovery. However, geolocators work well for birds caught at breeding sites and have been demonstrated to be an effective tool for looking at red-throated diver movements. Attaching geolocators at breeding sites is unlikely to be feasible across the full biogeographic range for this species as it extends at least from west Greenland to Siberia and potentially further. However, this may not constitute a fun-

damental problem if studied colonies were representative of the wider population range. Furthermore, the group agreed there was merit in using a mix of both methods. Tag technology development is also likely to allow GPS tags to be deployed over similar periods of time to geolocators but with significantly greater location accuracy, and remote data download.

- Stable isotope analysis could also provide insight into the origins of birds using the southern North Sea, without the need for tagging. In particular, stable isotope analysis would be useful for identifying post-breeding moult locations, something which is currently not well known. Analysis of the ratios of stable isotopes in a feather sample can indicate the geographic region in which the bird was when that feather was grown (the breeding grounds in the case of juveniles, moulting grounds in the case of adults). The difficulty is calibrating measures, which requires obtaining feathers from individuals of known origin. The group briefly discussed how to calibrate a stable isotope study. Feathers from breeding birds across the range might be needed, but obtaining such samples might be feasible. Sampling feathers from birds equipped with geolocators can be used for calibration, as has been done successfully for several other seabird species. Another approach is to use museum specimens of known origin. Due to climate change and other factors, certain isotope signatures from museum specimens might be misleading. Existing data from other bird species may already be adequate to provide a suitable 'isoscape' for use with red-throated diver samples.
- During winter of 2015/2016 coordinated joint national surveys of divers and seaducks are being undertaken in the Baltic by Denmark, Germany, Poland, Estonia, Latvia, Sweden and Finland as well as some survey of the North Sea. These surveys will be very useful for giving a snapshot estimate of total abundance of a species using a sea area. Post-consent monitoring obligations for offshore windfarm developments may be better targeted at similar large-scale coordinated strategic monitoring rather than monitoring of a specific development area. However, repeated monitoring of smaller areas, such as a development area, provides valuable information on temporal patterns in abundance that a single snapshot does not have, but of course tell us nothing about connectivity to protected sites or meta-population dynamics.
- Sea watching programmes (e.g. in Estonia, and data coordinated by Trektellen) also provide useful additional information on bird movements.

3.2.2 Possible research projects

Question: What are the cumulative impacts on seabird populations from offshore windfarms? To answer this we would need better knowledge of numbers of birds using different sea areas at different times of year and consistency in distributions across years, defining populations at a regional scale as a basis for assessment of cumulative transboundary effects and better data on survival rates of birds in populations thought to be affected by offshore windfarm impacts.

Species	Evidence need	Research idea
Northern gannet, Great black-backed gull	Improved understanding of baseline population demography to be able to assess population-level consequences of OWF impacts	Improved estimates of adult survival rates through colour ringing studies at several colonies. With sufficient effort at enough colonies, could also look at inter-colony movements among individuals, including colonies throughout Europe.
Northern gannet, possibly also gulls, auks, black-legged kittiwake	Improved understanding of baseline population demography to be able to assess population-level consequences of OWF impacts	Attach geolocators integral to a ring to a chick and then recapture it as a breeding adult several years later. Provides data on both movements and survival for juvenile/immature life stages which are currently poorly understood.
Great black-backed gull	Improved understanding of individual movements to understand cumulative risk and exposure of population to OWF impacts.	Attach GSM/GPS tags with harnesses to breeding adults for year-round detailed movement patterns. But, in case birds' behaviour is influenced by harnesses (e.g. less pelagic), also attach geolocators to get coarser picture of movements.
Red-throated diver	Improved understanding of individual movements to understand cumulative risk and exposure of population to OWF impacts.	Attach geolocators and (implanted?) GPS tags on breeding and wintering grounds, respectively, to better understand movements. Implanting GPS devices may not be the only option. FastLoc technology can deliver GPS fixes from very short duration exposures, and so ring mounted tags may have the potential to register accurate locations even for birds that spend the majority of the time swimming http://www.pathtrack.co.uk/Site/Fastloc.html, although leg mounting on divers may not be a practical solution and would need careful assessment.
Great black-backed gull	Improved understanding of non-breeding season populations and sources of birds for improved assessment of designated population impacted by OWF developments.	Coordinated ringing/ colour ringing/ geolocator deployment across potential source breeding populations (Scandinavia, Russia), alongside colony censuses.
Red-throated diver, seaducks, auks	Improved understanding of population size and distribution for improved assessment of population impacted by OWF developments.	Carry out coordinated aerial surveys across multiple countries concurrently, such as being undertaken in the Baltic in the 2015/16 winter, but covering the North Sea too. Ideally, such studies would be coordinated with tracking of individual birds as these complementary approaches used together would give much stronger insight into patterns and process.
Red-throated diver, gulls	Improved understanding of individual movements to understand cumulative risk and exposure of population to OWF impacts.	Stable isotope analysis of individuals in southern North Sea to infer their origin. Would require calibration through feather samples from known breeding locations and/or museum specimens. Proxy species could also be used for calibration.

Species	Evidence need	Research idea
Little gull	Improved understanding of individual movements to understand cumulative risk and exposure of population to OWF impacts.	Attach geolocators on breeding adults in colonies closest to the North Sea in order to assess seasonal movement patterns of this species and likely colonies of origin of birds occurring in different regions during migration and in winter.

3.3 Population modelling

3.3.1 General discussion

- Potential to build comprehensive models that incorporate other drivers of population change, e.g. climate change, bycatch, fisheries. Modelling would be highly challenging (model structures incompatible, e.g. individual-based models vs. age-structured population models) and there may be a severe lack of data on some aspects, but modelling was recognized as a very important component of the research needs to fill key gaps.
- Meta-population models would be very useful as they are more biologically realistic than the current process of modelling individual colonies as closed populations. They would also allow processes such as density-dependence to be modelled at a more biologically relevant scale. However, these models are data-hungry and would require information on emigration/immigration, natal dispersal, and migration as well as other demographic data. This approach might work best for northern gannet, with relatively few colonies and movements reasonably well understood, but also has potential for large gulls and auks. For species with many colonies or non-colonial breeding, a meta-population model becomes much more challenging. However, there is no requirement when constructing a meta-population model that all subpopulations are sampled; rather, it is important that study subpopulations are representative of the meta-population as a whole, so there may be opportunities for models even with such species.
- A previous paper explored meta-population modelling for seabirds (Matthiopoulos *et al*., 2005).

3.3.2 Possible research projects

Question: What are the cumulative impacts from offshore windfarms? Modelling to address this question needs to take account of known ecology of seabirds, specifically the fact that colonies are not closed populations but show meta-population dynamics. Models are needed to assess impacts in relation to the meta-population structure of seabird populations.

SPECIES	EVIDENCE NEED	RESEARCH IDEA
Northern gannet	Modelling of impacts of OWF on populations at relevant scale and with relevant population processes.	Meta-population model – consider movements of individuals between colonies during breeding season and non-breeding season. For this species, there would also be a need for colony-specific demographic data.
Other breeding species	Modelling of impacts of OWF on populations at relevant scale and with relevant population processes.	Meta-population model – could attempt to build model with main purpose being to identify where lack of empirical data is biggest problem, thereby informing future research projects.
Black-legged kittiwake, common guillemot	Understanding of the relative impact of OWF compared with other drivers of population change, particularly for management of pressures.	Comprehensive population model that considers various drivers of population change, particularly climate change.
All species	Estimates of combined cumulative effects over relevant scales.	Develop framework to estimate and combine effects from different sources (collision, displacement, etc), WFs, sectors, regions, etc.

3.4 Displacement and barrier effects

3.4.1 General discussion

- Displacement might be better described as 'habitat loss', as this terminology is more widely understood, though this term would exclude the consideration of barrier effects which may be of greater importance in some situations than displacement. However, offshore windfarms do not necessarily result in habitat loss as local site conditions could actually improve habitat. Additionally, birds may habituate to the presence of windfarms so any habitat loss might be temporary.
- It was recognized that mapping of the nonbreeding season seaduck and diver distributions in the Baltic could allow Marine Spatial Planning to establish potential offshore windfarm zones in the Baltic Sea that minimize the risk of impacts on these internationally important populations by avoiding areas of key habitat for these birds (noting for example the red-listing of red-throated diver by HELCOM).
- The group considered whether ecological principles could be used to assess the likelihood of a species/population being adversely affected by a development, e.g. ability to exploit alternative prey species, ability to move to new areas, mobility of prey species (with inference that the prey also could be displaced outside the windfarm). To some extent these factors are already incorporated into current assessments of the sensitivity of different species to displacement. Also, this framework would not permit a quantitative assessment of the impact of a development on a population, which is required under European legislation.
- Individual-based models are probably the only way to explore the energetic (and potentially fitness) costs of displacement and/or barrier effects. For harbour porpoises, empirical data are being collected to parameterize displacement models. The same has already been done in seabirds during the

breeding season, and this could be extended to year-round energetic modelling to investigate cumulative, transboundary effects of displacement. Models for seabirds built to date suggest that energy budgets are most sensitive to the travel costs associated with displacement and barrier effects, the spatial distribution of prey and assumptions about interference and competition between individuals for prey.

- There was a suggestion that it would make more sense to obtain a better understanding of how displacement/ barrier effects affects populations for a better-studied, more tractable species such as common guillemot, rather than on difficult to work on species such as red-throated diver. However, red-throated diver has proven to be an issue with consenting windfarms (several developments not gone ahead due to this species), whereas no offshore windfarm development has been stopped due to common guillemot, to our knowledge.

3.4.2 Possible research projects

Question: In relation to displacement/barrier effects, how can we gain an understanding of likely population-level impacts of the displacement of individual birds by offshore windfarms and associated activity?

Species	Evidence need	Research idea
Red-throated diver, seaducks, auks	Understanding of inter- and intraspecific competition for food and energetic implications of this.	Analyse aerial survey data to look at spatial patterns among individuals, using covariates, e.g. hydrodynamic models, e.g. Henrik Skov's work. How does spacing among individuals change with numbers of individuals using an area? Is there a finite maximum density at a local scale? Not immediately clear how to relate outputs from this type of modelling to parameters in displacement IBMs, but it may indicate the extent to which foraging habitat loss due to displacement may affect foraging ecology (e.g. densities being increased above optimal levels for foraging). Data suitable for such an analysis should already exist from previous aerial surveys.

Species	Evidence need	Research idea
Potentially any species, but the most likely species with data are common guillemot, black-legged kittiwake or northern gannet. Such models could be extended to red-throated diver, razorbill and other species but those would be likely to lack more of the required input data.	Quantification of the energetic costs of displacement/barrier effect of offshore windfarms through the annual cycle of individual birds, in relation to natural energy expenditures and constraints on energy budgets.	To quantify the cumulative effects of displacement and barrier effects of offshore windfarms throughout the year in seasonally mobile seabird populations, a powerful approach would be to construct energetic and demographic models that estimate time and energy budgets, and consequences on demographic rates. To build a baseline year-round energetic model requires data on the time activity budgets of individuals throughout the annual cycle. Such a model would simulate movement and foraging decisions of individual seabirds under the assumption that they were acting in accordance with optimal foraging theory. Each individual would select locations for feeding and other activities based on density maps of populations of known provenance. Year-round location and activity data are available for a number of species, though in many cases data are only available for a small number of colonies. In the absence of such data, including species where no such data exist, targeted data collection could be planned for priority species. Baseline simulations, in the absence of windfarms, can be parameterized based on these studies. Effects on survival and productivity can be estimated by using the energetic model to assess the impact upon individual mass and behaviour and then using published relationships between state and survival and between state, behaviour and productivity. The cumulative impacts of proposed windfarms could be quantified by comparing simulated values of survival and productivity in models that include multiple windfarms against baseline simulations, incorporating species and context-specific levels of displacement and barrier effects based on available evidence. These demographic rates would then be used to build population models to compare changes in population size, growth rate and other population parameters with and without the presence of windfarms (see earlier questions).

3.5 Collision

3.5.1 General discussion

- The group discussed the two potential directions for work in this area:
    - efforts to improve parameterization of collision risk models such as the Band model and/or;
    - efforts to obtain direct empirical measures of collisions.

- Given the ambitious and aspirational nature of the types of strategic projects we are aiming for in these discussions, we agreed to focus more on efforts to obtain direct empirical measures of collision. However, the two approaches are not mutually exclusive and we acknowledge that, in the short term, it will be necessary to continue using collision risk models. Studies are underway in the UK to improve the quality of flight height data used to parameterize collision risk models (e.g. study by Natural England and The Crown Estate). Given that, and that other European countries do not necessarily use the Band model, the group felt less need to identify projects to improve parameterization of collision risk models.
- Technology exists for directly measuring collisions, e.g. work underway using combined radar, cameras, and visual observers with laser rangefinders as part of the ORJIP Bird Collision Avoidance study. However, this technology may be prohibitively expensive and is in its infancy. The group considered how to encourage use of this technology and how it could be made less expensive and more widely available. It was noted that radar and camera technology is becoming more widely used in other sectors, e.g. remote monitoring of vessel activity around fish farms and offshore windfarms. The shift from ship-based surveys to visual aerial surveys and then to digital aerial surveys is analogous, with similar technological and financial limitations, but digital aerial surveys are now generally the accepted industry norm.

3.5.2 Possible research projects

Question: What approaches would be most effective in reducing uncertainty in numbers of seabirds killed by collision with offshore windfarm turbines?

Species	Evidence need	Research idea
Northern gannet, gulls	Empirical measures of collision mortality for reliable assessment of the population-level consequences of collision mortality.	We acknowledge that ORJIP BCA type studies are very useful and should be deployed more widely. In the longer term, such direct measures of collision mortality should be the preferred approach, to validate or to replace Collision Risk Modelling (CRM).
Northern gannet, gulls	Parameter values for input to Collision Risk Models (CRM)	There remains a short-term need for improved data on CRM parameters, including flight heights, flight speed and avoidance rates of seabirds at risk of collision mortality, to reduce uncertainty in CRM.

3.6 Acknowledgements

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3.7 References

Matthiopoulos, J., Harwood, J. and Thomas, L. 2005. Metapopulation consequences of site fidelity for colonially breeding mammals and birds. Journal of Animal Ecology, 74, 716–727.

4 Assessing the effects on seabirds of the new CFP Landings Obligations

Term of reference f): Design a protocol (or protocols) for assessing the effects on seabirds of the new CFP Landings Obligations. This continues on from work conducted by JWGBIRD in 2014 and could include the following:

iii) Conduct sensitivity scoring of species to reduction in food from discards (and offal) using the protocol developed by JWGBIRD 2014.

iv) Pre- and post-Obligations comparison of abundance and breeding success of those species scored as most sensitive.

v) Meta-analysis of diet studies of seabird species thought to depend largely on discards to seek species-specific, temporal and regional differences in such dependencies, to be able to predict where birds might be most affected.

vi) An inventory of the seabird colonies which may be vulnerable to the changed availability of discards to 'generalist piscivores' and studies into appropriate remedial action.

Scientific justification: The new CFP Landings Obligations will come into force for pelagic fisheries in 2015, for Baltic fisheries by 2015 and 2017 (depending on the fishery), for key demersal species (cod, hake, sole) in North Atlantic waters by 2016 and for all other commercial species in all waters by 2017. With some derogations, fishers will be obliged to land all commercial species they catch and will not be allowed to discard these species. The Landings Obligation is often referred to as the 'discard ban'. In 2014, JWGBIRD started to develop a protocol that could be used to assess the impact of the Landings Obligations on seabirds through potential changes in their food supply. ToR f) aims to continue this work.

4.1 Introduction

The adoption of the Landing Obligation set out in Article 15 of the reformed Common Fisheries Policy (Reg No 1380/2013) owes much to public pressure to end the practice of throwing marketable fish back into the sea. The Landing Obligation is only one component of the CFP reform (other key areas include managing stocks according to a maximum sustainable yield, increased regionalization, and multiyear management strategies). In the context of the CFP's objectives, the Landing Obligation is intended to have a positive impact on delivering Maximum Sustainable Yield (MSY) in fisheries by serving as a powerful incentive to fish more selectively and so pre-empt the capture of formerly discardable fish.

Under the Landing Obligation, 'unwanted catches' of quota fish may no longer be discarded, rather all the catch must be landed and counted against quota. This so-called 'discard ban' applies only to species subject to catch limits, and to minimum size limits in the case of the Mediterranean. To assist transition in the fishing sector, the Landing Obligation is being phased in over a number of years, starting on 1 January 2015 and is being implemented across all species subject to Total Allowable Catches (TACs) by 2019 at the latest.

The detailed phasing is:

1 January 2015: all pelagic fisheries, industrial fisheries (sandeel, etc.), salmon fisheries in the Baltic.

1 January 2016: demersal target species outside the Mediterranean.

1 January 2017: Mediterranean demersal target species.

1 January 2019: all other species including in the Black Sea.

The Landing Obligation is being implemented under the new process of regionalisation adopted in the CFP reform, in which Member States in each of the sea basin areas of EU waters (Baltic Sea, North Sea, Northwestern Waters, Southwestern Waters and Mediterranean Sea and Black Sea) confer to agree discard plans, in consultation with the respective Advisory Councils (ACs). By October 2015, the European Commission had adopted three discard plans for, respectively, the North Sea, Northwestern Waters and Southwestern Waters.

The Landing Obligation is applicable to 'fisheries defined by the species', i.e. it refers to certain species in certain fisheries such that the species may be discarded in some fisheries but not in others. This is decided by the regional bodies of Member States for their particular sea basin, and it is unlikely that the Commission will propose legislation concerning this. However, this legal uncertainty only applies in a transitional phase until 2019, after which the Landing Obligation will apply to all quota species and to all Mediterranean species under minimum size regulations.

These arrangements are significant in terms of the availability of discards to seabirds. Furthermore, the Landing Obligation is subject to limited derogation, notably the 'survivability exemption' allows discarding of species with high survival rates. Protected fish species (basking shark, common skate, etc.) must also be returned to the sea. There is also a small '*de minimis*' percentage of allowable discarding where selectivity cannot be improved, or where costs of handling unwanted catches are disproportionately high. Moreover, fish below the 'minimum conservation reference sizes' (fixed to protect juveniles) and not under the Landing Obligation (e.g. non-quota species) still have to be discarded.

Given that the pelagic fisheries are relatively 'clean', generating few discards, the phasing of the Landing Obligation for demersal species is key in terms of potential impact on seabirds. In practice, the phasing approach from 2016 averts any likelihood of a dramatic impact from the outset. In the North Sea, for example, and depending on mesh size, from 1 January 2016 trawlers must land saithe, haddock, plaice, common sole, hake, Norway lobster and northern prawn. Further species will be added in 2017 and 2018 to avoid the sudden addition of many species in 2019, by which time vessels have to be ready to retain everything on board. So the impact in the North Sea could potentially be much greater by 2018 when cod[1], whiting and hake will likely also come under the Landing Obligation for trawlers. Even then, the magnitude of the change will be dependent on the efficacy of enforcement offshore.

In terms of moving towards restoring the ecosystem to a more natural balance, the Landing Obligation is certainly beneficial, but it is not without potential ecological risks. First, some marine communities rely at least partly on discards and the elimination of a significant biomass of readily available food could result in energy loss and

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[1] The omission of cod from the outset is linked to the repeal of the current Cod Recovery Plan not being foreseen until 2018.

impact adversely on ecosystem functioning. Seabirds could be among the first to be adversely affected and measurably so, given the extensive use of discards by several species (Furness *et al*., 2007; Bicknell *et al*., 2013). Scavenging seabirds that are 'discard-deprived' from trawling activities might in some cases switch to preying on other seabirds (Votier *et al*., 2004), or seek alternative foraging opportunities associated with longline fishing vessels or other gears such as purse-seines, thereby risking incidental capture (see Remedial Measures, below). Second, the landing of discards will likely generate new capacity and markets for fishmeal production to meet the growing demand (notably from aquaculture) for marine resources. Although vessel owners are concerned about the constraints on storing large volumes of unwanted catches on board, new markets might potentially incentivise the capture of previously unexploited resources. This in turn heightens the need for enhanced gear selectivity to minimize the bycatch of non-target fish species (Sardà *et al*., 2013).

These concerns serve as caveats to the presumption that the 'discard ban' will have a universally positive impact on the marine environment. On the other hand, if the discard ban is accompanied by a progressive recovery of fish stocks, and not by the exploitation of new resources for fishmeal (see above), it is expected that the obligations will benefit the wider marine ecosystem and not seriously undermine seabird communities. A possible exception could be those seabird species that prey on small, low trophic level fish which could face growing competition for this common food resource from the growing biomass of large piscivorous fish (cod, hake etc.) in response to improved fisheries management.

At least in some EU sea basins or parts thereof, fishing effort has already declined significantly in recent years in response to overfishing and declining economic returns, reducing overall catches and, in turn, discards. In the northern North Sea, for example, roundfish (whiting, cod, haddock) discards are currently only 10–20% of their level 20 years ago (dataseries 1993–2012) owing to a combination of factors: reduced fleet size and more selective gear, large reductions in fishing mortality, and scarcity of big year classes in the target stocks (S. A. Reeves, pers. comm.). This reduction effectively mitigates the impact of the ongoing Landing Obligation because it suggests the birds using this region of the North Sea would already have adjusted to a downturn in availability of discards prior to the start of the Landing Obligation.

In contrast, in the southern North Sea, discard levels of plaice are about as high as they were twenty years ago, reflecting a number of factors including an increasing plaice stock currently at a record high (S. A. Reeves, pers. comm.). In this case, the Landing Obligation may represent a more significant change from the *status quo*. This comparison of the northern and southern North Sea illustrates that the impact of the Landing Obligation might potentially vary spatially within as well as between sea basins.

Although fish recruitment rates remain persistently low across a spectrum of fisheries in EU waters (Gascuel *et al*., 2014), the prospect of demersal stock recovery (e.g. as seen already in progress in the North Sea) under the new CFP, combined potentially with a resulting increased age-size spectrum of target fish, is expected to generate increased production and discarding of offal (which is not constrained by the Landing Obligation) (e.g. Reeves and Furness, 2002). This also may help offset a downturn in discards for some of those seabirds classed as 'generalist piscivores' (sensu Bicknell *et al*., 2013).

Despite these potentially positive qualifications, however, several negative effects of the Landing Obligation are predicted in the short term (Bicknell *et al*., 2013), and de-serve attention. This ToR is therefore aimed at designing a protocol for assessing the effects on seabirds of the Landing Obligation, and continues work conducted by JWGBIRD in 2014.

4.2 Assessing the sensitivity of seabirds to a reduction in the availability of discards

In 2014, JWGBIRD developed an example framework for scoring the sensitivity of species in the North Sea and Celtic Seas to a reduction in the availability of discards (ICES, 2015). This was built upon and further developed by JWGBIRD in 2015 for all relevant seabird species across the MSFD subregions (and the OSPAR Arctic subregion which is not included under MSFD). It was circulated to members of JWGBIRD, as well as to key experts outside this group, for them to use their expert judgement to score different factors relating to sensitivity. A detailed description of the sensitivity assessment framework is provided in Annex 12, and the resulting assessments are available on request to Advice@ices.dk

A total of 17 respondents provided sensitivity assessments; most provided scores for a single subregion, but some individuals provided assessments for multiple subregions. Between one and nine assessments were provided for each region (Table 1).

Table 1. The number of sensitivity assessments received for each subregion of interest.

Subregion	Number of assessments
Greater North Sea	9
Celtic Seas	3
Bay of Biscay and the Iberian Coast	3
Macaronesia	1
Western Mediterranean Sea	3
Baltic Sea	6
Arctic	2

The resulting sensitivity assessments can be used to identify key species which are potentially at relatively higher risk within the different subregions, and how sensitivity varies between subregions, therefore informing which species should be prioritized for study in each. For example, the smaller average size of discarded fish in the Mediterranean means that species such as European storm-petrel, European shag and common guillemot are able to exploit discards, while these species are not thought to exploit discards to such a great extent in the North Sea, where the average size of discards tends to be larger and/or competition from large scavenging species excludes the smaller species. Distributions of species will also influence subregional differences in the species potentially at risk; for example Audouin's gull is restricted to the Mediterranean and northwest Africa and is heavily reliant on discards in these areas. As sensitivity is scored separately for different factors relating to the mechanisms of the potential effects, this allows us to identify which aspects of their ecology might be affected and therefore which parameters might be most appropriate to monitor. A great deal of information is captured collectively across the sensitivity assessments and can be summarized in multiple ways. For simplicity, we have generated a coarse summary of the species which have been most frequently scored as being at highest risk (score of 5) for each factor (see Table 2). This has been done for all subregions where at least three responses were received.

Table 2. Species in each subregion which were scored most frequently as being at highest risk (score of 5) by (a) having a high reliance on discards; (b) likely to suffer from a high increase in being kleptoparasitised; (c) likely to suffer an increase in bycatch rates; and (d) with a high likelihood of conflict with humans in urban environments, in the event of a reduction in the availability of discards. Note that no species were scored most frequently as likely to suffer from an increase in predation. Best estimates unadjusted for levels of uncertainty were used to compile the tables.

(a) Reliance on discards	Greater North Sea	Celtic Seas	Bay of Biscay and the Iberian coast	Western Mediterranean Sea	Baltic Sea
Balearic shearwater				✓	
Common gull					✓
Cory's shearwater				✓	
European storm-petrel				✓3	
Great black-backed gull	✓	✓	✓		✓
Great skua	✓1	✓	✓	✓	
Herring gull	✓	✓	✓		✓
Lesser black-backed gull	✓1	✓	✓	✓	✓
Mediterranean gull				✓	
Northern fulmar	✓1	✓			
Northern gannet	✓1	✓	✓	✓	
Yellow-legged gull	✓	✓	✓	✓2	
Audouin's gull				✓	
Slender-billed gull				✓2, 3	

[1] Also considered to have low ability to offset reduced availability of discards in the North Sea.

[2] Also considered to have a low availability to offset increased foraging costs in the Mediterranean.

[3] Also considered to have a low competitive foraging ability in the Mediterranean.

(b) Increased kleptoparasitism	Greater North Sea	Celtic Seas	Bay of Biscay and the Iberian coast	Western Mediterranean Sea	Baltic Sea
Black-legged kittiwake			✓	✓	
Lesser black-backed gull				✓	
Yellow-legged gull				✓	
Audouin's gull				✓	

Change in bycatch rates	Greater North Sea	Celtic Seas	Bay of Biscay and the Iberian coast	Western Mediterranean Sea	Baltic Sea
Balearic shearwater	✓	✓	✓	✓	
Cory's shearwater	✓		✓	✓	
Northern fulmar		✓			
Yelkouan shearwater				✓	

Likelihood of urban conflict	Greater North Sea	Celtic Seas	Bay of Biscay and the Iberian coast	Western Mediterranean Sea	Baltic Sea
Black-headed gull					✓
Common gull	✓				
Herring gull	✓	✓	✓		✓
Lesser black-backed gull	✓	✓	✓		
Yellow-legged gull			✓	✓	

There are caveats associated with interpreting the results of the sensitivity assessments. The sensitivity framework does not currently distinguish between breeding and non-breeding periods, and consequently many respondents found some of the factors difficult to score. A key gap in our knowledge is the understanding of seabird-trawler interactions during the non-breeding period (but see Arcos, 2001), not least because many species which consume discards are expected to be even more heavily reliant on discards at that time (Reeves and Furness, 2002). This is of particular relevance since the effects of resource availability can be crucial to overwinter survival, when the majority of seabird mortality occurs (Barbraud and Weimerskirch, 2003). Therefore the sensitivity assessment tool could be further developed to provide seasonally explicit information using best judgement and could be updated as knowledge improves. Further work is also required to incorporate levels of uncertainty in the individual assessments and aggregate the scores into a single sensitivity index for each species/subregion (see Annex 12). However, the individual sensitivity assessments in themselves provide an invaluable starting point to inform prioritization of species and parameters for research within and across subregions.

4.3 Research protocols to assess the effects of the EU Landing Obligation on seabirds

Bicknell *et al*. (2013) identified the potential effects and consequences for seabirds in the EU and this was used by JWGBIRD in 2013 (ICES, 2013) and 2014 (ICES, 2015) to recommend broad study areas which merited research. We expand on the ideas in 2013 and 2014 in more detail to provide specific recommendations on the priority research areas which should be undertaken and the approaches through which this could be achieved. We explore these within two main areas: (i) Behavioural responses: research to improve our understanding on how diet, at-sea distribution and vessel associations change in response to a reduction in the availability of discards; and (ii) Population impacts: research which aims to understand whether there are any discernible population level impacts.

4.3.1 Behavioural responses

Diet

A priority area for research is the systematic study of seabird diet, ideally linking this to changes in seabird body condition, breeding success and/or mortality. Where existing diet studies are unavailable it will be crucial to initiate these as a matter of priority to provide a baseline during the early phasing stages of the discard ban in order to assess temporal and regional differences in the dependence on discards at the outset, and how species respond to the lower availability of different types of discards as the discard ban is phased in. Barrett *et al.* (2007) provides a review of the different available approaches to sample diet appropriate to various seabird species and which could form the basis of a systematic study.

Species which show some reliance on discards may show temporal differences in this reliance. For example, in the northern North Sea, fewer species are reliant on discards during the breeding season than over winter (Reeves and Furness, 2002), so diet studies during the breeding season need to be carefully targeted to such species (e.g. great skua and lesser black-backed gull in the northern North Sea). Collecting diet information can be challenging, but some of the generalist omnivores, such as skuas and gulls, produce pellets which contain otoliths of fish which can be used to identify species, size and age of fish prey consumed, and remains of any seabirds preyed upon will also be capable of identification (Votier, 2001). Collecting pellets from the breeding site, and indeed from gull roosts during winter, is relatively straightforward, so initiating a large-scale diet study across the range of these key species is a cost-effective approach to assessing changes in diet in response to changes in discard availability, both temporally and spatially. There is some evidence that, at least in great skuas, it is the larger colonies which show greatest reliance on discards (individuals breeding in smaller colonies show a higher tendency to prey on other seabirds) (Votier *et al.*, 2007), so focusing pellet collection at these larger colonies is recommended for a discard-focused study.

To maintain scientific rigour and remain cost-effective, care would need to be taken to ascertain at point of collection in the field the particular seabird species responsible for producing any given pellet(s), and this may prove challenging in a mixed gull roost. While individuals and organizations with the necessary expertise will be able to analyse the visible components (e.g. bones, feathers) of the pellets (e.g. following Härkönen, 1986), a central repository will be needed to store samples for future further examination such as DNA analysis. Appropriate and readily accessible storage facilities would need to be costed into any such programme.

Other techniques are available for sampling diet which are particularly useful for the non-breeding season and are worth exploring for their potential to yield insights into discard consumption during this time of year. Stable isotope analysis from feather tissue samples can provide information on trophic levels over longer time periods and can therefore be used for birds caught during the breeding season to provide an indication of diet over the preceding winter (Barrett *et al.*, 2007). When combined with information on timing of feather moult and isotope values of potential prey from known wintering grounds, this can yield information on the potential use of discards during the non-breeding period (Meier *et al.*, 2015). However, for species which have a wide dietary niche (e.g. great skuas in Shetland), the wide isotopic variation limits their utility for differentiating discards from other prey in the absence of complementary diet data (Bearhop *et al.*, 2001). However, analysing fatty acid signatures/stable isotopes from blood samples of birds caught during the non-breeding season can reflect the diet consumed during the previous weeks (e.g. Iverson *et al.*, 2007; Owen *et al.*, 2013) and therefore offer a valuable technique to assess diet composition for species which can be caught during the non-breeding period. Although many species are difficult to catch during the non-breeding season, some species such as Balearic shearwater, great shearwater, sooty shearwater, northern fulmar and great skua have been caught at sea using nets or hooks (Boué *et al.*, 2014; Bugoni *et al.*, 2008; Ronconi *et al.*, 2009; B. Cadiou and N. Markones, pers. comm.) and would be suitable for this approach. However, the individuals most likely to be caught will be those exhibiting ship-following behaviour and feeding on discards or offal, whereas individuals foraging on a natural diet will be less accessible, thus potentially biasing the sample.

A complementary approach to sampling the diet of individual seabirds are foraging observations at sea, which can be conducted throughout the year. Discarding experiments carried out in the 1990s (EC-funded 'DISCARDS' projects[2], see e.g. Camphuysen *et al.*, 1993; Camphuysen *et al.*, 1995; Garthe *et al.*, 1996) provides a highly valuable baseline for discard consumption during the height of discarding. The DISCARDS projects used trained observers on fishery research vessels to carry out a number of observations on which seabird species retrieved and consumed different sizes and species of discards, and the effects of different competitive interactions. Single discard items were experimentally released overboard under different circumstances (e.g. in the presence and absence of routine discarding from the fishery research activities, and over four different seasons).

A number of predictions could be made and tested by repeating the DISCARDS projects. For example, scavengers which were previously shown to have a preference for roundfish over flatfish, and which shunned invertebrates such as starfish, may potentially show an increase in the consumption of these less preferred prey in the event of a reduction in discards of roundfish. Likewise, dominance hierarchies, where northern gannets and large gulls (which are better able to swallow large discards) are known to outcompete smaller species such as black-legged kittiwakes for access to discards in a discard-'rich' environment, may show changes when discards become scarcer (see Arcos, 2001 for other predictions on species exploitation of fishing vessels as a possible consequence of competition).

A large-scale systematic experimental approach such as this is ideal but there are other possible opportunities for collecting information on discard use. For example, the current repeal of the Data Collection Framework (Council Regulation (EC) No 199/2008) under the Common Fisheries Policy, or monitoring programmes implemented under the Marine Strategy Framework Directive, might enable sampling studies on the consumption of discards by seabirds and other marine wildlife. It was noted, however, that Member States had already (in 2014) submitted their MSFD monitoring programmes to the Commission for approval and that these would not be reviewed until 2020, by which time discarding should be a thing of the past if the legal timetable is met and the Landing Obligation properly enforced.

Sampling studies could include timed representative counts and observations of the seabird community associated with fishing vessels carrying out discarding during the phasing in of the ban. Combined with discarding experiments, such as those described above, this could help fill the large evidence gap of discard consumption across different regions.

An advantage of having seabird observers on board fishing vessels is that information on bycatch rates and species affected can also be gathered. The phased in reduction in discarding could influence seabird association patterns with fishing vessels, therefore affecting bycatch rates (Bicknell *et al.*, 2013). For example Laneri *et al.* (2010) showed that the probability of longline bycatch of Cory's shearwaters in-

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[2] "Seabirds feeding on discards in winter in the North Sea", 1993, EC DG XIV research contract 92/3505 and "Consumption of discards by seabirds in the North Sea", 1994–1995, EC DG XIV research contract BIOECO/93/10.

creased in the absence of trawling activity (i.e. during trawling moratoria, weekends and holidays). Monitoring bycatch as part of research protocols to assess effects from a reduction in discards would therefore support the implementation of the EU Action Plan for reducing seabird bycatch in fishing gears (COM, 2012). The idea would be to perform a multi-fishery programme of on-board data collection. Taking the western Mediterranean as an example, observers would be deployed on board trawlers, as well as longliners, to assess discard consumption and potential bycatch on longlines.

As some discard-reliant species are expected to respond to a reduction in discard availability by switching to preying on other seabird species, parallel research to the diet studies should include studies on seabird species which could suffer from an increase in predation. This should include assessing breeding numbers, productivity and the level of predation in colonies identified as potentially vulnerable due to the presence of breeding great skuas or gulls. Although no species were consistently identified as likely to suffer high predation (see sensitivity assessment above), species considered at relatively higher risk were the storm petrels, Arctic skua, black-legged kittiwake, terns and auks.

Distributions and vessel associations

It seems likely that the discard ban will result in changes in the distributions and movements of seabirds as they change their foraging strategies (Bicknell *et al.*, 2013). For example, the movement patterns of Cory’s shearwater and Balearic shearwater during the breeding season have been shown to change in relation to discard availability (as measured by the presence and absence of trawling activity) in the Mediterranean (Bartumeus *et al.*, 2010). The provenance of birds at sea that are feeding on discards, whether during the breeding or non-breeding period, is largely unknown, and at present we have limited information on the distribution and individual movements of seabirds during the non-breeding season when many species are more heavily reliant on discards. Approaches which combine tagging of individual birds at the colony, as well as tagging of birds at sea would yield great insights into this area. Catching birds at sea is not trivial, but has been done for some species (see above). However the difficulty in relocating and re-catching such individuals caught at sea to recover the tag and the data stored within it currently precludes the use of archival tags and limits such studies to satellite transmitter technology that does not require recovery of the tag for data retrieval. Combining tracking technology with bird-borne cameras also has potential to yield unprecedented insights into vessel association behaviour for some species such as northern gannet (Votier *et al.*, 2013).

To relate movement data to changes in discard availability as the discards ban is phased in, distributions and other foraging parameters derived from individual movement information from tracking could be summarized spatially at the level of ICES fishing areas in the case of geolocator tags or ICES statistical rectangles in the case of GPS tags (which provide much higher spatial precision in location data than geolocators). This would allow comparison of preferred areas, albeit at coarse spatial scales in the case of ICES fishing areas, with fishery information for those areas. The monitoring and enforcement regime for the Landing obligation is still to be finalized, but ideally skippers’ e-logs would record, on a haul-by-haul (and therefore ICES statistical square) basis, fish to be landed, fish below the minimum conservation reference size, and remaining discards. However, pending effective enforcement by observers or remote electronic monitoring (cameras), survey vessels will still be important for monitoring these categories (to inform fish stock assessments).

Species which make frequent use of discards often fly at heights that are considered to increase the risk of collision with wind turbines (Cleasby *et al.*, 2015). In this respect, key species which could be prioritized for tagging studies are northern gannets, great skuas and gulls, where the combination of their sensitivity to both windfarms and a reduction in discard availability may pose heightened risks (see ToR e chapter). In particular, there is a large evidence gap in our knowledge of the distribution of great black-backed gulls outside the breeding season.

4.3.2 Assessing population-level impacts

Although there are examples of long-term population ecology studies for species which rely to varying extents on discards, to date there have been few published studies which investigate possible correlations of population level changes with indices of the availability of discards, so research in this area should be encouraged. The most detailed work relating seabird breeding performance to the availability of discards (measured by the opening and closing of demersal fisheries which provide discards) is from the Mediterranean. In the northwest Mediterranean, discards supply a significant proportion of the energy required by Audouin's gull and yellow-legged gull during the breeding season (Arcos, 2001), and the lack of this resource during trawling moratoria has been shown to strongly influence a wide variety of ecological and breeding parameters, as well as demographic parameters (see review in Oro, 1999; Oro *et al*., 2004). Similarly, discards form a significant component of the diet of Balearic shearwaters (Arcos and Oro, 2002) and interannual variability of breeding performance has been related to the changes in the availability of both small pelagic fish and trawling discards (Louzao *et al.*, 2006).

However, detecting any signal of the effects of a reduction in the availability of discards in data relating to population ecology (e.g. breeding success, survival, abundance) will be challenging, given both the variation in the data, as well as the need to disentangle any effects with those from other drivers. The challenge will be all the greater in those sea areas, as in the northern North Sea (see Introduction to this ToR), where a significant reduction in discarding has already taken place prior to the introduction of the Landing Obligation.

Careful prioritization will be required to determine which species, colonies and parameters might be suitable for such correlative studies, and considerations include:

i) Prioritizing species which have a heavy reliance on discards during the breeding season, when most population study data are collected. For example, existing evidence in the northern North Sea indicates that only great skua and lesser black-backed gulls might fall into this category.

ii) Which parameters are likely to be driven strongly by the availability of discards? For example, because seabirds exhibit delayed maturity, there is likely to be a lag between changes in the availability of discards and any response seen in breeding abundance, and in some species breeding success may be more strongly driven by the availability of natural prey such as sandeels rather than availability of discards (Furness, 2003).

iii) The practicality of data collection. For example, while information on immature survival and recruitment would be highly desirable (given that immature individuals are likely to have a heavier reliance on discards), collecting such data on a scale required to detect effects is likely to be impractical.

iv) What information is an appropriate index of discard availability? Here, the data collection protocol for vessels' e-logbooks, and the independent ground-truthing thereof, will be particularly important. Particular attention should be paid to the component of small fish in the catch composition as these are an important food source for the smaller scavenging seabird species (e.g. Reeves and Furness, 2002; Votier *et al.*, 2004).

4.3.3 Summary recommendations for priority research protocols

Priority research areas to assess behavioural responses (diet, at-sea distribution and vessel associations) to a reduction in the availability of discards:

i) Initiation of a region-wide protocol to collect and analyse pellets obtained from great skuas and large gull species at colonies, immature club sites, and winter roost sites (depending on the species).

ii) A repeat of the 1990s DISCARDS projects in the North Sea and initiation of similar experimental discarding projects and vessel-based observations in other regions. Information on bycatch should be collected concurrently where possible.

iii) Relating distribution and movement information gathered from tracking studies (particularly during the non-breeding season) to changes in discard availability.

Research to understand population level impacts to a reduction in the availability of discards:

iv) Encourage and ensure support for long-term correlative studies, linking parameters on abundance, body condition, breeding ecology and mortality with changes in the availability of discards, both historically and during the implementation of the EU Landing Obligation. Publication of a lack of evidence showing any effects will be as important as those studies which do indicate effects.

4.4 Potential remedial action

JWGBIRD proposed in 2014 that management measures to mitigate the impacts of the Landing Obligation on seabird populations could include:

1) Avoid sharp changes in discard availability, i.e. allow for a period of transition/ progressive reduction. (This is already being considered for socio-economic reasons and would also help to minimize ecological impacts).

2) Introduce measures to minimize predation by certain seabirds on other seabirds (e.g. through supplementary feeding of great skuas).

3) Implement or reinforce bycatch mitigation measures in areas where seabirds are considered vulnerable to bycatch from commercial fishing.

4) Promote a recovery of fish stocks, particularly those of forage fish species (e.g. lesser sandeel).

JWGBIRD did not in 2015 add any new proposals to this list but reflected further on them, with the following conclusions on 1–4, respectively:

1) Now that the implementation timetable for the Landing Obligation is becoming increasingly clear, it will arguably preclude 'sharp changes' in dis-

card availability for seabirds, and as such there seems little justification for slowing further the rate of change. Given our knowledge of the regional discard plans adopted so far, the phasing will result in an even more incremental progression towards a total discard ban than originally anticipated (see Introduction to ToR f, above). In the North Sea, for example, cod and whiting are not expected to be subject to the Landing Obligation until 2018. Moreover, changes in fishing activity over the past two decades have already substantially reduced discarding in the northern North Sea so at least in these waters the lowering of discard availability significantly predates the start of the Landing Obligation in 2015.

2) This proposal was considered by JWGBIRD 2015 to be neither practical nor desirable. The great skua, when discard-deprived, is one of the most likely to increase predation on other seabirds (Reeves and Furness, 2002; Bicknell *et al*., 2013, which see for other references). However, even if it were feasible to do supplementary feeding of this species on a trial basis, it could not be sustained on a sufficient spatial and temporal scale and its intended outcome could not be guaranteed.

3) There is evidence to suggest that this management proposal deserves attention in certain sea basins or sea areas. In the western Mediterranean, for example, different kinds of small-scale fishing gears coexist with the result that in statutory periods when trawling activity ceased, Cory's shearwaters were more likely to forage for longline baits during sunrise sets, leading to increased incidental capture (Laneri *et al*., 2010; Báez *et al*., 2014). More specifically, during the pre-breeding and chick-rearing periods, bycatch dramatically increased during sunrise sets in the absence of trawling activity (Laneri *et al*., 2010). The authors in these studies recommended an integrated multi-fisheries management approach for the conservation of seabirds, whereby longline fishing would be banned during periods of trawling inactivity in order to reduce the risk of bycatch. García-Barcelona *et al*. (2010; which see for other references) found the same relationship but highlighted both trawl- and purse-seine vessels as sources of discards, and also longline bycatch of not just Cory's shearwater but also notably yellow-legged gull, Audouin's gull and northern gannet. The implementation of mitigation measures (of which a temporary cessation of fishing is one option) for minimizing bycatch in longline fisheries is in keeping with the EU Seabird Action Plan (COM, 2012) which Member States are urged to implement. The ongoing revision of the Technical Measures Framework has the capacity to incorporate such mitigation measures (see e.g. section 'Minimizing the ecosystem impact of fishing gears in the Commission's January 2014 consultation: http://ec.europa.eu/dgs/maritimeaffairs_fisheries/consultations/technical-measures/documents/consultation-paper-tm_en.pdf).

4) Overall, the recovery of fish stocks is already being promoted. With the new CFP's MSY target, there is evidence that recovery is already happening in some sea basins. Since 2006, fishing has generally progressed towards MSY (fishing at or below B_{MSY}) in all areas of the Northeast Atlantic, North Sea and Baltic Sea; in the Mediterranean and Black Sea, however, stocks are largely overfished and/or in a bad state (COM, 2015). In terms of forage fish species such as lesser sandeel, given that 'recovery' is more challenging for this and possibly other low trophic level species in the face

of climate change-driven trophic disruption, the immediate focus should be on maintaining existing closed areas and managing commercial fisheries on an ecologically sustainable basis (see also ToR h). In 2014, the Scottish Government designated three marine protected areas for sandeels (http://www.gov.scot/Topics/marine/marine-environment/mpanetwork/developing/DesignationOrders), a precedent that should be followed in other sea areas for other forage fish species, provided that effective management follows designation.

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5 Assessment of the current scale of the threat and measures from non-native predators at seabird colonies in the NE Atlantic

Term of reference g): Assessment of the current scale of the threat and measures from non-native predators at seabird colonies in the NE Atlantic. The assessment could be made using existing literature, or on the basis of a questionnaire designed by JWGBIRD in 2014 to collect information on i) characteristics of the seabird colonies and their predators, ii) potential or existing pathways of introduction and invasion, iii) measures planned or already in place, iv) animal rights issues and hunting regulations and v) legislation and conservation aims.

Scientific justification: In addition to fisheries impacts, the other potentially manageable pressure from seabirds is from predation by non-native mammals that invade previously predator free islands. The scale of the ongoing impact or potential impact from non-native mammals is unknown. The group will build on work by JWGBIRD in 2014 and compile an inventory of threats and measures concerning non-native predators at seabird colonies on offshore islands. The work will also inform EU Member States on whether they should be further developing the OSPAR MSFD candidate indicator M4 - Non-native/invasive mammal presence on island seabird colonies.

5.1 Introduction

At the JWGBIRD meeting in 2014, the technical specification of the OSPAR candidate indicator B4 was reviewed and it was considered how applicable the indicator could be in assessing threats to marine birds from non-native and native invasive mammals in the OSPAR Area (ICES, 2015).

The proposed candidate indicator B4 is derived from observations of the presence or absence of non-native or invasive mammal species on key island seabird colonies. The aim of the indicator is to inform management aimed at reducing the pressure on seabird populations from depredation by non-native and native invasive mammals (Table 1). The proposed indicator metric is the number of island seabird colonies where non-native or invasive-native mammal species are present. The JWGBIRD report for 2014 (ICES 2015) contains a complete overview of the candidate indicator.

At the JWGBIRD meeting in 2015, the discussion was continued and expanded to cover the Baltic Sea region as proposed by JWGBIRD in 2014.

Table 1. Preliminary list of non-native and native invasive mammals considered as invasive at seabird colonies in the OSPAR and HELCOM regions following discussions in JWGBIRD 2014 and 2015.

NON-NATIVE SPECIES
Brown rat *Rattus norwegicus*
Black rat *Rattus rattus*
American mink *Neovison vison*
Domestic/feral cat *Felis catus*
Raccoon dog *Nyctereutes procyonoides*
Raccoon *Procyon lotor*
Muskrat *Ondatra zibethicus*
Native species
Red fox *Vulpes vulpes*
Hedgehog *Erinaceus europaeus*
Polecat *Mustela putorius*
Stoat *Mustela erminea*
Weasel *Mustela nivalis*
Beech marten *Martes foina*
Wild boar *Sus scrofa*

5.2 Scope of the threat

As already assessed at the JWGBIRD meeting in 2014 for the OSPAR region, the problems associated with non-native and native invasive species on islands in the Northeast Atlantic and in the Baltic Sea are very diverse. There are large differences between regional seas, between subregions, between countries and even at a local scale.

Nevertheless, general patterns in the Baltic Sea and the OSPAR area were evident. In the Baltic, the main problem is American mink. This species, which established feral populations in Europe in the first half of the 20th century, is widely distributed in Sweden and Finland. Due to its long history as an invasive species and its wide distribution, complete eradication at seabird colonies and breeding sites is not possible, and control measures in these countries are concentrated on protecting certain seabird species that are considered a conservation priority, i.e. auks and Caspian tern, or on areas where there are generally large numbers of breeding seabirds. Sea ice is exacerbates the problem in the Baltic, because it enables non-native mammals, such as raccoon dog in Estonia, to invade islands that they would not be able to swim to. Sea ice means that in winter some islands are always accessible to invasive mammals. In the OSPAR region, American mink is a widespread problem species too, however, problems with rats and native invasive mammals such as foxes and hedgehogs are an additional problem for seabird colonies (see ICES, 2015 for more information).

Discussions showed that there are significant effects of invasive predators on seabirds in both regional seas that JWGBIRD regard as requiring action. These include decreases in breeding range and the availability of breeding sites, decreases in numbers and reduced breeding success.

It was, however, not possible to obtain a complete picture of the situation in both regional seas and it was evident that in some countries, there is even a lack of information.

5.3 Eradication and control measures

In most countries in the Baltic Sea and OSPAR regions, some eradication or control programmes are in place. From the discussion it was evident that such measures are generally organized and implemented at a more local or regional scale than on a national scale. There is no known coordination at a trans-border or an international level.

In the Baltic, sea ice offers a major challenge to management, because it enables most invasive mammal species to reinvade an island even after they have been eradicated there. In parts of the OSPAR area, where there is no winter sea ice, islands can remain mammal free following eradication, as long as there is a sufficiently wide expanse of water between the island and nearest land (e.g. mink are thought not to regularly swim more than 2 km). Accidental or intentional reintroductions to such islands are the only way mammals could reinvade. In these areas, there is a greater likelihood that the investment of resources into eradication will reap rewards in terms of restoring seabird colonies and other native wildlife.

There is some indication of the benefits of more intact ecosystems on invasive species control. In Finland, there are observations that increases in white-tailed eagles, which predate on mink, are reducing visits of mink to outer islands, especially where mink have to swim over large stretches of open water. In addition, great cormorants can repel mink, and cormorant colonies can offer safe breeding sites for other bird species, for example in Finland.

Because the problems encountered in the OSPAR and HELCOM areas are very diverse, they will require local approaches. Considering the availability of diverse best-practice manuals i.e. from New Zealand, JWGBIRD was of the opinion that the production of a specific manual of eradication and control methods for the OSPAR and HELCOM regions was of no additional benefit. However, the use of JWGBIRD as a platform for exchange of information was considered valuable.

5.4 Assessing the threat

In 2014, JWGBIRD (ICES, 2015) proposed attempting to assess the present situation using a questionnaire. This was discussed again by JWGBIRD in 2015.

Due to the immense scale, potentially hundreds of thousands of islands in the two regional seas, and the huge diversity of the problem, it would not be possible to assess the situation on each individual island.

The possibility of using a questionnaire for the assessment of the situation at a meta-level was discussed. This could form part of a two-step approach. The first step could be a survey at the country level of what the general situation is, what the main concerns are, which data are available and how they can be obtained. This could be followed by a survey of selected islands. See Table 2 for aspects which could form the basis of the selection criteria of these islands.

Table 2. Proposed aspects, which could form the basis of criteria for selection of seabird breeding sites that should be included as a basis for indicator B4.

Current and recent–past marine bird breeding sites. (How far into the past do we go?)
Species selection (seabirds) (conservation aspects i.e. rare or endangered species should perhaps be a priority) local, regional, national scale
Individual islands or groups of islands that are at least X km (species-specific and in areas free of sea ice in winter) from adjacent mainland or other islands. (distance to source populations of predators)
Physical characteristics of the island (access)
Surrounding waters i.e. water currents, ice conditions, tidal (related to their influence on access for predators)
Minimum and maximum island size (importance for breeding birds and ease of eradication)
Prospects for complete eradication and/or seasonal control (i.e. eradication and/or control to a level not detrimental to bird populations - what do we mean by predator-free? (relates to assessment methods))
Conservation strategy aspects (species present, situated in protected area)
Number of human inhabitants on the island (related to potential of human-induced colonization by predators including rats and feral species)
Lower limit of number of breeding pairs (is related to conservation aspects i.e. trying to prevent predation on small numbers of rare or endangered species might be worthwhile)
Species of predators involved (eradication not effective or not an option for some species depending e.g. on island size or distance from a predator source, geographical region or animal rights and nature conservation legislation)

The value of present studies in Germany on seabird–predator interactions in enhancing knowledge of predators with regard to species involved, activity patterns, home ranges, diet composition etc. (e.g. by nest-cameras, tracking of predators, faeces analyses) and thereby in assessing their threat to seabird colonies was emphasized.

5.5 Development of the candidate indicator B4

In 2014, JWGBIRD raised a number of questions regarding the criteria used for selection of seabird breeding sites that could be included as a basis for indicator B4.

A proposed list of aspects, which could be used as a basis for the development of criteria, were discussed and revised (Table 2). This initial list should be simplified and the criteria grouped. Groups of criteria could include geography (island size, location, habitat, etc.), past and present breeding birds (including conservation priorities), mammals present or likely to invade, and practical issues related to eradication or reinvasion.

In order to be effective, the indicator will need to be focused on a relatively small number of islands, where it is possible to maintain monitoring of predator presence over an extended period of time. Any questionnaire collecting information at an island level will need to collect information on the current effort devoted to monitoring, and the prospects of maintaining this over an extended number of years. The indicator should not be restricted to islands where measures are possible, but also include a selection of sites where they are impossible or difficult to implement. The aim of the indicator should be to monitor the level of pressure invasive predators have on seabirds and their reproduction, as part of the assessment of the environmental state of the seas and in order to provide an early warning system for management. The fate e.g. of large colonies of rare species or species restricted to relatively few colonies should be monitored independently of their potential for benefiting from measures. Predation by invasive mammals is, for many bird species, one of a number of impacts which have a cumulative effect on population size and breeding success. If measures cannot be taken to combat invasive mammal predation, mitigation measures could target other impacting factors.

The further development and possible implementation of the indicator could be used to raise awareness of the threat from invasive mammals and provide a policy driver. It would thereby encourage each Contracting Party to attempt to reduce the impact and provide guidance on how this might be done.

By being responsible for the development and assessment of the indicator, JWGBIRD could continue to function as a knowledge exchange forum, by gathering and propagating ideas and information at a regional seas level, and could keep this important impact on seabirds on the political agenda.

Proposed steps forward in developing the indicator are shown in Table 3.

Table 3. Steps forward in developing indicator B4.

Develop a meta-data questionnaire and use JWGBIRD members and associates to collate data using the questionnaire.
Finalize the criteria for the selection of islands, which are to be used as the basis for the indicator. The results of the questionnaire would supply valuable information for defining sensible selection criteria.
Test selection criteria i.e. production of national lists of potential islands.
Select a (random/representative) sample of these islands at a national level for the indicator. This is probably the most critical aspect, because to be useable the indicator will need to be focused on a relatively small number of islands, where it is possible to maintain monitoring of predator presence for an extended period.
Development of detailed questionnaire to document the situation on the selected islands (baseline).

5.6 Non-native invasive species and EU legislation

Invasive species (e.g. American mink) are considered in MSFD legislation in at least two countries (Finland and UK), and invasive mammal control is included in the UK's programme of measures under the Marine Strategy Framework Directive, but not yet in Finland.

JWGBIRD proposes to assess the national programmes of measures and make an inventory of measures related to invasive mammals on seabird colonies.

With regard to the EU directive on the prevention and management of the introduction and spread of invasive alien species (REGULATION (EU) No 1143/2014), it is important to ensure that the most widespread and important mammalian predators causing problems on seabird colonies are included in the subset of invasive alien species considered to be of European Union concern.

5.7 Recommendations

1) JWGBIRD 2015 considers it necessary that action is taken to reduce the impact of non-native and invasive native mammals on breeding seabird populations in the NE Atlantic Region and the Baltic. There is comprehensive evidence that these invasive predators are having significant impacts on seabirds in the OSPAR and HELCOM regional seas.

2) If they have not already done so, Member States could include in their national programme of measures (under Article 13 of the Marine Strategy Framework Directive) actions to reduce or eliminate the negative effects of non-native and invasive mammal predators on seabirds. It is clear that predation by invasive mammals on seabirds will have an effect on bird numbers as well as breeding success and could therefore influence achievement of GES at a subregional and regional scale (at least within the NE Atlantic and Baltic).
3) Member states could ensure that mammalian predators causing problems on seabird colonies are included in the subset of invasive alien species considered to be of Union concern.
4) JWGBIRD will continue to develop the candidate indicator B4 as a measure of the impact of non-native and invasive mammalian predators on seabird colonies.
5) JWGBIRD will continue to function as a platform for the exchange of information on non-native and invasive mammalian predators on seabird colonies.
6) JWGBIRD will promote studies of seabird–predator interactions to enhance knowledge of predators with regard to involved species, activity patterns, home ranges, diet composition, etc. (e.g. by nest cameras, tracking of predators, faeces analyses).

5.8 References

ICES. 2015. Report on the Joint ICES/OSPAR Working Group on Seabirds (JWGBIRD), 17–21 November 2014, Copenhagen, Denmark. ICES CM 2014/ACOM:30, 115 pp.

6 Fishery-driven changes in the marine community of NW European waters and their consequences for seabirds

Term of reference h): Review long-term studies on fishery-driven changes in the marine community of NW European waters that have had consequences for seabirds, to provide insights into the ecological processes underlying changes in the seabird populations. This review could be used to provide recommendations to ICES for the management of fisheries, particularly low-trophic level (LTL) fisheries.

Scientific justification: Determining a causal link between fishing activities and apparent shortages of prey for seabirds has proved difficult to obtain. But could seabird demographic data (e.g. on breeding population size, breeding success), which is currently collected, be used to inform management of fish stocks, so that fishing does not have a detrimental impacts on the food supply of seabirds? The group will use the review they completed in 2014 of studies on the impact of fishing for seabird prey species on seabird demographics to consider how impacts may be included in ICES advice on fish stock management.

6.1 Introduction

The extensive exploitation of fisheries worldwide has reshaped marine communities, including the populations of higher level predators such as seabirds (Hunsicker *et al*., 2011). This ToR focuses on how fishery-driven changes in European waters have influenced seabird populations; this follows directly from the literature review carried out by JWGBIRD in 2014 on the same theme (ICES, 2015). The goal is to examine how long-term demographic data may provide insights into the ecological processes underlying changes in seabird populations. Demographic data such as breeding population size and breeding success may conceivably inform fisheries management such that fishing does not threaten the conservation status of seabirds.

Significant as context for this review are the findings of Cury *et al*. (2011), which concluded that good management of low-trophic level (LTL) stocks should leave 'one third for the birds'. With 19 long-term datasets, representing 14 seabird species across seven ecosystems, Cury *et al*. (2011) found significant relationships between seabird breeding success and size of LTL fish populations. These prey population sizes were determined independently from birds, usually as part of stock assessments for fisheries management, with datasets for between 15 and 47 years. The outcome of this analysis indicated that a threshold effect exists in the population level of prey needed for a high probability of successful reproduction by seabirds. If prey dropped below approximately one third of the maximum prey abundance recorded, then seabird breeding success declined. The pattern was common across species and ecosystems (Cury *et al*. 2011).

The result suggests a common fundamental process is creating a threshold effect. Cury *et al*. (2011) are not simply saying the 'third for birds' is required as the minimum prey biomass for the breeding populations, but instead they are suggesting that the removal of a large part of the LTL fish creates a perturbation in the marine community leading to short-term breeding failures of the dependent seabird predators, and in some cases their slow recovery. They note that the 'one-third for birds' threshold emerges despite all the confounding variables such as predation pressures and variation in the ocean habitat. The implication is that removal of LTL fish beyond a critical threshold changes the ecosystem capacity to support breeding birds; the same problems for breeding birds would be expected if prey abundance declines as the result of stochastic environmental change. In this regard, seabirds may simply represent an indicator of ecosystem condition, and the one-third for the birds may represent a convenient rule of thumb to ensure healthy ecosystem function, in addition to a guideline for fisheries management.

The patterns hold true not only across species of seabird with different life histories, but also LTL species with different life histories. Forage fish play an important linking role in energy transfer in marine ecosystems (Dickey-Collas *et al*., 2013; Alder *et al*., 2008). The examples that follow are evidence of the relationships between LTL prey and breeding seabirds selected to illustrate issues important to the application of the concept of 'one third for the birds'.

6.2 Seabird demographic data and impacts of fisheries

6.2.1 Barents Sea: guillemots, cod, capelin and herring

The collapse of the common guillemot population in the Barents Sea in the late 1980s was compelling and an early pointer to the potential catastrophic result of fisheries impacts on seabirds. Not only breeding failure but adult mortality occurred, with many colonies near extinction (Figure 1). Erikstad's *et al*. (2013) examination of long-term seabird and fisheries data has revealed the complexity of the situation.

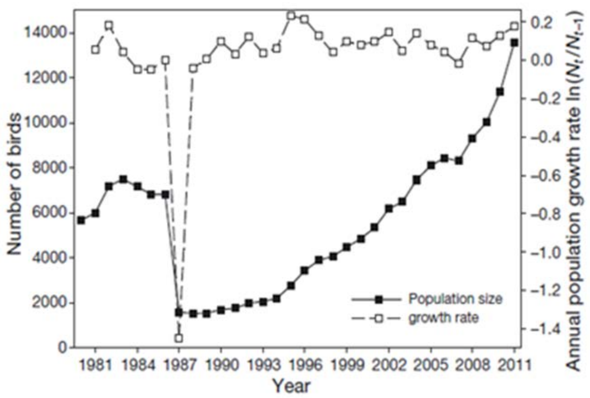

Figure 1. Annual variation in population size and annual growth rate of common guillemots breeding at Hornøya, NE Norway. Reproduced from Erikstad *et al*. (2013).

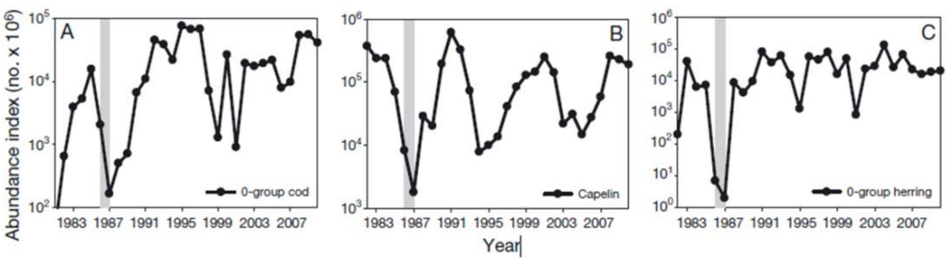

Figure 2. Annual variation in Barents Sea stock size indices of appropriate age classes of fish known as important prey for common guillemots breeding at Hornøya. Grey shading indicates the collapse in the common guillemot population. Reproduced from Erikstad *et al*. (2013).

Early accounts of the phenomenon identifying the low capelin stock as key prey species being the likely explanation of the population collapse (Vader *et al*., 1990) proved too simple. Long-term data on guillemot productivity and fish abundance suggested populations of several important prey species reached a nadir in 1987 (Figure 2). Capelin may have had a role in the guillemot population crash, but was not the only issue or even the major explanation (Erikstad *et al*., 2013). The capelin has collapsed twice since (1994/1995 and 2004/2005), without similar effects on the populations of common guillemot. In fact the abundance of 0-group cod explained most temporal variation in population growth rates over the long-term dataset, with adult guillemots depending heavily on 0-group cod, although they feed their chicks capelin, herring and sandeel (Bugge *et al*., 2011).

Erikstad's account of a more complex scenario should alert us to the need to appreciate that the relationship between seabirds and LTL prey is far from simple, variously because of poorly defined trophic relationships, because of the different impacts of fisheries (those for LTL fish and those removing predatory fish) and because of the many environmental factors which may result in perturbations in stocks. In the case of the Barents Sea stocks, the survival and transport of fish serving as prey past the colonies is identified as important (Erikstad *et al*., 2013; Myksvoll *et al*., 2013; Barrett *et al*., 2015). Stochastic events, the timing of storms or deviations in currents, can have a disproportionally large influence on larval fish (Cushing, 1982) and if stocks are low, there is clear potential for prey to be in short supply. When fish stocks are low there is overall a lower variation represented in the population, both in timing of hatching and in migration strategies. A smaller proportion of larvae are thus likely to find themselves in suitable conditions for survival and growth (match–mismatch hypothesis). This represents a fundamental characteristic of fish life history related to total spawning stock, and would result in a threshold effect in the survival and availability of LTL fish.

The Barents Sea guillemot example also emphasises the vulnerability of seabirds to extreme weather events, when several of their main prey stocks simultaneously drop below a critical level and the birds have experienced an extensive food shortage for a longer period of time (Mesquita *et al*., 2015). Reiertsen *et al*. (2014) shows that one of these LTL stocks, the Barents Sea capelin, is also a key factor for the survival of adult black-legged kittiwakes from the same colony, even if those birds spend most of the winter season in the West Atlantic.

6.2.2 Wadden Sea: common tern, herring and sprat

The long-term dataset (1977–2009) of LTL fish stocks and common tern productivity for the Wadden Sea provides insights into the scale and nature of dependencies (Dänhardt and Becker, 2011). Since 2002, during a period of low herring recruitment and low sprat abundance, Dänhardt and Becker documented very poor breeding success in common terns nesting at a number of sites in the Wadden Sea (Figure 3).

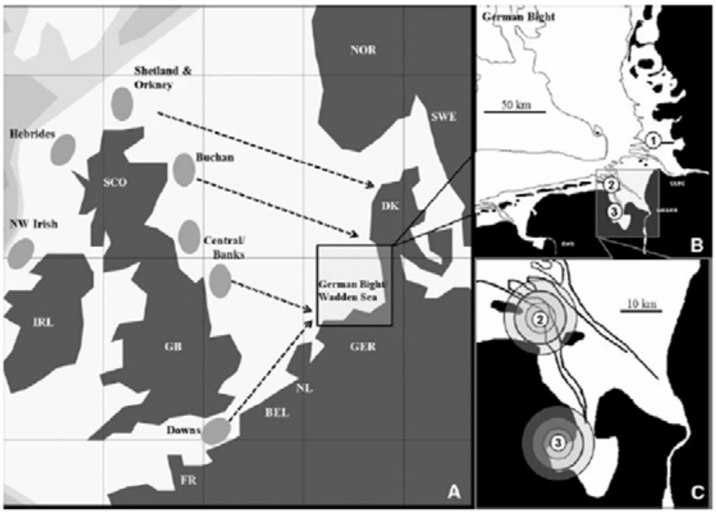

Figure 3. Geographic overview of the North Sea (A), the German Bight (B) and common tern breeding areas in the Lower Saxon Wadden Sea (C). Black arrows in the North Sea map (A) denote net drift directions of larvae being produced in the main spawning areas of North Sea autumn spawning herring. Numbers in the German Bight map (B) indicate (1) the fishing locations in the Meldorf Bight and the common tern breeding colonies (2) on the island of Minsener Oog and (3) at Banter See in Wilhelmshaven. Grey circles around the colony sites shown in the Wadden Sea map indicate the foraging range of the common terns (6.3 ± 2.4 km, mean ± SD). Reproduced from Dänhardt and Becker (2011).

The authors show that herring recruitment in the North Sea and sprat abundance in the Wadden Sea explained the largest part of the variation in common tern breeding success (Figure 4). A similar correlation between sprat abundance and common tern productivity has been recorded in the Firth of Forth (Jennings *et al.*, 2012). But it is the relationship between the birds in the Wadden Sea and North Sea herring recruitment that has interesting implications for fisheries management.

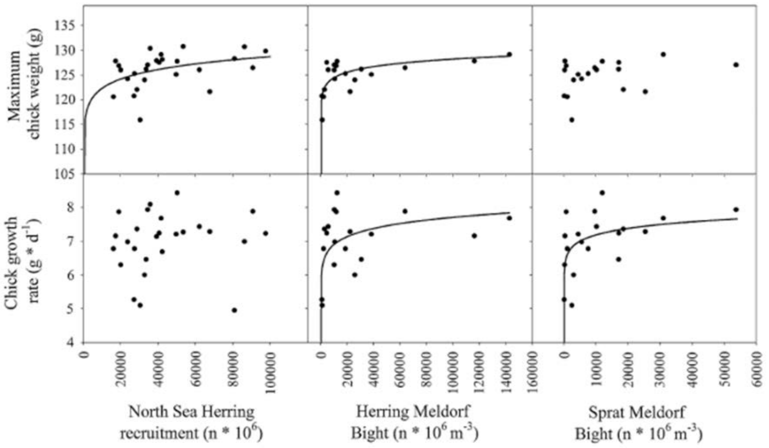

Figure 4. North Sea herring recruitment, and herring and sprat abundance in the Meldorf Bight as predictors of maximum weight (top) and growth rate (bottom) of common tern chicks at Banter See. Curves are only fitted to significant relationships. Reproduced from Dänhardt and Becker (2011).

If the aim is to secure populations of LTL fish for breeding seabirds, then defining the stocks is essential. To what extent are stocks of LTL fish discrete? In the Wadden Sea, the growth of common tern chicks is related to North Sea herring recruitment (Dänhardt and Becker, 2011). The movements of larval herring are well documented; the connectivity between the North Sea and Wadden Sea illustrates that the relevant spatial scale for management of LTL fish, if the aim is to secure the conservation status of dependent seabird populations, may extend well beyond the immediate breeding area.

6.2.3 Dogger Bank: kittiwakes and sandeels

Black-legged kittiwakes have repeatedly emerged as a species highly sensitive to changes in sandeel abundance. Frederiksen *et al*. (2004) showed strong effects of sandeel fishing locally on the breeding success of kittiwakes at the Isle of May (Firth of Forth, Scotland), independent of other environmental factors related to oceanographic change. Cook *et al*. (2014) found a very strong correlation between increases in breeding failure and fisheries pressure when sandeel populations were depleted; they concluded that sandeel fisheries had a significant impact on sandeel availability for seabirds. The implication of Cury *et al*. (2011) is that there are underlying functional responses that represent a problem if LTL fish are diminished below some critical abundance threshold. By implication, the infringement of a threshold for sandeel stocks may therefore be problematic for kittiwakes, and this may represent a functional shift in the marine ecosystem of greater consequence than previously thought.

Analysis of the kittiwake breeding success from 1986–2013 at Flamborough Head and Bempton Cliffs on the UK's North Sea coast shows that breeding success decreases as fishing mortality of sandeel on the Dogger Bank increases (Figure 5). The relationship seems robust, i.e. higher fishing mortality in year 1 is associated with lower kittiwake breeding success in year 3 (BirdLife International unpublished, 2015). The data also show a negative relationship between fishing mortality and spawning–stock biomass in the same year, suggesting that fishing mortality reduces SSB. This relationship was also present with lags of one year and two years, respectively (RSPB, unpublished). This gives a potential mechanism for the influence on kittiwake productivity.

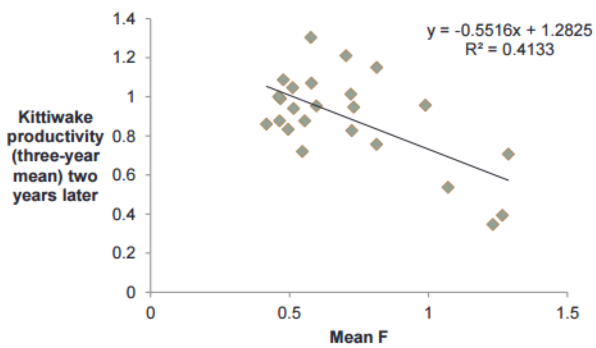

Figure 5. Kittiwake breeding success from 1986–2013 at Flamborough Head and Bempton Cliffs on the UK's North Sea coast as a function of fishing mortality of sandeels on the Dogger Bank, with a two year lag (BirdLife International unpublished data, 2015).

Based on the above assessment, BirdLife International argues that the commercial sandeel fishery on Dogger Bank could be having a negative impact on the productivity of kittiwake colonies at Flamborough and Filey Coast pSPA. The Royal Society for the Protection of Birds' (RSPB) records of kittiwake foraging trips from these colonies show that although a wide sea area is utilized, the birds from the Filey Brigg colony in the north tend to forage in a northeasterly direction towards, and reach as far as, the SW Dogger Bank (RSPB 'STAR' tracking data; Figure 6). The strength of the relationship between kittiwake productivity and sandeel fishing mortality suggests that the kittiwakes are dependent on this sandeel stock, and that the availability of prey to kittiwakes is affected by the fishery.

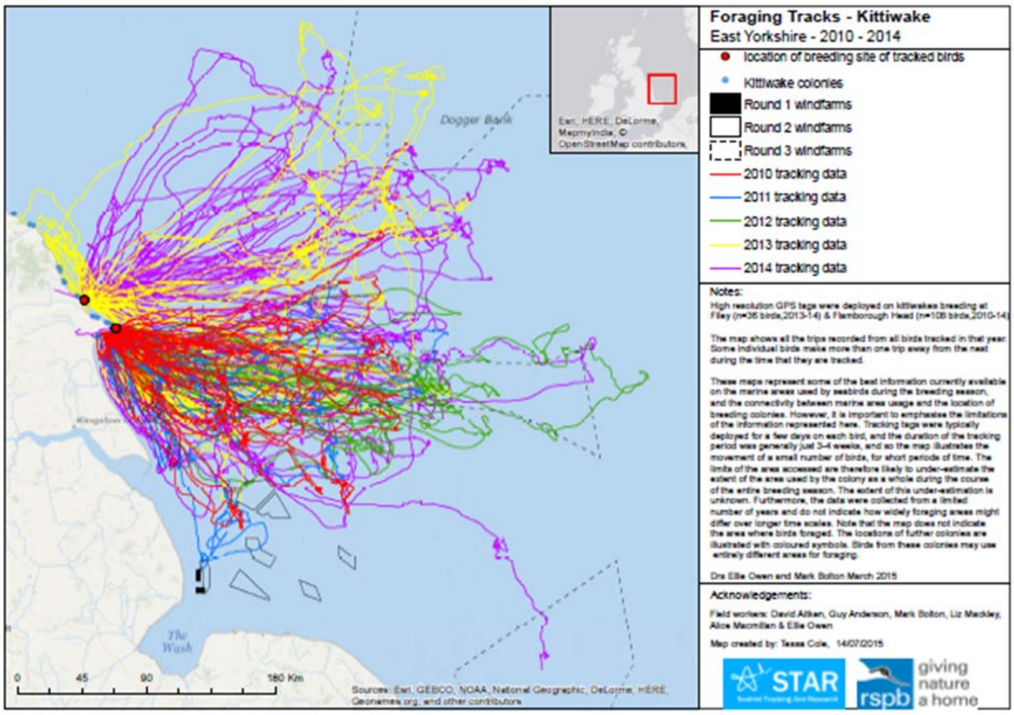

Figure 6. Kittiwake foraging trips from Flamborough Head and Bempton Cliffs on the UK's North Sea coast based on RSPB 'STAR' tracking data (RSPB, unpublished).

The concerns over the past 30 years over the potential impact of the North Sea sandeel fisheries on breeding seabirds lead to important questions in light of Cury *et al*. (2011). Is the management of sandeel stocks, particularly the definition of the stocks and decisions on the level of the harvest based on adequate scientific understanding? The divisions of North Sea sandeels into management units need to be justified in terms of the consequences for regional predators, whether kittiwakes or predatory fish. And the potential exists that the abundance of sandeels in one region will have implications for those in adjacent seas (e.g. they are not discrete).

Prior to 2010, North Sea sandeels were assessed and managed as a single stock, which was clearly too rough a scale as it did not account for strong regional variation in growth rate and recruitment as well as limited exchanges among substocks (Pedersen *et al*., 1999; Boulcott *et al*., 2007).

There is also a need to consider carry-over effects in seabirds. Birds breeding in one area may migrate elsewhere in the non-breeding season and so the population may be influenced by LTL fish stock abundance in more than one region. Food availability in winter may influence body condition of seabirds which may carry over into affecting their subsequent breeding success.

6.3 Filling gaps in knowledge

The value of long-term datasets showing the changing populations of seabirds and their fish prey suggests there is merit in considering how seabird demography serves as an indicator of altered foodwebs, and can be suggestive of underlying mechanisms, including indications of spatial scales of stocks (Dänhardt and Becker, 2011; Furness, 2007). The example from the Barents Sea illustrates the pitfalls and the need to assume trophic interactions rather than simplicity (Erikstad *et al*., 2013), which is not to justify inaction on the basis of complex trophic interactions. Sandvik *et al*. (2014) have provided a bleak outlook of the future of breeding black-legged kittiwakes in the Barents and Norwegian Seas, with a dependence on capelin and herring, respectively, affected by fisheries and climate change. Kittiwakes are of particular interest in this regard, sensitive to changing oceanographic conditions that affect prey availability and likely to experience significant population declines as the result of climate change (Carroll *et al*., 2015). Maintaining monitoring of demography, population size, breeding success and also chick weights and recruitment (when possible) is important; shedding light on the relative influence of anthropogenic and environmental perturbations on marine ecosystems.

Cury *et al*. (2011) does not imply we need to show restraint, keeping 'one third for the birds' to eat, but instead that at low stocks of LTL fish some functional change occurs in the marine community such that trophic flow stutters. As a priority there is a need for research with a focus on the underlying processes creating a threshold effect, creating problems for birds at low prey stock levels. Fisheries research could explore the basics of spawning success and larval survival at different stock levels (match–mismatch hypothesis), or density-dependent patterns of predation (particularly by fish, but also seabirds) including density-dependent changes in species interactions among marine predators. Also in the interest of improved sandeel fisheries management, the study of meta-populations is required. In terms of seabird research the 'one third for the birds' inspires interest in a more experimental approach. Such quasi-experiments are not easily designed and executed, with many confounding variables. They may be expensive, and the results may not be meaningful. With caution we recommend the following research.

Studies of foraging behaviour of seabirds in areas closed to LTL fisheries compared to fished areas would represent a simple quasi-experiment. The establishment of such scenarios for the sake of experimentation may not be appropriate, but if there are closures, or should closed areas reopen, it would be good to systematically collect relevant data. Is there evidence of stock depletion and does that have an effect on birds' foraging? One prediction is that as stocks of LTL fish are exploited there will be fewer and smaller prey patches, a pattern that could be evaluated with acoustic surveys. An ideal experimental design would include fished and unfished stocks of several LTL prey, for example including herring and sandeel, which differ in their life history; low populations of these two fish will not have same implications on functional relationships in the marine community, and would have different implications for different species of seabirds.

Where sandeel or sprat abundance is assessed by acoustic surveys, a study of seabird foraging in areas differing in prey density would provide a means of assessing the critical prey density required for profitable foraging by seabirds as implied by the

Cury *et al*. (2011) analyses. Tracking seabirds equipped with appropriate data loggers foraging in such areas of measured prey density would be an efficient way of demonstrating the immediate behavioural reactions of seabirds to changes in prey availability, and could shed light on the mechanisms underlying increased frequency of breeding failures.

Understanding the functional relationships within the ecosystem, whether due to fisheries or environmental changes, is aided by good understanding of the diet of predators (seabirds and fish) and how trophic links change through time. Given that seabird diet can be difficult to describe comprehensively, the documentation of the diet of predatory fish could be directed at the study of ecosystem changes in response to LTL fisheries. One innovative approach would be to establish a large-scale survey, a kind of citizen science project in which people gutting fish at sea during fishing operations document the stomach contents of the fish on an *ad hoc* basis. It would be possible to develop an app on a smartphone to track food chain events by generating images of the main stomach contents.

6.4 Implications for fisheries management

The simplest implication of Cury *et al*. (2011) is that 'one third for birds' should enter multispecies management plans, setting a default escapement level for commercially harvested stocks of LTL fish. Prey species which are critical for seabirds, particularly sandeel and sprat, are difficult to manage for MSY due to sensitivity to environmental stochasticity and the dependence of the fisheries on 0-class and 1-class fish, and there is an understanding that a precautionary approach is required when stocks are vulnerable (ICES, 2013); however management currently does not account fully for the importance of these stocks in marine ecosystems. The objectives for the Common Fisheries Policy (Regulation (EU) No 1380/2013) account for the potential environmental impact of fisheries. The Commission defined two important objectives:

- to ensure that decisions are based on best available knowledge of the interactions between fishing and ecosystems and that both direct and indirect impacts on the marine environment are minimized, in particular reducing the overall fishing pressure, and
- to ensure that fisheries measures are used fully to support the cross-sectoral approach defined by the EU's Marine Strategy Framework Directive and by the Habitats and Birds Directives.

Management of fisheries requires due attention to the impact on higher predators, namely the adoption of an ecosystem-based approach. The interactions between seabirds and their prey reflect complex processes within the marine environment (e.g. Erikstad *et al*., 2013). There is a growing understanding of the basis of seabird breeding failures and population changes, the extent to which they are at least in part a consequence of fisheries-driven changes in the marine ecosystem (Fauchald *et al*., 2011). While the principle of ecosystem-based fisheries management is written into the CFP, its application will be controversial as long as the evidence of impact on seabirds is weak or absent; Cury *et al*. (2011) provides a compelling argument that for fisheries exploiting LTL resources there is sufficient evidence. Furthermore, the generality of the relationship suggests it is broadly transferable when addressing seabird populations dependent on LTL resources.

There is a deficit of information on stock status of LTL fish, and therefore there is not the ability to evaluate the sustainability of fisheries (e.g. see ICES, 2013). A precautionary approach is frequently recommended, but these precautionary reductions in catch do not account for natural predation on the stocks and fall far short of securing 'one third for the birds'. ICES are currently (2015) advising a quota of 133 000 tonnes for Dogger Bank sandeel for 2015 despite the spawning–stock biomass being below the 'precautionary biomass threshold' in 2015. If the rule of thumb recommended by Cury *et al*. (2011) was used in management of this stock, the fact that the stock biomass is below one-third of maximum biomass should lead to considerations regarding management to protect dependent predators. If the obstacle to progress with an ecosystem-based approach is the lack of quantitative guidance on the stock required for the seabirds, then the results reported in Cury *et al*. (2011) are important. In short, it is recommended that the 'one-third for the birds' threshold be introduced as a useful rule of thumb for LTL fish stock management.

The assessment of, and allowable fishing effort for, sandeel in the respective management units need to be justified in terms of the consequences for kittiwakes and other dependent predators. In the case of the kittiwake, scrutiny of potential impacts is all the more relevant given that the species' threat status was raised in the 2015 IUCN European Red List to Vulnerable in Europe and Endangered at EU27 level (http://www.iucnredlist.org/details/22694497/1). Appropriate management action is also in keeping with OSPAR recommendations for the protection and conservation of kittiwake as a Threatened and Declining species (http://www.ospar.org/work-areas/bdc/species-habitats/list-of-threatened-declining-species-habitats).

Complex interactions between predators and the uncertainty that emerges when stocks are sensitive to environmental stochasticity are obstacles to management on an ecosystem scale. Ecosystem modelling is in development, with the goal of predicting the direct and indirect responses to fishing on one or more species, but the models are sensitive to initial assumptions (Jacobsen *et al*., 2015). However simplistic the 'one third for the birds' may be, setting thresholds in ecosystem modelling is sensible, with an understanding that once diminished to small numbers, stocks are highly vulnerable to environmental perturbations (Cushing, 1982). There are however two issues which must be addressed to implement the 'one third for birds' approach: to establish 'one third' there must be a good estimate of the total-stock biomass expected in the absence of fisheries, and there must be a biologically meaningful definition of the stock in space. Information on the population status and breeding success of seabirds may help with the latter in particular.

How can fisheries management practically integrate information on changing seabird demography into management recommendations? As part of all management the assessment of sensitive species of seabirds can serve as a measure of success, or provide a flag that something is wrong. The proposed indicator of black-legged kittiwake breeding performance as an important indicator of the state of the marine environment could serve this purpose.

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Annex 2: Agenda

Monday 9 November

14:00	Welcome by co-chairs, introduction to meeting structure and ways of working
14:30–18:00	Introduction to ToRs by leads
-	a & b, OSPAR indicators: Ian Mitchell
-	c & d, HELCOM indicators: Volker Dierschke
-	e, windfarms and seabird ecology: Bob Furness
-	f, assessing effects of Landings Protocol: Linda Wilson
-	g, threats and measures regarding non-native predators: David Fleet??
-	h, impacts of fishery-driven changes on seabirds: Nancy Harrison

Tuesday 10 November

09:00–11:00	ToR e plenary discussion
11:00–18:00	Parallel sessions:
-	ToRs a–d
-	ToR e
15:00–16:00	ToR F questionnaire on discard ban impacts

Wednesday 11 November

09:00–11:00	ToR f, g, h plenary discussion
11:00–16:30	Parallel sessions:
-	ToRs a–d
-	ToRs e and f
16:30–18:00	Concluding plenary, ToR e

Thursday 12 November

09:00–11:00	Concluding plenary, ToRs a–d
11:00–16:00	Parallel sessions:
-	ToRs f, g and h
16:00–18:00	Concluding plenary, ToRs f, g and h

Friday 13 November

09:00–15:00	Report writing and discussions *ad hoc*

Annex 3: Proposed DRAFT JWGBIRD terms of reference for 2016

Note that the draft ToR have been developed by the Joint Working Group and are subject to finalisation and adoption by all partners, HELCOM, ICES and OSPAR through their respective decision-making processes.

The **Joint ICES/OSPAR/HELCOM Working Group on Seabirds** (JWGBIRD), chaired by Morten Frederiksen (Denmark), Ian Mitchell (UK) and Volker Dierschke (Germany), will meet at the British Trust for Ornithology (BTO) HQ in Thetford, UK, 10–14 October 2016 to:

a) Develop a concept for incorporating at-sea data in the abundance indicators of HELCOM and OSPAR (OSPAR MSFD common indicator B1 and HELCOM wintering waterbirds abundance core indicator). This will include:

  i) Review of relevant data available from previous studies in the OSPAR area (respective information on seabird monitoring surveys carried out in the HELCOM area/ Baltic Sea since 1991 was already made available in the HELCOM BALSAM seabird meta-database).

  ii) Concept for coordinated large-scale at-sea surveys in the HELCOM and OSPAR areas in future years that will deliver the necessary data basis for the abundance indicator work (based on experiences during the HELCOM joint winter survey 2015/2016 and previous work in the North Sea using the ESAS data, see Annex 1 of the OSPAR CEMAP Guidelines for indicator B1-marine bird abundance).

  iii) Methodological considerations for the development of abundance indicators derived from at-sea data, in combination with land-based count data where applicable.

b) Implementation of the EU Plan of Action on Seabird Bycatch, potentially in collaboration with WGBYC.

  i) Gap analysis of what's being done and what could/should be done. Identify mitigation measures appropriate to the bycatch-relevant fishing métiers in the OSPAR and HELCOM areas.

  ii) How can we better use seabird samples from seabird bycatch on survey vessels (e.g. stable isotope analysis, ingested plastics, diet)?

  iii) Bycatch from the NE Atlantic long-lining fleets – can we improve on knowledge of the extent of bycatch?

c) Review of threats to marine birds that breed or overwinter in the OSPAR and HELCOM areas and spend the rest of the year elsewhere (e.g. northern gannets that overwinter in Mauretania; roseate terns in overwinter along the coast of West Africa; long-tailed ducks that breed in Arctic Russia).

d) Non-native and invasive mammal predation. If something shall still be discussed in 2016 it could be ideas on research projects enhancing our understanding of predator–seabird interactions which might help to develop mitigation measures.

e) Strategic use of new technologies: e.g. tracking, digital aerial surveys, etc.

  i) Sharing experiences of using new technologies.

  ii) What key questions can we use them to answer?

- iii) How can these be used with more traditional techniques for estimating abundance and demographic parameters?
- iv) Which completely new technologies would be really useful? A wish-list.

f) Use of citizen science; can we use it more extensively than we already do?

- i) Review of existing projects concerning seabirds, e.g. counts during breeding/wintering seasons and beached-bird surveys, with respect to their value for science and environmental assessments.
- ii) How do we capacity-build (i.e. increase appropriate skills in volunteers)?
- iii) How do we better use those highly skilled individuals?

JWGBIRD will report by DATE to the attention of ACOM.

Supporting Information

Priority	The current activities of this Group will lead ICES into issues related to the ecosystem affects of fisheries, especially with regard to the application of the Precautionary Approach. Consequently, these activities are considered to have a very high priority.
Scientific justification	Term of Reference a) ICES has played a key role in supporting the development of regional indicators of bird population status in the Greater North Sea since the inception of EcoQOs in 2001. The joint OSPAR/ICES Working Group was formed in 2014 in order to e.g. take forward the further development and testing of these indicators. It was joined in 2015 by HELCOM to further enhance coherence of environmental status assessments between the two RSCs. Coherence in the assessments is seen as being of particular relevance for the highly mobile seabirds migrating across the two regions. Both RSCs adopted a first set of common or core indicators to support the implementation of the EU MSFD each including two common/core indicators for marine birds. The first assessments of the abundance indicators could not cover all relevant species as crucial data on at-sea occurrence had not been available. The task will be to form a concept for integrating at-sea data in the abundance indicators of HELCOM and OSPAR. Term of Reference b) In 2012, the EU Commission launched an Action Plan which includes 30 recommended actions in order to address the problem of incidental catches of seabirds in fishing gears. Though the ICES Working Group on Bycatch of Protected Species (WGBYC) generally deals with bycatch related issues, there is a close link to the work of JWGBIRD to the bycatch problem with regard to science and environmental assessment. The HELCOM core indicator "Number of drowned mammals and waterbirds in fishing gear" aims to quantify seabird bycatch in gillnets, with results expected to lead to implementation of mitigation measures in the frame of MSFD. It is relevant that seabird experts review the success of the Action Plan and more specifically the actions actually taken as well as to compare those measures with the current state of knowledge based on more recent research (such as the application of net panels and the coloration of monofilaments). Bycatch monitoring and case studies can supply corpses of killed seabirds, which could support science in general (i.e. examination of diet, stable-isotope analyses) or marine environmental monitoring of bycatch itself (e.g. age and sex classes of birds affected) or of marine pollution (ingested plastic, contaminants in tissues). Relevant recommendations for future monitoring strategies would enhance cost-effective and comprehensive monitoring. JWGBird would appreciate to collaborate with WGBYC on these issues. Term of Reference c) Both OSPAR and HELCOM have implemented indicators measuring the abundance of seabirds in the breeding and wintering seasons. Most seabird species included in these indicators do not spend their whole annual cycle in the assessment areas, because as migratory birds they either leave to the west and south for distant wintering areas as far away as the Antarctic and Australia, or they breed in the Arctic of Eurasia and North America before and after spending winter in the NE Atlantic (including the Baltic Sea). Thus, the abundance of seabirds in OSPAR and HELCOM areas is influenced by factors acting outside these assessment areas and therefore observed trends have to be adjusted for external impacts in order to avoid erroneous conclusions, including measures derived from the assessment results. The task will be to identify relevant external influence on seabird abundance and how this knowledge can both be monitored and included into assessments. Term of Reference d)

	– Term of Reference e) – Term of Reference f) –
Resource requirements	The research programmes which provide the main input to this group are already underway, and resources are already committed. The additional resource required to undertake additional activities in the framework of this group is negligible. ICES members as well as HELCOM and OSPAR Contracting Parties are to commit national experts to participate in the annual meeting of the group as well as in intersessional work as needed.
Participants	About 20 participants are expected.
Secretariat facilities	None.
Financial	No financial implications for ICES.
Linkages to advisory committees	This is an ACOM group. Its outputs may inform the work of other groups working on integrated ecosystem assessments.
Linkages to other committees or groups	There is a close working relationship with all the groups of SSGEPI.
Linkages to other organizations	OSPAR (in particular ICG-COBAM and BDC) and HELCOM (Particularly HELCOM State and Conservation).

Annex 4: Recommendations

Recommendation	Adressed to
1. Assess the current status of and (past and future) trends in the availability of small pelagic fish for surface-feeding predators with special focus on the period from 1990 onwards, with particular emphasis on the North Sea. Background: It has been observed that population sizes of seabird species feeding on small fish at or close to the surface are declining, whereas those of species diving into deeper layers of the water column are doing better. JWGBIRD is interested in vertical shifts in the abundance of small pelagic fish which would help to explain the population trends of seabirds.	ICES WGSPEC (Working Group on Small Pelagic Fish, their Ecosystems and Climate Impact).
2.	
3.	
4.	
5.	

Annex 5: Common and scientific names of species mentioned in the report

For mammals, see Table 1 in Section 5.

Birds

Arctic skua	*Stercorarius parasiticus*
Arctic tern	*Sterna paradisaea*
Audouin's gull	*Ichthyaetus audouinii*
Balearic shearwater	*Puffinus mauretanicus*
Barnacle goose	*Branta leucopsis*
Black guillemot	*Cepphus grylle*
Black-headed gull	*Chroicocephalus ridibundus*
Black-legged kittiwake	*Rissa tridactyla*
Black-throated diver	*Gavia arctica*
Caspian tern	*Hydroprogne caspia*
Common coot	*Fulica atra*
Common eider	*Somateria mollissima*
Common goldeneye	*Bucephala clangula*
Common guillemot	*Uria aalge*
Common gull	*Larus canus*
Common pochard	*Aythya ferina*
Common raven	*Corvus corax*
Common scoter	*Melanitta nigra*
Common shelduck	*Tadorna tadorna*
Common tern	*Sterna hirundo*
Cory's shearwater	*Calonectris borealis*
Dunlin	*Calidris alpina*
Eurasian oystercatcher	*Haematopus ostralegus*
Eurasian teal	*Anas crecca*
Eurasian wigeon	*Anas penelope*
European storm-petrel	*Hydrobates pelagicus*
Goosander	*Mergus merganser*
Great black-backed gull	*Larus marinus*
Great cormorant	*Phalacrocorax carbo*
Great crested grebe	*Podiceps cristatus*
Great skua	*Catharacta skua*
Greater scaup	*Aythya marila*
Greylag goose	*Anser anser*
Herring gull	*Larus argentatus*
Lesser black-backed gull	*Larus fuscus*
Little gull	*Hydrocoloeus minutus*
Little tern	*Sternula albifrons*
Long-tailed duck	*Clangula hyemalis*

ARCTIC SKUA	*STERCORARIUS PARASITICUS*
Mallard	*Anas platyrhynchus*
Mediterranean gull	*Ichthyaetus melanocephalus*
Mute swan	*Cygnus olor*
Northern fulmar	*Fulmarus glacialis*
Northern gannet	*Morus bassanus*
Northern pintail	*Anas acuta*
Pied avocet	*Recurvirostra avosetta*
Razorbill	*Alca torda*
Red-breasted merganser	*Mergus serrator*
Red-necked grebe	*Podiceps grisegena*
Red-throated diver	*Gavia stellata*
Ringed plover	*Charadrius hiaticula*
Sandwich tern	*Thalasseus sandvicensis*
Slavonian grebe	*Podiceps auritus*
Slender-billed gull	*Chroicocephalus genei*
Smew	*Mergellus albellus*
Sooty shearwater	*Puffinus griseus*
Steller's eider	*Polysticta stelleri*
Tufted duck	*Aythya fuligula*
Velvet scoter	*Melanitta fusca*
White-tailed eagle	*Haliaeetus albicilla*
Whooper swan	*Cygnus cygnus*
Yelkouan shearwater	*Puffinus yelkouan*
Yellow-legged gull	*Larus michahellis*

Fish, etc.

Capelin	*Mallotus villosus*
Cod (Atlantic cod)	*Gadus morhua*
Common sole	*Solea solea*
Haddock	*Melanogrammus aeglefinus*
Hake (European hake)	*Merluccius merluccius*
Herring (Atlantic herring)	*Clupea harengus*
Northern prawn	*Pandalus borealis*
Norway lobster	*Nephrops norvegicus*
Plaice (European plaice)	*Pleuronectes platessa*
Saithe	*Pollachius virens*
Salmon (Atlantic salmon)	*Salmo salar*
Sandeel (lesser sandeel)	*Ammodytes marinus*
Sprat	*Sprattus sprattus*
Whiting	*Merlangius merlangus*

Annex 6: Intermediate Assessment 2017; Common indicator sheet: B1-Marine bird abundance

Key message

In both the Celtic Seas and Greater North Sea, the proportion of species for which relative abundance was above the desired thresholds, dropped below 75% in 2005 and has remained so since. Migratory and overwintering populations of waders and grazers that use intertidal areas appear to be doing relatively well. Species of seabird that breed in the two regions and can feed on fish throughout the water column are faring better than other breeding seabird species that can only feed on fish at the surface.

Background

This indicator describes changes in abundance of breeding and non-breeding marine birds, i.e. birds relying on marine food resources. Birds are a highly visible component of marine ecosystems. Collectively, these species represent a variety of feeding guilds, from herbivores to top predators. Due to the long lifespan of these species, abundance changes slowly and is sensitive to a variety of pressures.

This indicator will be affected by pressure from fishing, predation by non-indigenous mammals and habitat loss, as well as a variety of other human-induced factors. Fishing impacts include competition for food and mortality from bycatch. Many seabird species have benefited from food provided by the fishing industry through discards. This indicator may help us monitor the impact on seabird populations of the new EU Landings Regulations aimed at eliminating discards.

The indicator and its thresholds are derived from the OSPAR EcoQO on Seabird population trends as an index of seabird community health. The EcoQO on seabird population trends was adopted by OSPAR's Biodiversity Committee (BDC) in 2012 (see OSPAR 2012).The results of testing and development are documented in ICES (2008, 2010, 2011, 2012 and 2013a–d, 2015). Abundance is used as an indicator of seabird community health because it is:

- measured widely and relatively easily;
- a good indicator of long-term changes in seabird community structure;
- likely to change slowly under 'natural' conditions, so rapid changes in their numbers might indicate human-induced impacts, thereby providing a cue for immediate management actions.

This indicator includes information on marine bird species, which at some point in their annual life cycle, are reliant on coastal and/or offshore areas. The indicator is constructed from species-specific trends in annual abundance. The monitoring and data collation described below, concern marine birds when they are:

g) on land at breeding colonies or sites, nesting close to the coast and using marine environment (e.g. for food); and/or

h) in intertidal areas or close to the shore and counted from land during migration or overwinter.

In the context of MSFD, abundance indicators could also be constructed from time-series data collected at sea (see section on gaps below).

In this context, 'marine birds' include the following taxonomic groups that are commonly aggregated as 'waterbirds' and 'seabirds':

> Waterbirds: shorebirds (order Charadriiformes); ducks, geese and swans (Anseriformes); divers (Gaviiformes); and grebes (Podicipediformes);
>
> Seabirds: petrels and shearwaters (Procellariiformes); gannets and cormorants (Pelecaniformes); skuas, gulls, terns and auks (Charadriiformes).

Shorebirds, some duck species and some gulls feed on benthic invertebrates in soft intertidal sediments and on rocky shores. Geese mostly graze on exposed eelgrass beds (i.e. *Zostera* spp.). Diving duck species feed on invertebrate benthos in shallow inshore waters. All other marine birds, including some gulls, spend the majority of their lives at sea, feeding on prey living within the water column (i.e. plankton, fish and squid) or picking detritus from the surface. Divers, piscivorous ducks, grebes, cormorants, gulls and terns tend to be confined to inshore waters; whereas petrels, shearwaters, gannets, skuas and auks venture much further offshore and beyond the shelf break.

Assessment methods

Background

This indicator is generated using time-series of annual estimates of abundance of individual species.

Data used and not used in this assessment

This assessment is based on analyses that were conducted in 2014 as part of the process of testing the Indicator. In 2015, more recent data have been submitted by some contracting parties, but unfortunately technical problems encountered by the UK lead have meant that new analyses could not be run in time. An updated assessment that uses all available data is planned for spring 2016.

In 2014, data were submitted by CPs for the period 1980–2013. When all data from participating CPs had been collated, it became clear that variability of the quantity of data available at the beginning and end of the time-series may give an erroneous impression of species abundance in the OSPAR II subregion. For this reason, the time-series were restricted to the period 1991–2011.

Separate assessments were carried out for each OSPAR Region. The results below are confined to OSPAR Regions II-the Greater North Sea and III-the Celtic Seas. Unfortunately, this assessment does not include OSPAR Region I, despite Norway submitting both breeding and non-breeding data from the Norwegian Sea and Barents Sea (including Svalbard and Jan Mayen). The assessment of the Greater North Sea omits all data from the Skagerrak and Kattegat submitted in 2015 by Denmark and Sweden and omits data for the Norwegian and Danish North Sea Coasts that were submitted by Norway and Denmark in 2015 (but includes the Danish Wadden Sea). In 2014, no data were made available for OSPAR IV-Bay of Biscay and Iberian coast, but France did submit breeding counts in 2015, but unfortunately these are not included in this assessment. No data on non-breeding birds have yet been submitted by France. No data on breeding or non-breeding have been submitted yet by Spain and Portugal (including the Azores in Region V-Macaronesia).

Table 1 summarizes which data have been used in OSPAR Region and also shows those data that were submitted in 2015, but could not be used.

Table 1. List of Contracting Parties in each OSPAR Region that are included in the data on i) breeding abundance and ii) non-breeding abundance, which were used in this assessment. It also lists those data provided by each CP in 2015 that could not be used in the assessment (for technical reasons) and lists those data that will probably be available in the updated assessment, which is planned in 2016.

i) breeding abundance

CP	OSPAR REGION	Data used 2015 assessment	Data submitted in 2015	Data to be used in 2016 assessment
NO	I	None	1980-2014	up to 2015
NO	II	up to 2012	1980-2014	up to 2015
FR	II	up to 2012	none	up to 2015
BE	II	up to 2012	1980-2014	up to 2015
NL - DELTA	II	up to 2012	None	up to 2015
NL - Waddenzee	II	up to 2012	None	up to 2015
DE/DK -Waddenzee	II	up to 2012	None	up to 2015
DE- Helgoland	II	up to 2012	None	up to 2015
DK - Skager-rak/Kattegat	II	None	up to 2014	up to 2015
SE	II	None	2001-13	up to 2015
UK	II & III	up to 2012	up to 2014	up to 2015
IRE	III	up to 2012	up to 2014	up to 2015
FR	IV	none	up to 2014	up to 2015
ES	IV	none	none	?
PT	IV	none	none	?

ii) non-breeding abundance

CP	OSPAR REGION	Data used 2015 assessment	Data submitted in 2015	Data to be used in 2016 assessment
NO	I	None	1980-2014	up to 2015
NO	II	up to 2011	1980-2014	up to 2015
FR	II	up to 2011	none	?
BE	II	up to 2011	none	up to 2015
NL - DELTA	II	up to 2011	None	up to 2015
NL - Waddenzee	II	up to 2011	None	up to 2015
DE/DK -Waddenzee	II	up to 2011	None	up to 2015
DE- Helgoland	II	up to 2011		
DK - Skager-rak/Kattegat	II	None	up to 2014	up to 2015
SE	II	None	2001-13	up to 2015
UK	II & III	up to 2011	None	up to 2015
IRE	III	up to 2011	None	?
FR	IV	none	None	?
ES	IV	none	none	?
PT	IV	none	none	?

Species-specific indicators of abundance

Parameter/metric

The indicator metric is 'relative abundance', which is annual abundance expressed as a percentage of the baseline:

'relative abundance' % = 100 * (annual total abundance./ baseline abundance)

Data acquisition

This assessment uses breeding and non-breeding abundance data collected from 1991 to 2011 that were submitted in 2014.

The following data were requested from contracting parties:

1. Breeding seabird colonies (incl. gulls and terns) and breeding waterbirds (including waders) nesting close to the coast and using marine environment (e.g. for food); counts of breeding pairs (preferably or failing that, adults) per species per colony per year.
2. Wintering and passage waterbirds (including waders); numbers of birds per species per site per year that are counted from land. These data consisted mostly of maximum or single counts conducted in January. Data from the Wadden Sea consisted of mean counts conducted throughout the year from July to June. In order that counts from different areas of the same region are comparable, future assessments should use only January counts (or as close as possible e.g. in Northern Norway and Svalbard counts are conducted in March when there is sufficient daylight to do so).

Most data refer to individual colonies or sites rather than over large stretches of coastline; except Wadden Sea, Swedish Kattegat and Skagerrak and in the Netherlands.

Trend analysis

Since the first assessment of the EcoQO on seabird population trends (ICES, 2008), JNCC (UK) in collaboration with Biomathematics and Statistics Scotland developed an analytical 'wizard' for estimating trends in breeding numbers of individual species at various geographical scales including OSPAR Regions. The seabird trend wizard uses a modified chain method, first developed by Thomas (1993), to impute values of missing counts based on information in other years and sites (details of the Thomas method are given in Annex 3 of ICES, 2008). The advantage of this method is that it allows for site-specific variation at each colony, thereby avoiding the conventional assumption that changes in abundance at different colonies occur synchronously. The wizard is a small Delphi application that retrieves counts from an Access database and generates script files and a DOS batch file that instruct R to conduct the trend analysis using the Thomas (1993) method. A further advantage of the new wizard is that the analyses can incorporate both whole colony counts and plot counts, even when they exist for the same colony in the same year. When JNCC were developing the analysis tool they investigated using Bayesian Models (see Parsons *et al.*, 2008) which also negated the assumption of synchroneity that is required by other methods such as GAMs. The Bayesian models proved time consuming to run and the confidence in trends produced by the Thomas method compared well to the Bayesian output. Neither Bayesian or GAMs models could capture extinction or colonization events, and therefore were inappropriate to species that demonstrate no or low site fidelity between years, i.e. the great cormorant and the tern species.

The wide confidence intervals from the Thomas imputation method reflect the fact that the method is empirical, and that the intervals were based on a form of nonparametric re-sampling that makes only weak assumptions regarding the structure of the data.

Species selection & aggregation (functional groups)

There were sufficient data to construct species-specific indicators of relative breeding abundance for the following 19 species: Arctic skua, Atlantic Puffin, black guillemot, black-headed gull, common tern, fulmar, great cormorant, great skua, kittiwake, little tern, Manx shearwater, gannet, avocet, roseate tern, Sandwich tern, spoonbill, sandwich tern Kentish plover and European storm-petrel.

There were sufficient data to construct species-specific indicators of relative non-breeding abundance for the following 31 species: bar-tailed godwit, Brent goose, common merganser, curlew, dunlin, goldeneye, great crested grebe, greater scaup, greenshank, grey plover, little egret, long-tailed duck, mallard, oystercatcher, avocet, pintail, pochard, purple sandpiper, red-breasted merganser, red knot, redshank, ringed plover, sanderling, shelduck, Slavonian grebe, teal, tufted duck, turnstone and widgeon.

Species were assigned to the functional groups given in Table 2. The species assessed and the functional groups to which they were assigned, are given in Table 3.

Table 2. Marine bird functional groups.

Functional group	Typical feeding behaviour	Typical food types	Additional guidance
Wading feeders	Walk/wade in shallow waters	Invertebrates (molluscs, polychaetes, etc.)	
Surface feeders	Feed within the surface layer (within 1–2 m of the surface)	Small fish, zooplankton and other invertebrates	"Surface layer" defined in relation to normal diving depth of plunge-divers (except gannets)
Water column feeders	Feed at a broad depth range in the water column	Pelagic and demersal fish and invertebrates (e.g. squid, zooplankton)	Include only spp. that usually dive by actively swimming underwater; but including gannets. Includes species feeding on benthic fish (e.g. flatfish).
Benthic feeders	Feed on the seabed	Invertebrates (e.g. molluscs, echinoderms)	
Grazing feeders	Grazing in intertidal areas and in shallow waters	Plants (e.g. eelgrass, saltmarsh plants), algae	Geese, swans and dabbling ducks, coot

Table 3. Species included in assessment of B1-marine bird abundance 2015.

Species (English Name)	Species (Scientific Name)	Grazing feeders	Wading feeders	Surface feeders	Water column feeders	Benthic feeders	Used in B1
Red-throated diver	*Gavia stellata*				X		
Black-throated diver	*Gavia arctica*				X		
Great Northern diver	*Gavia immer*				X		
White-billed diver	*Gavia adamsii*				X		
Great crested grebe	*Podiceps cristatus*				X		X
Red-necked Grebe	*Podiceps grisegena*				X		
Slavonian grebe	*Podiceps auritus*				X		X
Northern Fulmar	*Fulmarus glacialis*			X			X
Sooty Shearwater	*Puffinus griseus*			X	X		
Manx Shearwater	*Puffinus puffinus*			X	X		X
Balearic shearwater	*Puffinus mauretanicus*			X	X		
Cory's Shearwater	*Calonectris diomedea*			X	X		
European Storm-petrel	*Hydrobates pelagicus*			X			X
Leach's Storm-petrel	*Oceanodroma leucorhoa*			X			
Northern gannet	*Morus bassanus*				X		X
Great Cormorant	*Phalacrocorax carbo*				X	X	X
European shag	*Phalacrocorax aristotelis*				X	X	X
Eurasian spoonbill	*Platalea leucorodia*		X				X
Mute Swan	*Cygnus olor*	X					
Bewick's Swan	*Cygnus bewickii*	X					
Whooper Swan	*Cygnus cygnus*	X					
Greylag goose	*Anser anser*	X					

Species (English Name)	Species (Scientific Name)	Grazing feeders	Wading feeders	Surface feeders	Water column feeders	Benthic feeders	Used in B1
Greenland white-fronted goose	*Anser albifrons flavirostris*	X					
Canada Goose	*Branta canadensis*	X					
Barnacle Goose	*Branta leucopsis*	X					
Brent Goose	*Branta bernicla*	X					X
Shelduck	*Tadorna tadorna*		X				X
Wigeon	*Anas penelope*	X					X
Teal	*Anas crecca*		X				X
Mallard	*Anas platyrhynchos*	X	X				X
Pintail	*Anas acuta*	X	X				X
Shoveler	*Anas clypeata*	X					
Pochard	*Aythya ferina*					X	X
Tufted Duck	*Aythya fuligula*					X	X
Greater Scaup	*Aythya marila*					X	X
Common Eider	*Somateria mollissima*					X	
King eider	*Somateria spectabilis*					X	
Steller's eider	*Polysticta stelleri*					X	
Long-tailed Duck	*Clangula hyemalis*					X	X
Common Scoter	*Melanitta nigra*					X	
Velvet Scoter	*Melanitta fusca*					X	
Goldeneye	*Bucephala clangula*					X	X
Common merganser	*Mergus merganser*				X		X
Red-breasted Merganser	*Mergus serrator*				X		X
Smew	*Mergellus albellus*				X		
Coot	*Fulica atra*	X					

Species (English Name)	Species (Scientific Name)	Grazing feeders	Wading feeders	Surface feeders	Water column feeders	Benthic feeders	Used in B1
Oystercatcher	*Haematopus ostralegus*		X				X
Black-winged Stilt	*Himantopus himantopus*		X				
Pied avocet	*Recurvirostra avosetta*		X				X
Lapwing	*Vanellus vanellus*		X				
Golden plover	*Pluvialis apricaria*		X				
Grey Plover	*Pluvialis squatarola*		X				X
Ringed plover	*Charadrius hiaticula*		X				X
Kentish Plover	*Charadrius alexandrinus*		X				X
Bar-tailed Godwit	*Limosa lapponica*		X				X
Whimbrel	*Numenius phaeopus*		X				
Curlew	*Numenius arquata*		X				X
Spotted Redshank	*Tringa erythropus*		X				
Redshank	*Tringa totanus*		X				X
Greenshank	*Tringa nebularia*		X				X
Wood Sandpiper	*Tringa glareola*		X				
Turnstone	*Arenaria interpres*		X				X
Red-necked Phalarope	*Phalaropus lobatus*			X			
Grey Phalarope	*Phalaropus fulicarius*			X			
Red Knot	*Calidris canutus*		X				X
Sanderling	*Calidris alba*		X				X
Little Stint	*Calidris minuta*		X				
Curlew Sandpiper	*Calidris ferruginea*		X				
Purple sandpiper	*Calidris maritima*		X				X

Species (English Name)	Species (Scientific Name)	Grazing feeders	Wading feeders	Surface feeders	Water column feeders	Benthic feeders	Used in B1
Dunlin	*Calidris alpina schinzii & arctica*		X				X
Ruff	*Philomachus pugnax*		X				
Arctic skua	*Stercorarius parasiticus*			X			X
Long-tailed Skua	*Stercorarius longicaudus*			X			
Pomarine Skua	*Stercorarius pomarinus*			X			
Great Skua	*Stercorarius skua*			X			X
Glaucous gull	*Larus hyperboreus*						
Great Black-backed Gull	*Larus marinus*			X			
Herring gull	*Larus argentatus*		X	X			
Lesser black-backed gull	*Larus fuscus intermedius/graellsii*		X	X			
Common Gull	*Larus canus*		X	X			
Mediterranean Gull	*Larus melanocephalus*			X			
Black-headed Gull	*Croicocephaplus ridibundus*		X	X			X
Little Gull	*Larus minutus*			X			
Black-legged kittiwake	*Rissa tridactyla*			X			X
Ivory gull	*Pagophila eburnea*			X			
Little Tern	*Sternula albifrons*			X			X
Roseate tern	*Sterna dougallii*			X			X
Common tern	*Sterna hirundo*			X			X
Arctic tern	*Sterna paradisaea*			X			
Sandwich tern	*Sterna sandvicensis*			X			X
Black Tern	*Chlidonias niger*			X			

Species (English Name)	Species (Scientific Name)	Grazing feeders	Wading feeders	Surface feeders	Water column feeders	Benthic feeders	Used in B1
Razorbill	*Alca torda*				X		
Common Guillemot	*Uria aalge*				X		
Brünnich's guillemot	*Uria lomvia*						
Black Guillemot	*Cepphus grylle*				X		X
Little Auk	*Alle alle*				X		
Puffin	*Fratercula arctica*				X		X

Assessments

Baselines

It is preferable to set baselines objectively, by using one of the methods (a) or (b), listed below (from ICES, 2015). But most CPs did not provide baselines in 2014. As an alternative, relative breeding abundance was calculated using a baseline equal to the abundance in the first year of the time-series (i.e. 1991). Likewise, relative non-breeding abundance was calculated using a baseline equal to the mean abundance during the first ten years of the time-series (i.e. 1991–2000).

a) 'Historical reference' where we know abundance a point in the past long before the time-series began; but don't know why it may have changed since. Historical population estimates were sued as baselines if they were recorded:

  i) before known human impacts; and /or

  ii) before other major declines in population; or

  iii) at known plateaus in population trends, following increases and peaks in population size.

b) Reference level-where we would expect the population size to be if anthropogenic impacts were negligible (this can be derived from known population sizes either historically or from within time-series). The highest known population estimate were used when the population has decreased in size, as a result of human impacts (e.g. periods of severe contamination) or following stochastic natural impacts (e.g. severe weather wrecks). Recent population estimates (e.g. previous five year mean) were used when a species has been colonizing.

Species-specific thresholds for relative abundance

Each species-specific trend in annual relative abundance (i.e. annual abundance as a percentage of the baseline) was compared against the following lower thresholds:

- 80% (i.e. desirable relative abundance is greater than 80%); only for species that lay one egg, or

- 70% (i.e. desirable relative abundance is greater than 80%); only for species that lay more than one egg.

These lower thresholds were developed for the EcoQO on seabird population trends (see ICES, 2008; 2010; 2011). The different thresholds are designed to reflect the resilience of populations to decline.

Each species-specific trend in relative abundance was also compared against an upper target threshold of 130% of the baseline. This upper threshold was used by the EcoQO on seabird population trends to flag-up potentially disruptive increases in some species that might impact on other species. However, this may mean that the EcoQO or GES is not achieved if some species recover to levels in excess of the baseline, without having a detrimental impact on other species. It appears that GES is not clearly indicated by the upper threshold, but it is used in the context of the IA2017 to provide a trigger for action (research and/or management) if appropriate.

Multispecies assessment

Multispecies assessments of B1 were derived from the number of species within an assessment unit (i.e. region or subdivision thereof) that had annual relative abundance greater than the species-specific thresholds of 70% or 80%, depending on species (see above). Multispecies assessments were made for all species and within each functional group.

The proportion of species exceeding these thresholds were compared against the following rule, as used for breeding abundance of seabirds in the EcoQO on seabird population trends: 'Changes in abundance of marine birds should exceed species-specific thresholds in 75% or more species that are assessed'.

Humphreys *et al*. (2012) also recommended a target threshold of 75% for non-breeding shorebirds and coastal breeding waterbirds in the UK because it is comparable to the thresholds used for shorebirds by the WeBS Alerts system (http://www.bto.org/volunteer-surveys/webs/publications/webs-alerts).

Results

The indicator is based on annual sample counts of breeding or non-breeding birds, derived using a variety of well-established techniques. This assessment is based on analyses that were conducted in 2014 as part of the process of testing the Indicator. In 2015, more recent data have been submitted by some contracting parties, but unfortunately technical problems encountered by the UK lead have meant that new analyses could not be run in time. An updated assessment that uses all available data is planned for spring 2016.

A baseline abundance is set for each species based on the imputed value at the start of the time-series. The indicator is derived from annual indices of relative abundance of each species in relation to the baseline population. The indicator for each species should be more than 70% or 80% of the baseline, depending on life history (the higher threshold being applied to those species with a slower recovery rate). Figure 1 shows an example of a species-specific trend in relative breeding abundance: the European shag in the Greater North Sea, Shag breeding numbers in the North Sea initially recovered following large-scale mortality due to severe winter weather in 1992/1993. Numbers have declined since 2003, dropping below target in 2006 and have been declining ever since, the cause is unknown.

During 1993–2004, more than 75% of species assessed in the Celtic Seas and Greater North Sea had exceeded species-specific thresholds for relative abundance (Figure 2). A proportion of 75% or more was required to achieve the EcoQO on seabird population trends and is being used here as a possible indication of GES. Since 2004, less than 75% species in both regions had exceeded thresholds; in 2011, 68% had done so in the Celtic Seas, compared to 48% in the Greater North Sea (Table 4). In both regions, the proportion of wintering (i.e. non-breeding) marine birds that were above thresholds, was very similar to that of breeding marine birds (Table 4).

Within the non-breeding birds, the wintering abundance of species that feed in intertidal areas (i.e. grazers and waders) was better than in other functional groups. For example, in the Celtic Seas 75% or more species of wading feeders and grazing feeders exceeded species-specific thresholds; this compares to only 20–25% of subtidal benthic and water column feeders (Table 4).

Within the breeding birds, the majority of species assessed were seabirds that forage offshore, mostly on fish. Of these, and in both Regions, 75% or more of species of water column-feeders had exceeded thresholds compared to 45–66% of surface-feeders.

Table 4 Percentage of species assessed that had a relative abundance in 2011 above threshold levels, in each functional group in OSPAR Regions II-Greater North Sea and III-Celtic Seas. Note i) Pintail (*Anas acuta*) and Mallard (*Anas Platyrhynchos*) are included in both wading feeders and grazing feeders; ii) Black-headed gull (*Croicocephalus ridibundus*) is included in both wading feeders and surface feeders; iii) Manx shearwater (*Puffinus puffinus*) is included in both water column feeders and surface feeders; iv) Pied avocet (*Recurvirostra avosetta*) is included in assessments of both breeding and non-breeding birds (in Region II only).

	Percentage of species above thresholds for relative abundance			
	II - Greater North Sea		III - Celtic Seas	
Functional group	**Breeding**	**Non-breeding**	**Breeding**	**Non-breeding**
Wading feeders	25% (4)	65% (17)	0% (1)	88% (16)
Surface feeders	45% (11)		66% (6)	
Water column feeders	80% (5)	25% (4)	75% (4)	25% (4)
Benthic feeders		0% (5)		20% (5)
Grazing feeders		50% (4)		75% (4)
Breeding/non-breeding total	50% (18)	46% (28)	70% (10)	67% (27)
Regional total	48% (46)		68% (37)	

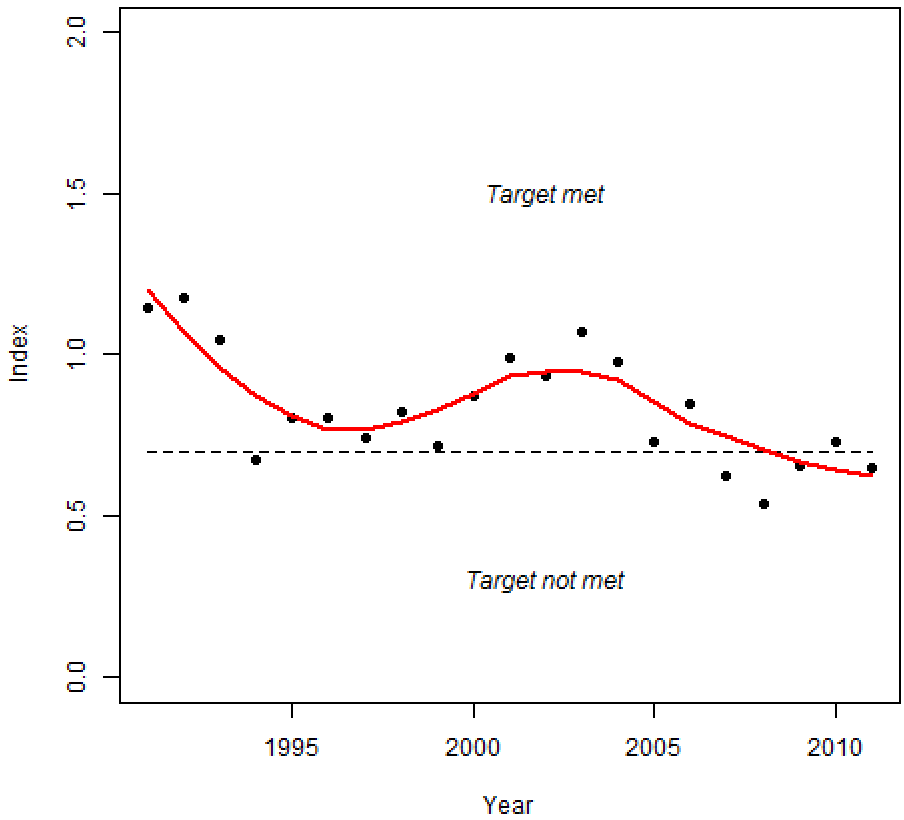


Figure 1. Example of a species-specific trend in relative breeding abundance: European shag in the Greater North Sea 1991–2011. The baseline (i.e. Relative abundance = 100) is derived from an estimate of 37 700 pairs at the start of the time-series in 1991. Black dotted line indicates the assessment threshold of 70% of the baseline.

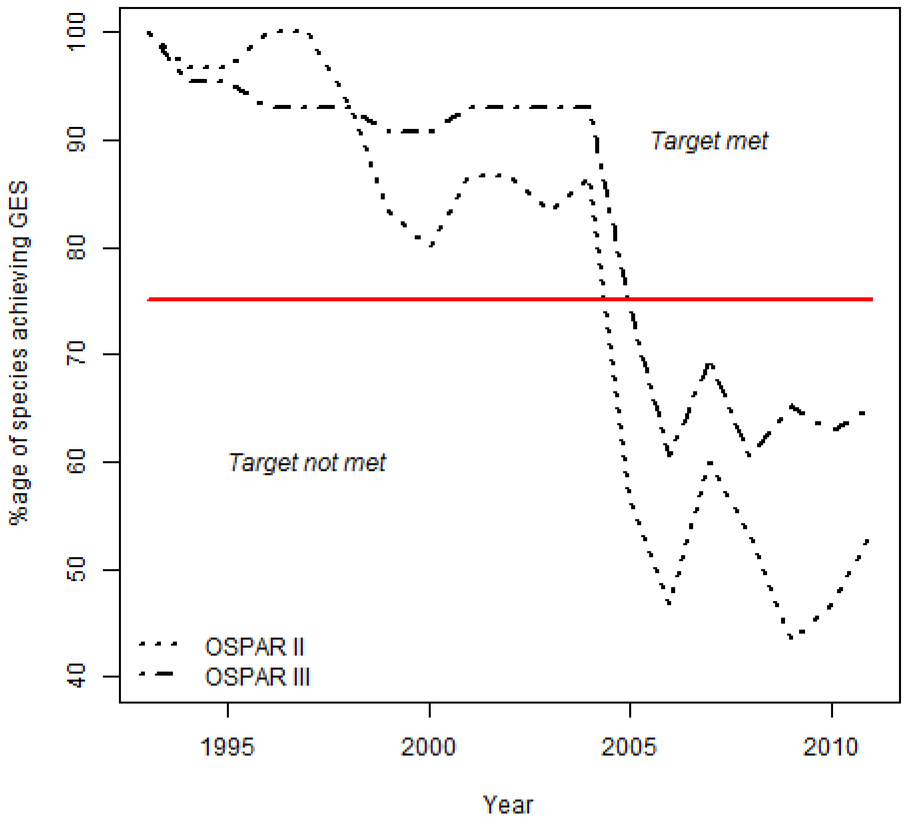
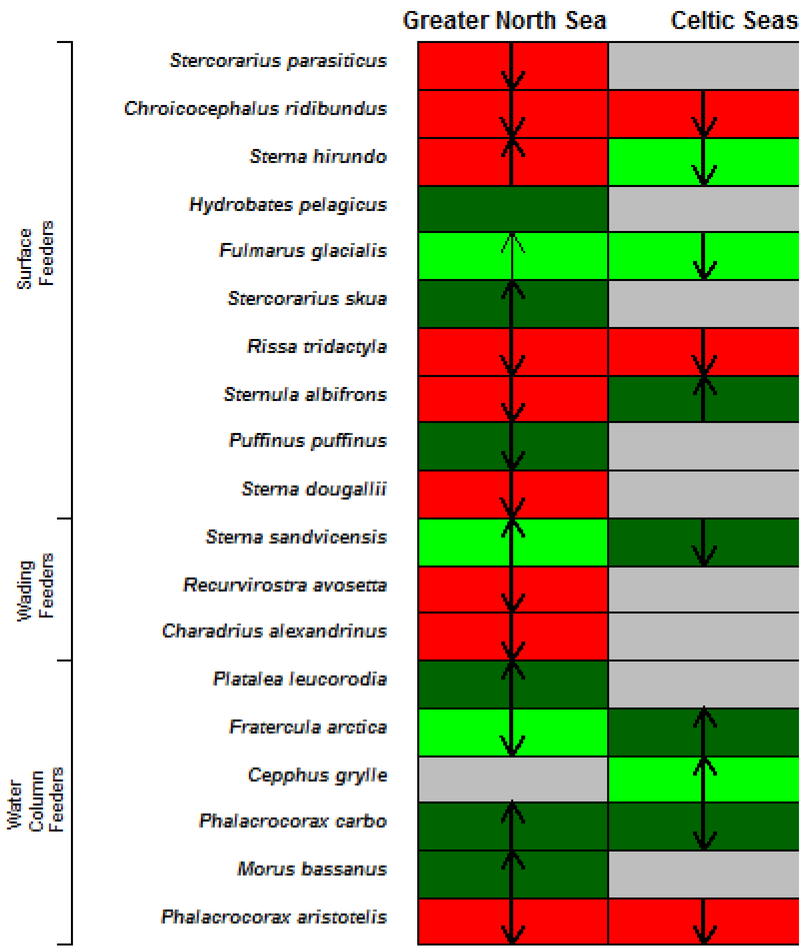
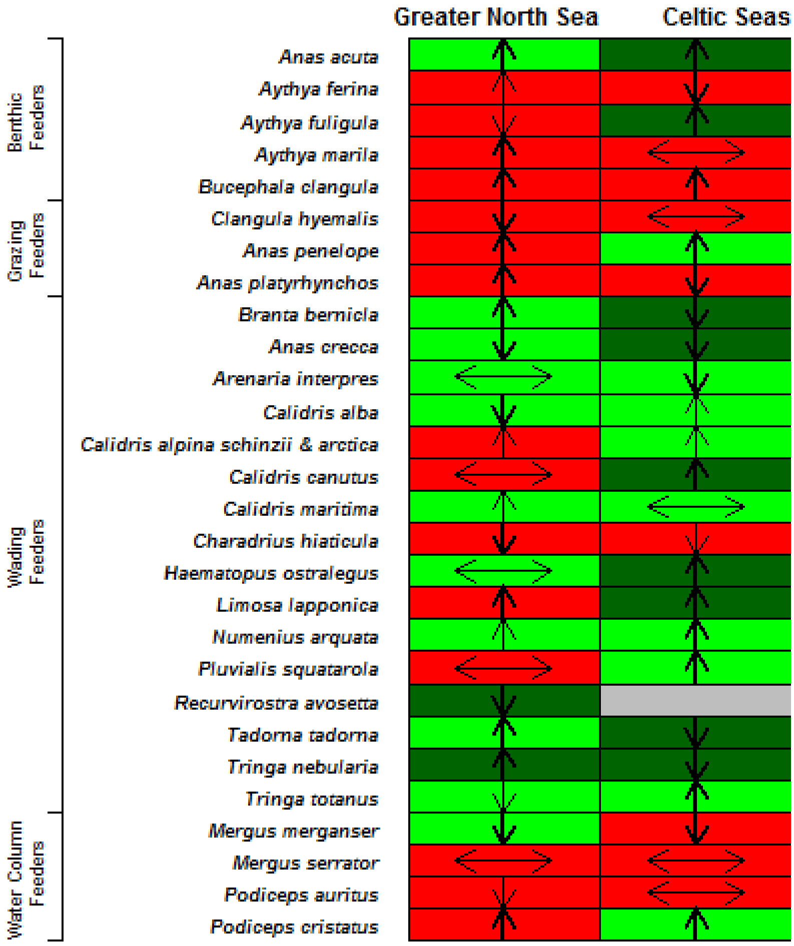


Figure 2. Changes in annual proportion of species exceeding thresholds for relative abundance in the Celtic Seas (36 species) and the Greater North Sea (46 species) during 1993–2011. The red line denotes the threshold of 75% used in the EcoQO on seabird population trends.

a) Breeding abundance



b) Non-breeding abundance



Population trend in previous 10 years		Species assessment
↑	strong increase (>5% p.a.)	Relative abundance in year x <70 or 80% (depending on clutch size)
↑	weak increase (2-5% p.a.)	Relative abundance in year x ≥70 or 80% (depending on clutch size)
↔	no change (<2% p.a.)	Relative abundance in year x ≥ 130%
↓	weak decrease (2-5% p.a.)	
↓	strong decrease (>5% p.a.)	

Figure 3. Species-specific assessment of abundance in a) the Celtic Seas and b) the Greater North Sea in 2011. Species grouped by functional group.

Conclusions

In both the Celtic Seas and Greater North Sea, the proportion of species for which relative abundance was above the desired thresholds, dropped below 75% in 2005 and has remained so since.

Of the 'non-breeding' species that visit the two regions during migration and/or during winter, wading and grazing feeders that use intertidal areas appear to be doing relatively well compared with other functional groups.

The majority of the breeding populations assessed were seabirds that forage offshore, mostly on fish. In the Greater North Sea, the species that feed on fish within the water column are faring much better than those that feed at the surface. This concurs with the results of the Common indicator on marine bird breeding success/failure: the availability of small forage fish species (e.g. lesser sandeel, sprat) at the surface is probably limiting the breeding success of some species (e.g. black-legged kittiwake). Drivers of food availability are likely to be ecosystem-specific changes, possibly initiated by past and present fisheries in combination with climate change.

Knowledge gaps

Data gaps

In 2016, data that were provided by contracting parties in 2015 will be included in the assessment, as listed in Table 5. A call will be issued for more recently collected data that may be available (e.g. from the 2015 breeding season).

Spatial disaggregation

In the 2016 update of B1, separate assessments will be produced for subdivisions of the Greater North Sea and of the Norwegian parts of OSPAR Region I-the Arctic, to be in line with the assessment for Common Indicator B3-Marine bird breeding success/failure.

Baselines

Most CPs did not provide baselines in 2014, and the assessments above used a baseline equal to the abundance at the start of each time-series. The aim in 2016 will be to use more objective baselines where these are provided by CPs. Objective baselines include 'historical reference levels', where we know abundance a point in the past long before the time-series began; or 'reference levels', where we would expect the population size to be if anthropogenic impacts were negligible.

Barriers to data availability

Table d data describe the contribution of Contracting Parties to provide data for the assessment of indicator B1 in the Intermediate Assessment 2017. It also identifies gaps in data availability. These gaps are described below.

Arctic (OSPAR I)

The Arctic subregion contains the highest concentrations of marine birds in the NE Atlantic. None of the contracting parties in the subregion are implementing the MSFD there. Norway have provided data on non-breeding and breeding abundance for inclusion in B1 in IA2017.

It would be beneficial if other CPs in the subregion would mobilize their monitoring data in a similar way. Iceland is a CP of OSPAR, but have so far not provided any data input to the work of the relevant ICES/OSPAR working groups on this subject. Russia is not a CP of OSPAR. Greenland and the Faroes are represented in OSPAR by Denmark. None of these countries have provided any data input to the work of the relevant ICES/OSPAR working groups on this subject. There are known shortcomings in the monitoring of marine birds in these areas that are likely to restrict the full implementation of B1 in OSPAR I to Norwegian areas.

Greater North Sea (OSPAR II)

All contracting parties bordering the Greater North Sea, with the exception of France, have provided all their available data on breeding seabirds and waterbirds and on non-breeding waterbirds. Data on at-sea abundance have not been provided so far.

The French regions of Nord Pas de Calais and Picardie have a lot of missing data due to lack of coordination for collating and formatting the data. Partial data have been provided for Normandy because of a lack of authorization to use annual data outside period of national censuses (every ten years). Data on wintering birds is collected in both regions as part of Wetlands International's International Waterbird Census (IWC) and are potentially available. Efforts are underway to develop data sharing agreements between the French Government and the independent data holders.

Celtic Seas

The Republic of Ireland gave the UK permission to supply data on breeding seabird colonies that had previously been submitted to the Seabird Monitoring Programme Database. The future availability of these data will depend on whether seabird colony monitoring in Ireland is continued. Data on breeding waterbirds and non-breeding waterbirds were not accessible due to lack engagement in bird indicator development by experts from Ireland.

Bay of Biscay and Iberian Coast (OSPAR IV)

Indicator B1 is applicable to the OSPAR IV. Of the 21 species breeding in OSPAR IV, ICES (2008) found nine to occur in very small numbers and no monitoring data have been collected on Cory's shearwater and band-rumped storm-petrel. The quality of data for six of the ten remaining species were assessed as 'good', three were assessed as sparse, and the quality of monitoring data on little terns breeding in Portugal was unknown (ICES 2008). France has supplied abundance data from breeding colonies of 15 species.

Spain has limited information regarding seabird colony monitoring. Occasional national counts have been coordinated by SEO/BirdLife, compiling existing information, for most seabird groups (excluding Procellariiforms so far). Best monitored (and most relevant) species in the Spanish area of OSPAR IV is the European shag, with two 'long-term' series (starting 1992 and 2003) and several colonies counted intermittently (with a national census in 2006). These series are the result of particular research initiatives, but should be easily accessed. No monitoring of breeding success is conducted extensively for other species. As for Procellariiforms, several colonies of European storm-petrel, with only a few small colonies regularly visited. Cory's shearwater which was recently discovered breeding in Galicia, are currently monitored.

The main barrier to the inclusion of data from Portugal has been the lack of engagement by experts from Portugal in the Bird indicator development process, which is preventing access to any data. Other possible barriers were identified by ICES (2008) that included questions over the extent of monitoring data available and the lack of any mechanism for collating monitoring data.

Macaronesia (OSPAR V)

ICES (2008) concluded that sufficient data on breeding seabirds had been collected and collated on the Azores to construct an indicator for OSPAR region V-Macaronesia. Only nine species of seabird breed on the Azores, but of these, good quality monitoring data exists for four: band-rumped storm-petrel, Bulwer's petrel, roseate tern and common tern. Engagement is required from Portugal in order to make the indicator operational in this subregion.

Table 5. Utilization of data from each Contracting Party in the assessment of B1 for the IA2017, indicated by 'Y' or 'N'. 'A' indicates data have been collected and are potentially available, but were not used in the assessment. '?' denotes no information obtained.

Contracting Party	OSPAR Region	Country Region	Counts of breeding seabird	Counts of breeding waterbirds	Counts of wintering and passage waterbirds
Norway	I (Barents Sea)	Barents Sea coasts, including Svalbard and Jan Mayen	Y	Y	Y
Russia	I (Barents Sea)		?	?	?
Denmark	I (Greenland and Iceland Seas)	Greenland	?	?	?
Iceland	I (Greenland and Iceland Seas)		A	?	?
Denmark	I (Faroes)	Faroe Islands	?	?	?
Norway	I (Norwegian Sea)	Norwegian Sea coast	Y	Y	Y
UK	II-a, d, e, f		Y	N*	Y
Norway	II-b	Coast of western Norway	Y	Y	Y
Denmark	II-c	Skagerrak/Kattegat coast	Y	Y	Y
Norway	II-c	Norwegian Skagerrak coast	Y	Y	Y
Sweden	II-c		Y	Y	Y
Belgium	II-d		Y	Y	Y
Germany	II-d	Wadden Sea	Y	Y	Y
Germany	II-d	Helgoland	Y	N	A
Denmark	II-d	Wadden Sea	Y	Y	Y
Denmark	II-d	North Sea coast Jutland	Y	Y	Y
Netherlands	II-d		Y	Y	Y
France	II-e	Nord Pas de Calais & Picardie	A	A	A
France	II-e	Normandy	Y/A	A	A
France	II-e	Brittany	Y	A	A
France	III	Brittany	Y	A	A
UK	III		Y	N	Y
Rep. Ireland	III		Y	?	?
France	IV	Pays de Loire, Poitou Charente, Aquitaine	Y	A	A
Portugal	IV		?	?	?
Spain	IV		A	N	A
Portugal	V	Azores	A	N	N

At-sea data

Data on seabirds or waterbirds at-sea, collected from boats or planes were not included in the abundance indicator so far. However this needs to be done in future to obtain reliable results on trends of species that occur in substantial numbers in the offshore regions. This requires joint coordinated surveys of all CPs at the level of the whole OSPAR area which are not available at the current stage. At the moment several CPs carry out or plan national at-sea monitoring programmes while there are no or only limited at-sea surveys carried out in other countries. Overall, coordination of surveys, e.g. with regard to timing, between countries is lacking. There is a need to develop (a) a concept for joint survey efforts delivering the necessary data basis for the abundance indicator work, (b) implement this concept in the frame of national survey programmes in future years and (c) develop a methodological approach for aggregating and analysing the data.

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Annex 7: Intermediate Assessment 2017; Common indicator sheet: B3-Marine bird breeding success/failure

Key message

During 2009–2014, widespread colony failures occurred in four years or more in 44%, 40% and 22% of seabird species assessed in the Norwegian part of OSPAR I, in the Greater North Sea and in the Celtic Seas, respectively.

Background (extended)

This indicator describes changes in breeding failure rates in marine birds, defined as the failure of a colony to produce on average at least 0.1 chicks per breeding pair, clutch or nest per year. The indicator is derived from annual data on mean breeding success (number chicks fledged per pair, clutch or nest) of marine bird species at colonies throughout the NE Atlantic.

As long-lived species with delayed maturity, changes in productivity of marine birds are expected to reflect changes in environmental conditions long before they are evident as changes in population size. A recent analysis of the breeding failure indicator for nine species in UK North Sea waters (Cook *et al.*, 2014b) provides evidence of a link to fishing pressure and suggest that failure rate of seabirds could be an indicator of GES achievement in parts of the North Sea where fisheries and seabirds target the same prey. The indicator could also provide evidence of other impacts, from e.g. human disturbance, contaminants and predation by invasive species. Natural factors will also affect this indicator, such as climate driven perturbations in prey-fish availability, and predation and disturbance from native predators, e.g. peregrine falcon, red fox).

This assessment will determine how frequently widespread breeding failures in marine birds occur. The spatial extent of failure will be assessed for each species and year by the proportion of colonies that fail. If widespread failures occur in more than three years out of six, the cumulative effect of successive failures is likely to have a significant impact on recruitment into the regional population.

Separate assessments were carried out for OSPAR Regions I-Arctic (Norwegian areas only, including Svalbard and Jan Mayen), II-the Greater North Sea and III-the Celtic Seas. (No data were provided by contracting parties in OSPAR Regions IV-Bay of Biscay and Iberian Coast, and V-Macaronesia).

In this context, 'marine birds' include taxonomic groups that are commonly aggregated as 'waterbirds' and 'seabirds'. The assessment described below features only seabird species from the following taxa: petrels and shearwaters (Procellariiformes); gannets and cormorants (Pelecaniformes); skuas, gulls, terns and auks (Charadriiformes). Most of these species spend the majority of their lives at sea, feeding on prey living within the water column (i.e. plankton, fish and squid) or picking detritus from the surface. Cormorants, gulls and terns tend to be confined to inshore waters; whereas petrels, shearwaters, gannets, skuas and auks venture much further offshore and beyond the shelf break.

This indicator is also applicable to waterbirds, including shorebirds (order Charadriiformes); ducks, geese and swans (Anseriformes); divers (Gaviiformes); and grebes (Podicipediformes). Shorebirds and some duck species feed on benthic invertebrates in soft intertidal sediments and on rocky shores. Geese mostly graze on exposed eelgrass beds (i.e. *Zostera* spp.). Diving duck species feed on invertebrate benthos in shallow inshore waters. Divers, piscivorous ducks and grebes tend to be confined to inshore waters. No data on these taxa were available for this assessment of B3.

Assessment method (extended)

Background

This indicator is generated using time-series of annual mean breeding success (number of chicks fledged per pair, clutch or nest) of marine bird species at colonies (total counts or survey plots throughout the NE Atlantic. A separate indicator was constructed for each species in each OSPAR Region. We also conducted an assessment for each subdivision of OSPAR Region II-Greater North Sea, as shown in Figure b. The Norwegian part of OSPAR Region 1-the Arctic was also subdivided (see Figure b). Separate assessment were not conducted for each Arctic subdivision because there were too few colonies included in each subdivision.

The indicators for each species are constructed from a time-series of annual estimates of breeding success at a sample of colonies. For practical reasons, not all the colonies in the sample will have been observed every year in the time-series. Prior to analysis, missing annual observations were therefore predicted by models, see below.

Species-specific indicators of breeding failure

Parameter/metric

'**Annual colony failure rate'** i.e. the percentage of colonies failing per year, per species (from Cook *et al.*, 2014a).

The definition of 'failure' proposed by Cook *et al.* (2014a) was when productivity drops below 0.1 chicks per pair, clutch or nest. As failure could be interpreted as an unusual deviation from 'normal' levels of breeding success, the precise threshold below which a colony is defined as failing may be different at some colonies, even for the same species. The threshold used for determining failure can be adjusted according to experience of the colonies in question. Ideally, the threshold should be taken from any clear step functions in response to important environmental factors such as low food availability (e.g. Cury *et al.*, 2011). The threshold of 0.1 chicks per pair should be used as a default threshold, unless there is good evidence to show that 'failure' of some species in some areas should be set at a different level.

Trend analysis

The indicators for each species are constructed from a time-series of annual estimates of breeding success at a sample of colonies. Not all the colonies in the sample will have been observed every year in the time-series. Missing annual observations were predicted by using a Generalised Linear Model (GLM) framework with a binomial error structure (after Cook *et al.*, 2014a & b). Breeding success for each colony in each year was calculated, and where this value was below 0.1 chicks per pair, the colony was assessed as having failed in that year. Breeding success or failure was modelled in relation to year and site, to account for the fact that not all sites were covered in all years. The coefficient for each year was then taken to represent the probability of breeding failure occurring at any given site within that calendar year. Year was fitted as a fixed effect factor, rather than a random effect so that the coefficients would not be constrained to follow a normal distribution.

To minimize the impact of differences in sampling rate, and ensure that breeding success was likely to be representative of the colony as a whole, minimum thresholds were set for inclusion of data within the model. Only those colonies at which a mean of ten nests were monitored for at least three years were considered. So that no individual site had undue influence over the value of the coefficients, a jack-knife approach was used, dropping each site from the model in turn. Models were run for each species in each subregion in turn. The final indicator value presented for each species, in each subregion, in each year is the mean probability of breeding failure calculated from each run of the jack-knife.

Assessment

Assessing colony failure rate

The annual colony failure rate (i.e. percentage of colonies failing in each region) of each species was assessed against one of the two upper thresholds below, depending on the species:

v) Terns: mean percentage of colonies failing per year, over the preceding 15 years;

vi) all species except terns: 5% of colonies failing per year.

The aim of the thresholds is to identify widespread breeding failures and to differentiate large-scale anthropogenic impacts from local problems, where only a small proportion of colonies fail per year. The above thresholds were taken from Cook *et al.* (2014a), who tested various target thresholds on each species indicator of annual colony failure rate. A different threshold was applied to the breeding failure rate of terns because they often desert colonies, sometimes before laying, in response to local disturbances or impacts on food supply (Shealer and Kress, 1991; Holt, 1994; Cook *et al.*, 2011). The threshold for terns is designed to identify years of unusually high rates of breeding colony failure.

A fixed threshold of 5% was appropriate to all other species, which do not tend to desert colonies *en masse* in the same way as terns use colony desertion as a life-history strategy. Years in which colony failure rate is more than 5% are much rarer in other species and therefore provide a good indicator that pressures may be impacting on the population.

Cook *et al.* (2014a) proposed using the threshold used here for terns (i.e. mean percentage of colonies failing per year, over the preceding 15 years) to assess breeding failure in all species if it is greater than 5%. It was apparent from the results of this assessment (see below) that for all species, except terns, no colonies would fail in most years and that failure rates of over 5% of colonies were significant events. The use of a threshold derived from mean breeding failure rates would risk assessing some years as 'normal', in which more than 5% of colonies have failed and were clearly not typical of 'normal' conditions. The decision by JWGBIRD to deviate from the recommendation of Cook *et al.* (2014a) is documented in ICES (2015).

Assessing the frequency of colony failure

For each species, we assessed the number of years of 'widespread colony failure' in which annual colony failure rate exceeded the appropriate threshold (as detailed above). The frequency of colony failure was assessed over each consecutive period of six years. The six-year period was chosen because it equals the length of the MSFD reporting cycle. The most recent six-year period assessed was 2009–2014, inclusive. In order to carry out the assessment the colony data for a species in a region needed to contain some values from 2014, because these could not be interpolated.

One or two years of widespread colony failure were considered as 'acceptable', given the wide range of possible natural and anthropogenic factors that could cause breeding failure in some species. The cumulative effect of widespread colony failures in more than three years out of six, was considered to most likely have a significant impact on recruitment into the regional population. Low recruitment could lead to declines in population size and affect the assessments of indicator B1-marine bird abundance.

Species selection & aggregation (functional groups)

There were sufficient time-series data from at least one of the three OSPAR Regions to construct indicators for a total of 25 species. The assessment in the Norwegian part of OSPAR Region I contained 16 species and those in the Greater North Sea and Celtic Seas contain 21 and 22 species respectively. Some species were omitted because the time-series did not contain an estimate of breeding success in 2014 (see above). These species included Pied Avocet, Oystercatcher and Common Eider from the Greater North Sea and Roseate Tern from the Celtic Seas.

The species assessed in each Region were from two of the five marine bird functional groups given in the Table 1:

i) Surface feeders, which forage on small fish, zooplankton and other invertebrates at or within the surface layer (within 1–2 m of the surface);

ii) Water column feeders, which actively dive below the surface to a broad range of depths to feed on fish and invertebrates (e.g. squid, zooplankton) in the water column or close to the seabed.

The species assessed and the functional groups to which they were assigned, are given in Table 2.

Table 1. Marine bird functional groups.

Functional group	Typical feeding behaviour	Typical food types	Additional guidance
Wading feeders	Walk/wade in shallow waters	Invertebrates (molluscs, polychaetes, etc.)	
Surface feeders	Feed within the surface layer (within 1–2 m of the surface)	Small fish, zooplankton and other invertebrates	"Surface layer" defined in relation to normal diving depth of plunge-divers (except gannets)
Water column feeders	Feed at a broad depth range in the water column	Pelagic and demersal fish and invertebrates (e.g. squid, zooplankton)	Include only spp. that usually dive by actively swimming underwater; but including gannets. Includes species feeding on benthic fish (e.g. flatfish).
Benthic feeders	Feed on the seafloor	Invertebrates (e.g. molluscs, echinoderms)	
Grazing feeders	Grazing in intertidal areas and in shallow waters	Plants (e.g. eelgrass, saltmarsh plants), algae	Geese, swans and dabbling ducks, coot

Table 2. Species included in assessment of B3-marine bird breeding success/failure 2015, in each OSPAR Region.

Species (English Name)	Species (Scientific Name)	Grazing feeders	Wading feeders	Surface feeders	Water column feeders	Benthic feeders	Arctic	Greater North Sea	Celtic Seas
Red-throated diver	*Gavia stellata*				X				
Black-throated diver	*Gavia arctica*				X				
Great Northern diver	*Gavia immer*				X				
White-billed diver	*Gavia adamsii*				X				
Great crested grebe	*Podiceps cristatus*				X				
Red-necked Grebe	*Podiceps grisegena*				X				
Slavonian grebe	*Podiceps auritus*				X				
Northern Fulmar	*Fulmarus glacialis*			X	(X)		X	X	X
Sooty Shearwater	*Puffinus griseus*			X	(X)				
Manx Shearwater	*Puffinus puffinus*			X	(X)				X
Balearic shearwater	*Puffinus mauretanicus*			X	(X)				
Cory's Shearwater	*Calonectris diomedea*			X	(X)				
European Storm-petrel	*Hydrobates pelagicus*			X	(X)				
Leach's Storm-petrel	*Oceanodroma leucorhoa*			X	(X)				
Northern gannet	*Morus bassanus*			(X)	X		X	X	X
Great Cormorant	*Phalacrocorax carbo*				(X)	X	X	X	
European shag	*Phalacrocorax aristotelis*				X	(X)	X	X	X
Eurasian spoonbill	*Platalea leucorodia*		X						
Mute Swan	*Cygnus olor*	X							
Bewick's Swan	*Cygnus bewickii*	X							
Whooper Swan	*Cygnus cygnus*	X							
Greylag goose	*Anser anser*	X							
Greenland white-fronted goose	*Anser albifrons flavirostris*	X							
Canada Goose	*Branta canadensis*	X							
Barnacle Goose	*Branta leucopsis*	X							
Brent Goose	*Branta bernicla*	X							
Shelduck	*Tadorna tadorna*		X						
Wigeon	*Anas penelope*	X							
Teal	*Anas crecca*		X						
Mallard	*Anas platyrhynchos*	X	X						
Pintail	*Anas acuta*	X	X						
Shoveler	*Anas clypeata*	X							
Pochard	*Aythya ferina*					X			
Tufted Duck	*Aythya fuligula*					X			
Greater Scaup	*Aythya marila*					X			
Common Eider	*Somateria mollissima*					X			
King eider	*Somateria spectabilis*					X			
Steller's eider	*Polysticta stelleri*					X			
Long-tailed Duck	*Clangula hyemalis*					X			
Common Scoter	*Melanitta nigra*					X			
Velvet Scoter	*Melanitta fusca*					X			
Goldeneye	*Bucephala clangula*					X			
Common merganser	*Mergus merganser*				X				
Red-breasted Merganser	*Mergus serrator*				X				
Smew	*Mergellus albellus*				X				
Coot	*Fulica atra*	X							
Oystercatcher	*Haematopus ostralegus*		X						
Black-winged Stilt	*Himantopus himantopus*		X						

Species (English Name)	Species (Scientific Name)	Grazing feeders	Wading feeders	Surface feeders	Water column feeders	Benthic feeders	Arctic	Greater North Sea	Celtic Seas
Pied avocet	*Recurvirostra avosetta*		X						
Lapwing	*Vanellus vanellus*		X						
Golden plover	*Pluvialis apricaria*		X						
Grey Plover	*Pluvialis squatarola*		X						
Ringed plover	*Charadrius hiaticula*		X						
Kentish Plover	*Charadrius alexandrinus*		X						
Bar-tailed Godwit	*Limosa lapponica*		X						
Whimbrel	*Numenius phaeopus*		X						
Curlew	*Numenius arquata*		X						
Spotted Redshank	*Tringa erythropus*		X						
Redshank	*Tringa totanus*		X						
Greenshank	*Tringa nebularia*		X						
Wood Sandpiper	*Tringa glareola*		X						
Turnstone	*Arenaria interpres*		X						
Red-necked Phalarope	*Phalaropus lobatus*			X					
Grey Phalarope	*Phalaropus fulicarius*			X					
Red Knot	*Calidris canutus*		X						
Sanderling	*Calidris alba*		X						
Little Stint	*Calidris minuta*		X						
Curlew Sandpiper	*Calidris ferruginea*		X						
Purple sandpiper	*Calidris maritima*		X						
Dunlin	*Calidris alpina schinzii & arctica*		X						
Ruff	*Philomachus pugnax*		X						
Arctic skua	*Stercorarius parasiticus*			X				X	
Long-tailed Skua	*Stercorarius longicaudus*			X					
Pomarine Skua	*Stercorarius pomarinus*			X					
Great Skua	*Stercorarius skua*			X			X	X	
Glaucous gull	*Larus hyperboreus*			X			X		
Great Black-backed Gull	*Larus marinus*			X			X	X	X
Herring gull	*Larus argentatus*		X	X			X	X	X
Lesser black-backed gull	*Larus fuscus intermedius/graellsii*		X	X			X	X	X
Common Gull	*Larus canus*		X	X				X	X
Mediterranean Gull	*Larus melanocephalus*			X					
Black-headed Gull	*Croicocephalus ridibundus*		X	X				X	X
Little Gull	*Larus minutus*			X					
Black-legged kittiwake	*Rissa tridactyla*			X			X	X	X
Ivory gull	*Pagophila eburnea*			X					
Little Tern	*Sternula albifrons*			X				X	X
Roseate tern	*Sterna dougallii*			X				X	
Common tern	*Sterna hirundo*			X				X	X
Arctic tern	*Sterna paradisaea*			X				X	X
Sandwich tern	*Sterna sandvicensis*			X				X	X
Black Tern	*Chlidonias niger*			X					
Razorbill	*Alca torda*				X		X	X	X
Common Guillemot	*Uria aalge*				X		X	X	X
Brünnich's guillemot	*Uria lomvia*				X		X		
Black Guillemot	*Cepphus grylle*				X		X		X
Little Auk	*Alle alle*				X		X		
Puffin	*Fratercula arctica*				X		X	X	X

Results

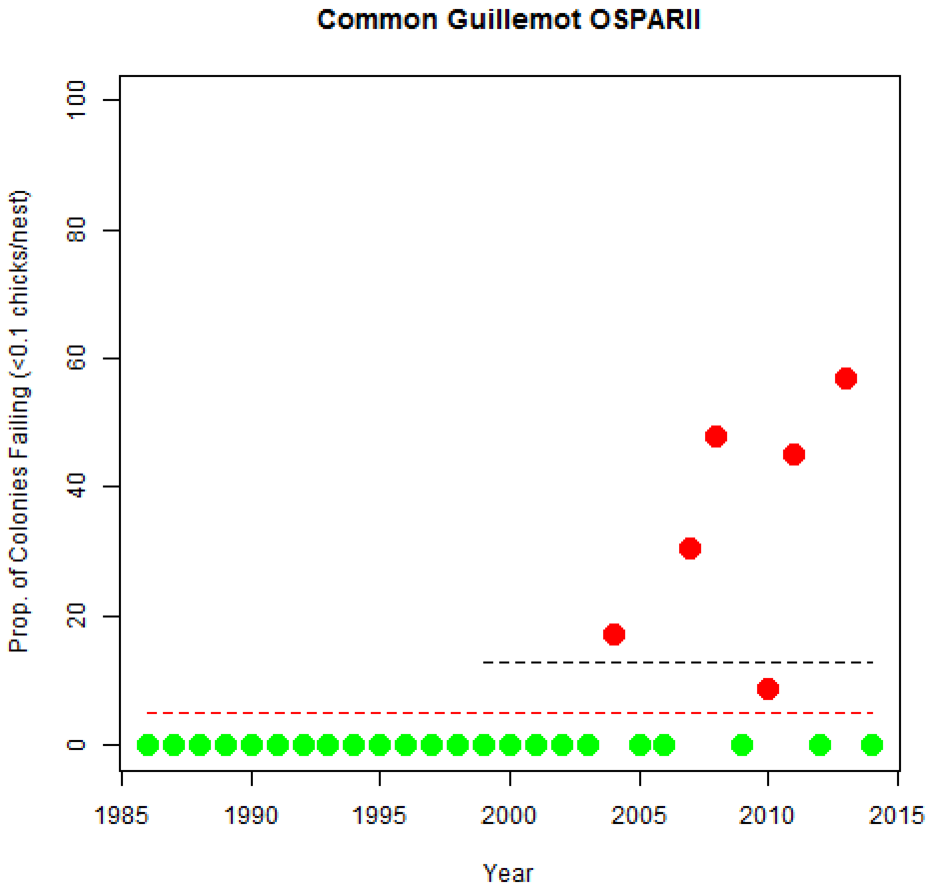
Assessing annual colony failure in Marine birds

The annual colony failure rate (i.e. percentage of colonies failing in each region) of each species was assessed against one of two thresholds, depending on species (see Figure 1). If more than 5% of colonies fail in a region in a year, it is normally a significant event in most species and provides an indication of a widespread effect (see example of Common guillemot in Figure 1b). Failure is a much more common event at colonies of terns, which often desert colonies in response to local disturbances or impacts on food supply. Other species do not exhibit colony desertion to the same extent. The threshold used for terns was the mean percentage of colonies failing per year, over the preceding 15 years; in order to identify years of unusually high rates of breeding colony failure (see example of Common tern in Figure 1a).

Species-specific assessments

For each species, we assessed the number of years of 'widespread colony failure' in which annual colony failure rate exceeded the appropriate threshold (as detailed above). The frequency of colony failure was assessed over each consecutive period of six years to coincide with the MSFD reporting cycle. Figure 2 shows the species-specific assessments in each Region during the period 2009–2014. One or two years of widespread colony failure were considered as 'acceptable' and labelled 'green', given the wide range of possible natural and anthropogenic factors that could cause breeding failure in some species. The cumulative effect of widespread colony failures in more than three years out of six, was considered to most likely have a significant impact on recruitment into the regional population and labelled 'red' in Figure 2. Low recruitment could lead to declines in population size and affect the assessments of indicator B1-marine bird abundance.

In 2014, in the Norwegian part of OSPAR I, seven out of the 16 species assessed had exhibited widespread colony failures in four years or more since 2009 (labelled as 'red' in Figure 2). In the Greater North Sea, eight out of 20 species were assessed as 'red' and in the Celtic Seas, four out of 18. In the North Sea and Celtic Seas, a further four and five species respectively, were labelled as 'amber' in Figure 2 (i.e. had exhibited widespread annual colony failure rates in three years since 2009). Only three species were assessed as 'red' in more than one OSPAR Region in Figure 2: Lesser black-backed gull was 'red' in all three Regions; Black-legged kittiwake was 'red' in the Arctic and Greater North Sea (and 'amber' in the Celtic Seas); Sandwich tern was 'red' in the Greater North Sea and the Celtic Seas. The Maps in Figure 3, show some spatial patterns in breeding failure occurrence in lesser black-backed gull and Black-legged kittiwake colonies, but a more even spread of failures in Sandwich tern colonies.


Common Guillemot OSPARII
Prop. of Colonies Failing (<0.1 chicks/nest)
0
20
40
60
80
100
1985
1990
1995
2000
2005
2010
2015
Year

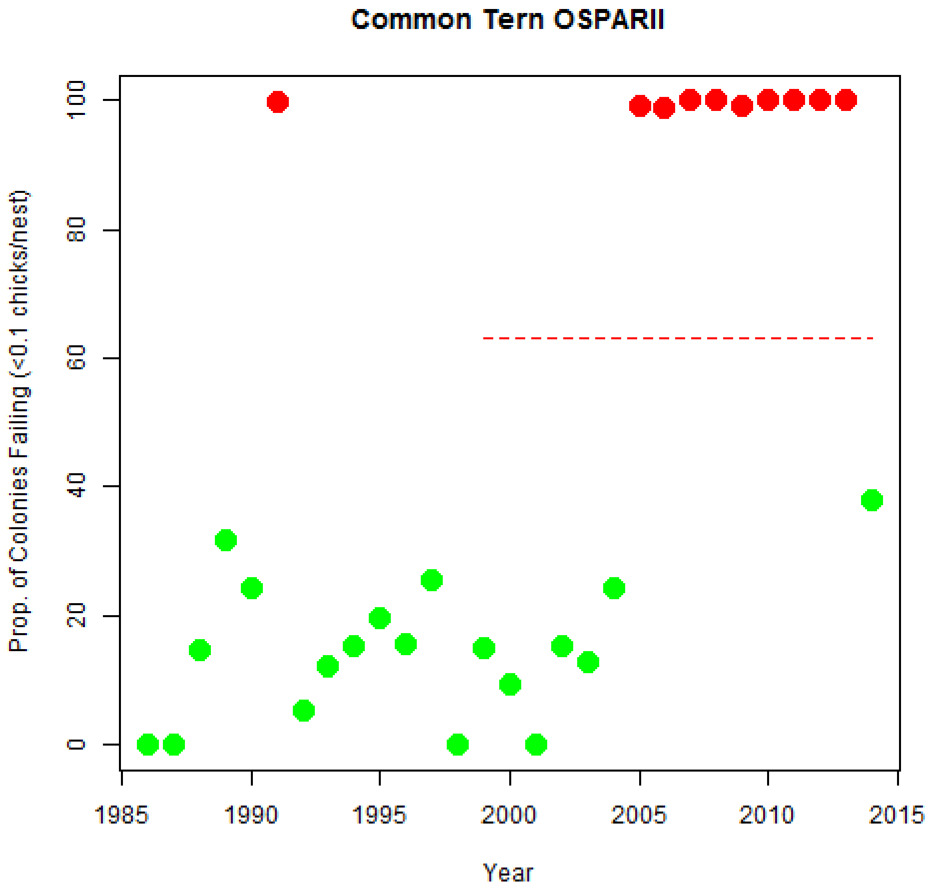


Figure 1. Examples of species-specific indicators of annual colony failure in relation to different thresholds, for a) Common guillemot and b) Common tern in the Greater North Sea 1986–2014. Thresholds are shown as red dotted lines. The threshold for tern species is the mean percentage of colonies failing per year, over the preceding 15 years. The threshold for all other species (except terns) is 5% of colonies failing per year. The black dotted line denotes the mean percentage of colonies failing per year, over the preceding 15 years, where this is not used as the threshold. All values below the threshold are coloured green and all those above are coloured red and indicate 'widespread breeding failure'.

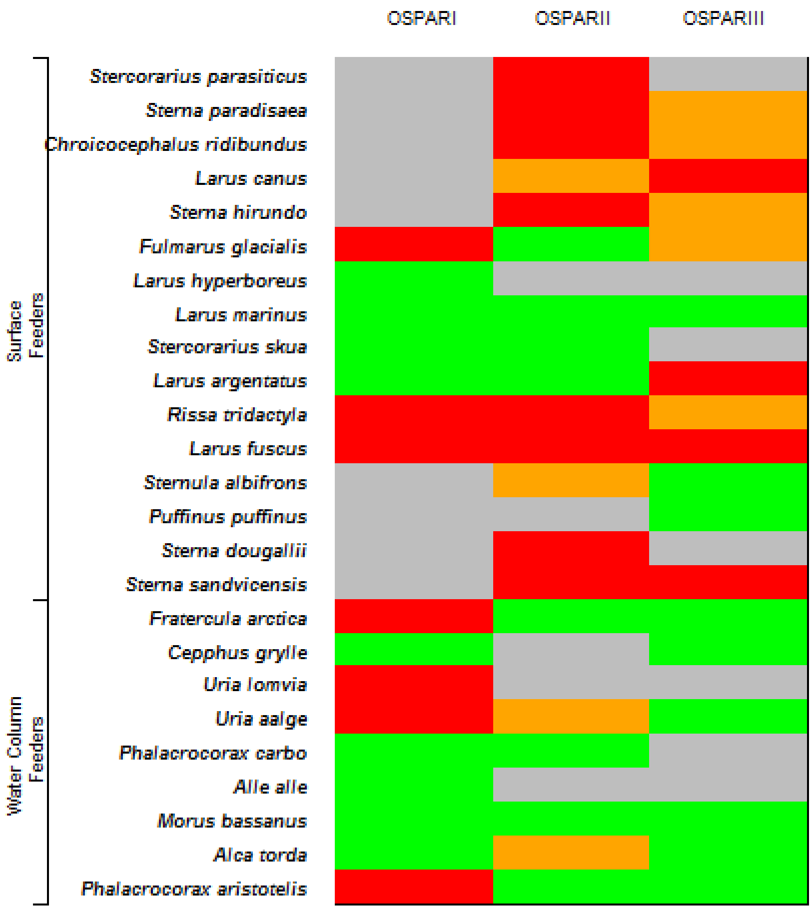
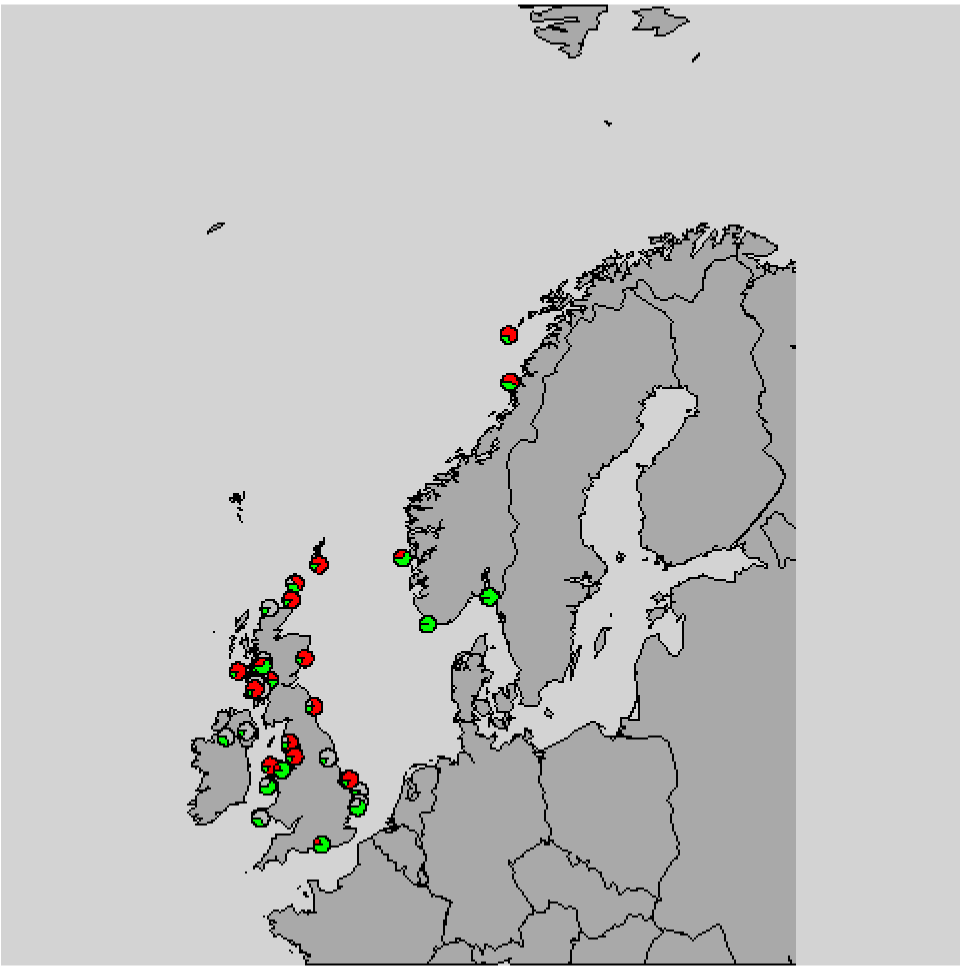
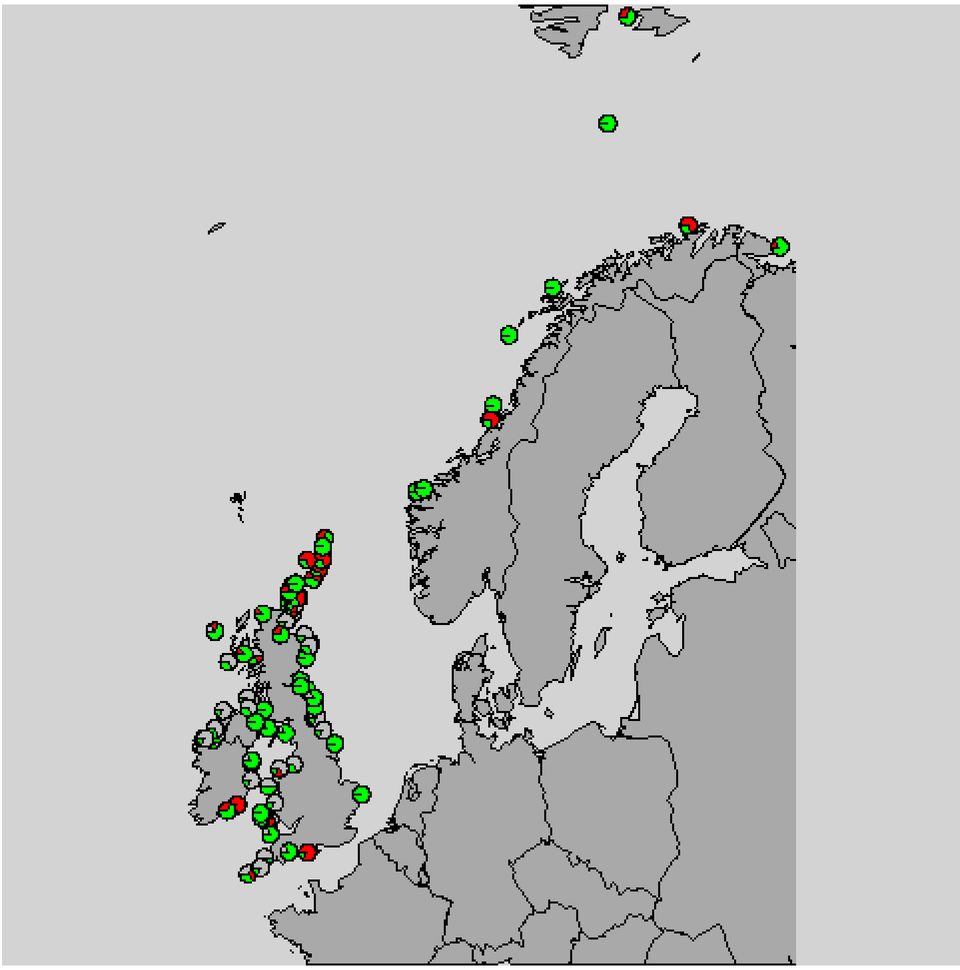


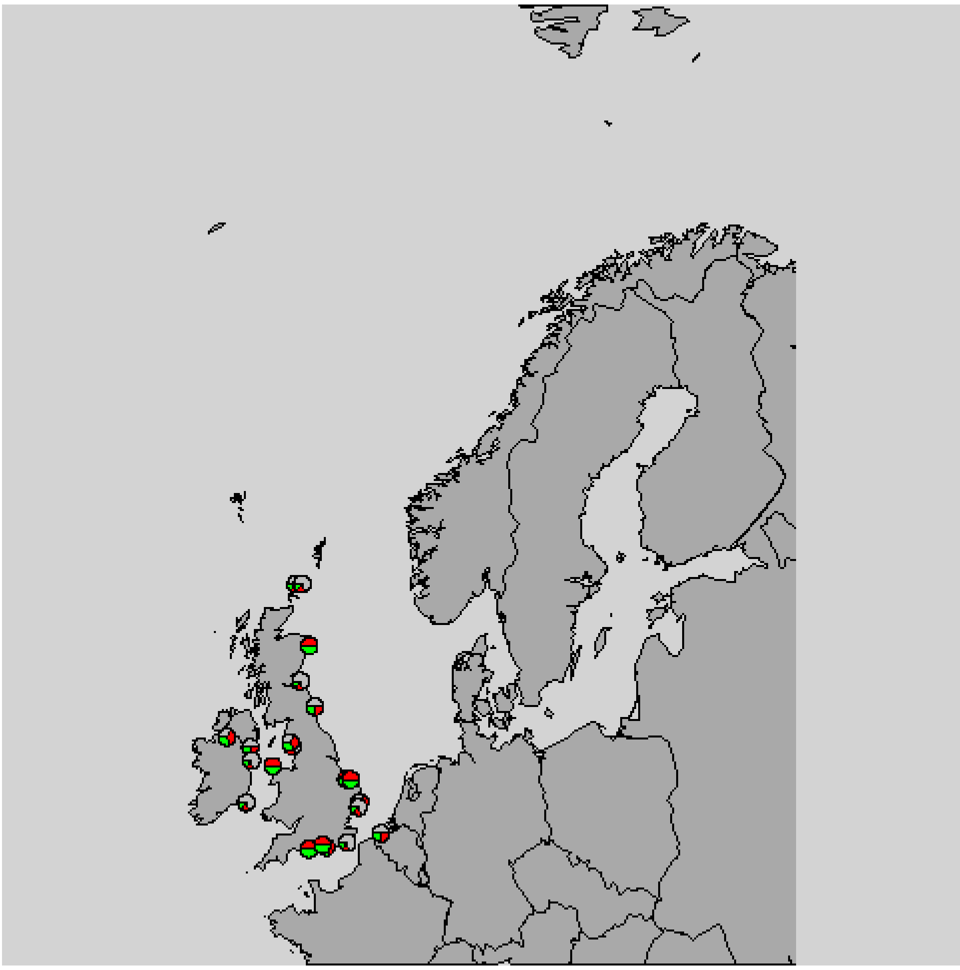
Figure 2. Species-specific assessments of annual colony failure in the Arctic (Norway only, including Svalbard and Jan Mayen), the Greater North Sea and Celtic Seas in 2014. Species ordered by functional group. Colour of cells indicates the number of years during the six year assessment period (2009–2014) that annual colony failure rate was widespread (i.e. exceeded species-specific thresholds, see Figure 1): green = two years or less; orange cells = three years; red = four years or more.



a) Lesser black-backed gull



b) Black-legged kittiwake



c) Sandwich tern.

Figure 3. Spatial distribution in breeding colony failures of a) Lesser black-backed gull, b) Black-legged kittiwake and c) Sandwich tern. Pie charts show proportion of years during 2009–2014 in breeding success was more than 0.1 chicks per pair (green), or less than 0.1 chicks per pair (red). Grey indicates number of years in which breeding success was not measured.

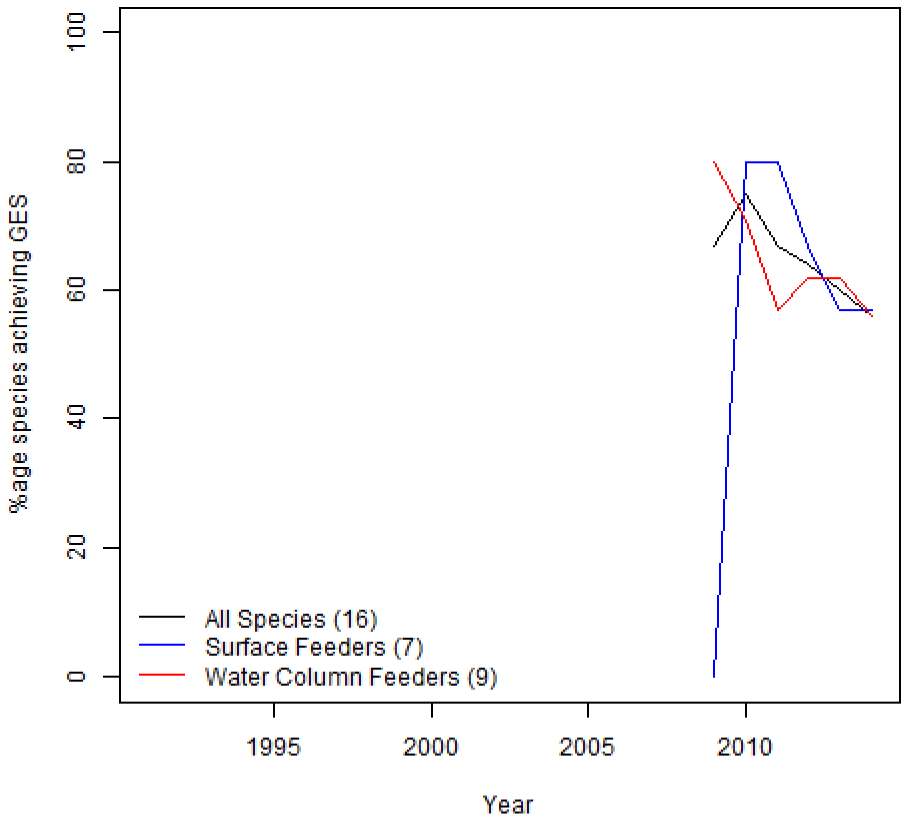
Functional group assessments

The species assessed in each Region were from two of the five marine bird functional groups:

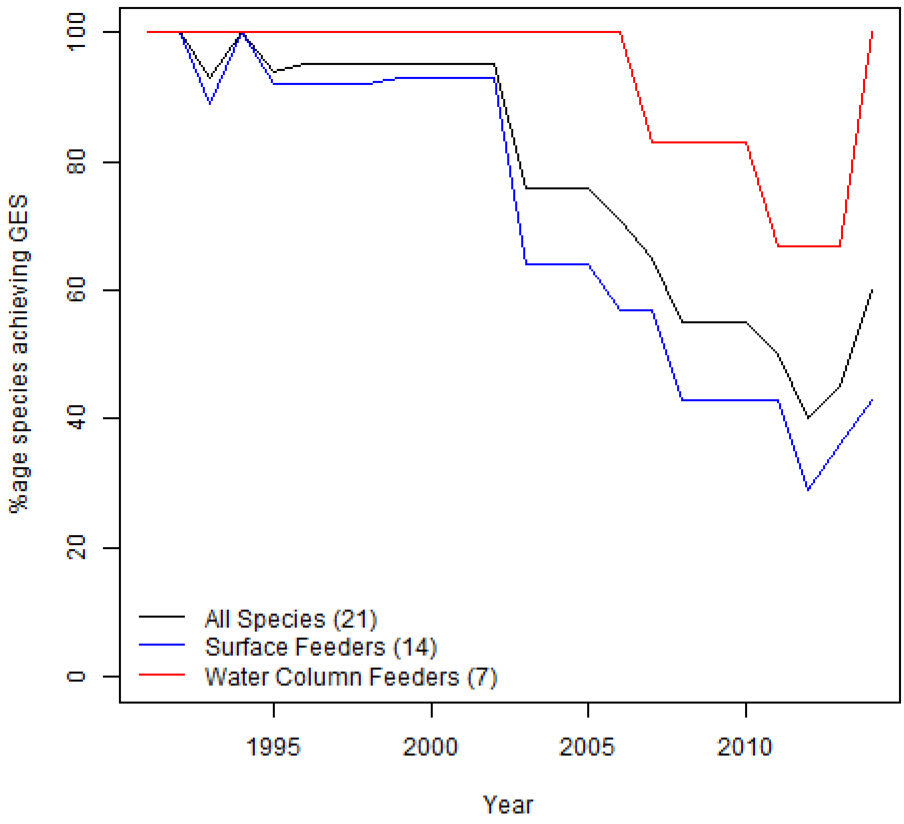
i) Surface feeders, which forage on small fish, zooplankton and other invertebrates at or within the surface layer (within 1–2 m of the surface);

ii) Water column feeders, which actively dive below the surface to a broad range of depths to feed on fish and invertebrates (e.g. squid, zooplankton) in the water column or close to the seabed.

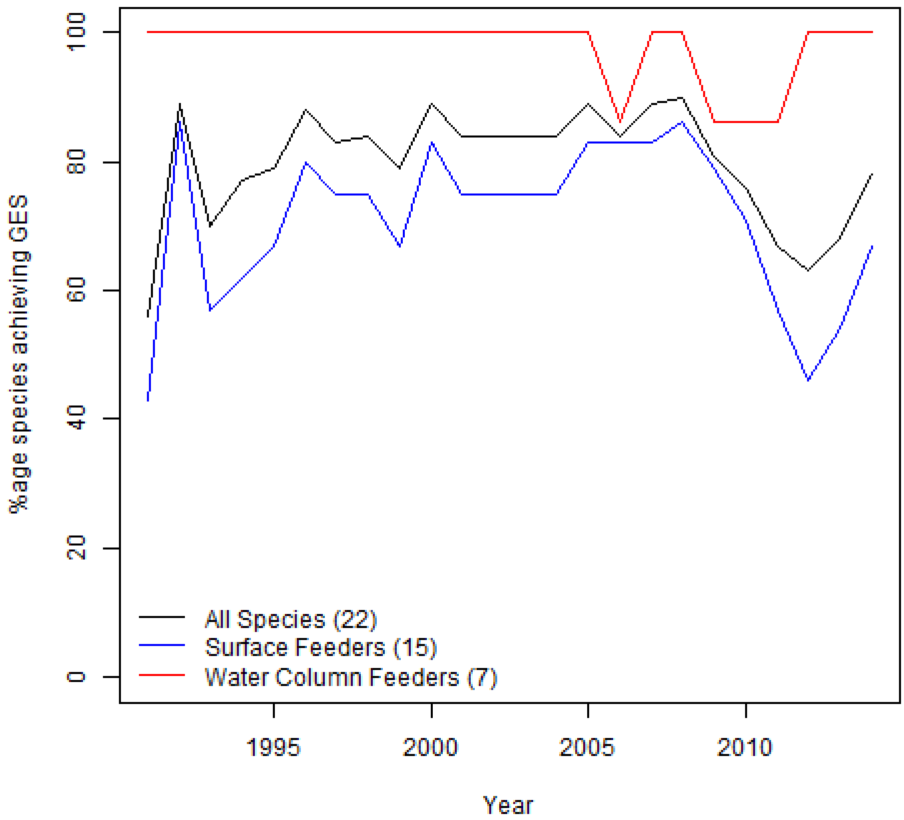
The proportion of species that have not experienced widespread colony failures in more than three of the previous six years declined in all three regions during 2009–2014, but improved during 2013 and 2014 (Figure 3). The declines in the Celtic Seas and Greater North Sea were much greater for surface feeders than for water column feeders. The declines in the Arctic were similar for both functional groups.



a) Norwegian part of OSPAR I - Arctic



b) Greater North Sea



c) Celtic Seas

Figure 4. Changes in the proportion of marine bird species have not experienced widespread annual colony failures in more than three of the previous six years, in a) Norwegian Arctic, b) Greater North Sea, and c) Celtic Seas. Trends are shown for all species as well as for surface feeders and water column feeders. Number of species included in each group shown in brackets in the figure legend.

Conclusion

During 2009–2014, widespread colony failures had occurred in four years or more in 44%, 40% and 22% of seabird species assessed in the Norwegian part of OSPAR I, in the Greater North Sea and in the Celtic Seas, respectively. In the North Sea and Celtic Seas these species were all surface-feeders, as oppose to water column feeders. This would suggest the availability of small forage fish species (e.g. lesser sandeel, sprat) at the surface is limiting the breeding success of some species (e.g. black-legged kittiwake). In the Norwegian Part of OSPAR I, an equal number of surface-feeders and water column feeders exhibited widespread breeding failures, suggesting the availability of prey fish (e.g. 1-year old cod) may be low throughout the water column in some areas. Drivers of food availability are likely to be ecosystem-specific changes, possibly initiated by past and present fisheries in combination with climate change.

In all regions, breeding failure, particularly at tern and gull colonies has been caused by predation and disturbance from avian predators (e.g. other seabirds, ravens, White-tailed Eagle) and from invasive native mammals (e.g. fox) and non-native mammals (e.g. American Mink).

Knowledge gaps (extended)

Data coverage

This assessment does not include OSPAR Regions IV (Bay of Biscay and Iberian Coast) and V (Macaronesia) because data were not supplied by France, Spain and Portugal. Data for the OSPAR Arctic Region assessment were supplied by Norway only. It is uncertain whether monitoring in other countries in the Arctic is sufficient to generate data for B3.

The main gap in monitoring in the Greater North Sea is in the Skagerrak/Kattegat where breeding success is measured along the Norwegian coast, possibly along the Swedish coast, but not along the Danish coast. Data from the Wadden Sea, areas part of the North Sea, were not supplied for this assessment but will be supplied by the Netherlands, Denmark and Germany to be included in an update, in time for the IA2017. Data from France were also not supplied.

Arctic (OSPAR I)

There is sufficient monitoring of seabird productivity along the Norwegian coasts (including Svalbard and Jan Mayen) of the Norwegian and Barents seas to construct an indicator of B3 there. It is uncertain whether monitoring in other countries in the Arctic subregion is sufficient to generate data for B3. The Arctic subregion contains the highest concentrations of marine birds in the NE Atlantic. None of the contracting parties in the subregion are implementing the MSFD there. Norway intend to construct indicators (similar to OSPAR common indicators) in their seas within the Arctic. It would be beneficial if other CPs in the subregion would mobilize their monitoring data in a similar way. The Arctic subregion encompasses several very different ecosystems in terms of key species and trophic interactions. It would be very difficult to set appropriate target and reference levels for the population of a seabird species across such a large area, because in different ecosystems it may respond very differently to pressures and environmental factors. ICES (2008) therefore suggested that the EcoQO on seabird population trends should be based on trends within subdivisions of OSPAR I. They recommended subdivisions similar to the ecoregions for Greenland and Iceland Seas, Barents Sea, Faroes and Norwegian Sea that were proposed to ICES (and subsequently rejected) as part of the ecosystem approach in European waters: i) Barents Sea, ii) Norwegian Sea, iii) Greenland and Iceland Seas, iv) Faroes. A similar, but not identical, division into large marine ecosystems (LMEs) has also been recommended for the Arctic Council, and is implemented for various assessment purposes in the work of CAFF.

Greater North Sea (OSPAR II)

Most countries in the Celtic Seas and Greater North Sea collect breeding productivity data on marine bird species. More species of seabirds are monitored compared with waterbirds (see Table c). The main gap in monitoring is in the Skagerrak/Kattegat where breeding success is measured along the Norwegian coast, possibly along the Swedish coast, but not along the Danish coast. There is a coordinated scheme of annual monitoring of breeding success within the Wadden Sea (Netherlands, Denmark and Germany) that was initiated in 2009. Data from this monitoring were not available for use in the current assessment. Sufficient data should be available from the Dutch part of Wadden Sea to include in an assessment of B3 during IA2017; but there are doubts whether data collected since 2012 will be available from Denmark and Schleswig-Holstein (DE).

Celtic Seas (OSPAR III)

The Republic of Ireland gave the UK permission to supply data on breeding success at seabird colonies that had previously been submitted to the Seabird Monitoring Programme Database. The future availability of these data will depend on whether seabird colony monitoring in Ireland is continued. Data on breeding waterbirds were not accessible due to lack of engagement in bird indicator development by experts from Ireland.

Bay of Biscay and Iberian Coast (OSPAR IV)

In the Bay of Biscay and Iberian coast subregion (OSPAR IV), monitoring of productivity in France and Spain has created time-series of data suitable for constructing B3, but in Spain this is restricted to a single species, the European shag. It is uncertain what productivity monitoring is carried out along the Portuguese mainland coast (OSPAR IV) and on the Azores (OSPAR V-Macaronesia).

Macaronesia (OSPAR V)

The main barrier to the inclusion of data from Portugal and the Azores has been the lack of engagement by experts from Portugal in the bird indicator development process. It is uncertain what productivity monitoring data are available and accessible.

Table 3. Utilization of data from each Contracting Party in the assessment of B3 for the IA2017, indicated by 'Y' or 'N'. 'A' indicates data have been collected and are potentially available, but were not used in the assessment. '?' denotes no information obtained.

Contracting Party	OSPAR Region	Country Region	Seabird Breeding success	Waterbird Breeding success
Norway	I (Barents Sea)	Barents Sea coasts, including Svalbard and Jan Mayen	Y	N
Russia	I (Barents Sea)		?	?
Denmark	I (Greenland and Iceland Seas)	Greenland	?	?
Iceland	I (Greenland and Iceland Seas)		?	?
Denmark	I (Faroes)	Faroe Islands	?	?
Norway	I (Norwegian Sea)	Norwegian Sea coast	Y	N
UK	II-a		Y	N
Norway	II-b	Coast of western Norway	Y	N
Denmark	II-c	Skagerrak/Kattegat coast	N	N
Norway	II-c	Norwegian Skagerrak coast	Y	N
Sweden	II-c		N	N
Belgium	II-d		Y	N
Germany	II-d	Wadden Sea	Y	Y
Germany	II-d	Helgoland	A	N
Denmark	II-d	Wadden Sea	N	N
Denmark	II-d	North Sea coast Jutland	N	N
Netherlands	II-d		Y	Y
UK	II-d		Y	N
France	II-e	Nord Pas de Calais & Picardie	A	N
France	II-e	Normandy	A	N
UK	II-e		Y	N
France	II-e	Brittany	A	N
France	III	Brittany	A	N
UK	III		Y	N
Rep. Ireland	III		Y	?
France	IV	Pays de Loire, Poitou Charente, Aquitaine	A	N
Portugal	IV		?	?
Spain	IV		A	N
Portugal	V	Azores	?	N

Assessment methods

The ICES/OSPAR/HELCOM Joint Working Group on Marine Birds (JWGBIRD) developed this indicator but have acknowledged some limitations with the assessment methods used above (see ICES, 2015). These limitations are described below. They will take several years to address. In the meantime, the existing assessment methods are sufficient for identifying populations in poor condition in terms of productivity, before these changes will be identified by indicator B1-marine bird abundance.

i) The metric 'annual colony failure rate' does not fully capture all the aspects of breeding performance that might cause reductions in population condition and ultimately, population size. By focusing on the extreme event of less than 0.1 chicks being produced by a colony, on average, per year, it fails to identify other years where poor breeding success (but higher than 0.1 chicks per pair) could still have significant negative impacts on the population in the longer term.

ii) Breeding failure is a life-history strategy of some species such as Arctic terns, which if conditions are suboptimal, they will desert a colony *en masse*, rather than staying on and trying and failing to raise young. Therefore the metric may provide an over-pessimistic indicator of breeding performance in such species. However the target setting approach (see above) probably reduces the chance of false negative assessments being made.

iii) In some areas, where only a few colonies are monitored (e.g. in Norwegian North Sea) the indicator metric (proportion of colonies failing) cannot be calculated with any confidence. An alternative approach would be to categorize annual breeding success as 'good' or 'poor'. The reason this has not been recommended for B3 is that the number of chicks that need to be produced each year to sustain a population or make it grow, varies substantially as other demographic parameters (e.g. survival rates) change. Information on demographics like survival rate, age at first breeding and immature survival rates are difficult to measure because of the need to monitor individual birds from year to year. For well-studied species and at a few intensively studied sites these data do exist.

A possible step forward towards setting accurate and objective targets for annual breeding success rates, would be to collate an inventory of ongoing monitoring of survival rates in the Northeast Atlantic and conduct a review of published estimates. Once survival estimates and other demographics have been collated, some simple population modelling could be undertaken to produce some preliminary estimates of the levels of breeding success required to sustain or grow the population, equivalent to GES.

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Annex 8: OSPAR CEMAP Guidelines-Common Indicator B-1 Marine Bird Abundance

Introduction

The OSPAR Common Indicator: B1-Marine bird abundance will contribute to assessments of the state of marine bird populations and assessments of Good Environmental Status under the Marine Strategy Framework Directive: MSFD criterion: 1.2 Population Size; MSFD indicator: 1.2.1 Population abundance.

This indicator includes information on marine bird species, which at some point in their annual life cycle, are reliant on coastal and offshore areas. The indicator is constructed from species-specific trends in annual abundance. The monitoring and data collation described below, concern marine birds when they are:

a) on land at breeding colonies or sites, nesting close to the coast and using marine environment (e.g. for food); and/or

b) in intertidal areas or close to the shore and counted from land during migration or overwinter.

In the context of MSFD, abundance indicators could also be constructed from time-series data collected at sea (see Annex 1).

In this context, 'marine birds' include the following taxonomic groups that are commonly aggregated as 'waterbirds' and 'seabirds':

Waterbirds: shorebirds (order Charadriiformes); ducks, geese and swans (Anseriformes); divers (Gaviiformes); and grebes (Podicipediformes);

Seabirds: petrels and shearwaters (Procellariiformes); gannets and cormorants (Pelecaniformes); skuas, gulls, terns and auks (Charadriiformes).

Shorebirds, some duck species and some gulls feed on benthic invertebrates in soft intertidal sediments and on rocky shores. Geese mostly graze on exposed eelgrass beds (i.e. *Zostera* spp.). Diving duck species feed on invertebrate benthos in shallow inshore waters. All other marine birds, including some gulls, spend the majority of their lives at sea, feeding on prey living within the water column (i.e. plankton, fish and squid) or picking detritus from the surface. Divers, piscivorous ducks, grebes, cormorants, gulls and terns tend to be confined to inshore waters; whereas petrels, shearwaters, gannets, skuas and auks venture much further offshore and beyond the shelf break.

The indicator and its target are derived from the OSPAR EcoQO on *Seabird population trends as an index of seabird community health*. The EcoQO on seabird population trends was adopted by OSPAR's Biodiversity Committee (BDC) in 2012 (see OSPAR, 2012). When adopting the EcoQO on seabird population trends, the OSPAR BDC agreed that it, along with the other EcoQOs, should be taken forward as part of the implementation of the EC Marine Strategy Framework Directive (MSFD) (OSPAR, 2012). Subsequently, OSPAR's ICG-COBAM identified the EcoQO as an appropriate target for assessing the achievement of Good Environmental Status (GES) under MSFD.

Indicator B1 has already been tested in the Celtic Seas and in the Greater North Sea using data on breeding colonies of seabirds to assess the OSPAR EcoQO on seabird population trends, which uses the same targets and baselines as proposed for B1 to assess progress towards GES. The results of this testing have been published over the last five years, in ICES (2008, 2010, 2011, 2012 and 2013a, c). The most recent results have formed the basis of advice from ICES to OSPAR (ICES, 2013b, d).

Monitoring

Purpose

Marine bird species represent a variety of feeding guilds, from herbivores to top predators. Due to the long lifespan of these species, abundance changes slowly under ‘natural’ conditions, so rapid changes in their numbers might indicate human-induced impacts.

This indicator will be affected by pressure from fishing, predation by non-indigenous mammals and habitat loss. Fishing impacts include competition for food and mortality from bycatch. Many seabird species have benefited from food provided by the fishing industry through discards. This indicator may help us monitor the impact on seabird populations of the new EU Landings Regulations aimed at eliminating discards.

The indicator and its target are derived from the OSPAR EcoQO on Seabird population trends as an index of seabird community health. Abundance is used as an indicator of seabird community health because it is:

a) measured widely and relatively easily;

b) a good indicator of long-term changes in seabird community structure;

c) likely to change slowly under ‘natural’ conditions, so rapid changes in their numbers might indicate human-induced impacts, thereby providing a cue for immediate management actions.

Quantitative objectives

Temporal and spatial distribution for the monitoring programme

The monitoring required for indicator B1 is ideally, annually repeated counts of breeding pairs or birds; and of birds on land and at sea during migration and over winter. Data from at-sea monitoring (i.e. from boats and planes) may be added to the indicator in future years once a joint large-scale survey programme has been developed and implemented (see Appendix 1). Monitoring should be conducted on a site by site basis but needs to be representative of each subregion and subdivision therein.

The IA2017 assessment is based on data from transitional waters as well as coastal and marine, in order to provide a more meaningful subregional assessment of marine bird populations. Estuarine water bodies or ‘transitional waters’ are generally not included by Member States as ‘coastal waters’ as defined by Article 3 (1) of the Marine Strategy Framework Directive. Such areas within the Northeast Atlantic are used by millions of migrating waterbirds each year. Many estuaries are considered to be internationally important for migrating or wintering aggregations of waterbirds. Excluding estuarine populations of migrating and wintering waterbirds would miss out a large and important part of the marine bird community in the Northeast Atlantic. For instance in the southern North Sea, the exclusion of data form estuarine sites would omit form the assessment of B1 species hundreds of thousands of birds from around 10–15 species.

Marine birds are highly mobile and cross between subregions within a year. Monitoring should be representative of all subregions in order to identify impacts and threats.

All the countries in the Celtic Seas and Greater North Sea conduct annual monitoring of abundance of breeding and non-breeding marine birds. All these schemes need to continue in order to make the indicator B1 operational at a subregional scale in the Celtic Seas and the Greater North Sea.

Monitoring in some countries may need to be expanded to construct a more robust indicator. For example, monitoring of non-breeding waterbirds (including waders) in the Greater North Sea and Celtic Seas is concentrated in transitional waters, so additional monitoring of non-estuarine coasts may be required to construct the indicator for these species.

Power to detect change

Currently, many of the species-specific indicators of abundance produced during the testing had a large margin of error. It will not always be possible to ascertain, with a high degree of confidence, whether or not a target for GES has been achieved or not. In most of the monitoring schemes that contributed data to the B1 indicator trial, more sites should be monitored and others should be monitored more frequently. These enhancements will improve the precision of the indicators and hence, the confidence we will have in our assessments against targets for GES. One example of this is the UK, where, despite having a large long-running coordinated scheme for monitoring breeding birds (The Breeding Bird Survey-BBS), the data generated from surveys of waterbird species breeding at coastal sites were insufficient to provide representative trends for each of OSPAR Region II and III.

Monitoring Strategy

Data collection is currently carried out and funded by national monitoring schemes. Monitoring of breeding abundance of marine birds is conducted in all OSPAR regions and as part of nationally coordinated schemes. The contribution of monitoring data by Contracting Parties for the assessment of indicator B1 in the Intermediate Assessment 2017 is described in Annex 1. It also identifies gaps in data availability (see Table A1-1) and describes the potential for an operational indicator B1 in each OSPAR Region.

Most national schemes have a central data storage mechanism (e.g. national database).

Most countries monitor a sample of their colonies, with some but not all counted annually. Periodically, all colonies may be surveyed as part of a total census, sometimes carried out successively (area-by-area) over a number of years (e.g. ten year mapping scheme in Norway).

The intensity of monitoring (i.e. number of colonies and frequency) also varies depending on species. The minimum amount of monitoring locations depends on species and the inherent variability of trends between locations, and the magnitude of change that needs to be detected with statistical confidence. If a compromise between frequency and spatial coverage needs to be made, the then counts should be made less frequently but over at more sites to better represent the birds’ distribution within a subregion.

Monitoring methods

Monitoring breeding abundance is more straightforward in some species than others, so species-specific methods have been designed and are widely used (see e.g. Walsh *et al.*, 1995). Generally, the number of nests, pairs or individuals within an entire colony, or specially selected subsections, or plots are counted. This requires one or two observers visiting a colony several times during the breeding season (i.e. usually May–August, but varies with species and latitude). Resources required for these visits are dependent on how accessible the colony is, i.e. colonies in remote areas and on uninhabited offshore islands are more expensive to monitor than colonies on mainland coasts in populated areas.

The time required for data collection depends on the number of sites and types of marine bird being surveyed (e.g. breeding seabird at colonies on remote offshore islands or wintering waders along mainland stretches of coast). Each national monitoring programme currently manages time allocations.

Monitoring costs in most countries are minimized by using volunteer observers, but professional observers are sometimes used to monitor the less accessible colonies, especially in the north. Hence, monitoring costs will vary between countries depending on the number of colonies to be monitored, the accessibility of these colonies and on how much of the monitoring can be done by volunteers. During colony visits for abundance monitoring, some data on breeding success for common indicator B-3 (Breeding success/failure of marine bird species) can also be collected. Monitoring costs for both indicators are thus not necessarily additive.

Quality assurance/ Quality Control

Each national monitoring scheme has QA/QC protocols, but European standards should be developed. A minimum standard should be to follow internationally recognized monitoring methods (e.g. Walsh *et al.*, 1995; Koffijberg *et al.*, 2011).

Data reporting, handling and management

Each CP has its own data storage mechanism. Within each subregion and subdivision therein, indicator B1 is constructed from all available data from constituent CPs before being assessed. This process of international assessment can be carried out annually to better inform management actions or to trigger research. It requires the annual submission of national data to a central data custodian who is also responsible for analysis of data and dissemination of results. The process could be established for each subregion or for the entire NE Atlantic. Currently, JNCC (UK) provides temporary storage of the data. A more permanent central data storage mechanism is required.

Reporting format (Available via a link in the CEMP Appendices)

The following data were requested from contracting parties:

i) Breeding seabird colonies (including gulls and terns) and breeding waterbirds (incl. waders) nesting close to the coast and using marine environment (e.g. for food); counts of breeding pairs (preferably or failing that, adults) per species per colony per year.

ii) Wintering and passage waterbirds (including waders): numbers of birds per species per site per year that are counted from land[3].

iii) Baselines (all species): The baseline for each species, should be set at a population size that is considered desirable for each individual species within the whole of OSPAR III, in OSPAR II and in each subdivision of OSPAR II.

iv) Regional weightings (all species, OSPAR II only): size of the population of each species in each subdivision of OSPAR Region II, shown in Figure 1. These data will be used to weight the annual estimates of abundance in each subdivision before constructing indicator B1 for the OSPAR Region II. The weightings are required because the proportion of a subdivisional population that is monitored varies between species and between subdivisions. In a given year, the trend models will be used to estimate numbers at colonies that were not surveyed in that year and adds them to the observed counts from those colonies that were surveyed. Without the weighting, there would be a bias, in that those subdivisions where few colonies are monitored are underrepresented in the resultant trends, compare to those subdivisions where a larger proportion of colonies are monitored.

Assessment

Data acquisition

This indicator is generated using time-series of annual estimates of abundance of individual species.

Construction of indicators and their assessment against targets will be conducted by the use of a bespoke data tool (see above). The tool will enable non-specialists to produce quickly and easily indicators and assessments at a variety of geographical scales (e.g. country, subdivision, subregion, region). The tool will ensure consistent employment of QA on data products and will negate the use of expensive data analysis contracts. Data on seabirds or waterbirds at-sea, collected from boats or from planes were not requested. These data may be incorporated in the indicator B1 in future years once development work has been completed (see Annex 1).

The data analysis tool described above will provide bespoke outputs for reporting. It will enable easy, quick and inexpensive updates on an annual or periodic basis.

Preparation of data

Spatial aggregation of data

For indicators of non-breeding bird abundance (e.g. during winter, staging or moulting), the scale of assessment needs to be larger than the subregion i.e. region or flyway. For some species there may need to a combined assessment across regional borders e.g. between North Sea and Baltic. More work is needed to define the appropriate assessment scale for each species. This work should benefit from the increasing amount of evidence on bird migration routes, obtained from tagging studies.

This indicator is assessed for each OSPAR Region and subdivisions therein (see Figure 1).

ICES (2013c, d) suggest that subdividing OSPAR regions into smaller, more ecosystem-uniform areas will make it easier to interpret results of indicator B1. Although there is no single environmental factor that defines such areas. Based on a coarse assessment of the main oceanographic features such as currents and depths, and some relatively clear-cut differences in seabird/waterbird community structures and population trends (e.g. Cook *et al*., 2011), they recommended splitting OSPAR II into six subdivisions (Figure 1):

a) Northeast coast of Britain: Duncansby Head (in the north) to Staithes (in the south);
b) West coast of Norway: Northwest from Lindesnes;
c) Skagerrak/Kattegat area: all coasts east of Lindesnes (NO) and Hanstholm (DK), i.e. the Skagerrak and the Kattegat; equals ICES Area IIIa;
d) Southern North Sea: all coasts south of Teesmouth (UK) and Hanstholm (DK), and north of the Channel subdivision (e);
e) The Channel: all coasts of OSPAR II south of Dover (UK) and Calais (FR).
f) North coast of Scotland and the Northern Isles: OSPAR II/III North Boundary to Duncansby Head, plus Orkney and Shetland.

OSPAR Region I-Arctic, encompasses several very different ecosystems in terms of key species and trophic interactions. It would be very difficult to set appropriate thresholds and reference levels for the population of a seabird species across such a large area, because in different ecosystems it may respond very differently to pressures and environmental factors. ICES (2008) therefore suggested that the EcoQO on seabird population trends should be based on trends within subdivisions of OSPAR I. They recommended subdivisions similar to the ecoregions for Greenland and Iceland Seas, Barents Sea, Faroes and Norwegian Sea that were proposed to ICES (and subsequently rejected) as part of the ecosystem approach in European waters: i) Barents Sea, ii) Norwegian Sea, iii) Greenland and Iceland Seas, iv) Faroes. A similar, but not identical, division into large marine ecosystems (LMEs) has also been recommended for the Arctic Council, and is implemented for various assessment purposes in the work of CAFF. In Figure 1, OSPAR I has so far only been divided into Barents Sea (North and South) and Norwegian Sea and all other areas because Norway are the only CP to have contributed to the development of indicator B1.

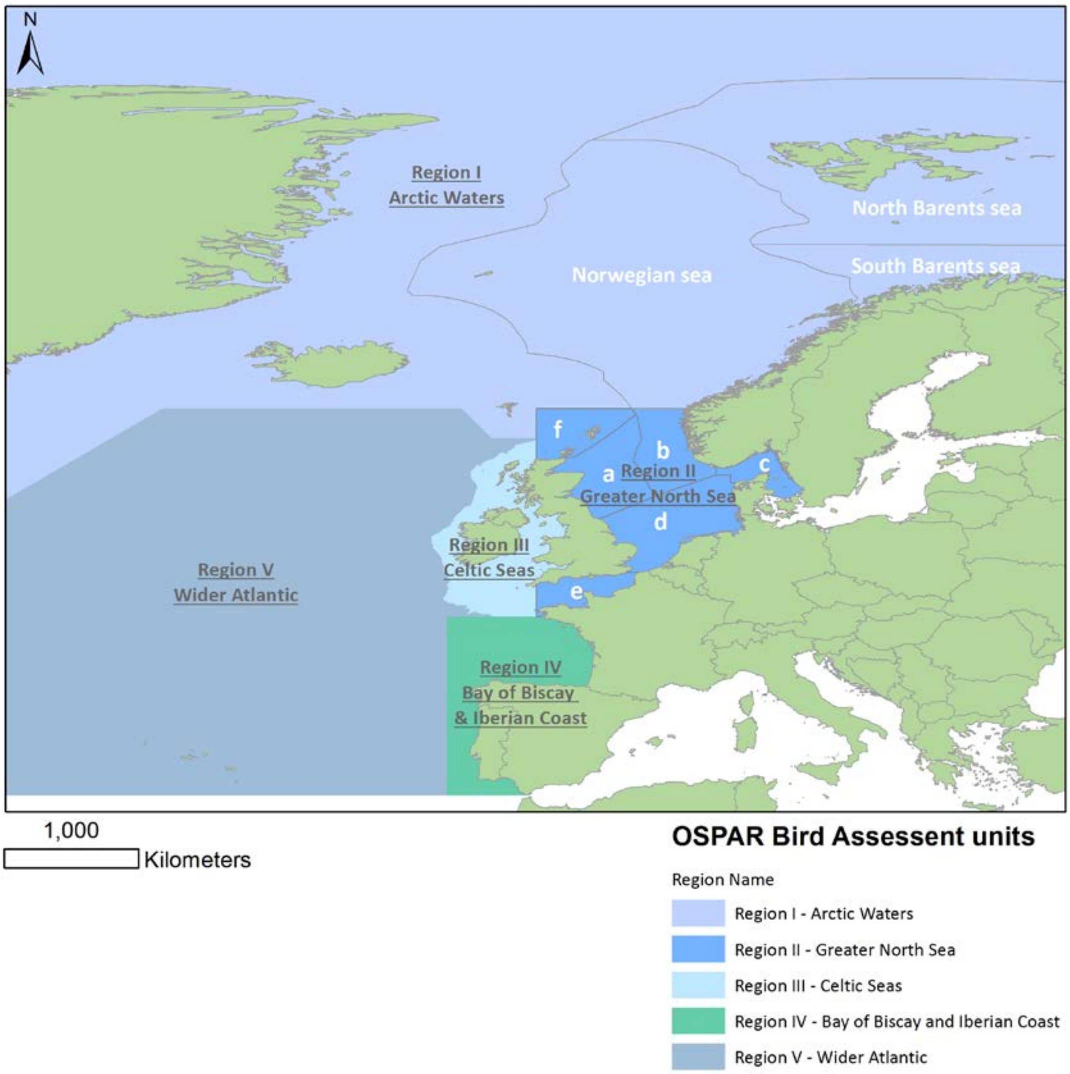


Figure 1. Marine Bird assessment units (source ICES 2013a, b).

Species aggregation-functional groups

The indicator metric is relative abundance: annual abundance as a percentage of the baseline. Species were assigned to the functional groups given in the Table 1. The species assessed during the testing and the functional groups to which they were assigned, are given in the table in Annex 3. The table also lists additional species which could be brought into the indicator following inclusion of additional OSPAR subregions and/or if existing monitoring programmes were extended.

Table 1. Marine bird functional groups.

Functional group	Typical feeding behaviour	Typical food types	Additional guidance
Wading feeders	Walk/wade in shallow waters	Invertebrates (molluscs, polychaetes, etc.)	
Surface feeders	Feed within the surface layer (within 1–2 m of the surface)	Small fish, zooplankton and other invertebrates	"Surface layer" defined in relation to normal diving depth of plunge-divers (except gannets)
Water column feeders	Feed at a broad depth range in the water column	Pelagic and demersal fish and invertebrates (e.g. squid, zooplankton)	Include only spp. that usually dive by actively swimming underwater; but including gannets. Includes species feeding on benthic fish (e.g. flatfish).
Benthic feeders	Feed on the seabed	Invertebrates (e.g. molluscs, echinoderms)	
Grazing feeders	Grazing in intertidal areas and in shallow waters	Plants (e.g. eelgrass, saltmarsh plants), algae	Geese, swans and dabbling ducks, coot

Spatial Analysis and / or trend analysis

Since the first assessment of the EcoQO on seabird population trends (ICES, 2008), JNCC (UK) in collaboration with Biomathematics and Statistics Scotland developed an analytical 'wizard' for estimating trends in breeding numbers of individual species at various geographical scales including OSPAR Regions. The seabird trend wizard uses a modified chain method, first developed by Thomas (1993), to impute values of missing counts based on information in other years and sites (details of the Thomas method are given in Annex 3 of ICES, 2008). The advantage of this method is that it allows for site-specific variation at each colony, thereby avoiding the conventional assumption that changes in abundance at different colonies occur synchronously. The wizard is a small Delphi application that retrieves counts from an Access database and generates script files and a DOS batch file that instruct R to conduct the trend analysis using the Thomas (1993) method. A further advantage of the new wizard is that the analyses can incorporate both whole colony counts and plot counts, even when they exist for the same colony in the same year. When JNCC were developing the analysis tool they investigated using Bayesian Models (see Parsons *et al.*, 2008) which also negated the assumption of synchroneity that is required by other methods such as GAMs. The Bayesian models proved time consuming to run and the confidence in trends produced by the Thomas method compared well to the Bayesian output. Neither Bayesian or GAMs models could capture extinction or colonization events, and therefore were inappropriate to species that demonstrate no or low site fidelity between years, i.e. the great cormorant and the tern species.

The wide confidence intervals from the Thomas imputation method reflect the fact that the method is empirical, and that the intervals were based on a form of nonparametric re-sampling that makes only weak assumptions regarding the structure of the data.

Assessment criteria

Parameter/metric

The indicator metric is relative abundance: annual abundance as a percentage of the baseline. Species were assigned to the functional groups given in the table below.

The species assessed during the testing and the functional groups to which they were assigned, are given in the table in Appendix 3. The table also lists additional species which could be brought into the indicator following inclusion of additional OSPAR subregions and/or if existing monitoring programmes were extended.

Baseline and reference level

The baseline for each species, should be set at a population size that is considered desirable for each individual species within each geographical area. Baselines should be set as follows:

a) 'Historical reference' where we know abundance a point in the past long before the time-series began; but don't know why it may have changed since.

b) Reference level-where we would expect the population size to be if anthropogenic impacts were negligible (this can be derived from known population sizes either historically or from within time-series).

c) Start level of time-series- at the start: first ten years, use start point if a significant trend was present, or the mean if no trend was present. Use the mean for non-breeding data.

It is preferable to set baselines objectively (i.e. a) or b)) than arbitrarily (i.e. c)). Option a) potentially provides the most objective baseline, but the limited length of the time-series available may mean some assumptions are made in setting them. The following criteria can be used to steer and standardize expert judgement when selecting baselines.

- Use historical population estimates that were recorded:
    - before known human impacts; and /or
    - before other major declines in population; or
    - at known plateaus in population trends, following increases and peaks in population size.
- Use the highest known population estimate when the population has decreased in size, as a result of human impacts (e.g. periods of severe contamination) or following stochastic natural impacts (e.g. severe weather wrecks).
- Use start level of time-series when no historical data or reference level are available.
- Use recent population estimate (e.g. previous five year mean) when a species is colonizing.

Environmental target

The criterion level target for Population Size (1.2) should be identical with the EcoQO on seabird population trends: 'Changes in abundance of marine birds should be within individual target levels in 75% of species monitored'.

Humphreys *et al*. (2012) recommended a target threshold of 75% for non-breeding shorebirds and coastal breeding waterbirds in the UK because it is comparable to the thresholds used for shorebirds by the WeBS Alerts system (http://www.bto.org/volunteer-surveys/webs/publications/webs-alerts).

Indicator thresholds

The supporting targets attached to each species-specific indicator of trends in relative abundance are set on the magnitude of change relative to baselines: species-specific annual breeding abundance should be more than 80% of the baseline for species that lay one egg, or more than 70% of the baseline for species that lay more than one egg (ICES, 2008, 2010; 2011).

These different lower thresholds were set according to the resilience of populations to decline. These species-target thresholds could be changed or set individually for each of the species-specific trends.

An upper target threshold has previously been applied to indicators of the EcoQO on seabird population trends (ICES, 2008; 2010; 2011), so that annual abundance should not be greater than 130% of the baseline. This upper threshold was used to flag-up potentially disruptive increases in some species that might impact on other species. However, this may mean that the EcoQO or GES is not achieved if some species recover to levels in excess of the baseline, without having a detrimental impact on other species. It appears that GES is not clearly indicated by the upper threshold, but it could provide a useful trigger for action (research and/or management).

When reporting on the annual results of the species-specific indicators, species that have exceeded 130% of the baseline, should be highlighted as shown in Figure 4.

Spatial assessments and aggregations

The following steps will be required in order to complete an assessment in OSPAR II or in other subregions that are subdivided:

1) Produce separate indicators for each subdivision of OSPAR II. This consists of a suite of species-specific trends in relative abundance; species composition may vary between subdivisions.

2) Assess each species-specific trend against its respective target (i.e. ≥70% for species that lay >one egg and ≥80% for species that lay one egg).

3) Count the number of species in each subdivision that have met their respective targets. Assess proportion of species meeting targets against the 75% threshold to determine if the EcoQO or GES has been achieved in each subdivision.

4) Construct indicator for the whole of OSPAR II. This consists of a suite of species-specific trends in relative abundance that are weighted for the respective total population sizes in each subdivision.

5) Assess each OSPAR II species-specific trend against its respective target (i.e. ≥70% for species that lay >one egg and ≥80% for species that lay one egg).

6) Count the number of species in OSPAR II that have met their respective targets. Assess proportion of species meeting targets against the 75% threshold to determine if the EcoQO or GES has been achieved in OSPAR II.

Presentation of assessment results

The indicator should be updated as frequently as possible; annually is preferable. The assessments of the indicator against its target should be conducted and reported annually also. This will enable management measures to be instigated to restore GES before the state of indicator declines too much, which may save considerable resources. Annual reports would also enable the effectiveness of the management measures to be frequently assessed and adjusted if required.

Figure 2 shows how the trends and target assessment for individual species indicators can be presented. Figure 3 provides an example of a subregional assessment of the criterion target for population size. Figure 4 shows how the species-specific assessments in the different subregions were presented side by side and visually interpreted via a traffic light system. The colour coding in Figure 4 relative abundance (i.e. 70% or 80% depending on clutch size) or if it has exceeded 130%. The arrows in Figure 4 illustrate recent direction of change and are useful in identifying those species that are either recovering after being below target, or those species that are currently on target, but decreasing and may drop below the target threshold in the near future. A standard protocol for determining the direction of recent changes: the annual rate of change over the ten year period preceding each annual assessment. Ten years is the period over which change is assessed by IUCN when determining Red List status (http://jr.iucnredlist.org/documents/redlist_cats_crit_en.pdf). The rate of change per annum, should be categorized as strong (>5% p.a.) or weak (2–5% p.a.) increases or decreases and no change (<2% p.a.) (following Blew *et al*., 2013). Note the imputation method use to estimate trends (see above) is non-parametric and cannot be used to determine if a change from one period to the next is significant or not.

Figure 5 is used to illustrate spatial patterns in indicator status. A bar chart uses colours to indicate the proportion of species missing or reaching their targets (red and green respectively; see Figure 4) in each subdivision of the Greater North Sea subregion, and in the Celtic Seas. Wintering marine birds (right hand bar) and were at GES than breeding marine birds (left hand bar) are shown separately. The size of the bars reflects the number of species monitored.

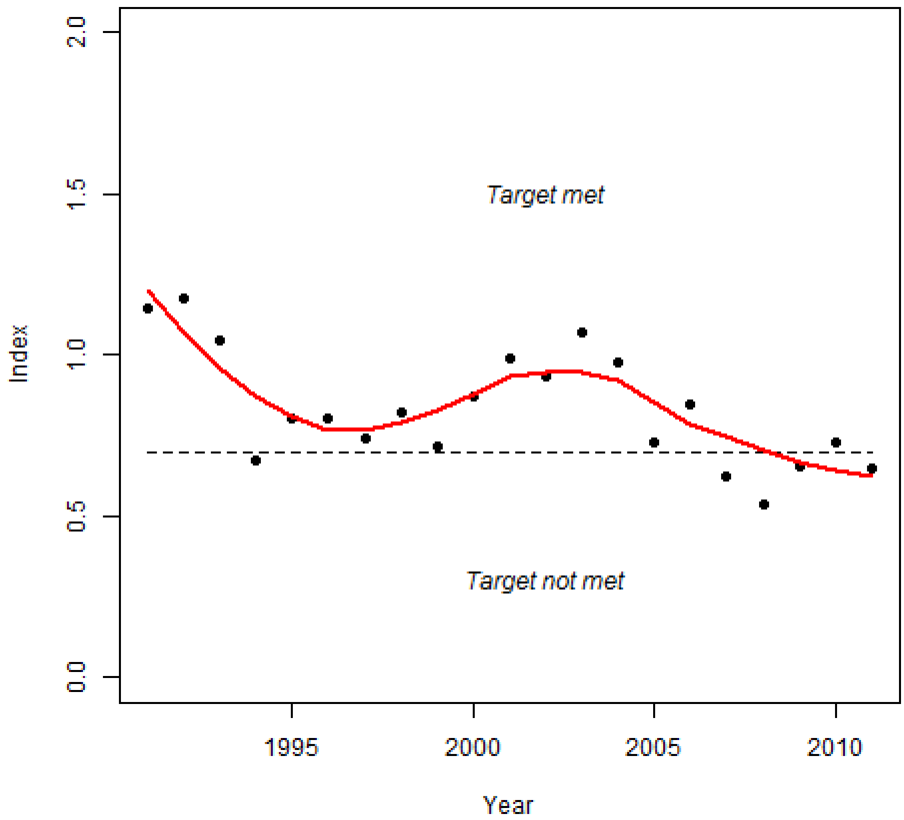


Figure 2. Example of a species-specific trend in relative breeding abundance: European shag in the Greater North Sea 1991–2011. The baseline (i.e. Relative abundance = 100) is derived from an estimate of 37 700 pairs at the start of the time-series in 1991. Black dotted line indicates the assessment threshold of 70% of the baseline.

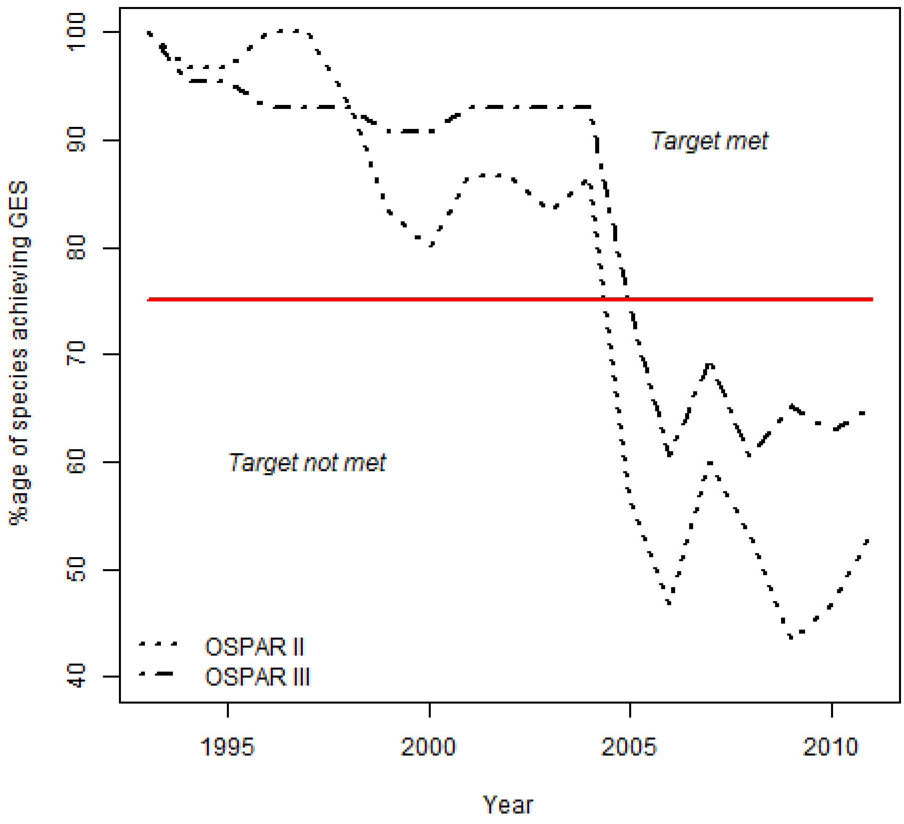
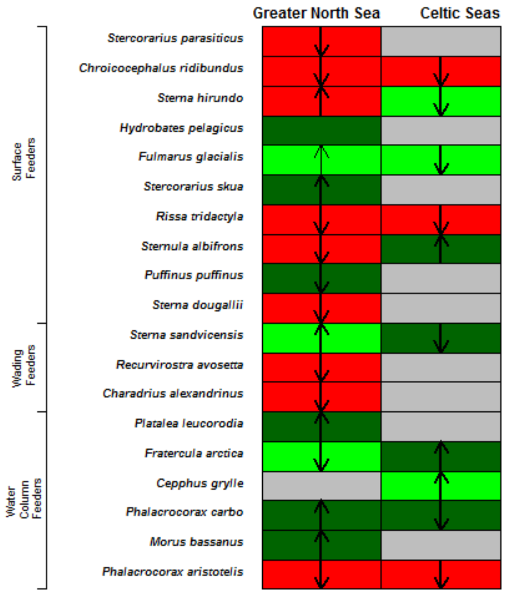
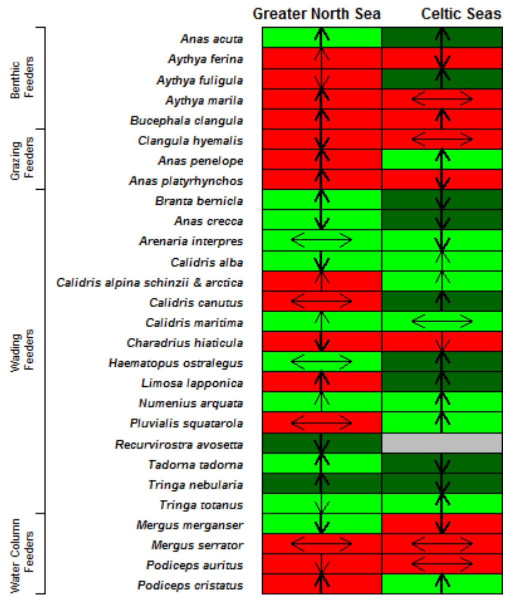


Figure 3. Changes in annual proportion of species exceeding thresholds for relative abundance in the Celtic Seas (36 species) and the Greater North Sea (46 species) during 1993–2011. The red line denotes the threshold of 75% used in the EcoQO on seabird population trends.

a) breeding marine bird abundance



b) wintering marine bird abundance



POPULATION TREND IN PREVIOUS 10 YEARS		SPECIES ASSESSMENT
↑	strong increase (>5% p.a.)	Relative abundance in year x <70 or 80% (depending on clutch size)
↑	weak increase (2–5% p.a.)	Relative abundance in year x ≥70 or 80% (depending on clutch size)
↔	no change (<2% p.a.)	Relative abundance in year x ≥ 130%
↓	weak decrease (2–5% p.a.)	
↓	strong decrease (>5% p.a.)	

Figure 4. Species-specific assessment of abundance in a) the Celtic Seas and b) the Greater North Sea in 2011. Species grouped by functional group.

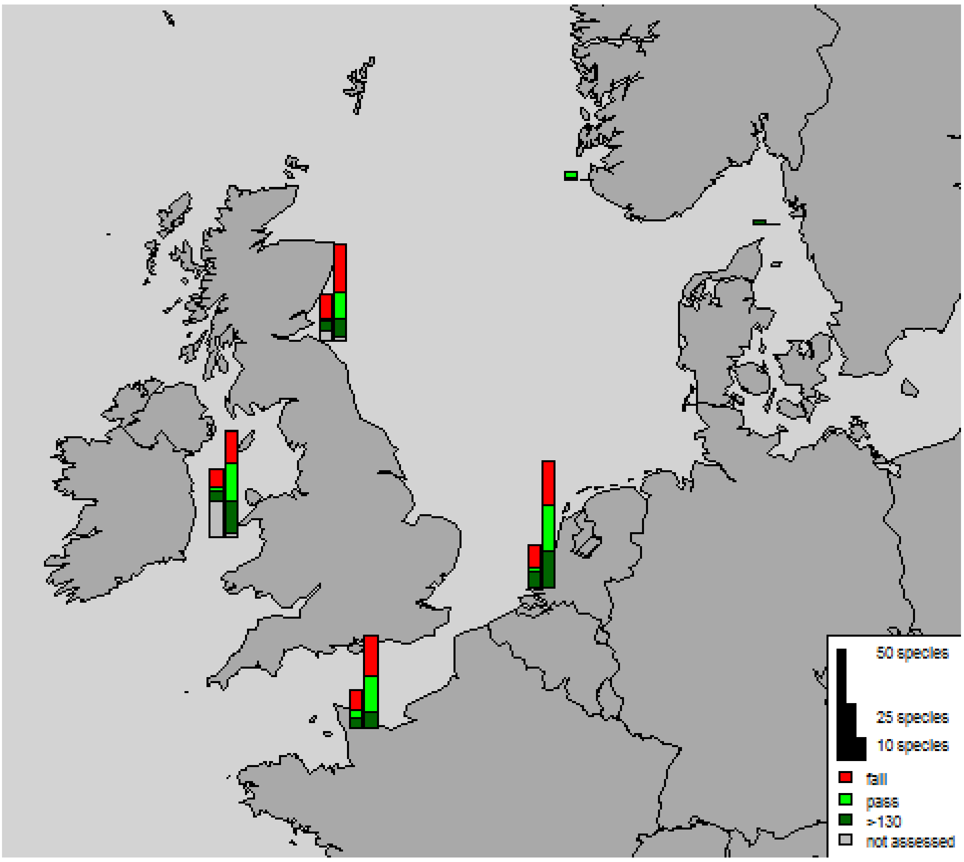


Figure 5. Spatial patterns in indicator status in 2011: Indicator status varied spatially in 2011. In each subdivision of the Greater North Sea subregion, and in the Celtic Seas a greater proportion of wintering marine birds (right hand bar) were at GES than breeding marine birds (left hand bar). Size of the bars reflect that fact that a greater number of species are monitored in North Sea subdivisions a, d and e and in the Celtic Seas than in the eastern part of the North Sea.

Change management

Responsibility for follow up of assessment (e.g. if the monitoring is not adequate) (Tech subgroup - > Committee e.g. for Beach litter – ICG-ML->EIHA).

NB is there a need to draw further incorporate from/ relate to: Article 8 EU Reporting format update/ monitoring fact sheets?

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Appendix 1: Utilization of at-sea data

Data on seabirds or waterbirds at-sea, collected from boats or planes were not included in the abundance indicator so far. However this needs to be done in future to obtain reliable results on trends of species that occur in substantial numbers in the offshore regions. Indicators could then be generated for non-breeding ducks, divers and grebes (i.e. in inshore waters outside the breeding season) and seabirds at sea (i.e. seabird species in inshore and offshore waters throughout the year). Such indicators may give an early warning of declines in some breeding populations and include species and populations not breeding in the area of assessment. In contrast to other supporting indicators of B-1 (non-breeding shorebirds and waterbirds, breeding seabirds), which are more or less restricted to coastal waters, indicators for waterbirds and seabirds at sea would help to assess the status of inshore and offshore areas. Furthermore, bird data can be directly linked to environmental parameters, helping to interpret observed trends, and bird data themselves (e.g. biomass) can be incorporated into foodweb indicator D4 for the respective marine areas.

However, considerable development of such indicators is required. The necessary data basis for these indicators is to be derived by joint coordinated surveys of all CPs at the level of the whole OSPAR area which are not available at the current stage. At the moment several CPs carry out or plan national at-sea monitoring programmes while there are no or only limited at-sea surveys in other countries. Overall, coordination of surveys, e.g. with regard to timing, between countries is lacking. Consequently, there is a need to develop (a) a concept for survey efforts delivering the necessary data basis for the abundance indicator work, (b) implement this concept in the frame of national survey programmes in future years and (c) develop a methodological approach for aggregating and analysing the data. Similar work is being undertaken in the Baltic Sea by HELCOM.

A potential approach for the North Sea could follow a preliminary trend analysis that has been conducted on time-series data from German waters. Germany is conducting an at-sea monitoring of marine birds, based on ship-based and aerial transect surveys and with data available back to 1990. Trends are calculated on the basis of trend boxes scattered all over the German section of the North Sea (including EEZ) by the help of TRIM. It is proposed to expand this monitoring approach to the Greater North Sea according to a preliminary study (Garthe *et al.*, in prep.). An example of boxes for the calculation of trends is shown in Figure A1-1. Baselines and targets can be set in the same way as in other sections of the indicator B-1.

Using these boxes and aggregating data from three year-periods, data from the ESAS database (version 5.0) already allowed calculating trends for the period 1980–1982 to 2007–2009 for the following species:

> Breeding season / summer: Northern Fulmar, Northern Gannet, Great Skua, Lesser Black-backed Gull, Herring Gull, Great Black-backed Gull, Black-legged Kittiwake, Common Guillemot, Razorbill, Atlantic Puffin. Non-breeding season / winter: Northern Fulmar, Northern Gannet, Herring Gull, Great Black-backed Gull, Black-legged Kittiwake, Common Guillemot, Razorbill, Atlantic Puffin.

Currently, not all CPs are running at-sea monitoring programmes supporting this approach. In the Greater North Sea, operational or planned monitoring schemes can be found in the France, Belgium, Denmark, The Netherlands, Germany and Sweden.

Offshore monitoring is also conducted in OSPAR subregions I (Norwegian Barents Sea) and IV (Spain). As density estimates rather than raw data are needed for the trend calculation, it is possible to include results from other studies such as SPA monitoring and EIA into the analysis, also retrospectively. It is aimed to cover all subdivisions of OSPAR II, and at-sea monitoring should be encouraged in order to enlarge the geographical coverage.

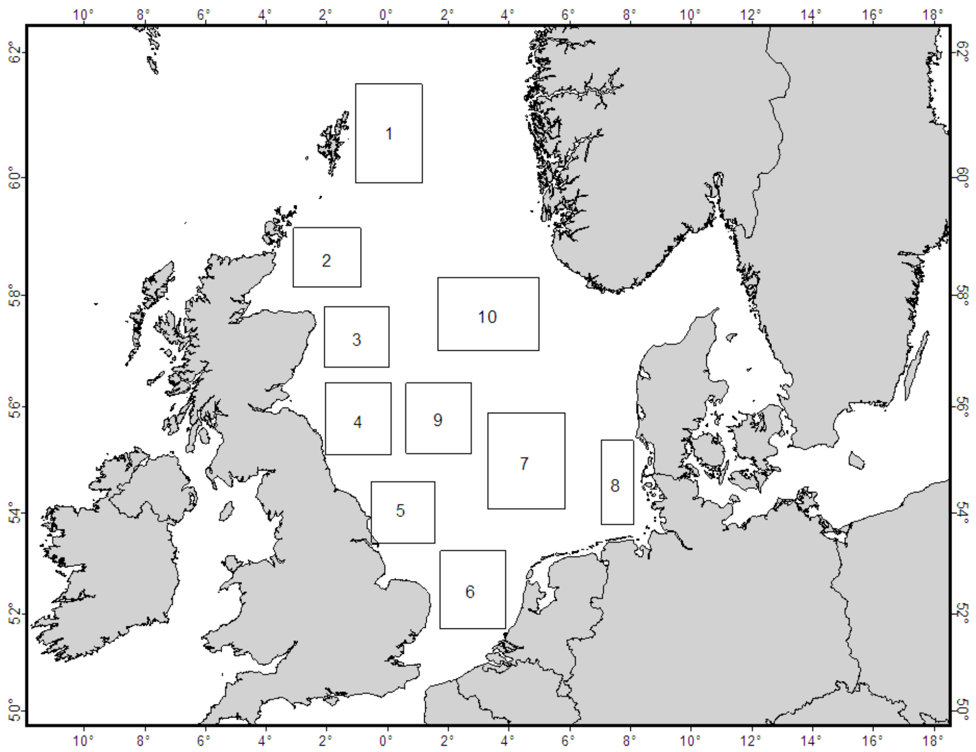

Figure A1-1. Trend boxes in OSPAR II designed for the preliminary analysis of seabird-at-sea trends, based on data of ship-based transect surveys (Garthe *et al.*, in prep.).

Appendix 2: Data availability and utilization

This appendix describes the contribution of Contracting Parties to provide data for the assessment of indicator B1 in the Intermediate Assessment 2017. It also identifies gaps in data availability (see Table A2-1) and describes the potential for an operational indicator B1 in each OSPAR Region.

Arctic (OSPAR I)

The arctic subregion contains the highest concentrations of marine birds in the NE Atlantic. None of the contracting Parties in the subregion are implementing the MSFD there. Norway intend to construct indicators (similar to OSPAR common indicators) in their seas within the Arctic and have provided data on non-breeding and breeding abundance for inclusion in B1 in IA2017.

It would be beneficial if other CPs in the subregion would mobilize their monitoring data in a similar way. Iceland is a CP of OSPAR, but have so far not provided any data input to the work of the relevant ICES/OSPAR working groups on this subject. Russia is not a CP of OSPAR. Greenland and the Faroes are represented in OSPAR by Denmark. None of these countries have provided any data input to the work of the relevant ICES/OSPAR working groups on this subject. There are known shortcomings in the monitoring of marine birds in these areas that are likely to restrict the full implementation of B1 in OSPAR I to Norwegian areas.

The Arctic subregion encompasses several very different ecosystems in terms of key species and trophic interactions. It would be very difficult to set appropriate target and reference levels for the population of a seabird species across such a large area, because in different ecosystems it may respond very differently to pressures and environmental factors. ICES (2008) suggested that the EcoQO on seabird population trends should be based on trends within subdivisions of OSPAR I. They recommended subdivisions similar to the ecoregions for Greenland and Iceland Seas, Barents Sea, Faroes and Norwegian Sea that were proposed to ICES (and subsequently rejected) as part of the ecosystem approach in European waters (ICES, 2004): i) Barents Sea, ii) Norwegian Sea, iii) Greenland and Iceland Seas, iv) Faroes.

Greater North Sea (OSPAR II)

All contracting parties bordering the Greater North Sea, with the exception of France, have provided all their available data on breeding seabirds and waterbirds and on non-breeding waterbirds. Data on at-sea abundance have not been provided so far.

The French regions of Nord Pas de Calais and Picardie have a lot of missing data due to lack of coordination for collating and formatting the data. Partial data have been provided for Normandy because of a lack of authorization to use annual data outside period of national censuses (every ten years). Data on wintering birds are collected in both regions as part of Wetlands International's International Waterbird Census (IWC) and are potentially available. Efforts are underway to develop data sharing agreements between the French Government and the independent data holders.

Celtic Seas

The Republic of Ireland gave the UK permission to supply data on breeding seabird colonies that had previously been submitted to the Seabird Monitoring Programme Database. The future availability of these data will depend on whether seabird colony monitoring in Ireland is continued. Data on breeding waterbirds and non-breeding waterbirds were not accessible due to lack engagement in bird indicator development by experts from Ireland.

Bay of Biscay and Iberian Coast (OSPAR IV)

Indicator B1 is applicable to the OSPAR IV. Of the 21 species breeding in OSPAR IV, ICES (2008) found nine to occur in very small numbers and no monitoring data have been collected on Cory's shearwater and band-rumped storm-petrel. The quality of data for six of the ten remaining species were assessed as 'good', three were assessed as sparse, and the quality of monitoring data on little terns breeding in Portugal was unknown (ICES, 2008). France has supplied abundance data from breeding colonies of 15 species.

Spain has limited information regarding seabird colony monitoring. Occasional national counts have been coordinated by SEO/BirdLife, compiling existing information, for most seabird groups (excluding Procellariiforms so far). Best monitored (and most relevant) species in the Spanish area of OSPAR IV is the European shag, with two 'long-term' series (starting 1992 and 2003) and several colonies counted intermittently (with a national census in 2006). These series are the result of particular research initiatives, but should be easily accessed. No monitoring of breeding success is conducted extensively for other species. As for Procellariiforms, several colonies of European storm-petrel, with only a few small colonies regularly visited. Cory's shearwater which was recently discovered breeding in Galicia, are currently monitored.

The main barrier to the inclusion of data from Portugal has been the lack of engagement by experts from Portugal in the Bird indicator development process, which is preventing access to any data. Other possible barriers were identified by ICES (2008) that included questions over the extent of monitoring data available and the lack of any mechanism for collating monitoring data.

Macaronesia (OSPAR V)

ICES (2008) concluded that sufficient data on breeding seabirds had been collected and collated on the Azores to construct an indicator for OSPAR region V-Macaronesia. Only nine species of seabird breed on the Azores, but of these, good quality monitoring data exists for four: band-rumped storm-petrel, Bulwer's petrel, roseate tern and common tern. Engagement is required from Portugal in order to make the indicator operational in this subregion.

Table A2-1. Utilization of data from each Contracting Party in the assessment of B1 for the IA2017, indicated by 'Y' or 'N'. 'A' indicates data have been collected and are potentially available, but were not used in the assessment. '?' denotes no information obtained.

Contracting Party	OSPAR Region	Country Region	Counts of breeding seabird	Counts of breeding waterbirds	Counts of wintering and passage waterbirds
Norway	I (Barents Sea)	Barents Sea coasts, including Svalbard and Jan Mayen	Y	Y	Y
Russia	I (Barents Sea)		?	?	?
Denmark	I (Greenland and Iceland Seas)	Greenland	?	?	?
Iceland	I (Greenland and Iceland Seas)		A	?	?
Denmark	I (Faroes)	Faroe Islands	?	?	?
Norway	I (Norwegian Sea)	Norwegian Sea coast	Y	Y	Y
UK	II-a, d, e, f		Y	N*	Y
Norway	II-b	Coast of western Norway	Y	Y	Y
Denmark	II-c	Skagerrak/Kattegat coast	Y	Y	Y
Norway	II-c	Norwegian Skagerrak coast	Y	Y	Y
Sweden	II-c		Y	Y	Y
Belgium	II-d		Y	Y	Y
Germany	II-d	Wadden Sea	Y	Y	Y
Germany	II-d	Helgoland	Y	N	A
Denmark	II-d	Wadden Sea	Y	Y	Y
Denmark	II-d	North Sea coast Jutland	Y	Y	Y
Netherlands	II-d		Y	Y	Y
France	II-e	Nord Pas de Calais & Picardie	A	A	A
France	II-e	Normandy	Y/A	A	A
France	II-e	Brittany	Y	A	A
France	III	Brittany	Y	A	A
UK	III		Y	N*	Y
Rep. Ireland	III		Y	?	?
France	IV	Pays de Loire, Poitou Charente, Aquitaine	Y	A	A
Portugal	IV		?	?	?
Spain	IV		A	N	A
Portugal	V	Azores	A	N	N

Appendix 3: Species List–B1 Marine bird abundance

The species assessed during the testing and the functional groups to which they were assigned are given in the table below. The table also lists additional species which could be brought into the indicator following inclusion of additional OSPAR subregions and/or if existing monitoring programmes were extended. Final column based on assessment in 2015.

Species (English Name)	Species (Scientific Name)	Grazing feeders	Wading feeders	Surface feeders	Water column feeders	Benthic feeders	Used in B1
Red-throated diver	*Gavia stellata*				x		
Black-throated diver	*Gavia arctica*				x		
Great Northern diver	*Gavia immer*				x		
White-billed diver	*Gavia adamsii*				x		
Great crested grebe	*Podiceps cristatus*				x		x
Red-necked Grebe	*Podiceps grisegena*				x		
Slavonian grebe	*Podiceps auritus*				x		x
Northern Fulmar	*Fulmarus glacialis*			x			x
Sooty Shearwater	*Puffinus griseus*			x	x		
Manx Shearwater	*Puffinus puffinus*			x	x		x
Balearic shearwater	*Puffinus mauretanicus*			x	x		
Cory's Shearwater	*Calonectris diomedea*			x	x		
European Storm-petrel	*Hydrobates pelagicus*			x			x
Leach's Storm-petrel	*Oceanodroma leucorhoa*			x			
Northern gannet	*Morus bassanus*				x		x
Great Cormorant	*Phalacrocorax carbo*				x	x	x
European shag	*Phalacrocorax aristotelis*				x	x	x
Eurasian spoonbill	*Platalea leucorodia*		x				x
Mute Swan	*Cygnus olor*	x					
Bewick's Swan	*Cygnus bewickii*	x					
Whooper Swan	*Cygnus cygnus*	x					
Greylag goose	*Anser anser*	x					
Greenland white-fronted goose	*Anser albifrons flavirostris*	x					
Canada Goose	*Branta canadensis*	x					
Barnacle Goose	*Branta leucopsis*	x					
Brent Goose	*Branta bernicla*	x					x
Shelduck	*Tadorna tadorna*		x				x
Wigeon	*Anas penelope*	x					x
Teal	*Anas crecca*		x				x
Mallard	*Anas platyrhynchos*	x	x				x
Pintail	*Anas acuta*	x	x				x
Shoveler	*Anas clypeata*	x					

Species (English Name)	Species (Scientific Name)	Grazing feeders	Wading feeders	Surface feeders	Water column feeders	Benthic feeders	Used in B1
Pochard	*Aythya ferina*					x	x
Tufted Duck	*Aythya fuligula*					x	x
Greater Scaup	*Aythya marila*					x	x
Common Eider	*Somateria mollissima*					x	
King eider	*Somateria spectabilis*					x	
Steller's eider	*Polysticta stelleri*					x	
Long-tailed Duck	*Clangula hyemalis*					x	x
Common Scoter	*Melanitta nigra*					x	
Velvet Scoter	*Melanitta fusca*					x	
Goldeneye	*Bucephala clangula*					x	x
Common merganser	*Mergus merganser*				x		x
Red-breasted Merganser	*Mergus serrator*				x		x
Smew	*Mergellus albellus*				x		
Coot	*Fulica atra*	x					
Oystercatcher	*Haematopus ostralegus*		x				x
Black-winged Stilt	*Himantopus himantopus*		x				
Pied avocet	*Recurvirostra avosetta*		x				x
Lapwing	*Vanellus vanellus*		x				
Golden plover	*Pluvialis apricaria*		x				
Grey Plover	*Pluvialis squatarola*		x				x
Ringed plover	*Charadrius hiaticula*		x				x
Kentish Plover	*Charadrius alexandrinus*		x				x
Bar-tailed Godwit	*Limosa lapponica*		x				x
Whimbrel	*Numenius phaeopus*		x				
Curlew	*Numenius arquata*		x				x
Spotted Redshank	*Tringa erythropus*		x				
Redshank	*Tringa totanus*		x				x
Greenshank	*Tringa nebularia*		x				x
Wood Sandpiper	*Tringa glareola*		x				
Turnstone	*Arenaria interpres*		x				x
Red-necked Phalarope	*Phalaropus lobatus*			x			
Grey Phalarope	*Phalaropus fulicarius*			x			
Red Knot	*Calidris canutus*		x				x
Sanderling	*Calidris alba*		x				x
Little Stint	*Calidris minuta*		x				
Curlew Sandpiper	*Calidris ferruginea*		x				
Purple sandpiper	*Calidris maritima*		x				x
Dunlin	*Calidris alpina schinzii & arctica*		x				x
Ruff	*Philomachus pugnax*		x				
Arctic skua	*Stercorarius parasiticus*			x			x

Species (English Name)	Species (Scientific Name)	Grazing feeders	Wading feeders	Surface feeders	Water column feeders	Benthic feeders	Used in B1
Long-tailed Skua	*Stercorarius longicaudus*			x			
Pomarine Skua	*Stercorarius pomarinus*			x			
Great Skua	*Stercorarius skua*			x			x
Glaucous gull	*Larus hyperboreus*						
Great Black-backed Gull	*Larus marinus*			x			
Herring gull	*Larus argentatus*		x	x			
Lesser black-backed gull	*Larus fuscus intermedius/graellsii*		x	x			
Common Gull	*Larus canus*		x	x			
Mediterranean Gull	*Larus melanocephalus*			x			
Black-headed Gull	*Croicocephalus ridibundus*		x	x			x
Little Gull	*Larus minutus*			x			
Black-legged kittiwake	*Rissa tridactyla*			x			x
Ivory gull	*Pagophila eburnea*			x			
Little Tern	*Sternula albifrons*			x			x
Caspian tern	*Hydriprogne caspia*			x			
Roseate tern	*Sterna dougallii*			x			x
Common tern	*Sterna hirundo*			x			x
Arctic tern	*Sterna paradisaea*			x			
Sandwich tern	*Sterna sandvicensis*			x			x
Black Tern	*Chlidonias niger*			x			
Razorbill	*Alca torda*				x		
Common Guillemot	*Uria aalge*				x		
Brünnich's guillemot	*Uria lomvia*						
Black Guillemot	*Cepphus grylle*				x		x
Little Auk	*Alle alle*				x		
Puffin	*Fratercula arctica*				x		x

Annex 9: OSPAR CEMAP Guidelines-Common Indicator B-3 Marine bird breeding success/failure

Introduction

The OSPAR Common Indicator: B3-Marine bird breeding success/failure will contribute to assessments of the state of marine bird populations and assessments of Good Environmental Status under the Marine Strategy Framework Directive: MSFD criterion: 1.3 Population Condition; MSFD indicator: 1.3.1 Demographic characteristics.

This indicator describes changes in breeding failure rates in marine birds, defined as the failure of a colony to produce on average at least 0.1 chicks per breeding pair, clutch or nest per year. The indicator is derived from annual data on mean breeding success (number chicks fledged per pair, clutch or nest) of marine bird species at colonies throughout the NE Atlantic.

As long-lived species with delayed maturity, changes in productivity of marine birds are expected to reflect changes in environmental conditions long before they are evident as changes in population size.

The failure rate of seabirds could be a valuable indicator of GES achievement, especially in areas where fisheries and seabirds target the same prey. The indicator could also provide evidence of other impacts, from e.g. human disturbance, contaminants and predation by invasive species.

This assessment will determine how frequently widespread breeding failures in marine birds occur. The spatial extent of failure will be assessed for each species and year by the proportion of colonies that fail. If widespread failures occur in more than three years out of six, the cumulative effect of successive failures is likely to have a significant impact on recruitment into the regional population.

The indicator is derived from data on annual mean breeding success (number chicks fledged per pair, clutch or nest) of marine bird species at colonies and in survey plots throughout the NE Atlantic.

In this context, 'marine birds' include the following taxonomic groups that are commonly aggregated as 'waterbirds' and 'seabirds':

> Waterbirds: shorebirds (order Charadriiformes); ducks, geese and swans (Anseriformes); divers (Gaviiformes); and grebes (Podicipediformes);
>
> Seabirds: petrels and shearwaters (Procellariiformes); gannets and cormorants (Pelecaniformes); skuas, gulls, terns and auks (Charadriiformes).

Shorebirds, some duck species and some gulls feed on benthic invertebrates in soft intertidal sediments and on rocky shores. Geese mostly graze on exposed eelgrass beds (i.e. *Zostera* spp.). Diving duck species feed on invertebrate benthos in shallow inshore waters. All other marine birds, including some gulls, spend the majority of their lives at sea, feeding on prey living within the water column (i.e. plankton, fish and squid) or picking detritus from the surface. Divers, piscivorous ducks, grebes, cormorants, gulls and terns tend to be confined to inshore waters; whereas petrels, shearwaters, gannets, skuas and auks venture much further offshore and beyond the shelf break.

Monitoring

Purpose

As long-lived species, changes in productivity of marine birds might be expected to reflect changes in environmental conditions before they are evident in changes in population size. A recent analysis of the breeding failure indicator for nine species in UK North Sea waters (Cook *et al*., 2014b) provides evidence of link to fishing pressure. The results of Cook *et al*. (2014b) suggest that failure rate of seabirds could be an indicator of GES in parts of the North Sea where fisheries and seabirds target the same prey. The indicator could also provide evidence of other impacts, from e.g. human disturbance, contaminants and predation by invasive species. There are strong links to management, especially with regard to food availability, human disturbance and predation.

Quantitative objectives

Temporal trend and spatial distribution for the monitoring programme

The monitoring required for indicator B3 is on the annual mean breeding success (number chicks fledged per pair, clutch or nest) of marine bird species at colonies and in survey plots throughout the NE Atlantic. A separate indicator should be constructed for each species in each OSPAR Region or subdivision, thereof. Depending in species and area, the indicator B3 could also be derived from monitoring of hatching success (i.e. number of eggs hatched per pair, clutch or nest).

Monitoring should be conducted on a site by site basis but needs to be representative of each subregion and subdivision therein.

Marine birds are highly mobile and cross between subregions within a year. Monitoring should be representative of all subregions in order to identify impacts and threats.

Monitoring Strategy

Data collection is currently carried out and funded by national monitoring schemes. Data collection is currently carried out and funded by national monitoring schemes. The contribution of monitoring data by Contracting Parties for the assessment of indicator B3 in the Intermediate Assessment 2017 is described in Annex 1. It also identifies gaps in data availability (see Table A1-1) and describes the potential for an operational indicator B3 in each OSPAR Region.

Most schemes have a central data storage mechanism (e.g. national database). Most countries monitor a sample of their colonies, with some but not all are monitored annually.

Monitoring methods

Monitoring breeding success is more straightforward in some species than others, so species-specific methods have been designed and are widely used (see e.g. Walsh *et al*., 1995). Generally monitoring is conducted by observing a sample of breeding-territories or nests within a colony and recording progress from laying, hatching and fledging. This requires one or two observers visiting a colony several times during the breeding season (i.e. usually May–August, but varies with species).

The time required for data collection depends on the number of sites and types of marine bird being surveyed (e.g. breeding seabird at colonies on remote offshore islands or wintering waders along mainland stretches of coast). Each national monitoring programme currently manages time allocations. The minimum amount of monitoring locations depends on species and the inherent variability of trends between locations.

Monitoring costs in most countries are minimized by using volunteer observers, but professional observers are sometimes used to monitor the less accessible colonies especially in the north. Hence, monitoring costs will vary between countries depending on the number of colonies to be monitored, the accessibility of these colonies and on how much of the monitoring can be done by volunteers. During colony visits for productivity monitoring, some data on abundance for common indicator B-1 (marine bird abundance) can also be collected. Monitoring costs for both indicators are thus not necessarily additive.

Quality assurance/ Quality Control

Each national monitoring scheme has QA/QC protocols, but European standards should be developed. A minimum standard should be to follow internationally recognized monitoring methods (e.g. Walsh *et al.*, 1995; Koffijberg *et al.*, 2011).

Data reporting, handling and management

Each CP has its own data storage mechanism. Within each subregion and subdivision therein, indicator B3 is constructed from all available data from constituent CPs before being assessed. This process of international assessment can be carried out annually to better inform management actions or to trigger research. It requires the annual submission of national data to a central data custodian who is also responsible for analysis of data and dissemination of results. The process could be established for each subregion or for the entire NE Atlantic. Currently, JNCC (UK) provides temporary storage of the data. A more permanent central data storage mechanism is required.

Reporting format

The following data were requested from contracting parties: counts of young fledged (preferably or fail that counts of young hatched), per species per colony per year.

Assessment

This indicator is generated using time-series of annual mean breeding success (no. chicks fledged per pair) of marine bird species at colonies and in survey plots throughout the NE Atlantic. A separate indicator should be constructed for each species in each subregion. Depending in species and area, the parameter may be derived from data hatching success (i.e. number of eggs hatched per pair).

> The indicators for each species are constructed from a time-series of annual estimates of breeding success at a sample of colonies. Not all the colonies in the sample will have been observed every year in the time-series. Missing annual observations can be predicted by models, see Section 3.4 below.
>
> Construction of indicators and their assessment against targets will be conducted by the use of a bespoke data tool (see above). The tool will enable non-specialists to produce quickly and easily indicators and assessments at a

variety of geographical scales (e.g. country, subdivision, subregion, region). The tool will ensure consistent employment of QA on data products and will negate the use of expensive data analysis contracts.

The data analysis tool described above will provide bespoke outputs for reporting. It will enable easy, quick and inexpensive updates on an annual or periodic basis.

Preparation of data

Spatial aggregation of data

This indicator is assessed for each OSPAR Region and subdivisions therein (see Figure 1).

ICES (2013c, d) suggest that subdividing OSPAR regions into smaller, more ecosystem-uniform areas will make it easier to interpret results of indicator B3. Although there is no single environmental factor that defines such areas. Based on a coarse assessment of the main oceanographic features such as currents and depths, and some relatively clear-cut differences in seabird/waterbird community structures and population trends (e.g. Cook *et al.*, 2011), they recommended splitting OSPAR II into six subdivisions (Figure 1):

a) Northeast coast of Britain: Duncansby Head (in the north) to Staithes (in the south);

b) West coast of Norway: Northwest from Lindesnes;

c) Skagerrak/Kattegat area: all coasts east of Lindesnes (NO) and Hanstholm (DK), i.e. the Skagerrak and the Kattegat; equals ICES Area IIIa;

d) Southern North Sea: all coasts south of Teesmouth (UK) and Hanstholm (DK), and north of the Channel subdivision (e);

e) The Channel: all coasts of OSPAR II south of Dover (UK) and Calais (FR).

f) North coast of Scotland and the Northern Isles: OSPAR II/III North Boundary to Duncansby Head, plus Orkney and Shetland.

OSPAR Region I-Arctic, encompasses several very different ecosystems in terms of key species and trophic interactions. It would be very difficult to set appropriate thresholds and reference levels for the population of a seabird species across such a large area, because in different ecosystems it may respond very differently to pressures and environmental factors. ICES (2008) therefore suggested that the EcoQO on seabird population trends should be based on trends within subdivisions of OSPAR I. They recommended subdivisions similar to the ecoregions for Greenland and Iceland Seas, Barents Sea, Faroes and Norwegian Sea that were proposed to ICES (and subsequently rejected) as part of the ecosystem approach in European waters: i) Barents Sea, ii) Norwegian Sea, iii) Greenland and Iceland Seas, iv) Faroes. A similar, but not identical, division into large marine ecosystems (LMEs) has also been recommended for the Arctic Council, and is implemented for various assessment purposes in the work of CAFF. In Figure 1, OSPAR I has so far only been divided into Barents Sea (North and South) and Norwegian Sea and all other areas because Norway are the only CP to have contributed to the development of indicator B3.

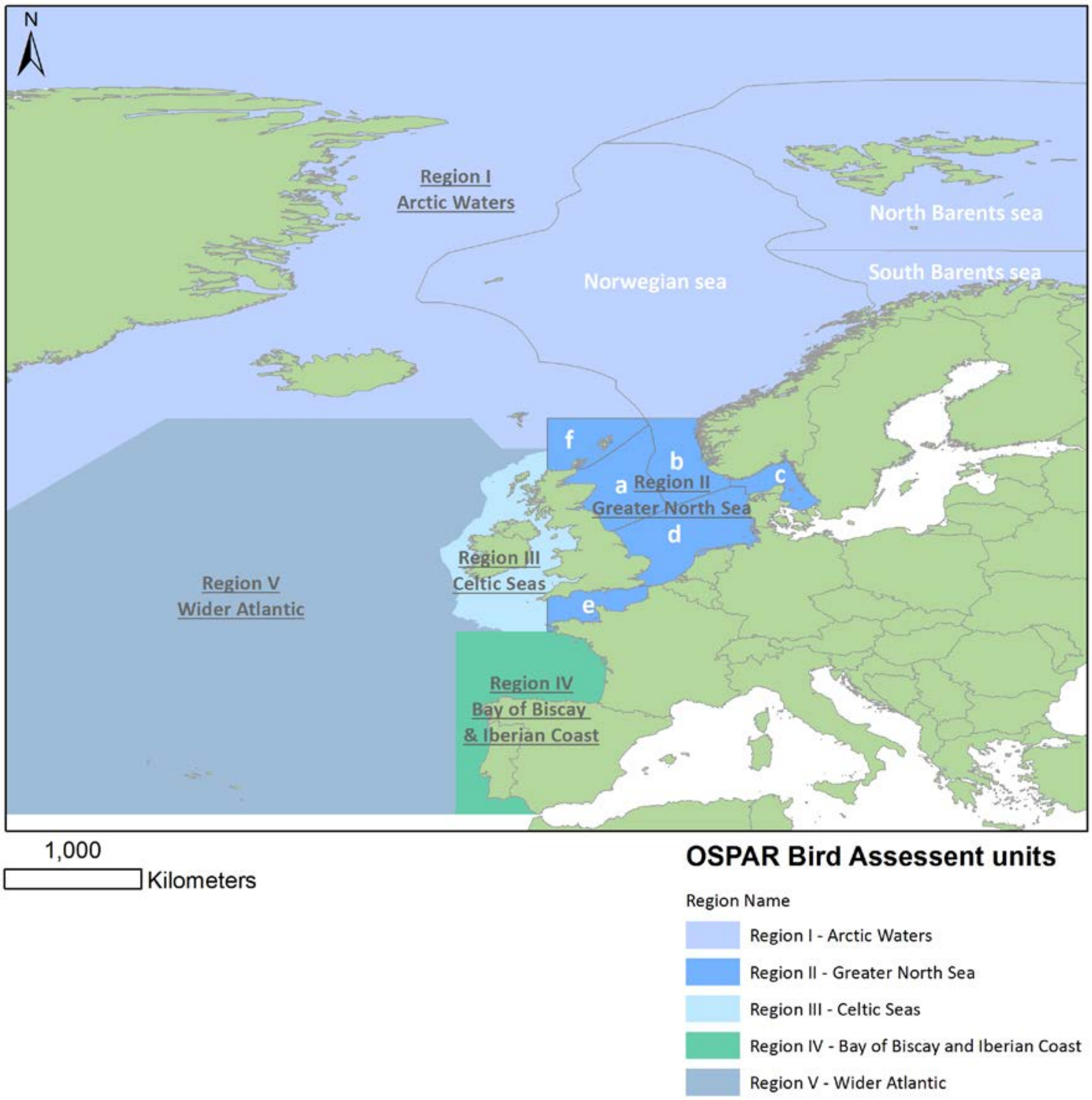

Figure 1. Marine Bird assessment units (source ICES 2013a, b).

Species aggregation-functional groups

Species were assigned to the functional groups given in the Table 1. The species assessed during the testing and the functional groups to which they were assigned, are given in the table in Annex 2. The table also lists additional species which could be brought into the indicator following inclusion of additional OSPAR subregions and/or if existing monitoring programmes were extended.

Table 1. Marine bird functional groups.

Functional group	Typical feeding behaviour	Typical food types	Additional guidance
Wading feeders	Walk/wade in shallow waters	Invertebrates (molluscs, polychaetes, etc.)	
Surface feeders	Feed within the surface layer (within 1–2 m of the surface)	Small fish, zooplankton and other invertebrates	"Surface layer" defined in relation to normal diving depth of plunge-divers (except gannets)
Water column feeders	Feed at a broad depth range in the water column	Pelagic and demersal fish and invertebrates (e.g. squid, zooplankton)	Include only spp. that usually dive by actively swimming underwater; but including gannets. Includes species feeding on benthic fish (e.g. flatfish).
Benthic feeders	Feed on the seabed	Invertebrates (e.g. molluscs, echinoderms)	
Grazing feeders	Grazing in intertidal areas and in shallow waters	Plants (e.g. eelgrass, saltmarsh plants), algae	Geese, swans and dabbling ducks, coot

Assessment criteria

Parameter/metric

'**Annual colony failure rate'** i.e. the percentage of colonies failing per year, per species (from Cook *et al*., 2014a).

The definition of 'failure' proposed by Cook *et al*. (2014a) was 0.1 chicks per pair, clutch or nest. But failure could be interpreted as an unusual deviation from 'normal' levels of breeding success and therefore the precise threshold below which a colony is defined as failing may be different at some colonies, even for the same species. The threshold used for determining failure can be adjusted according to experience of the colonies in question. The threshold should be taken from any clear step functions in response to important environmental factors such as low food availability (e.g. Cury *et al*., 2011). The threshold of 0.1 chicks per pair should be used as a default threshold, unless there is good evidence to show that 'failure' of some species in some areas is defined as something different.

Spatial analysis and / or trend analysis

The indicators for each species are constructed from a time-series of annual estimates of breeding success at a sample of colonies. Not all the colonies in the sample will have been observed every year in the time-series. Missing annual observations can be predicted by models: Cook *et al*. (2012, 2014) used a Generalised Linear Model (GLM) framework with a binomial error structure. Breeding success for each colony in each year was calculated, and where this value was below 0.1 chicks per nest, the colony was assessed as having failed in that year. Breeding success or failure was modelled in relation to year and site, to account for the fact that. The coefficient for each year was then taken to represent the probability of breeding failure occurring at any given site within that calendar year. Year was fitted as a fixed effect factor, rather than a random effect so that the coefficients would not be constrained to follow a normal distribution.

Environmental target

The Environmental target for the indicator is:

> Widespread seabird colony breeding failures should occur rarely in other species that are sensitive to changes in food availability.

The target will be assessed on the basis of the number of species achieving species-specific supporting targets: The annual percentage of colonies experiencing breeding failure does not exceed the mean percentage of colonies failing over the preceding 15 years, or 5%, depending on species, in more than three years out of six.

Assessing colony failure rate

The annual colony failure rate (i.e. percentage of colonies failing in each region) of each species was assessed against one of the two upper thresholds below, depending on the species (see Figure 2):

i) Terns: mean percentage of colonies failing per year, over the preceding 15 years;

ii) all species except terns: 5% of colonies failing per year.

The aim of the thresholds is to identify widespread breeding failures and to differentiate large-scale anthropogenic impacts from local problems, where only a small proportion of colonies fail per year. The above thresholds were taken from Cook *et al.* (2014a), who tested various target thresholds on each species indicator of annual colony failure rate. A different threshold was applied to the breeding failure rate of terns because they often desert colonies, sometimes before laying, in response to local disturbances or impacts on food supply (Shealer and Kress, 1991; Holt, 1994; Cook *et al.*, 2011). The threshold for terns is designed to identify years of unusually high rates of breeding colony failure.

A fixed threshold of 5% was appropriate to all other species, which do not tend to desert colonies *en masse* in the same way as terns use colony desertion as a life-history strategy. Years in which colony failure rate is more than 5% are much rarer in other species and therefore provide a good indicator that pressures may be impacting on the population.

Cook *et al.* (2014a) proposed using the threshold used here for terns (i.e. mean percentage of colonies failing per year, over the preceding 15 years) to assess breeding failure in all species if it is greater than 5%. It was apparent from the results of this assessment (see below) that for all species, except terns, no colonies would fail in most years and that failure rates of over 5% of colonies were significant events. The use of a threshold derived from mean breeding failure rates would risk assessing some years as 'normal', in which more than 5% of colonies have failed and were clearly not typical of 'normal' conditions. The decision by JWGBIRD to deviate from the recommendation of Cook *et al.* (2014a) is documented in ICES (2015).

Assessing the frequency of colony failure

For each species, we assessed the number of years of 'widespread colony failure' in which annual colony failure rate exceeded the appropriate threshold (as detailed above). The frequency of colony failure was assessed over each consecutive period of six years. The six-year period was chosen because it equals the length of the MSFD reporting cycle. The most recent six-year period assessed was 2009–2014, inclusive. In order to carry out the assessment the colony data for a species in a region needed contain some values from 2014, because these could not be interpolated.

One or two years of widespread colony failure were considered as 'acceptable', given the wide range of possible natural and anthropogenic factors that could cause breeding failure in some species. The cumulative effect of widespread colony failures in more than three years out of six, was considered to most likely have a significant impact on recruitment into the regional population. Low recruitment could lead to declines in population size and affect the assessments of indicator B1-marine bird abundance.

Development of assessment methods

Indicator B3 has already been tested in the Celtic Seas and in the Greater North Sea using data on seabirds at breeding colonies in the UK (Cook *et al.*, 2014a & b). The applicability of the indicator and its targets (as proposed by Cook *et al.*, 2014a) to other parts of both subregions have been assessed by OSPARs Expert Group on Marine Birds (ICES, 2013). The group agreed that the indicator and target-setting approach could be applied to other areas where many colonies are monitored, as in the UK (ICES, 2013). However some concerns over the target-setting approach where expressed and reiterated by JWGBIRD during the current tests. These concerns are:

i) The metric, breeding failure rate, does not fully capture all the aspects of breeding performance that might cause reductions in population condition and ultimately, population size. By focusing on the extreme event of less than 0.1 chicks being produced by a colony, on average, per year, it fails to identify other years were poor breeding success (but higher than 0.1 chicks per pair) could still have significant negative impacts on the population.

ii) Breeding failure is a life-history strategy of some species such as Arctic terns, which if conditions are suboptimal, they will desert a colony *en masse*, rather than staying on and trying and failing to raise young. Therefore the metric may provide an over pessimistic indicator of breeding performance in such species. However the target setting approach (see above) probably reduces the chance of false negative assessments being made.

iii) In some areas, where only a few colonies are monitored (e.g. in Norwegian North Sea) the indicator metric (proportion of colonies failing) cannot be calculated with any confidence.

An alternative approach would be to categorise annual breeding success as 'good' or 'poor'. The reason this has not been recommended for B3 is that the number of chicks that need to be produced each year to sustain a population or make it grow, varies substantially as other demographic parameters (e.g. survival rates) change; see Figure 3.

Information on demographics like survival rate, age at first breeding and immature survival rates are difficult to measure because of the need to monitor individual birds from year to year. For well-studied species and at a few intensively studied sites these data do exist (e.g. the Norwegian SeaPop Database contains 46 time-series (average length 12 years) of annual survival rates for15 species.

A possible step forward towards setting accurate and objective targets for annual breeding success rates, would be to collate an inventory of ongoing monitoring of survival rates in the Northeast Atlantic and conduct a review of published estimates. Once survival estimates and other demographics have been collated, some simple population modelling could be undertaken to produce some preliminary estimates of the levels of breeding success required to sustain or grow the population, equivalent to GES.

The above work will take several years to complete. In the meantime, the existing target setting approach for B3 should be used and assess for IA2017, because it will identify populations in poor condition in terms of productivity, before these changes will be identified by indicator B1-marine bird abundance.

Presentation of assessment results

Data need to be collated centrally from CPs and then analysed to produce the indicator of annual colony failure, which can then be compared against thresholds. The indicator can be assessed on an annual basis.

In addition to the species-specific plots of annual monitoring failure in Figure 2, the following methods of presentation are recommended:

Species traffic lights (see Figure 4)

Cook *et al*. (2014a) suggested a colour-coded alerts system, which enables an early warning that targets may not be met in subsequent years and may enable pre-emptive measures to be applied Colours cells indicate the number of years during the six year MSFD assessment period that annual colony failure rate was widespread (i.e. exceeded species-specific thresholds, see Figure 2): green = two years or less; orange cells = three years; red = four years or more.

Maps (see Figure 5)

Maps showing for each species showing the spatial distribution of colony failure. There are pie charts marking the location of each colony used in the assessment. The pie charts show the proportion of years in the six-year period of the assessment in which the colony Pie charts show proportion of years during 2009–2014 in which breeding success was more than 0.1 chicks per pair (green), or less than 0.1 chicks per pair (red). Grey indicates number of years in which breeding success was not measured.

Multispecies assessments (see Figure 6)

Curves representing the interannual changes in the proportion of marine bird species have not experienced widespread annual colony failures in more than three of the previous six years. The proportion of species achieving the target that breeding failure rates should not exceed 5% or the mean over the previous 15 years, whichever is greater, in more than three of the previous six years. This enables multispecies assessments e.g. for all species or for functional groups.

Change management

Responsibility for follow up of assessment (e.g. if the monitoring is not adequate) (Tech subgroup - > Committee e.g. for Beach litter – ICG-ML->EIHA)

NB is there a need to draw further incorporate from/ relate to: Article 8 EU Reporting format update/ monitoring fact sheets?

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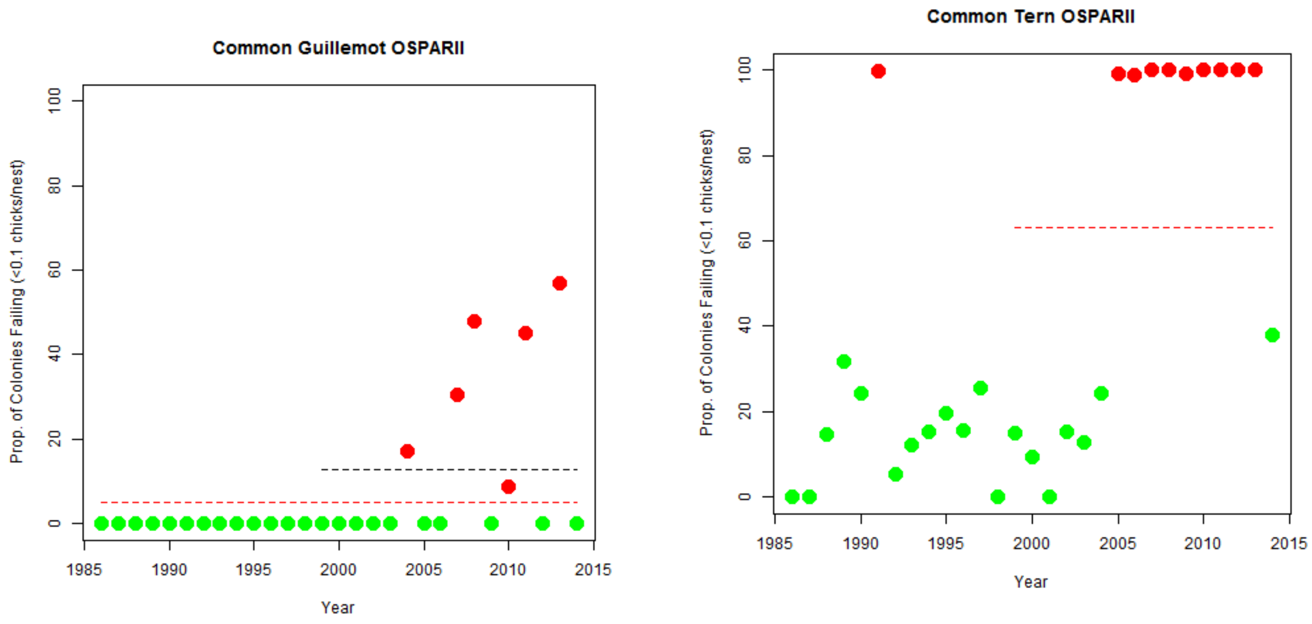


Figure 2. Examples of species-specific indicators of annual colony failure in relation to different thresholds, for a) Common guillemot and b) Common tern in the Greater North Sea 1986–2014. Thresholds are shown as red dotted lines. The threshold for tern species is the mean percentage of colonies failing per year, over the preceding 15 years. The threshold for all other species (except terns) is 5% of colonies failing per year. The black dotted line denotes the mean percentage of colonies failing per year, over the preceding 15 years, where this is not used as the threshold. All values below the threshold are coloured green and all those above are coloured red and indicate 'widespread breeding failure'.

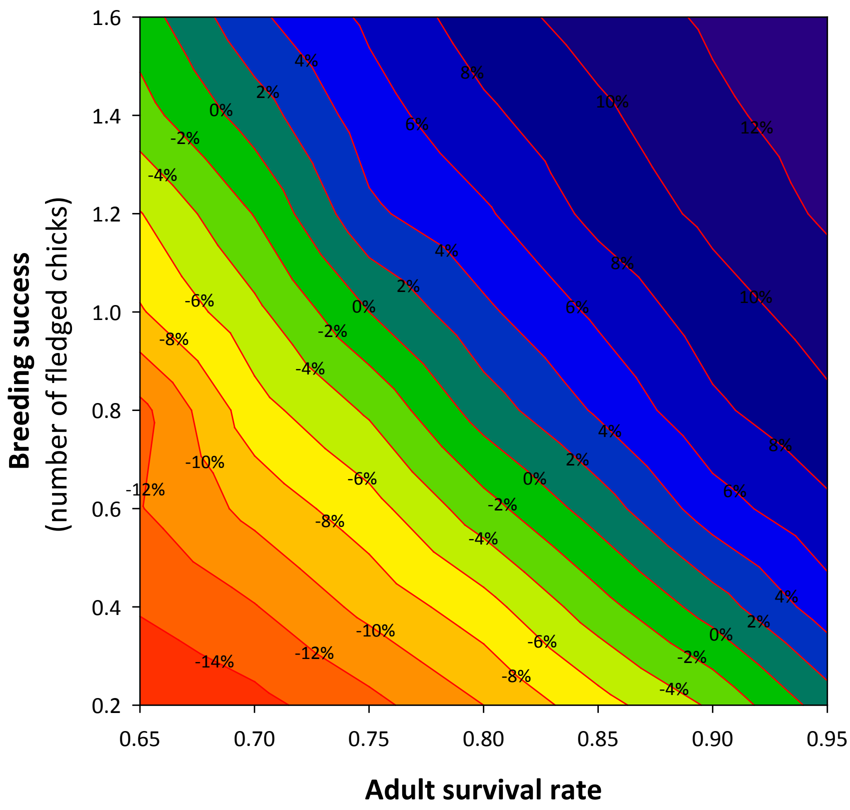
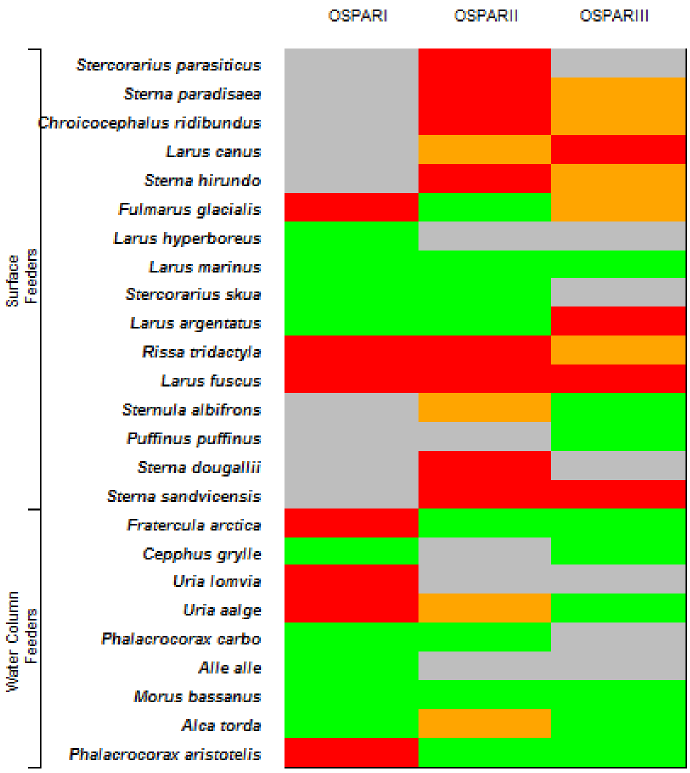


Figure 3. Annual population trends (% change) for kittiwake populations that would result from different combinations of adult survival rates and annual breeding success rates (contour lines). This plot illustrates that if survival rate falls from 0.9 to 0.85, the level of breeding success requires to maintain population size (i.e. 0% change) would have to increase from 0.38 to 0.58 chicks per pair. The model assumes that the kittiwake starts to breed at three years of age, that the survival rate of young birds from fledging to first breeding is 0.7, and that the sex ratio at fledging is 0.5. (From Erikstad and Systad, 2009)


OSPARI
OSPARII
OSPARIII
Surface Feeders
Water Column Feeders
Stercorarius parasiticus
Sterna paradisaea
Chroicocephalus ridibundus
Larus canus
Sterna hirundo
Fulmarus glacialis
Larus hyperboreus
Larus marinus
Stercorarius skua
Larus argentatus
Rissa tridactyla
Larus fuscus
Sternula albifrons
Puffinus puffinus
Sterna dougallii
Sterna sandvicensis
Fratercula arctica
Cepphus grylle
Uria lomvia
Uria aalge
Phalacrocorax carbo
Alle alle
Morus bassanus
Alca torda
Phalacrocorax aristotelis

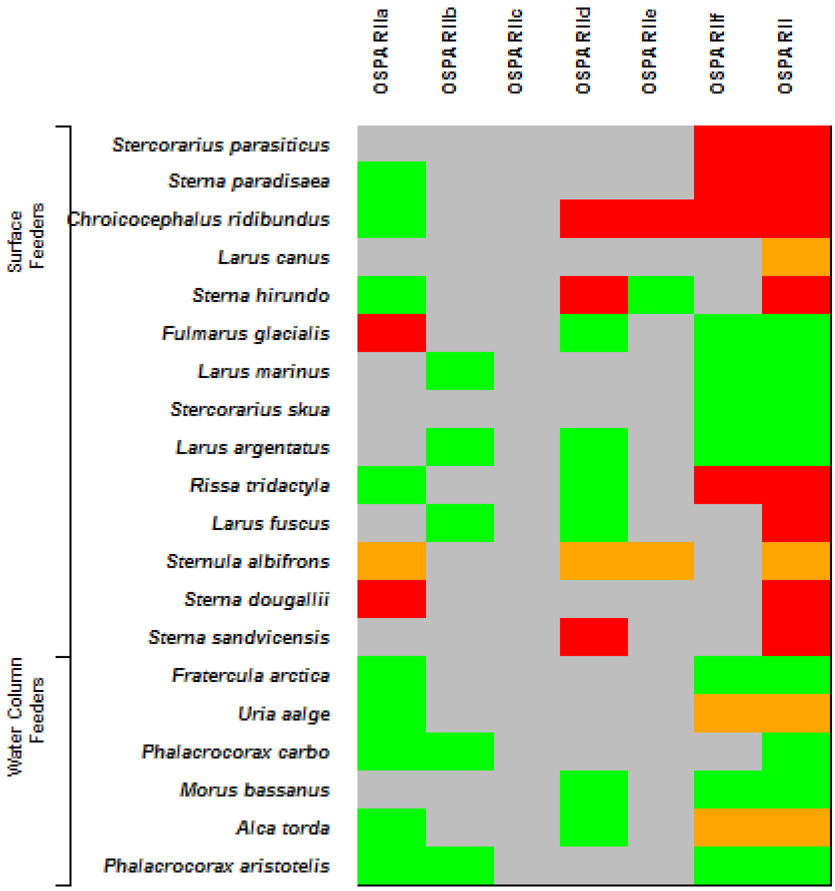


Figure 4. Species-specific assessment of breeding failure in 2014 in the OSPAR Regions I-Arctic (Norway only, including Svalbard and Jan Mayen), II-the Greater North Sea and III-Celtic Seas and each subdivision of OSPAR II (as shown in Figure 1). Species ordered by functional group. Colour of cells indicates the number of years during the six year assessment period (2009–2014) that annual colony failure rate was widespread (i.e. exceeded species-specific thresholds, see Figure 2): green = two years or less; orange cells = three years; red = four years or more.

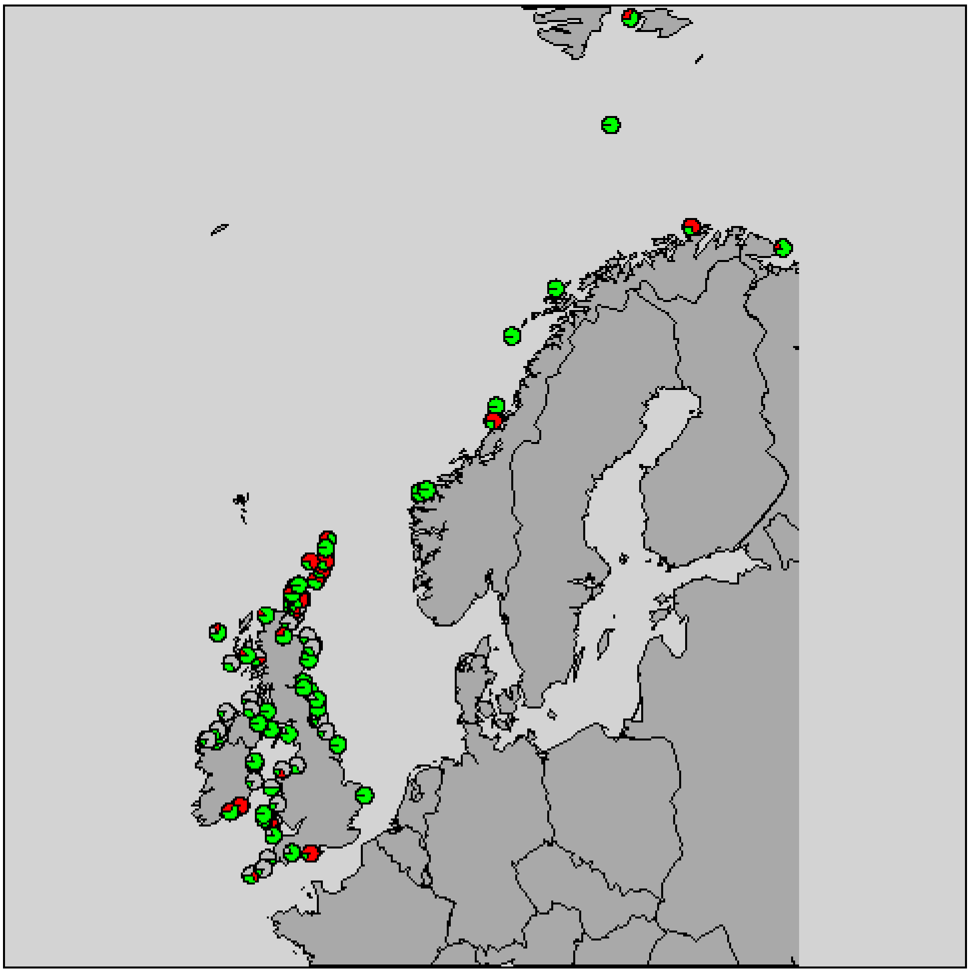


Figure 5. An example of a map showing spatial distribution in breeding colony failures of Black-legged kittiwake. Pie charts show proportion of years during 2009–2014 in which breeding success was more than 0.1 chicks per pair (green), or less than 0.1 chicks per pair (red). Grey indicates number of years in which breeding success was not measured.

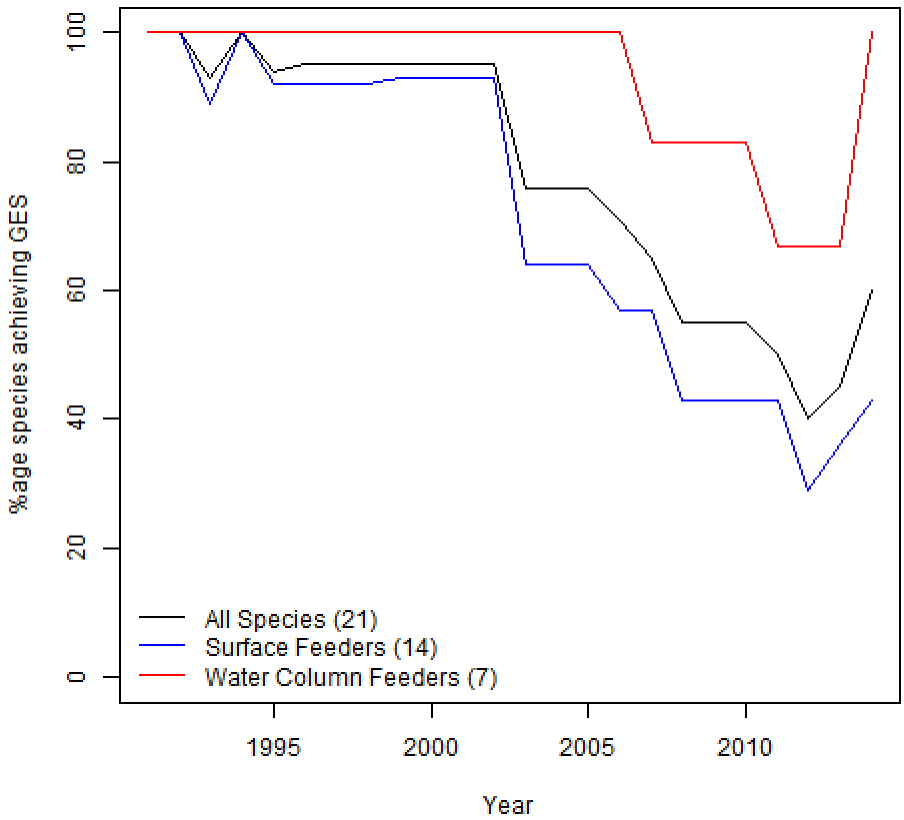


Figure 6. Example plot of the changes in the proportion of marine bird species have not experienced widespread annual colony failures in more than three of the previous six years, in Greater North Sea. Trends are shown for all species as well as for surface feeders and water column feeders. Number of species included in each group shown in brackets in the figure legend.

Appendix 1: Data availability and utilization

This Annex describes the contribution of Contracting Parties to provide data for the assessment of indicator B1 in the Intermediate Assessment 2017. It also identifies gaps in data availability (see Table A2-1) and describes the potential for an operational indicator B1 in each OSPAR Region.

Arctic (OSPAR I)

There are sufficient monitoring of seabird productivity along the Norwegian coasts of the Norwegian and Barents seas to construct an indicator of B3 there. It is uncertain whether monitoring in other countries in the Arctic subregion is sufficient to generate data for B3. The arctic subregion contains the highest concentrations of marine birds in the NE Atlantic. None of the contracting Parties in the subregion are implementing the MSFD there. Norway intend to construct indicators (similar to OSPAR common indicators) in their seas within the Arctic. It would be beneficial if other CPs in the subregion would mobilize their monitoring data in a similar way. The Arctic subregion encompasses several very different ecosystems in terms of key species and trophic interactions. It would be very difficult to set appropriate target and reference levels for the population of a seabird species across such a large area, because in different ecosystems it may respond very differently to pressures and environmental factors. ICES (2008) suggested that the EcoQO on seabird population trends should be based on trends within subdivisions of OSPAR I. They recommended subdivisions similar to the ecoregions for Greenland and Iceland Seas, Barents Sea, Faroes and Norwegian Sea that were proposed to ICES (and subsequently rejected) as part of the ecosystem approach in European waters (ICES, 2004): i) Barents Sea, ii) Norwegian Sea, iii) Greenland and Iceland Seas, iv) Faroes.

Greater North Sea (OSPAR II)

Most countries in the Celtic Seas and Greater North Sea collect breeding productivity data on marine bird species. More species of seabirds are monitored compared with waterbirds (see Table 1). The main gap in monitoring is in the Skagerrak/Kattegat (Subdivision IIc in Figure 4) where breeding success is measured along the Norwegian coast, possibly along the Swedish coast, but not along the Danish coast. There is a coordinated scheme of annual monitoring of breeding success within the Wadden Sea (Netherlands, Denmark and Germany) but it was only initiated in 2009. Data from this morning were not used in the current because they were only available up to 2011, which would not have allowed an assessment of the indicator B3's target that is assessed over a six year period. However, sufficient data should be available from the Wadden Sea to include in an assessment of B3 during IA2017.

Celtic Seas (OSPAR III)

The Republic of Ireland gave the UK permission to supply data on breeding success at seabird colonies that had previously been submitted to the Seabird Monitoring Programme Database. The future availability of these data will depend on whether seabird colony monitoring in Ireland is continued. Data on breeding waterbirds were not accessible due to lack engagement in bird indicator development by experts from Ireland.

Bay of Biscay and Iberian Coast (OSPAR IV)

In the Bay of Biscay and the Iberian coast subregion (OSPAR IV), monitoring of productivity in France and Spain has created time-series of data suitable for constructing B3, but in Spain this is restricted to a single species, the European shag. It is uncertain what productivity monitoring is carried out along the Portuguese mainland coast (OSPAR IV) and on the Azores (OSPAR V-Macaronesia).

Macaronesia (OSPAR V)

The main barrier to the inclusion of data from Portugal and the Azores has been the lack of engagement by experts from Portugal in the Bird indicator development process. It is uncertain what productivity monitoring data are available and accessible.

Table A1-1. Utilization of data from each Contracting Party in the assessment of B1 for the IA2017, indicated by 'Y' or 'N'. 'A' indicates data have been collected and are potentially available, but were not used in the assessment. '?' denotes no information obtained.

Contracting Party	OSPAR Region	Country Region	Seabird Breeding success	Waterbird Breeding success
Norway	I (Barents Sea)	Barents Sea coasts, including Svalbard and Jan Mayen	Y	N
Russia	I (Barents Sea)		?	?
Denmark	I (Greenland and Iceland Seas)	Greenland	?	?
Iceland	I (Greenland and Iceland Seas)		?	?
Denmark	I (Faroes)	Faroe Islands	?	?
Norway	I (Norwegian Sea)	Norwegian Sea coast	Y	N
UK	II-a		Y	N
Norway	II-b	Coast of western Norway	Y	N
Denmark	II-c	Skagerrak/Kattegat coast	N	N
Norway	II-c	Norwegian Skagerrak coast	Y	N
Sweden	II-c		N	N
Belgium	II-d		Y	N
Germany	II-d	Wadden Sea	Y	Y
Germany	II-d	Helgoland	A	N
Denmark	II-d	Wadden Sea	N	N
Denmark	II-d	North Sea coast Jutland	N	N
Netherlands	II-d		Y	Y
UK	II-d		Y	N
France	II-e	Nord Pas de Calais & Picardie	A	N
France	II-e	Normandy	A	N
UK	II-e		Y	N
France	II-e	Brittany	A	N
France	III	Brittany	A	N
UK	III		Y	N
Rep. Ireland	III		Y	?
France	IV	Pays de Loire, Poitou Charente, Aquitaine	A	N
Portugal	IV		?	?
Spain	IV		A	N
Portugal	V	Azores	?	N

Appendix 2: Species List-B3 Marine bird breeding success/failure

The species assessed during the testing and the functional groups to which they were assigned are given in the table below. The table also lists additional species which could be brought into the indicator following inclusion of additional OSPAR subregions and/or if existing monitoring programmes were extended.

Species (English Name)	Species (Scientific Name)	Grazing feeders	Wading feeders	Surface feeders	Water column feeders	Benthic feeders	Used in B3
Red-throated diver	*Gavia stellata*				X		
Black-throated diver	*Gavia arctica*				X		
Great Northern diver	*Gavia immer*				X		
White-billed diver	*Gavia adamsii*				X		
Great crested grebe	*Podiceps cristatus*				X		
Red-necked Grebe	*Podiceps grisegena*				X		
Slavonian grebe	*Podiceps auritus*				X		
Northern Fulmar	*Fulmarus glacialis*			X			X
Sooty Shearwater	*Puffinus griseus*			X	X		
Manx Shearwater	*Puffinus puffinus*			X	X		
Balearic shearwater	*Puffinus mauretanicus*			X	X		
Cory's Shearwater	*Calonectris diomedea*			X	X		
European Storm-petrel	*Hydrobates pelagicus*			X			
Leach's Storm-petrel	*Oceanodroma leucorhoa*			X			
Northern gannet	*Morus bassanus*				X		X
Great Cormorant	*Phalacrocorax carbo*				X	X	X
European shag	*Phalacrocorax aristotelis*				X	X	X
Eurasian spoonbill	*Platalea leucorodia*		X				
Mute Swan	*Cygnus olor*	X					
Bewick's Swan	*Cygnus bewickii*	X					
Whooper Swan	*Cygnus cygnus*	X					
Greylag goose	*Anser anser*	X					
Greenland white-fronted goose	*Anser albifrons flavirostris*	X					
Canada Goose	*Branta canadensis*	X					
Barnacle Goose	*Branta leucopsis*	X					
Brent Goose	*Branta bernicla*	X					
Shelduck	*Tadorna tadorna*		X				
Wigeon	*Anas penelope*	X					
Teal	*Anas crecca*		X				
Mallard	*Anas platyrhynchos*	X	X				
Pintail	*Anas acuta*	X	X				
Shoveler	*Anas clypeata*	X					
Pochard	*Aythya ferina*					X	

Species (English Name)	Species (Scientific Name)	Grazing feeders	Wading feeders	Surface feeders	Water column feeders	Benthic feeders	Used in B3
Tufted Duck	*Aythya fuligula*					X	
Greater Scaup	*Aythya marila*					X	
Common Eider	*Somateria mollissima*					X	
King eider	*Somateria spectabilis*					X	
Steller's eider	*Polysticta stelleri*					X	
Long-tailed Duck	*Clangula hyemalis*					X	
Common Scoter	*Melanitta nigra*					X	
Velvet Scoter	*Melanitta fusca*					X	
Goldeneye	*Bucephala clangula*					X	
Common merganser	*Mergus merganser*				X		
Red-breasted Merganser	*Mergus serrator*				X		
Smew	*Mergellus albellus*				X		
Coot	*Fulica atra*	X					
Oystercatcher	*Haematopus ostralegus*		X				
Black-winged Stilt	*Himantopus himantopus*		X				
Pied avocet	*Recurvirostra avosetta*		X				
Lapwing	*Vanellus vanellus*		X				
Golden plover	*Pluvialis apricaria*		X				
Grey Plover	*Pluvialis squatarola*		X				
Ringed plover	*Charadrius hiaticula*		X				
Kentish Plover	*Charadrius alexandrinus*		X				
Bar-tailed Godwit	*Limosa lapponica*		X				
Whimbrel	*Numenius phaeopus*		X				
Curlew	*Numenius arquata*		X				
Spotted Redshank	*Tringa erythropus*		X				
Redshank	*Tringa totanus*		X				
Greenshank	*Tringa nebularia*		X				
Wood Sandpiper	*Tringa glareola*		X				
Turnstone	*Arenaria interpres*		X				
Red-necked Phalarope	*Phalaropus lobatus*			X			
Grey Phalarope	*Phalaropus fulicarius*			X			
Red Knot	*Calidris canutus*		X				
Sanderling	*Calidris alba*		X				
Little Stint	*Calidris minuta*		X				
Curlew Sandpiper	*Calidris ferruginea*		X				
Purple sandpiper	*Calidris maritima*		X				
Dunlin	*Calidris alpina schinzii & arctica*		X				
Ruff	*Philomachus pugnax*		X				
Arctic skua	*Stercorarius parasiticus*			X			X
Long-tailed Skua	*Stercorarius longicaudus*			X			
Pomarine Skua	*Stercorarius pomarinus*			X			

Species (English Name)	Species (Scientific Name)	Grazing feeders	Wading feeders	Surface feeders	Water column feeders	Benthic feeders	Used in B3
Great Skua	*Stercorarius skua*			X			X
Glaucous gull	*Larus hyperboreus*						X
Great Black-backed Gull	*Larus marinus*			X			X
Herring gull	*Larus argentatus*		X	X			X
Lesser black-backed gull	*Larus fuscus intermedius/graellsii*		X	X			X
Common Gull	*Larus canus*		X	X			X
Mediterranean Gull	*Larus melanocephalus*			X			
Black-headed Gull	*Larus ridibundus*		X	X			X
Little Gull	*Larus minutus*			X			
Black-legged kittiwake	*Rissa tridactyla*			X			X
Ivory gull	*Pagophila eburnea*			X			
Little Tern	*Sternula albifrons*			X			X
Roseate tern	*Sterna dougallii*			X			X
Common tern	*Sterna hirundo*			X			X
Arctic tern	*Sterna paradisaea*			X			X
Sandwich tern	*Sterna sandvicensis*			X			X
Black Tern	*Chlidonias niger*			X			
Razorbill	*Alca torda*				X		X
Common Guillemot	*Uria aalge*				X		X
Brünnich's guillemot	*Uria lomvia*						X
Black Guillemot	*Cepphus grylle*				X		X
Little Auk	*Alle alle*				X		X
Puffin	*Fratercula arctica*				X		X

Annex 10: Coordinated survey of seabirds in the Baltic Sea in winter 2015/2016

Background

The Baltic area is a very important area for wintering waterbirds. The large areas of shallow waters host millions of ducks, divers, auks and other waterbirds. Describing the Baltic wide bird distributions and abundances require a coordinated effort.

Aim

- to organize coordinated surveys to collect data of waterbird abundances and distributions in the Baltic as recommended by the HELCOM BALSAM project;
- to provide waterbird abundance and distribution data from a combined dataset;
- to provide input to the HELCOM indicator of wintering waterbird abundances.

Actual plan

- in the winter months of 2015/2016 to survey waterbird distributions in a large part of the Baltic (Figure 1);
- surveys from aircraft as well as from ship;
- data collection using either line transect or strip transect sampling methods;
- Participating countries: Finland, Estonia, Lithuania (?), Latvia, Poland, German, Denmark, Sweden (Figure 1).

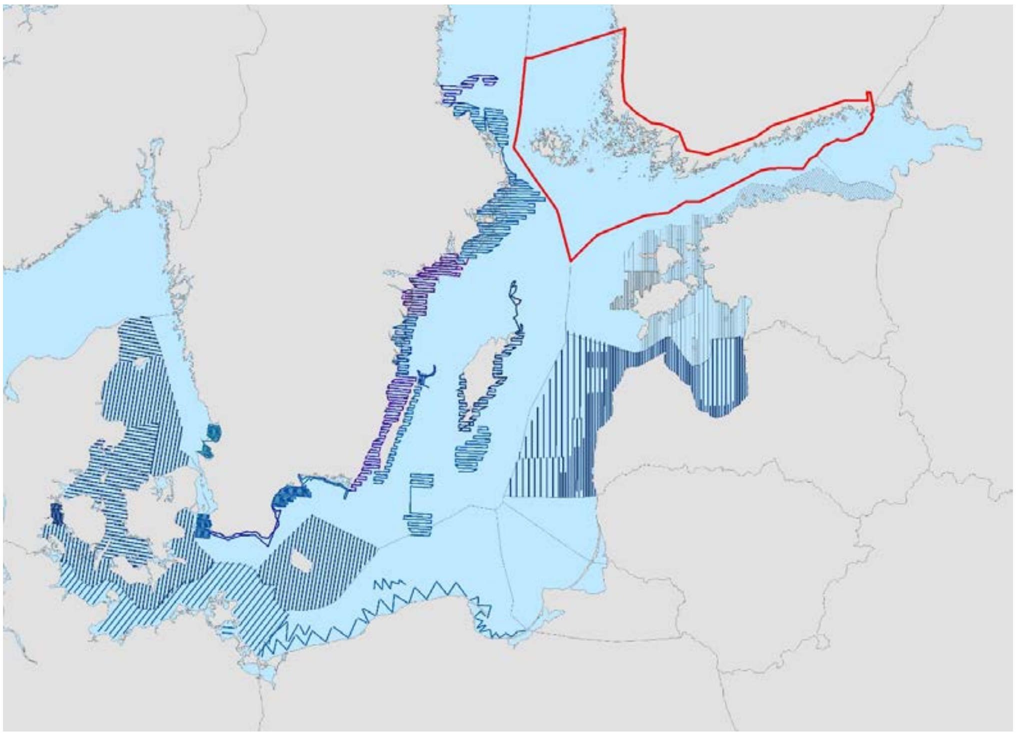


Figure 1. Transect design for the seabird survey in winter 2015/2016, mostly referring to aerial surveys (ship-based surveys in Poland). Transect design in Finland pending decision (survey area surrounded by red line).

Annex 11: Guidelines for coordinated cost-effective future monitoring of marine birds in the Baltic

version: 19 September 2015, provided at HELCOM State & Conservation 2-2015

Background

This document contains recommendations/guidelines for bird monitoring in the Baltic as prepared by the Baltic Sea Pilot Project: Testing new concepts for integrated environmental monitoring of the Baltic Sea (BALSAM) Work Package 3: Regional coordination of monitoring of marine mammals and seabirds. The draft document proposes the use of a combination of ground counts and plane or ship counts for monitoring of birds in marine environment during non-breeding seasons and ground counts in the breeding season as a solution to cover all stages of the life cycle and all areas important for birds.

Recommendations and guidelines for bird monitoring in the Baltic

Written by: Ainars Aunins, LFN, LV

The Guidelines were discussed in a Baltic marine bird experts meeting that took place in 28–29 January, 2015 in Jurmala, Latvia. The following experts attended in the meeting: Markus Ahola (FI), Lena Avellan (HELCOM), Mindaugas Dagys (LT), Volker Dierschke (DE), Johanna Karhu (HELCOM), Antti Lappalainen (FI), Leho Luigujoe (EE), Wlodimierz Meissner (PL), Ian Mitchell (UK), Leif Nilsson (SE), Ib Krag Petersen (DK), Jukka Rintala (FI), and Antra Stipniece (LV). Nele Markones (DE) submitted written suggestions and comments to the draft Guidelines. Additional suggestions to improve the draft Guidelines were submitted at the HELCOM meeting of State and Conservation 2-2015 by Sweden and Germany.

Introduction

The waterbirds are an integral part of the Baltic marine ecosystem. They are predators of fish, macroinvertebrates and other bird species, scavengers of carcasses and fishery discards and herbivores of littoral vegetation.

This document describes recommendations and guidelines for bird monitoring in the Baltic Sea, which were developed within the BALSAM project Work Package 3 "Regional coordination of monitoring of marine mammals and seabirds". The work will be discussed with marine bird experts in all HELCOM Contracting Parties.

All the Baltic Sea countries (the HELCOM contracting parties) are carrying out marine bird monitoring. However, currently these efforts are not coordinated.

During the non-breeding seasons the distribution areas of marine bird species can cover large parts of the Baltic Sea and the individuals belong to the same population. Mobility of marine birds during non-breeding period allows them to adjust their territorial distribution according to changing accessibility of the suitable feeding sites. Thus counting birds in different parts of the Baltic Sea in different years may cause difficulties to carry out Baltic Sea wide scale assessments. To avoid the risk of missing or double-counting the birds during nationally restricted counting sessions, the coordination of data collection schemes among the Baltic Sea countries is required.

Sufficiently wide assessment units and monitoring approaches could enable the production of high-quality assessments for the MSFD and BSAP. The sharing of tasks and international optimization of monitoring activities could reduce the total costs of assessment.

Therefore, it is important that the Baltic Sea countries coordinate all the wide scale counting activities during the non-breeding seasons (e.g. performing large-scale counts in the same winter) and establish a data interchange and sharing system that facilitates carrying out Baltic Sea wide scale assessments.

These monitoring guidelines are limited to abundance and distribution of marine birds during the non-breeding seasons only. It was not intended to duplicate the existing more detailed monitoring guidelines and monitoring manuals or give precise field protocols (e.g. Camphuysen *et al*., 2004; Wetlands International, 2010). The intention rather was to set common standards for bird monitoring in the Baltic Sea to facilitate data exchange, development of a common database and use for Baltic Sea wide assessments.

Abbreviations used for the names of the Contracting Parties:

DK	DENMARK
EE	Estonia
FI	Finland
DE	Germany
LV	Latvia
LT	Lithuania
PL	Poland
RU	Russia
SE	Sweden

Policy relevance

Monitoring of birds is required by several international policy documents binding to all or most of the Baltic Sea countries. All but one HELCOM Contracting Party (RU) are the EU member states and thus they have to comply with the requirements of EU Directives. This sets overall standards regarding biodiversity monitoring in the Baltic Sea.

HELCOM Baltic Sea Action Plan (BSAP) is a programme to restore the good ecological status of the Baltic marine environment by 2021. The strategy, adopted by all the coastal states and the EU in 2007, is a crucial stepping stone for wider and more efficient actions to combat the continuing deterioration of the marine environment resulting from human activities. The HELCOM ecological objective "Viable populations of species" is part of the biodiversity goal "Favourable conservation status of Baltic biodiversity" (Helsinki Commission, 2007). The following bird related CORESET indicators have been developed to achieve this goal:

- Abundance of waterbirds in the wintering season.
- Abundance of waterbirds in the breeding season.
- Number of drowned mammals and waterbirds in fishing gear.
- Marine bird health (White-tail eagle productivity).

Article 11 of the **Marine Strategy Framework Directive** (European Parliament, 2008) provides legally binding requirements for Member States to establish and implement coordinated monitoring programmes for the ongoing assessment of the environmental status of marine waters. The Directive provides no particular guidance on the design and content of the monitoring programmes, the setting of environmental targets or determination of GES. However, criteria and methodological standards on good environmental status of marine waters (European Commission, 2010) have been defined to harmonize approach between the countries.

The Article 12 of the **Birds Directive** (European Parliament, 2010) requires that the EU member states every three years report on the implementation of the national provisions taken under this Directive. Until 2013 the reporting under Article 12 primarily reflected the legal transposition and technical implementation of the directive on the national level. In 2008 it was agreed to start exploring a new system of bird reporting, which would deliver data on the actual state and trends of bird populations, similar to the reporting under Article 17 of the Habitats Directive, as well as a change from a three year to a six year reporting cycle. The 1st reporting according to the new format took place in 2013. The Birds Directive applies to all species of naturally occurring birds in the wild state in the European territory of the Member States, as defined in Article 1. Thus detailed report has to be completed for all regularly occurring species in the relevant seasons. For marine bird species wintering and passage are among the reporting seasons.

Several marine bird species can be considered as the "typical species" of the **Habitats Directive** Annex I habitat types such as 1110 Sandbanks which are slightly covered by seawater all the time and 1170 Reefs (Council of the European Communities, 1992). Article 17 of this directive requires detailed reporting on each of the listed habitat types and the requested information includes information on the status of typical species of the habitat.

The same data collection schemes can provide data that serve the data needs for the indicators under BSAP as well as MSFD, BD and HD reporting.

Recommendations for monitoring abundance and distribution of waterbirds during non-breeding seasons

Seasons

The Baltic Sea is used by waterbirds outside the breeding season as a moulting, feeding and wintering areas, and also as migration staging place.

Wintering is the most suitable period for waterbird monitoring as they aggregate in certain feeding grounds and are less mobile than in other non-breeding seasons. Thus coordinated counts within this period allows collecting the least biased data and the winter season is top priority for waterbird monitoring during the non-breeding period.

The moult is a critical period in the life cycle of seaducks when most species are flightless or near-flightless. Although the flightless moulting ducks appear to establish a relatively regular diurnal pattern of local movement and habitat use, they have limited opportunity to move if conditions change following the onset of moult. Thus populations during this period can be considered as closed. Besides the need to monitor important moulting grounds (site monitoring), carrying out full-scale surveys provides an opportunity to collect reliable data on total population size moulting in the Baltic Sea and to discover new sites. Although currently there is no HELCOM

CORESET indicator developed for the moulting birds due to lack of suitable data, collection of appropriate data should be promoted.

It has been shown recently that the counts of arctic breeding seaducks such as Long-tailed Duck at the key bottle-neck sites in Finland and Estonia during the spring migration period can well reflect population changes and status of the populations of these species wintering in the Baltic Sea. Continuation of this type of monitoring is highly desirable.

EU member states have designated Marine SPAs to protect sites where marine bird species are regularly aggregating in large numbers for wintering, moulting or staging during the migrations. Monitoring of these sites in different seasons is needed to fulfil the obligations arising from Birds Directive and regular updating of the Natura 2000 database. Although monitoring of these sites in the wintering and moulting periods might be covered with the generic large-scale marine bird monitoring surveys, there is a need for a dedicated monitoring for some of these sites during the migration periods. There might be also a need to have different sampling design or counting platform to obtain more precise site-specific data which might be difficult using the one intended for large-scale surveys.

To be able to specify to which extent the Marine SPAs grasp the amount of birds present in the national waters, the monitoring of the marine SPAs should not be limited to the sites only. They should cover also the general marine areas.

Current situation

All Baltic Sea countries are currently monitoring wintering birds and collecting data on species numbers and distribution; however, counting methods, time frame and type of financing varies greatly among the countries.

Inshore surveys. Ground count based coastal surveys are carried out in all countries. In the countries with larger inshore areas that cannot be counted from coast, the ground counts are usually accompanied by plane counts. Unlike the ground based coastal counts, the inshore plane surveys are not carried out annually and in most countries, where they take place, the regularity is not strictly set. These plane surveys most usually are carried out as total counts or strip counts because using line transects in the complex inshore environment is difficult.

In the winter season the inshore counts are internationally coordinated by Wetlands International as a part of the International Waterbird Census (IWC). The ground counts are carried out annually and mostly are done by volunteers. They are well synchronized in time among the European countries as the weekend closest to the 15th of January is the central dates for the IWC. However, there is no international coordination in timing of the inshore plane surveys and they may take place in different years in different countries.

Inshore surveys in the duck moulting period and during the passage have been carried out only in part of the Baltic Sea countries. Where they are, they often were carried out on project basis. Thus they also lack the coordination among countries.

Offshore surveys by plane and ship have been carried out in all countries, however, usually they have occurred as one-off surveys on project basis and rarely covering entire waters of the countries. Years of the large-scale counting are not synchronized between countries and the choice of the counting platform mostly depends on the tradition. There is an increasing use of line transects, however strip transects are also used.

Offshore monitoring, especially in winter, lacks coordination and is geographically not representative. Because of the spatially and temporally uneven survey coverage across the Baltic region, assessments of offshore seaducks or auks are not possible with the current monitoring. There is also a need for revising the winter population monitoring in the northern part of the Baltic Sea, as it is expected that due to general climate warming, iceless winters in the Northern Baltic will become more frequent in future. Thus, to monitor Baltic populations of marine birds, spatial scale in the marine bird censuses need to be increased.

Wide scale monitoring of offshore moulting waterbirds takes place on regular basis only in Denmark. There is a need to carry out baseline surveys of moulting seaducks in the rest of the countries and to establish national monitoring programmes with appropriate sampling design where needed. Baltic wide coordination of such surveys will be the next step.

Coordination should be enhanced by building a platform for marine bird monitoring in the Baltic. Adopting common monitoring guidelines and establishing common monitoring database are the first steps to take. Wide scale survey activities should be coordinated between Baltic Sea counties to collect more reliable data for the Baltic Sea wide assessments.

Choice of methods

There are three conventional monitoring methods to record population numbers and distribution. Each of them has its strengths and weaknesses which, in short, are given below. The novel methods are discussed after the conventional methods.

Ground based survey is the oldest of the methods and is the least demanding regarding the personnel and costs. There are many volunteers, especially in the western part of the Baltic Sea available that are able to carry out waterbird counts using this methodology. Due to the International Waterbird Census established decades ago and currently organized by Wetlands International, all Baltic Sea countries have and existing monitoring network, covering significant portion of the Baltic coastline as well as established field survey protocols and procedure (Wetlands International, 2010). However, the method can be used to monitor the very coastal areas only. Usually the effective counting belt reaches up to a distance of 1km from coast, however, the actual distance depends on the species and visibility during the count. While this might be sufficient for species with very coastal distribution such as dabbling ducks or mergansers, it is not able to cover significant populations occurring further from coast such as Long-tailed Duck or scoters. In addition, it is difficult to use distance sampling during ground based surveys as the counting routes are not randomly positioned against the existing habitats and environmental gradients. Thus it is not possible to account for birds not detected.

Shipboard and **aerial** line transect surveys are widely used for estimating the abundance of marine birds in offshore areas (Camphuysen *et al*., 2004) as they do not have limitations of the ground based surveys regarding the geographic coverage. They allow accounting for birds present but not detected using the distance sampling (Thomas *et al*., 2002). On aerial or ship based surveys it is impractical to record individual distance to every observation, so the observations are grouped within distance belts and detection functions are calculated using these distance belts. In marine bird surveys the unit of observation is a flock of birds and for each flock also the flock size is recorded. For single birds the flock size is 1. If a flock spreads over several distance belts, number of birds is recorded for each belt separately.

Aerial or **plane based surveys** allow covering large areas in a relatively short time. This is particularly important during the winter season when the light time of day is very short and days with weather conditions appropriate to bird counting at sea are infrequent. The aerial surveys would allow efficient use of the short periods of available light and suitable weather which is not possible for the ship-based surveys. For countries having large areas that need to be surveyed the aerial counts are the only viable choice for full-scale surveys. However, aerial surveys are more expensive and demanding regarding the weather conditions during the surveys, which can be rarely available. This can become a major obstacle if the survey has to be carried out in a specified and narrow time period. Especially during the period when birds are very mobile (e.g. migration) this can lead to surveys that are very fragmented in time and thus not able to deliver a representative picture of bird occurrence.

Several disadvantages of observer based aerial surveys have been reported: larger flocks tend to get underestimated during aerial surveys (e.g. Bellebaum *et al*., 2014), identification of birds is considerably harder and there are groups that usually can be identified up to the genus level only and aerial surveys are not suitable for small, inconspicuous species (such as grebes or auks), in particular in concentration areas. However, the aerial surveys cause less disturbance reactions for some of the species groups (e.g. divers). Field experts for the aerial surveys need additional training on species recognition, bird detection and estimation of flock size.

Ship based surveys outperform the aerial surveys regarding bird detection and species identification and are preferred if faunistic precision or precise counts of rarer species are important. Species identification skills obtained in ground counts are usually sufficient for carrying out ship based surveys, however observers need additional training on estimation of distances and flock size. On the negative side, surveying speed of ships do not allow covering large areas. For countries with large territories to be surveyed, the amount of ship time needed might be prohibiting due to availability of days with suitable weather. During winter when days are short, ratio of counting and waiting time is cost inefficient. However, as being less demanding than aerial surveys regarding the weather conditions, there might be situations where the ship surveys are the only option to carry out surveys at all. Additional disadvantage is that most of the ships suitable as a platform for bird counting may not be able to cross very shallow banks and approach coastline. Zigzag line transect designs (Strindberg and Buckland, 2004) are needed for ship surveys as the classical parallel line sampling design is not cost-effective for ships.

Line transects vs. strip transects. The two sampling techniques are relevant to both plane and ship based counting platforms. Using strip transects the objects of interest outside the strip are not counted. Width of the strip should not be larger than area where detectability of the objects is 100%. In practice, this assumption rarely is true even for narrow strips thus resulting in underestimation of the population size (Ronconi and Burger, 2009). The proportion of undetected birds varies between the species. Distance sampling allows using all observations collected during the counts and is not restricting them to one particular counting belt. The method takes into account the well-known fact that detectability of objects decreases with increased distance from observer. Species and observer specific detection curves allow more robust population estimates than those obtained in the strip transects. Within the aerial transect surveys there is a difference from the classical line transects. The belt that is nearest to the transect line is not used as it falls in the zone below the aircraft that cannot be observed.

Aerial imaging. Current developments in object based image analysis techniques allow listing the aerial imaging as a possible alternative to the conventional counting platforms (Gordon *et al.*, 2013; Groom *et al.*, 2013, 2007; Thaxter and Burton, 2009). The studies comparing visual counts and aerial imaging often show considerable differences in the results of both types of surveys (Kulemeyer *et al.*, 2011). Aerial imaging can provide more precise estimates, by improving bird detection and reducing biases due to imperfect detectability of birds in conventional methods. It establishes a traceable sampling method which allows storing of collected samples for later reuse. Nevertheless, currently the method is considerably more expensive than the conventional methods. It requires considerable investments and steep learning curve to establish the workflow, especially the developing an automated rule-set based recognition of candidate image segments for birds; it does not reduce the overall man-time needed. Due to the current cost-effectiveness, currently it is not recommended to fully replace the visual counts with aerial imaging in the national monitoring programmes.

Recommendations for the choice of sampling platform and method. To harmonize the monitoring methods across the Baltic sea, a combination of ground based counts and plane based visual counts using line transects are recommended if new large-scale national monitoring schemes for waterbird populations in the Baltic Sea during the non-breeding period are designed. It is recommended to use line transects with distance sampling instead of strip transects.

However, it is not recommended to change the currently running monitoring schemes if the counting platform for offshore birds is the only difference from the recommended setup (e.g. ship-based line transects instead of plane based line transects). It is recommended to use ship based surveys for fine scale monitoring of offshore sites if the topography of the site allows it. Ship-based surveys qualify also for high concentration-areas as they generally provide more precise estimates for big flocks, especially when consisting of different species as well as for small, inconspicuous species mixed with big seaduck flocks (such as auks and grebes).

Recommended standards for aerial surveys. Aerial survey techniques described in Camphuysen *et al.* (2004) and Petersen *et al.* (2006) can be regarded as a standard for offshore bird monitoring in the Baltic Sea. Flights have to be performed at an altitude of 250 feet (76 m) with a speed that does not exceed 100 knots (185 km/h). Flying higher and faster negatively affects recognizing the species. Moreover, the view angles for distance belts that are given below are calculated for the altitude of 250 feet and changes in altitude render the given angles unusable.

The observed flocks or individual birds have to be assigned to the transect belts. The recommended parameters of the distance belts are given in the Table 1. These parameters are valid only if the recommended flight altitude is kept.

Table 1. Parameters of distance belts for aerial surveys; the band boundaries (distances from transect lines) and angles from horizon if aircraft flies at altitude of 250 feet.

Band		Band boundaries (perpendicular to transects)	Angle from horizon
A*	A1	44–91	60–40
	A2	92–163	40–25
B		164–432	25–10
C		433–1000	10–4
(D)**		(1000–1500)	(3–4)

*** in some survey protocols currently in use (e.g. Research and Technology Centre (FTZ), University of Kiel) the band A is split into A1 and A2 as it has been shown that the detection decreases within the band A and detection is lower in A2 than in A1.**

**** although usually discarded from the data analysis due to very low detection in band D, it is recommended to keep this band in the survey protocol to avoid observers attributing these distant flocks to band C.**

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**** although usually discarded from the data analysis due to very low detection in band D, it is recommended to keep this band in the survey protocol to avoid observers attributing these distant flocks to band C.**

Recommended standards for ship surveys. Ship survey techniques described in Camphuysen *et al*. (2004) can be regarded as a standard for ship based offshore bird monitoring in the Baltic Sea. Preferred ship type is a stable motor vessel with forward viewing possibilities at least 5 m above sea level (higher viewing platform preferred). It should be able to keep a constant speed during the surveys. The preferred ship cruising speed is 10 knots (18.52 km/hour).

The observed flocks or individual birds have to be assigned to the transect belts. The recommended parameters of the distance belts are given in the Table 2. To avoid an overestimate of bird numbers in flight, a regular snapshot of flying birds over the transect and within 300 m distance ahead of the ship, is performed.

Table 2. Parameters of distance belts for ship surveys; the band boundaries (distances from transect lines).

Band	Band boundaries (perpendicular to transects)
A	0–50
B	50–100
C	100–200
D	200–300
E	>300

Territorial coverage of monitoring programmes

The HELCOM agreement covers the whole territory of the Baltic Sea. The "marine waters under the sovereignty and jurisdiction of Member States of the European Union" are in scope of the MSFD and thus its reporting obligations cover both its territorial and EEZ waters. Thus it is recommended that the territorial scope of the national marine bird monitoring programmes for the Baltic Sea are not limited to territorial waters and cover EEZ waters too, especially if they include sandbanks, reefs or other sites holding significant waterbird populations. The Birds Directive applies to all species of naturally occurring birds in the wild state in the European territory of the Member States. While there are no doubts regarding the territorial waters, the directive does not explicitly state whether EEZ waters need to be included for reporting.

Timing and regularity (temporal sampling)

Coordinating efforts. All countries, except RU, have reported that they are aiming for large-scale surveys of wintering populations at least once in six years in their monitoring programmes. Many countries even have reported such surveys every 3rd or 2nd year. For Baltic Sea wide population estimations and assessments, an effort should be taken that the surveys at least once during the MSFD reporting cycle (six years) are coordinated. The national institutions responsible for marine bird monitoring are invited to harmonize financing plans of the national monitoring programmes to allow carrying out large-scale surveys during the same winter. The winter 2015/2016 is recommended for carrying out the first coordinated Baltic Sea wide marine bird counts for monitoring. If the weather does not allow performing Baltic wide survey in the suggested winter, it should be carried out in the next suitable winter.

Synchronization of large-scale surveying of moulting populations is also recommended. However, before establishing coordinated monitoring of moulting populations, baseline surveys and designation of important moulting sites is needed in the majority of the Baltic Sea countries.

Time of the year. Populations of wintering birds have to be monitored during winter (mid-December–end of February). If the weather allows, the January is preferred. There is a need to coordinate timing of the counts within winter when coordinated surveys take place to avoid double-counting or undercounting birds due to freezing of suitable areas in the northern part of the Baltic seas and cold-weather movements of birds.

Although it would be preferable if all countries could carry out the surveys in an agreed short period of time, the weather constraints and availability of suitable planes might make it impossible.

For monitoring moulting populations, July and August are preferred.

Time of the day. The light time of day has to be used for counting. The optimal time for counts is from 10:00 till 14:00 when the sun is highest and its reflections on water do not reduce detectability of birds. However, deviations from the optimal time period might be needed to allow for two count sessions per day, especially in spring and summer seasons when the days are long and the sun is high.

Weather conditions. Surveys can be performed only in weather conditions that are suitable for bird counts. The most important is the sea state; during aerial surveys it should not exceed three according to Beaufort scale or five during ship-based surveys respectively. It is important that there is no fog or any other precipitation during the surveys as they influence detectability of birds negatively. Good light conditions are important, however, it is not mandatory to have a sunny weather. Often slightly overcast weather is even better as there are no sun reflections that reduce detectability of birds.

Sampling design (statistical sampling)

There is an existing network of survey sites for the ground based surveys used for the annual International Waterbird Census programme (Wetlands International, 2010). It is recommended to use this network for counts of coastal birds in the national monitoring programmes. However, to avoid incomplete data from the sites that have been counted only partly in some of the years, the survey sites should be organized so that they consist of smaller "counting units" that are always counted completely if the particular unit has been counted at all in the particular year. The reporting has to be done on the level of counting units.

The sampling design in the offshore areas or inshore areas that are not fully accessible from coast largely depends on the choice of the counting platform. Typically to survey these areas, the survey design comprises a series of parallel lines, either randomly spaced or systematically spaced with a random start. Featureless open water is naturally characterized by a range of physical and environmental factors that are likely to influence the abundance and distribution of the birds, but about which little can be inferred from the surface without taking measurements. The systematic spacing of lines is more practical with a constant and relatively short turning and transit between the ends of successive lines.

The disadvantage of the parallel design is that the ship or aircraft must travel from one line to the next without counting of birds. If counting is carried out on these connecting lines, the random design is compromised, as there is greater effort along the boundaries of the survey region where densities of most species are atypical. Thus design based estimation of abundance is biased. If searching is not carried out on these connecting lines, resources are not used efficiently, especially in the case of shipboard surveys, for which ship time is expensive. This is not an issue for the plane based counts, as the short time intervals spent on the connecting lines give the counting crew a break and allow them to get prepared for the next transect line. Such a design is problematic for ship based surveys where the counting crew does not need breaks as the observers work in shifts. Ships often are either not able to move straight from the transect endpoint to the beginning of the next transect due to curved coastline or, to avoid this, there is a need to reduce the survey area. Additionally, the loss of search effort decreases the cost efficiency. As a consequence, in ship surveys continuous zigzag designs are preferred, because no time is spent moving from one line to the next.

Thus for the plane based surveys, systematically spaced parallel lines with a random start are preferred. For ship based surveys, an adjusted angle zigzag design is preferred.

Orientation of sampling lines. The most statistically efficient study design is a set of line transects running perpendicular to the major environmental gradient. In the Baltic Sea for most marine bird species the dominant environmental gradient runs perpendicular to the shore (i.e. increasing depth out to sea). For this reason, planning transects to run to and from the coastline out into deeper water might beneficial. However, visibility may be another concern. If the sun is positioned on either side of the aircraft it may considerably decrease the detectability of birds on that side of the aircraft. As bird counting during the winter season usually takes place in the middle of the day when the sun is highest (from ca 10:00 to 14:00 local time), it may be beneficial to position the transect lines in the north–south direction to have sun in front or back of the plane and thus reducing the glare. Often it is not possible to take into account both considerations (environmental gradient and position of sun in the middle of the day) simultaneously. Thus the final decision on orientation of the transect lines have to be taken considering additional practical aspects and either decision is possible. If the sampling design comprises a series of transects where the whole transect line is treated as single sampling unit, the lines should be placed against the main gradient, if the transect lines are divided further into segments and thus allowing to use spatial distribution modelling for calculating the population size, the positioning of the lines against the gradient is less important and north–south orientation of the transect lines might be more beneficial to improve detection.

Distance between the sampling lines. As the counting belt C reaches up to 1 km distance from the transect line, placing a transect line every 2 km would fully cover the target area (except the areas below aircraft). Intervals less than this will run a high risk of double counting of birds. While 2 km interval is preferable for fine scale studies such as site surveys or EIAs, it might be too expensive for national monitoring, especially for countries with large areas of territorial and EEZ waters. Thus distance of 3 to 10 km is recommended. To avoid large sampling effort over deep waters with very low densities of marine birds, stratification and choosing different line placement interval for either of strata is recommended. Higher density of sampling lines need to be placed in the stratum more suitable for marine birds. Considerations on the minimum sampling effort per each stratum have to be taken into account to generate confident estimates of bird numbers. The maximum recommended distance between sampling lines is 10 km.

Species

All species of waterbirds observed during the counts are recorded regardless the platform. However, only a part of the species have sufficient data to carry out meaningful analyses of populations in the Baltic Sea.

Marine birds function trophically as marine organisms, mostly as important predators (Brown, 1980). In winter, when they aggregate in suitable feeding habitats, their abundance depends on the ecosystem productivity. However, they also have top–down impacts on their prey species. The structure of species communities is driven by the large number of variables that influence species interactions. Depending on use of resources of different structural parts of the ecosystem species can be aggregated in functional groups.

The species assessed for the CORESET indicator "Abundance of waterbirds in the wintering season" form the list of target species for bird monitoring in the Baltic Sea.

Common Data Format for Interchange of Data

The bird monitoring data are currently stored in national or institutional databases with *ad hoc* data extractions for regional assessment products. Part of the data (mostly coastal and inshore sites) is stored also in the Wetlands International IWC database.

To facilitate future Baltic Sea assessments, a common data interchange format and a database need to be developed to store bird monitoring data from all Baltic Sea countries. For the database to serve the intended purpose, it was agreed that it should be able to contain the data at the highest possible resolution (i.e. as it was collected in the field). European Seabirds At Sea (ESAS) database has been developed and a number of institutes from countries around the North Sea use it to store data in a common format following recommendations of standard recording techniques. The meeting of Baltic marine bird experts in January 28–29 in Jurmala, Latvia agreed to take the structure of this database as an initial template for the marine bird database of the Baltic Sea. The database is suitable to store data from both plane and ship surveys.

Since its development in early 1980s the ESAS database has undergone several incremental changes to adjust for advancements in the fieldwork protocols and data analysis methods. Currently several institutions carrying out surveys of seabirds at sea have made modifications and extensions to the ESAS database to facilitate storing of important additional information which cannot be recorded in the current ESAS data format. These modified database versions are still backwards compatible with the ESAS standard.

While acknowledging differences in the national and institutional data standards, it is important to ensure compatibility of them with the data interchange standard agreed by the experts of the Baltic Sea countries. While it is recommended to develop and agree on a special Baltic data interchange standard taking advantage of the best examples of the data standards, it is recommended to currently use the ESAS data standard for the data interchange needs.

It is recommended also to develop a web-based interface to facilitate the data entry or uploading in the database. However, before it has been developed, any spreadsheet (e.g. xls or ods), database (e.g. dbf) or text (e.g. csv or tab) format that can be read in general office spreadsheet software such as Microsoft Excel can be used for data submission.

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Annex 12: Assessing the sensitivity of seabirds to a reduction in the availability of discards

The sensitivity of a species is a measure of its susceptibility to changes in environmental conditions, disturbance or stress which incorporates the species' resistance and resilience (Holt *et al.*, 1995; McLeod, 1996; Tyler-Walters *et al.*, 2001; Zacharias and Gregr, 2005). The species' resistance (tolerance/intolerance) is a measure of the degree to which it can absorb changes in environmental conditions, disturbance or stress without changing in character, while its resilience is its ability to recover from disturbance or stress (Holling, 1973).

In this case we are interested in assessing the sensitivity of the populations of different seabird species to a reduction in the availability of discards. In the absence of empirical data, assessing the sensitivity of a species to a pressure, such as a reduction in the availability of a food source, can be assessed based on the aggregation of judgement-based scores given to factors related to different characteristics of a species (Certain *et al.*, 2015). Here we divide factors into those which score:

i) the **resistance (tolerance/intolerance)**, using factors based on ecology and behaviour;

ii) the **resilience** of the species, using factors based on life-history traits and population status.

Bicknell *et al.* (2013) identified the potential direct and indirect effects on seabirds which might result from a reduction in the availability of discards, and this has been used here as a basis to identify eight factors to be used to score resistance (Table 1). An important consideration when aggregating the scores across factors is that factors might not be independent and their relation may not be additive. Accordingly, we recognized a hierarchy between Primary Factors which directly control sensitivity and Aggravation Factors which can increase/decrease a sensitivity that already exists (*sensu* Certain *et al.*, 2015).

A number of experts were asked to score each of the factors on a three-point scale from 1 (least severe) to 5 (most severe), using expert judgement. Guidance was provided to indicate the type of situation represented by each score. In some cases, negative score options were available to allow for possible benefits resulting from a reduction in discard availability. It was recognized that each expert would have some uncertainty over his or her judgement on their scores and that it would be important to record this. We adopted the 'triangular fuzzy number' approach (McBride *et al.*, 2011), whereby for each factor, the experts recorded the following:

i) An opinion on what the highest and lowest scores could be;

ii) Best estimate based on expert judgement;

iii) An indication of confidence that the interval between the lowest and highest scores contains the truth (in the range of 50–100%).

There are a number of ways to use information on uncertainty to derive a compiled estimate for each factor (Barnard and Boyes, 2013), and this would be a logical next step for the sensitivity assessment work.

Experts were only asked to score factors relating to resistance; for assessing the ability of a species population to recover from any effects, suggested factors relating to resilience are provided in Table 2. These resilience factors are considered more 'data-driven' rather than judgement-led, and scores for these factors should be collated through a separate data gathering exercise.

Scoring was done separately for each region of interest. Regions were based on the ten MSFD subregions plus the OSPAR Arctic subregion (which is not covered by MSFD).

If desired, the resulting scores for each species/region can be aggregated within an overall sensitivity index equation (see Certain *et al.*, 2015; Furness *et al.*, 2012; Furness *et al.*, 2013 for examples). For each region, it is then possible to rank species in terms of their overall sensitivity to a reduction in the availability of discards and to compare these rankings across regions. Aggregating scores to provide a single species- and region-specific overall sensitivity index has not been done for the purposes of the current work. In theory, the driving mechanisms behind any differences between species and regions can be investigated by comparing scores assigned to individual factors, which provide an indication of the strength of each potential effect pathway. However it is important to note that differences will also occur due to the fact that not all experts will have scored all regions, and there may be inconsistencies between how the factors were scored across regions due to differences in interpretation regarding what information each factor represents.

Table 1. The factors identified to assess the resistance (tolerance/intolerance) of seabirds to a reduction in the availability of discards and their relevance to the issue.

Resistance Factor	Rationale
Reliance on discards	The implications of reduced availability of discards will depend on how much a species currently relies on discards, so this factor scores whether a species makes occasional or frequent use of discards, or has no reliance on them at all.
Ability to offset reduced discard availability	This factor is treated as an 'aggravation' factor to the factor 'Reliance on Discards' and is scored only for those species which have some reliance on discards. This factor scores the degree to which a discard-reliant species can compensate for a reduction in discards in terms of: its ability to prey switch; its prey range (e.g. generalist omnivore/generalist piscivore/specialist piscivore); the quality of the alternative prey (alternative prey may differ nutritionally or have higher pollutant burdens e.g. offal); the availability of the alternative prey; and digestive efficiency (those species with low digestive efficiency (e.g. short gut retention times), will be unable to extract as much nutrition from discards compared to those with high digestive efficiency. Species with low digestive efficienty may therefore have even more to gain if they are able to switch to higher quality prey).
Ability to offset increased foraging costs	Discards represent an abundant and fairly predictable food source. So a reduction in discards may force seabirds to forage on more dispersed food sources, which will require more effort (energy). This factor uses 'predominant type of foraging flight' as a proxy for the ability of a species to offset such increased foraging costs, and is scored only for those species which have some reliance on discards.
Change in bycatch rates	Seabirds may reduce their association with trawlers as a result of a reduction in discards. Consequently they may be less likely to be caught in nets. However, if species switch from associating with trawlers to other fishing gear types (e.g. longliners), they may suffer increased bycatch. Alternatively, there may be no change in bycatch rates. This factor scores whether there is likely to be a change in bycatch rates for those species which have some reliance on discards.
Likelihood of urban conflict	Some discard-reliant species may move inland to exploit alternative food sources and this could cause conflict with humans (e.g. gulls colonizing urban areas). This factor scores the likelihood of such conflict and is scored only for those species which have some reliance on discards.
Increased predation from any species with score >1 for reliance on discards	Discard-reliant species may switch to predating more heavily on other seabirds in the event of reduced discard availability. This factor scores how much a species might be subjected to increased predation.
Increased kleptoparasitism from any species with score >1 for reliance on discards	Discard-reliant species may switch to kleptoparasitising more heavily on other seabirds in the event of reduced discard availability. This factor scores how much a species might be subjected to increased kleptoparasitism.
Competitive foraging ability	With a reduction in discards, populations of large, dominant scavengers may change their foraging behaviour/locations in a way that might increase competition for more natural food sources and therefore smaller, less competitive species will lose out.

Table 2. Suggested factors that could be used to assess the resilience of a species population (its ability to recover) from a reduction in the availability of discards.

RESILIENCE FACTOR	RATIONALE
Adult survival rate	Adult survival rate recognizes that added mortality of adult birds with high natural survival rates (and corresponding low productivity) has a greater impact on population dynamics than added mortality to populations with low survival rates. Adult survival score groupings based on Garthe and Huppop (2004); Birds Directive Status and % of the biogeographic population score groupings taken from Furness *et al*., 2012
Age at first breeding	Populations are more sensitive to age of first breeding than productivity and given the importance of scavenging for immature birds, this may be a key element.
Conservation status	This factor combined conservation status information from the EU Birds Directive with IUCN criteria to represent conservation status for each species. Species listed on Annex 1 on the Birds Directive are considered rare or vulnerable at a European level, while the IUCN criteria incorporates information on population declines at a global level. IUCN criteria were given greater emphasis in the scoring, with Annex 1 listing on the Birds Directive being used to indicate species which were not considered as threatened by IUCN, but nevertheless at a European level are considered rare or vulnerable.
% of the biogeographic population hosted within Europe	Percentage of biogeographic population in the focal area – in this case Europe - emphasizes endemism and the importance of Europe as a host to the species. Since this metric may vary seasonally, the highest seasonal score available for each species should be used, following Furness *et al*. (2012).

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