ICES JWGBIRD REPORT 2014

ICES ADVISORY COMMITTEE

ICES CM 2014/ACOM:30

REF. ACOM, SCICOM, OSPAR

Report of the Joint ICES/OSPAR Working Group on Seabirds (JWGBIRD)

17-21 November 2014

Copenhagen, Denmark

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

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Recommended format for purposes of citation:

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

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1.1 Introduction

Full ToR a) Test the operation of OSPAR MSFD common indicators: B1 – marine bird abundance and B3 – marine bird breeding success. A project issued by OSPAR, will produce an assessment for these indicators in the Greater North Sea and Celtic Seas. JWGBird will review the outputs of the project and provide recommendations on the future operation of these indicators by Contracting Parties. The reporting will follow a format predefined by OSPAR via ICG-COBAM and will ensure access to the underlying data used to produce the assessment. The report will include:

i) Recommendations for gap-filling for monitoring of breeding seabirds, breeding waterbirds and non-breeding shorebirds and seabird breeding success in each subregion;

ii) Arrangements for data-handling, storage and analysis of data bearing in mind that products produced as a result of the meetings should be made available and accessible, in the appropriate format, to OSPAR.

This ToR was fully completed. The testing reports for indicators B1 and B3 were presented by the JWGBird chair to OSPAR's ICG-COBAM on 2 December 2014, at their meeting in Madrid. These reports are appended here as Annex 1 and 2, respectively. They were later submitted to OSPAR's Biological Diversity Committee in March 2015, in Cork, Republic of Ireland (Paper ref: BDC 15/3/Info.2-E; summary paper ref: BDC 15/3/2). 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 III and IV contain the technical specifications for indicators B1 and B3 respectively. These are in a format specified by OSPAR's ICG-COBAM and contain details on how each indicator will be constructed and assessed. These technical specifications were updated by JWGBird in order to incorporate changes that became necessary as a result of the testing. Some of the key discussions that led to these updates are summarised below.

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. JWGBird wrote the testing reports and designed the presentation of results (see Annexes I-IV).

Below, we include a summary of the testing results and report on the main discussion points and conclusions.

1.2 Summary of bird Common Indicator testing results

1.2.1 Testing of B1 – Marine Bird Abundance

This indicator describes changes in abundance of breeding and non-breeding marine birds. 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.

Indicator Type	Success of testing	Sub Regions where tested	Relevance of Indicator	Contribution to IA 2017	Countries Involved in testing
State	Successful	Regions II and III	MSFD criterion: 1.2 (population size) and of secondary importance to 4.3 (population trends of key species)	The indicator will provide an assessment of the changes in abundance of breeding and non-breeding marine birds in regions II and III	All in both Regions (data not provided by SE)

1.2.1.1 Testing method

The indicator metric, 'relative abundance' was tested utilising time-series (1991–2011) of annual counts of breeding and non-breeding marine birds**.** Targets were set for each species-specific time-series, as a percentage deviation from a baseline. The baseline for the testing was set at the start of time-series (1991). 75% or more of species in the indicator are required to meet their species-specific targets for GES to be achieved. Assessments in the Greater North Sea were subdivided into five assessment units as well as being conducted across the entire subregion.

1.2.1.2 Quality of testing

Testing covered the OSPAR regions II and III, using data from UK, IE, FR, BE, NL, DE, DK (Waddenzee only) and NO. There were sufficient data to construct species-specific indicators of relative breeding abundance for 19 species and species-specific indicators of relative non-breeding abundance for 31 species.

The indicator is partly operational for Regions II and III and could also be made operational in Region I (NO) and IV and V. The indicator is cost-effective, as most of the required monitoring is already in place. Due to the long lifespan of these species, abundance changes slowly and is sensitive to a variety of pressures.

1.2.1.3 Further development

Monitoring schemes are already established in each CP. Assessment units (subregions and further subdivisions in the Greater North Sea) and assessment methods have been proposed (in the COBAM Technical Specification for this indicator) and require agreement from CPs. The UK, in 2015, will complete building a data analysis tool, which will enable non-statisticians to construct indicators, assess, targets and to disseminate outputs. A new seabird database has been built and is hosted by the ICES DataCentre. CPs will need to agree on data sharing and access to these data. Prior to IA2017, CPs will be required to submit all available data on breeding seabirds, breeding waterbirds and non-breeding waterbirds. This will include additional data from transitional areas in the UK and the Netherlands to avoid bias in the Danish and German Waddenzee.

1.2.1.4 Problems, barriers and gaps

Although there are some data gaps, no major problems are foreseen in getting more data from existing monitoring programmes. Application of the indicator B1 to Regions I, IV and V is possible, but would require the acquisition of additional data from CPs in those regions. Portugal and Denmark have yet to fully engage with the development and testing of bird indicators.

1.2.2 Testing of B3 – Marine Bird Breeding Success/Failure

This indicator describes changes in breeding failure rates in marine birds. 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. The premise for the indicator is, if GES is achieved, widespread seabird colony breeding failures should occur rarely in species that are sensitive to changes in food availability.

Indicator Type	Success of testing	Sub Regions where tested	Relevance of Indicator	Contribution to IA 2017	Countries Involved in testing
State	Successful	Regions II and III	MSFD criterion 1.3 (population condition)	The indicator will provide an assessment of the rates of breeding failure in marine birds in OSPAR Regions II and III	All in both regions, except DK. Data provided only by UK, IE, BE, NL and DE.

1.2.2.1 Testing method

The indicator was derived from data on annual mean breeding success (number of chicks fledged per pair) of marine bird species at colonies and in survey plots. The indicator metric 'Annual colony failure rate' is the percentage of colonies failing per year, per species. For the purpose of the testing we defined 'failure' as 0.1 chicks per pair. 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 could be adjusted according to experience of the colonies in question.

Species-specific targets are applied to the proportion of colonies failing and the frequency at which these targets are achieved.

1.2.2.2 Quality of testing

Testing covered the OSPAR regions II and III, using data from UK, IE, BE, NL and DE (incomplete: Helgoland seabird colony only). There was sufficient data to construct species-specific indicators of breeding failure rates for 24 species.

The indicator is partly operational for Region II and III. Additional data are available for FR, DE, DK (Waddenzee only), NO and probably SE. The indicator is cost efficient as most of the required monitoring is already in place. A recent analysis of the breeding failure indicator for nine species in UK North Sea waters provides evidence of a link to fishing pressure. The indicator could also provide evidence of other impacts, from e.g. human disturbance, contaminants and predation by invasive species. National experts have raised questions over the metric and whether an indicator based on breeding success (rather than failure), should be an aspiration for CPs. In the meantime, the breeding failure metric should be used for IA2017.

1.2.2.3 Further development

Monitoring schemes are already established in each CP. Assessment units (subregions and further subdivisions in the Greater North Sea) and assessment methods have been proposed (in the COBAM Technical Specification for this indicator) and require agreement from CPs. The UK, in 2015, will complete building a data analysis tool, which will enable non-statisticians to construct indicators, assess, targets and to disseminate outputs. A new seabird database has been built and is hosted by the ICES DataCentre. CPs will need to agree on data sharing and access to these data. Prior to IA2017, CPs will be required to submit all available data on breeding seabirds and waterbirds.

1.2.2.4 Problems, barriers and gaps

Although there are some data gaps, no major problems are foreseen in getting more data from existing monitoring programmes. Application to Regions I, IV and V would require the acquisition of additional data from CPs in those regions. Portugal and Denmark have yet to fully engage with the development and testing of bird indicators.

In future, R&D should be undertaken to develop, for some species, quantitative targets for breeding success levels that would be required to maintain or grow a population. These targets need to vary according to changes in other demographic characteristics of the population, such as survival rates.

1.3 Discussion points

1.3.1 Baselines for indicator B1 – marine bird abundance

JWGBird re-examined and challenged the baseline setting approach that had been proposed by the group previously (see ICES 2012, 2013a–d). We challenged our proposed use of an aspirational baseline. In comparison, assessments of Favourable Conservation Status, under the EC Habitats Directive, set baselines as the 10-year trend at the beginning of a time-series (if available). We considered this appropriate to some species of bird in the context of B1 (see below). Such an approach should be used with caution, given that most available time-series for birds start in the mid-1980s when there was a regime shift in the North Sea ecosystem: cold-water species in the zooplankton community were largely replaced by warmer-water species and overall zooplankton biomass decreased sharply (Beaugrand *et al.*, 2003). JWGBird recommend the following options for baseline-setting and advise when the various options should be used (see also B1 Technical Specifications in Annex 1). In the current testing for indicator B1 the start level of the time-series was used.

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 standardise expert judgement when selecting baselines.

1) Use historical population estimates that were recorded:
   1.1) before known human impacts; and /or
   1.2) before other major declines in population; or
   1.3) at known plateaus in population trends, following increases and peaks in population size.
2) 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).
3) Use start level of time-series when no historical data or reference level are available.
4) Use recent population estimate (e.g. previous five year mean) when a species is colonising.

1.3.2 Metric for indicator B3 – marine bird breeding success and failure

As described above (and previously in ICES 2013a,c; Cook *et al.*, 2012), indicator metric for B3 is 'Annual colony failure rate' i.e. the percentage of colonies failing per year, per species (from). However, some concerns over the target-setting approach where expressed and reiterated by JWGBird during the current tests. These concerns were:

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.

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 for 15 species (http://www.seapop.no/opencms/export/sites/SEAPOP/no/files/short-reports/2009/)).

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.

1.3.3 Utilisation of seabirds-at-sea data in indicator B1 – marine bird abundance

The testing report for B1 (in Annex 1) explores the possibility generating abundance-trend indicators 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). A preliminary trend analysis has been conducted on time-series data from German waters and is described in Annex 1 (Garthe *et al.*, in prep.). Similar work is also being undertaken by expert working with HELCOM's CORESET project to develop 'core' MSFD indicators in the Baltic. In view of these developments, JWGBird undertook an analysis of the pros and cons of incorporating at-sea data into indicators of marine bird abundance; see Table 1.1.

Table 1.1. Pros and cons of incorporating at-sea data into indicators of marine bird abundance.

Pros	Cons
Seabirds spend most of their lives at sea, i.e. good indicators for conditions at sea (e.g. regarding GES). Note: All the other bird indicators (including B-1 so far) deal more or less with coastal areas only).	Not able to cover large areas – reliant birds being in the survey area.
Early warning system: As immatures are covered by surveys, changes can be detected 5–10 years earlier compared to breeding numbers. Note: According to MSFD (article 13), conservation measures shall derive from assessments in order to achieve GES). Therefore, monitoring at sea can help to identify the need for measures earlier.	Large fluctuation sin abundance when birds move in and out of survey area
We can also develop a distribution indicator from these data, but a shift in distribution of a species does not necessarily say anything about GES except that foraging conditions are probably better where the birds move to.	Surveys are a snap shot and do not account for temporal variability.
Includes species that breed outside the assessment area or other species that cannot be assessed at breeding colonies or sites.	Large time and resources – difficult to carry out simultaneous surveys indifferent parts of a survey area
Can link at -sea data with environmental parameters and pressure data (e.g. from fisheries)	
More appropriate to D4 – foodwebs – e.g. use parameters such as biomass of seabirds in particular geographic locations compared to oterh trophic levels	
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1.3.4 Revised Functional groups of marine birds

JWGBird re-examined and challenged the marine bird functional groups that had been proposed by the group previously (see ICES 2012, 2013a–d). JWGBird acknowledged that the aim of functional groups is to combine information on different species in order to illustrate the effect of common factor. JWGBird recognised that natural and anthropogenic factors are likely to act similarly on species that share the same food types and display similar feeding behaviours and are those, subject to the same constraints on food availability. The group proposed the functional groups listed in Table 1.2. These have been incorporated in to the revised for B1 and B3 that are included in Annex I and II respectively. The technical specifications also include appended lists of marine bird species that are each assigned to at least one functional group.

Table 1.2. Revised functional groups for marine birds.

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

1.4 References

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2 ToR b) Design a protocol (or protocols) for assessing the effects on seabirds of the new CFP Landings Obligations

2.1 Introduction

The new CFP Landings Obligation 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'.

The CFP Landings Obligation responds specifically to public pressure to end the practice of throwing marketable fish back into the sea, and is intended to exert a positive effect on the marine ecosystem. However, it is worth noting the potential ecological risks of such a policy. First, some communities within marine ecosystems rely at least partly on discards. The elimination of a large biomass of readily available food could cause energy loss and severe changes in the ecosystem functioning. Second, and most important, the landing of discards will most likely encourage new markets for fishmeal to meet the growing demands (e.g. from aquaculture) for marine resources. The latter could lead to increased fishing pressure on resources that were not previously exploited. To avoid this second impact, the selectivity of fisheries should be enhanced to avoid or significantly reduce the bycatch of non-target species (Sardà *et al.*, 2013).

These concerns depart from the assumption that the 'discard ban' will have an overall positive impact on the marine environment. The CFP Landings Obligations may also have some detrimental side effects, especially in the short term. Seabirds are expected to be particularly affected, given the extensive use of discards by several species (Furness *et al.*, 2007). In the long term, 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 both the marine ecosystem and the seabird communities. A possible exception could be for species that prey on small fish, which could face growing competition for this common food source from an increased biomass of large predatory fish, as commercial stocks recover (see Chapter on ToR f).

In the short term several negative effects are predicted, and deserve attention (Bicknell *et al.*, 2013). This ToR is aimed at developing a protocol that could be used to assess the impact of the Landings Obligation on seabirds through potential changes in their food supply. As specified within the full text of ToR b), we considered four complimentary areas of study:

i) Sensitivity scoring of species to reduction in food from discards (and offal);

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.

2.2 Sensitivity scoring of seabird species to reduction in food from discards

Table 1 shows a proposal for a data-sheet that could be used to record expert opinion on the sensitivity of individual seabird species to the direct and indirect effects of the elimination of discards as listed by Bicknell *et al*. (2013). The direct effect will be a reduction in the number of feeding opportunities; seabirds will need to rely on naturally available prey at sea. For example, discards have enabled some surface-feeding species to feed on large fish that otherwise, would not have been naturally available to them. The impact on a species of reducing such feeding opportunities will depend on how much it relies on discards as a food source, but this will be tempered by its ability to switch to other food sources. The sensitivity score will be a product of the reliance of a species on discards and its ability to be flexible and exploit other food sources. Bicknell *et al*. (2013) contains a thorough review of the evidence that could be used to quantify reliance and flexibility for each species likely to be directly impacted by the discards ban.

The reduction in feeding opportunities is likely to have knock-on effects for the species that rely on discards and also for species that do not feed on discards; listed as 'indirect impacts in Table 1 (and in Bicknell *et al*., 2013). Species that rely on discards and that are able to switch to other food sources, such as great skua (*Stercorarious skua)* and large gulls, may increase depredation and kleptoparasitism of other seabird species (e.g. Votier *et al*., 2004, 2007, 2008; Oro *et al*., 1995, 1996; Martínez-Abraín, 2003). In this way, these seabird prey and host species will be impacted indirectly by the discard ban. The scoring of sensitivity in Table 1 to increased predation and increased kleptoparasitism is intended to assess the sensitivity of species to this impact (i.e. as prey or host) and is not meant to score the likelihood of a predatory or kleptoparasitic species to rely on these behaviours. For this reason, the scoring of impacts could be extended to waterbirds and other seabirds that do not feed on discards.

A switch in food source could also lead to conflicting interactions with humans and to impacts on other wildlife. Such human/wildlife conflicts are likely to involve large gull species that tend to be heavily reliant on discards and have an omnivorous diet that enables them to move inland and exploit other natural food sources (e.g. small mammals; Camphuysen *et al*., 2010) and other sources of human waste (e.g. refuse dumps). New conflicts with humans are likely to arise if gulls colonise more urban areas.

Discards represent an abundant and fairly predictable food resource to many seabirds. The reduction of this resource will force seabirds to forage on more dispersed food sources. This will require more effort because of extended foraging time, larger foraging range and increased costs of capturing prey (Weimerskirsch, 2007).

Ultimately, a reduction in discards will cause food shortages that may negatively affect the fitness of some seabird species, by lowering breeding success, body condition and survival[1] (e.g. Oro *et al.*, 2004; Hüppop and Wurm, 2000; Louzao *et al.*, 2006).

Altered bycatch of seabirds could be a positive impact of the discards ban if, as a result of it, seabirds associate less with trawlers and are less likely to be trapped and killed by nets. However, some seabirds may switch from associating with trawlers to longliners (Laneri *et al.*, 2010), where the chance of being caught and killed would be greater. In the first few years after the 'discard ban', the mortality of some species from bycatch in the longline fisheries could increase. However, in the long term, and provided a progressive recovery of fish stocks occurs, it is expected that seabirds will shift to forage on natural resources, and their tendency to attend fishing vessels might be reduced if these natural resources are readily accessible. This way, in the long term, the 'discard ban' could even contribute to reducing seabird bycatch (Bicknell *et al.*, 2013).

In the example given in Table 1, three JWGBird experts scored the sensitivity of each seabird species to the effects of the discard ban that were described above. The list of species contains those commonly occurring in the North Sea and Celtic Seas that are likely to be included in OSPAR Common Indicator B1; marine bird abundance (see chapter on ToR a). Sensitivity was scored on a three-point scale and highlighted with colours to ease interpretation: (1) green = insensitive or low sensitivity, (2) amber = medium sensitivity, (3) red = high sensitivity.

The next step for JWGBird will be to encourage other experts to apply their own scores. Guidance on how to score will be drafted to ensure different experts employ same rationale when applying different scores to each of the list impacts. There is scope to change the scoring system: for instance to introduce additional scores if three categories prove insufficient at describing the range of sensitivity displayed by different species. The guidelines should contain a clear definition of 'sensitivity' and provide a distinction from other commonly used terms such as 'vulnerability'. Separate scoring should be undertaken for each OSPAR region and subdivisions therein, because different fishing methods predominate in each region the reliance on discards by a single species can vary from region to region. There are also substantial differences in seabird species composition between different regions.

Each expert will have some uncertainty over to his or her judgement on the sensitivity or certain species. It is important to record this level of uncertainty. We propose to follow the recommendation of Barnard and Boyes (2013) and use 'fuzzy logic' (Zadeh, 1965) to quantify the level of uncertainty around the collective opinion of experts. The 'triangular fuzzy number' approach (McBride *et al.*, 2011) requires experts to provide, for each species/impact combination, their best estimate of the sensitivity score, their opinion on what the highest and lowest scores could be an indication of their confidence that this range contains the true score (e.g. a confidence score of 50–100%).

[1] The category of 'fitness consequences (reproduction, body condition and survival)' is meant to cover impacts in addition to those included in the other categories.

Table 1. Provisional scoring of the sensitivity of seabird species to the likely direct effect and indirect effects of the discards ban. (1) Green = insensitive or low sensitivity, (2) Amber = medium sensitivity, (3) red = high sensitivity; ? = unknown/unsure; Y = yes, species feeds on discards; O = species occasionally feeds on discards; N = no, does not feed on discards.

		DIRECT EFFECT	INDIRECT EFFECTS					
Species	feeding on discards	reduced feeding opportunities	increased predation	increased kleptoparasitism	human/wildlife conflict	increased foraging costs	fitness consequences (reproduction, body condition and survival)	alterred bycatch
Fulmarus glacialis	Y	2	2?	2?	1	1	2	2
Calonectris diomedea	Y	?	1	1	1	2?	2?	2?
Puffinus puffinus	N	1	3	1	1	1	1	1
Puffinus balearicus	Y	2	1	1	1	2?	2?	2?
Hydrobates pelagicus	N	1	3	1	1	1	1	1
Morus bassanus	Y	3	1	1	1	3	3	?
Phalacrocorax aristotelis	N	1	1	1	1	1	1	1
Phalacrocorax carbo	N	1	1	1	1	1	1	1
Stercorarius skua	Y	3	?		1	2	3	2
Stercorarius parasiticus	?	?	3	3	?	?	3	?
Sterna sandvicensis	O	1	3	2	2	1	1	1
Sterna dougallii	?	1	3	2	2	1	1	1
Sterna paradisaea	?	1	3	2	2	1	1	1
Sterna hirundo	O	1	3	2	2	1	1	1
Sternula albifrons	N	1	3	1	2	1	1	1
Chroicocephalus ridibundus	Y	2	3	1	2	1	1	1
Larus melanocephalus	?							
Larus argentatus	Y	3	3	3	3	3	3	2?
Larus canus	Y	3	3	3	3	3	3	1
Larus fuscus	Y	3	3	3	3	3	3	1
Larus marinus	Y	3	3	3	1	3	3	2?
Rissa tridactyla	Y	2	3	3	1	1	2	1?
Uria aalge	N	1	3?	1	1	1	1	1
Alca torda	N	1	3?	1	1	1	1	1
Fratercula arctica	N	1	3	1	1	1	1	1

2.3 Pre- and Post-Obligations comparison of abundance and breeding success of those species scored as most sensitive

For some of the species list in Table 1, pre-obligation data on breeding numbers and breeding success are available for OSPAR II. Data during the Post-Obligation period will most likely be available if current monitoring continues after 2017. Depending on the outcome of the sensitivity scoring, additional monitoring may be required to include either all sensitive species or a representative sample of them.

In order to monitor all the impacts listed in Table 1, it would be advisable to include pre and post-obligations monitoring of survival rates and body condition, where these data are available. Survival rates are useful when investigating the effects of increased predation, fitness consequences and altered bycatch. Body condition measures will provide an indication of the extent of the impact of increased foraging costs and fitness consequences.

2.4 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

Changes in diet of those species that currently rely on discards will be just one impact of the 'discard ban' (see Table 1). The sensitivity scores provide a more inclusive indicator of all the likely impacts. The species-specific scores could be combined with distribution maps of breeding colonies and of non-breeding distribution to predict where seabird are potentially more vulnerable to impacts of the discard ban.

The diet of those species most reliant on discards should be monitored to provide information on the extent to which they switching prey in order to predict the consequences on their fitness and that of other species (i.e. through predation or kleptoparasitism).

2.5 An inventory of the seabird colonies which may be vulnerable to the changed availability of discards to 'generalist and specialist piscivores,' and studies into appropriate remedial action

Considering the diverse effects that the discard ban could have on seabirds, it is essential to monitor these changes properly, and to take action to mitigate them whenever possible. For a proper assessment, monitoring and research needs will include:

a) Long-term monitoring programmes of seabird colonies, collecting information on population size and demographic parameters (breeding success, adult survival, etc.). This will be the first necessary action to assess any impacts of the discard ban.

b) Dietary studies, through the sampling of pellets and using stable-isotopes analysis, to identify temporal and spatial changes.

c) Monitoring of predation and kleptoparasitism at seabird colonies, as these are expected to increase as some species switch from feeding on discards.

d) Tracking studies to assess seabirds' activity rhythms, distribution patterns and interaction with fishing vessels. It is expected that generalist and specialist piscivores will eventually be less exposed to bycatch-risk following the discard ban. If fish populations increase in size over the longer term, they will also increasingly switch to natural prey (Tew Kai *et al*., 2013).

e) At-sea surveys to assess seabird distribution patterns and behaviour.

f) Observer programmes on fishing vessels, particularly longliners, to assess potential increase of bycatch rates (over the shorter term) as a consequence of the lack of discards. This is also a likely requirement of EU Member States under the EU National Plan of Action on Seabird Bycatch (COM, 2012).

2.6 Combining the four elements within an integrated approach

Once the above four areas of study have been developed, there will be a need to assess how they can best work together within an integrated approach and how to implement them collaboratively across multiple countries.

Management measures 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 minimise ecological impacts).

2) Introduce measures to minimise 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).

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3 ToR e) Scope out work required to compile an inventory of threats and measures concerning non-native predators at seabird colonies on offshore islands

3.1 Introduction

In addition to fisheries impacts, the other potentially manageable pressure on seabirds is from predation by native and non-native mammals that invade or are introduced to naturally predator-free islands. The scale of the ongoing impact or potential impact from non-native and invasive native mammals is unknown. The aim of this ToR, was to scope out the work required to compile an inventory of threats and measures concerning non-native predators at seabird colonies on offshore islands. The work will also inform OSPAR Contracting Parties on whether they should be further developing the OSPAR MSFD candidate indicator B4 - Non-native/invasive mammal presence on island seabird colonies.

At the JWGBird 2014, a small breakout group reviewed the latest version of the technical specification the indicator B4 (see Annex 5). In doing so, they considered how applicable the indicator would be in assessing the scope of the threat to marine birds from non-native/invasive mammals and in helping to address this threat along the NE Atlantic coast. The following sections provide a record of their initial comments and proposals. The final section contains proposals for an inventory of current impacts of non-native/invasive mammals and of the management measures applied to eliminate or reduce these impacts.

3.2 Scope of the 'threat'

There is comprehensive evidence from around the world that the introduction of both native and non-native mammals on to previously mammal-free islands has a substantial negative impact on ground-nesting seabirds, by reducing breeding success, by reducing breeding numbers and in some cases, causing colony extinction (Moores and Atkinson, 1984; Atkinson, 1985; Jones *et al*., 2008; Towns *et al*., 2006). Seabirds that nest on the ground are most vulnerable to their eggs and young and themselves being killed by terrestrial mammals. In a natural state most inshore and offshore islands would be free of mammals.

In the NE Atlantic, human intervention (both intentional and unintentional), has resulted in many such islands being invaded by both native species (including fox *Vulpes vulpes*, hedgehog *Erinaceus europaeus*, polecat *Mustela putorius*, stoat *Mustela erminea*, weasel *Mustela nivalis*, beech marten *Martes foina*, wild boar *Sus scrofa*) and non-native species (e.g. brown rat *Rattus norwegicus*, black rat *Rattus rattus*, American mink *Neovison vison,* domestic/feral cat *Felis catus*, racoon dog *Nyctereutes procyonoides*, raccoon *Procyon lotor*) (Ratcliffe *et al*., 2009; Langgemach and Bellebaum, 2005).

Some of the largest colonies of seabirds in the NE Atlantic are on mammal-free islands (Mitchell *et al*., 2004). The populations of species that are most vulnerable to mammal predation, shearwaters and petrels (Procellariiformes), gulls (Laridae), terns (Sternidae), Atlantic puffin (*Fratercula arctica*) and black guillemot (*Cepphus gryle)* as well as ground-nesting shorebirds and waterfowl, tend to be aggregated on a relatively small number of mammal-free islands. This concentration makes their populations vulnerable to other small-scale impacts (e.g. from oil spills or local fish-stock collapse).

3.3 Assessing the 'threat'

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 that will reduce the pressure on seabird populations from depredation by non-native or invasive mammals.

The proposed indicator metric is:

Number of island seabird colonies where non-native or invasive-native mammal species are present.

Where seabirds and mammals coexist, the effect of the predators is difficult to quantify, unless there are concrete observations of predation events or strong evidence (e.g. carcasses, eggs with tooth marks, etc.). In such circumstances, it could be that seabird numbers are limited the by availability of safe breeding sites that are inaccessible to the mammals (Ewins and Tasker, 1985); or reductions in seabird survival and breeding success may be masked by other negative factors such as poor food supply, disturbance and predation by avian predators.

Where seabirds are absent and mammalian predators are present, it is difficult to diagnose any impacts, given that the mammals may have reached an island centuries ago and may have extirpated the most vulnerable seabird species from islands long before ornithologists documented their presence (Martin *et al*., 2000; Heaney *et al*., 2002; de Leon *et al*., 2006).

JWGBird felt that the indicator should be formulated to cover the situation in all OSPAR subregions, but should also be applicable in other marine areas, e.g. on the Baltic coast (HELCOM).

The technical specification for B4 proposes that eradication and quarantine measures should be applied to create more habitat than is currently available to breeding seabirds and should meet the following target: *"No non-native or invasive-native mammal species on islands that are already free of such species. The proportion of islands where non-native or invasive-native mammal species are present or having a significant impact, should be decreasing.*

In order to achieve this target, a programme of measures should aim to "*minimise the risk of invasion by non-native mammals on all island seabird colonies, where this has not already occurred (including islands where mammals have been eradicated); and eliminate detrimental impacts caused by mammals at a prioritised list of island seabird colonies*".

The technical specification defined 'islands', referred to in the above targets, as meeting both criteria:

a) Be current, past or potential marine bird breeding sites.
b) Be individual islands or groups of islands that are at least 2 km from adjacent mainland or other islands.

In relation to these targets, JWGBird raised the following questions:

i) Should the indicator include all past or potential marine bird breeding sites or can a "sensible" selection be made? It has to be discussed whether the indicator can be restricted to a selection of island seabird colonies, which are representative for the respective marine area. Alternatively, all colonies specified have to be monitored for a more global assessment, which is unlikely to be feasible. A number of studies could provide ideas for how to prioritise islands to be included in the indicator (Brooke *et al*., 2007; Capizzi *et al*., 2010; Ratcliffe *et al*., 2009).

ii) What other criteria could be used to select a 'colony' for inclusion: Does a colony have to have a minimum size, i.e. a minimum number of breeding pairs? Does it have to host more than one species?

iii) The proposed targets are applicable only to breeding seabirds; could breeding concentrations of waterbirds be included, e.g. Avocets or other wader species?

iv) Do 'colonies' have to be on islands? Seabird colonies on the mainland coast could possibly be included, especially in special situations such as peninsular breeding sites, which can be effectively "fenced off" from the rest of the mainland.

v) What do we mean by predator-free? Does it have to be complete eradication or can it be reduction of predators to a level which allows seabirds to breed successfully?

vi) How is predator-free status assessed? Best practice for the assessment of predator-free status should to be developed. This can include the use of cameras, traps and dogs specially trained to detect problem species, but could also be the visual detection or the assessment of tracks and signs, etc.

Criterion b above, was deemed necessary to prevent invasion or reinvasion from American Mink. Employing mammal control or eradication measures on islands that could easily be reinvaded by mink, would be a waste of resources (Ratcliffe *et al*., 2009). JWGBird considered this 2 km buffer not to be generally applicable to all OSPAR Contracting Parties. For example, it is not just the distance from the mainland that would affect the chance of reinvasion; the strength of water currents between islands or between the coast and islands can be important. American Mink is not always the main predatory species, so the proposed 2 km distance might not always be relevant. A solution might be to make clear that the suggested default is 2 km in relation to American mink, but that this can be revised in light of local information regarding accessibility and the mammalian species which are potential threats. There are important island colonies closer to the coast where predator eradication schemes are already in force. Even on these islands corrective measures can be effective, even if they have to be carried out regularly (annually). This pressure indicator should not focus on American mink, but reflect predator pressure more generally. This 2 km buffer is not applicable to all island breeding colonies in the NE Atlantic. In some island colonies eradication and or reduction of predator levels may need to be, and in fact is in some cases, a continuous process carried out to protect important breeding colonies.

3.4 Addressing the 'threat'

The problem of predation on seabird colonies will be diverse and will require diverse measures. It was felt that an exchange of knowledge of best practice including an inventory of measures and perhaps a best practice manual on measures would be advantageous.

3.5 The next step: assess the present situation

An assessment of the present situation in the NE Atlantic would help to answer some of the above questions. The results could form the basis of best practice manuals for the eradication or control of predators and the assessment of parameters necessary for the indicator. The assessment could be made using existing literature, or on the basis of a questionnaire filled in by each Contracting Party or members of JWGBird. A proposal for the questionnaire is included below in Table 3.5.1. The questionnaire is designed to collect information on the following:

Characteristics of the seabird colony and its predators

An aggregation of basic information helps to assess the information about threats from mammalian predators. Useful characteristics are the size of the island, its distance from the mainland coast (or to other islands), the predominant habitat types, number of human inhabitants, numbers and species of breeding seabirds as well as mammalian predators recorded.

Potential or existing pathways of introduction and invasion

Pathways of introduction and invasion of predatory mammals can vary between islands and between predator species. It is important to know whether accidental or deliberate introduction, anthropogenic structures or simply natural colonisation is involved. Additional information about how often (e.g. annually, irregularly) predators invade an island. Such information is useful in determining which control measures will be most effective.

Measures planned or already in place

It is important to know, whether eradication, removal, killing, fencing or other measures have been applied on the respective island or in the seabird colony. Also the success should be reported and which methods have been used to assess the success (i.e. how was the predator-free status determined).

Animal rights issues and hunting regulations

Are there any animal rights issues which have to be taken into consideration when planning and applying measures? Do hunting regulations apply and how do they influence measures?

Legislation and conservation aims

Nature conservation legislation and aims need to be considered. Eradication of one animal to protect another animal may not be in line with some conservation aims and it may not be allowed to “cause harm” to some predator species. Control measures can be very expensive and strong legislative drivers may be necessary to justify the expense.

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Table 3.5.1. Questionnaire for assessing the presence of non-native/invasive mammals on island seabird colonies.

Question	Possible answers (where applicable)	Example
Name of island seabird colony		Hallig Oland
Country		DE
Latitude, longitude		54° 40' 43'' N, 8° 42' 25'' E
Size (km²)		0.96
Distance to coast (km)		2.0
Habitat	saltmarsh, cliff, beach, etc	saltmarsh
Number of human inhabitants		27
No. seabird breeding pairs		2500
Seabird species present		Arctic Tern, Black-headed Gull, Herring Gull, Lesser black-backed Gull, Common Gull, Oystercatcher, Avocet, Redshank, Spoonbill, Eider, Shelduck
Seabird species affected		Gulls, terns, Spoonbill, Oystercatcher
Mammalian predators	red fox, racoon dog, American mink, raccoon, wild boar, sheep, beech marten, hedgehog, polecat, stoat, weasel, feral cat, black rat, brown rat	red fox, beech marten
When did the predators invade the island		2008
How did predators invade island? Or How could predators invade the island?	anthropogenic structures, deliberate introduction, accidental introduction, natural colonization	anthropogenic structures: dam (fox), accidental introduction (marten)
How often do predators occur?	annually, irregularly, sporadically	annually (fox), irregularly (marten)
Eradication and/or quarantine measures planned or in place? Success?	killing, trapping, removal, scaring, fencing	fencing, trapping (fox), killing (marten)
Animal rights issues with eradication		Trapping and killing is carried out according to hunting regulations
How is predator-free status assessed?	cameras, traps, dogs, visual observation, tracks and signs, or no monitoring of predator presence/ absence is carried out	no monitoring of predator presence/ absence is carried out
Does nature conservation legislation allow measures against mammalian predators?		Yes

4 ToR f) Review studies on the impact of fishing for seabird prey species on seabird demographics and consider how impacts may be included in ICES advice on fish stock management

4.1 Introduction

The large-scale exploitation of fisheries will inevitably influence the composition of marine communities with changes in the population sizes and demography of higher trophic level predators such as seabirds (Hunsicker *et al*., 2011). The nature of these changes will vary depending upon the spatial and temporal overlap between resources sought by predators and fisheries. Altered prey availability may affect seabird productivity, demography and population size. However, seabird population declines are not easily attributable to competition with fisheries, because demonstrating such relationships require long time-series data for both seabirds and prey. But, there are some convincing patterns emerging from seabirds dependent on low tropic level (LTL) prey such as sandeels and capelin (Frederiksen *et al*., 2008). The following provides a review of the substantive papers reporting evidence of the consequences of the interactions between seabirds and fisheries in terms of demographic changes in seabird populations. This body of work has indicated the level of fish stocks required for healthy seabird populations. Translating this information into advice for fisheries management remains challenging. Notably, an important global review by Cury *et al*. (2011) examined long-term datasets from seabirds and forage fish to test the relationship between seabird breeding success and forage fish abundance. They demonstrated a convincing pattern across species and ecosystems, in which seabird populations became vulnerable when populations of prey fell below one-third the recorded maximum. This observation and the implications for management will be explored here.

Some impacts on seabirds from fisheries targeting LTL prey have been demonstrated; from which we have an understanding of the vulnerability of some seabird populations (see below). However, there are likely to be other more diffuse ways in which fisheries influence the availability of seabird prey, which have not been similarly studied and will be difficult to demonstrate (Furness, 2003). Seabird demography may be influenced as the result of poor recruitment or high winter mortality (e.g. Oro and Furness, 2002; Gimenez *et al*., 2012; Reiertsen *et al*., 2014); such effects are less easily described than breeding failures. Patterns of vulnerability and resilience among seabirds are complex because there are many species of seabirds occupying different sea areas (Cook *et al*., 2014) and individual species may move between regions and between ecosystems. We will examine the strength of evidence of impacts of LTL fisheries on seabirds. We will consider when we can and cannot take ideas based on this evidence and transfer them into broader management principles.

4.1.1 Dependence of seabirds on forage fish for reproduction

During the breeding season many seabird species converge on seasonally abundant high energy prey (Cook *et al*., 2014). In each marine region in the NE Atlantic it is possible to identify a lower trophic level fish which is the driver of success for many of the region's seabirds: lesser sandeel (*A. marinus*) in the North Sea (e.g. Frederiksen *et al*., 2004), capelin (*Mallotus villosus*) in the Barents Sea (e.g. Barrett, 2007), sprat (*Sprattus sprattus*) in the Baltic, sprat and herring (*Clupea harengus*) in the Wadden Sea (Dänhardt and Becker, 2011), herring and saithe (*Pollachius virens*) in the Norwegian Sea (e.g. Durant *et al*., 2003; Bustnes *et al*., 2013). Where predictable prey dependencies have been shown, there have also been breeding failures when fisheries have targeted local stocks of the forage fish (e.g. Frederiksen *et al*., 2004; 2008). Some of these forage fish form the basis of globally important fisheries; capelin makes up to 10% of the global fish landings for fishmeal (Adler *et al*., 2008).

In some regions, trophic interactions between commercially harvested fish stocks also contribute to the variations in availability of forage fish for seabirds. One example is the importance of young herring as a predator on capelin in the Barents Sea (e.g. Hjermann *et al*., 2004). First-year herring of the Norwegian spring-spawning stock are a key food source for seabirds along the coast of the Norwegian Sea. The advection of young herring to their nursery grounds in the Barents Sea occurs too late to provide a significant source of food for seabirds there (Anker-Nilssen *et al*., 1997; Barrett, 2002; 2003; 2007). During their subsequent 2–3 year adolescence in the southeast Barents Sea, herring are an important predator of capelin and can severely reduce the availability of capelin to both seabirds and fisheries (Hjermann *et al*., 2004). Another example is the increasing stock of Northeast Atlantic (NEA) mackerel (*Scomber scombrus*) in the Norwegian Sea. The mackerel not only compete with herring for their key copepod prey, *Calanus finmarchicus*, but may also be an important predator of young herring (e.g. Frederiksen *et al*., 2013 and refs. therein). Gannets are one of few seabird species in the Norwegian Sea that are able to prey efficiently on mackerel and the NEA stock spawns too far away and too late for their young to be an important food source for seabirds breeding in northern Norway. Fisheries management will no doubt continue to influence the composition of the pelagic fish communities in the Norwegian and Barents Seas and, by doing so, it will also affect the food base for seabirds breeding along the Norwegian coast.

There has been some scepticism about the magnitude of the impact of fisheries, given the inconsistency in studies seeking to relate seabird breeding success and prey stocks. The adverse effect of fisheries on seabirds may be highly localised (Furness, 2002), reflecting the constraints on seabird foraging range when they are breeding. There is characteristic stochasticity in seabird breeding seasons; the birds are long-lived and their populations survive a pattern of boom and bust. The success of some breeding populations is more tightly dependent on one resource; for example black-legged kittiwakes are demonstrably dependent on sandeel populations in the North Sea (Rindorf *et al*., 2000; Frederiksen *et al*., 2004; 2005; 2007a), but not in the Celtic Sea (Lauria *et al*., 2012). This is likely to relate to the marine community and alternative prey, but also to the physical environment and how prey is made available (e.g. Chivers *et al*., 2013). Even when the patterns of availability of prey at the sea surface is critical (e.g. as the result of hydrographic fronts) the overall abundance of prey is likely to be important, even if the relationship between breeding success and a prey population is weak. Frederiksen *et al*. (2008) in an assessment of the vulnerability of kittiwakes to low sandeel abundance observed that at lower overall prey abundance, there may be a disproportionate drop in prey availability within the surface waters where kittiwakes are feeding. However, Frederiksen *et al*. (2005) in their review of nearly 50 kittiwake colonies in the North Sea concluded that regional variation in kittiwake demographic parameters was explained better by regional variation in prey availability than by prey depletion by fisheries.

4.1.2 Cury *et al*., 2011: one-third for the birds

Across species and regions, Cury *et al*. (2011) found significant non-linear relationships between breeding success and the size of forage fish populations. This finding was based on 19 datasets from seven different ecosystems and 14 seabird species.

The data included time-series from individual breeding sites, which varied in duration from 15 to 47 years. The prey population sizes were estimated independently from the birds, usually as part of population assessments for fisheries management. The results indicated that a threshold effect exists in the population level of prey required for a high probability of seabirds being able to reproduce successfully: seabird breeding success declined if prey abundance dropped below 34.6% (95% confidence interval 31 to 39%), or approximately one-third of the maximum prey abundance recorded (Cury *et al.*, 2011).

Cury *et al.* (2011) concluded that a simple rule for fisheries management is to aim to leave 'one-third for the birds'. This level of prey abundance is usually needed for seabirds to be able to obtain enough food to sustain their young. While this is an empirically derived recommendation for management, the authors point out that the generality of the relationship they found suggests that the functional responses within the ecosystem are at play and ring-fencing one-third may be important for sustainable exploitation of LTL resources.

4.1.3 Patterns of vulnerability and resilience

The published evidence illustrates that it is not always possible to demonstrate that seabird populations are vulnerable to the introduction of fisheries for LTL fish; clearly, some populations are more resilient than others (Furness and Tasker, 2000). In some cases, the absolute prey abundance is not constraining to the birds, but their ability to access the prey is. The availability of prey may depend upon variables other than prey population size, such as hydrographic structure (Chivers *et al.*, 2013), or the abundance and behaviour or other seabird species (Fauchald *et al.*, 2011), or through competition with other predators (e.g. fish). Functional diversity, as discussed in Fauchald *et al.* (2011), is useful in explaining the variation in the responses of seabirds to changes in prey availability at different temporal and spatial scales. Ecological processes differ with scale, and consequently seabird populations may be more or less vulnerable to competition from fisheries depending upon their ecology and during different seasons or phases in their life history. Forage fish have an important role in ecosystems; they transfer energy from plankton to higher trophic levels. Intensive fishing on these LTL fish can perturb the local ecosystem. Trophic flow within marine communities can be complex, and scale dependent processes may be important in either ameliorating or exacerbating the effect on a seabird population.

Interacting factors also influence fish stocks, with some collapses in the North Sea attributed to climate change (Frederiksen *et al.*, 2013; Daunt and Mitchell, 2013), arguably making responsible fisheries management of LTL stocks all the more important. Gimenez *et al.* (2012) showed that local climatic conditions had an indirect effect on puffin survival, via the mechanism of changed herring abundance. There is uncertainty on how the impacts of 'fishing down' marine food chains may interact with climate change, and how these fisheries can be managed given this uncertainty (Adler *et al.*, 2008).

4.2 Integrating impacts of fisheries on seabird foraging conditions into management framework

4.2.1 Ecosystem-based fisheries management

The objectives for the Common Fisheries Policy account for the potential environmental impact of fisheries. The Commission defined two important objectives:

i) 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 minimised, in particular reducing the overall fishing pressure; and

ii) 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.

There are both proven and potential interactions between fisheries and seabirds which require attention. The potential interactions are easily outlined, because they are the direct consequence of changes to the marine ecosystem that are taking place and are partly driven by fisheries (Fauchald *et al.*, 2011). An ecosystem-based approach to fisheries management requires due attention is given to the impact on higher predators. While the principle of ecosystem-based fisheries management is written into the CFP, its application will be controversial as long as the evidence of the 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 found by Cury *et al.* (2011) suggests it is broadly transferable when addressing seabird populations dependent on LTL resources. Transfer of this understanding across ecosystems is appropriate. Otherwise; if evidence of impact is required in each management unit of a fishery for any action to be taken, there are likely to be recurring breeding failures among resident seabird populations, before any evidence can be gathered.

A further challenge exists in how exactly to manage fisheries in the interest of the marine ecosystem. Reducing the number of fish harvested does not simply make more fish available for higher predators (Engelhard *et al.*, 2013). The primary consumer of the small forage fish important for seabird populations are predatory fish (Furness, 2003) and seabirds have no doubt benefitted from the removal by fisheries of a large number of these competitors. In the western North Sea, kittiwake populations are food-limited (Frederiksen *et al.*, 2007a, b; Daunt *et al.*, 2008), while haddock (*Melanogrammus aeglefinus*) and whiting (*Merlangius merlangus*) that feed on the same prey (e.g. sandeels) in the same area, are not food-limited (Reilly *et al.*, 2014). Reilly *et al.* (2014) suggested that haddock and whiting could outcompete kittiwakes for sandeels and, if management succeeds in recovering stocks of these two fish species, the resulting competition could have a greater impact on the availability of sandeels to kittiwakes than the industrial fishery had in the past (Frederiksen *et al.*, 2004; 2008).

If harvesting of LTL species is to be managed in the interest of the marine ecosystem, then the levels of fishing mortality need to be considered alongside estimated levels of 'natural' predation by large fish. The findings by Cury *et al.* (2011) suggest it is important to accept that a threshold effect exists, and that stocks of forage fish should not be depleted below a set level, by both fishing and natural predation.

It is inevitable that fisheries for fish low in the food chain will increase given the changes apparent in marine ecosystems, and reduced opportunities for commercial fisheries. Forage fish play an important linking role in energy transfer in marine ecosystems (Dickey-Collas *et al.*, 2013; Alder *et al.*, 2008). There is the responsibility to consider the consequences of harvesting species such as sandeels or capelin on diverse marine predators. Populations of forage fish are dynamic with recruitment varying markedly through time as the result of various climatic and ecosystem effects. However, fishing mortality is an anthropogenic effect that can be managed and the flexible management of fisheries for LTL resources should make it possible to mitigate against variation in stocks of forage fish.

This review indicates that managing fisheries based on the best available information on the interaction between fisheries and marine ecosystems is difficult because of the complexity of those interactions. However, the wealth of long-term studies on seabirds in NW Europe provides a basis for establishing sound recommendations on the management of fisheries based on the scientific understanding of the ecosystem effects of fisheries.

4.2.2 Management through fisheries closures/ marine protected areas

Management through fisheries closures has a long history, and has been adopted as a logical approach to reducing seabird-fisheries conflict in the immediate area of seabird breeding colonies. However as a European system of marine protected areas (MPAs) are established, the effectiveness of MPAs as a means of protecting marine wildlife from fisheries has been called into question (Frederiksen *et al*., 2008). There has been some success (e.g. black-legged kittiwakes on the Wee Bankie – Daunt *et al*., 2008), but also failure, which has often been a product of poor understanding of the regional variation in the ecology of the seabirds or more generally, of the ecological processes at work (Fauchald *et al*., 2011). However there is a growing understanding and reason to believe that JWGBird would be able to develop a range of informed recommendations for the management of fisheries. These could include marine protected areas and fisheries closures that could buffer breeding populations of seabirds from the impacts of fisheries.

4.2.3 'One-third for birds': an experiment in the ecosystem-based approach of managing LTL fisheries

The complexity of the interactions at the ecosystem scale between seabirds, their prey, and their competitors (i.e. fisheries and large predatory fish), means gaining robust evidence of these processes is very difficult. Evidence of such interactions is limited to a local scale at a few well-studied seabird colonies. Hence, there is more evidence to support the localised management of fisheries to protect individual seabird colonies, than there is to support an ecosystem-based approach to fisheries management. The 'one-third for the birds' approach suggested by Cury *et al*. (2011) is based on empirical results of long-term research; they identified a universal pattern in which a large catch of LTL fish resulted in failed reproduction in seabirds. The results are compelling and suggest that this simple approach to the management of LTL fisheries should be considered, perhaps as an experiment in the first instance. The uncertainty of the impacts of climate change and other environmental perturbations are further reasons for considering such a measure.

4.2.4 OSPAR MSFD common indicators and sandeel dependent species

As part of OSPAR's role in coordinating the implementation of the Marine Strategy Framework Directive (MSFD) in the NE Atlantic Region, JWGBird has overseen the development of 'Common Indicators' on marine birds that EU Member States could jointly use to measure progress towards Good Environmental Status (GES). Two of these indicators could potentially be used to monitor the effects of changing food availability on seabird populations and to identify positive and negative impacts of fisheries management. Both indicators are derived from data on annual mean breeding success (no. chicks fledged per pair) of seabird species at colonies and in study plots. Both indicators have been correlated with the sandeel fishing pressure in the North Sea (Cook *et al*., 2014). The indicators are:

4.2.4.1 B3 Marine bird breeding success/failure

The indicator metric 'Annual colony failure rate' is the percentage of colonies failing per year, per species. Cook *et al*. (2014) defined 'failure' as <0.1 chicks per pair. 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 could be adjusted according to experience of the colonies in question.

Species-specific targets are applied to the proportion of colonies failing and the frequency at which these targets are achieved:

The annual percentage of colonies experiencing breeding failure does not exceed the mean percentage of colonies failing over the preceding 15 years, or 5%, whichever value is greater, in more than three years out of six.

The aim of the target is to ensure that only a small proportion of colonies fail per year, probably due to local problems, rather than any large-scale anthropogenic impact. The aim of the target of 'three years out of six' is to ensure that the cumulative effect of successive failures does not have a significant impact on recruitment into the regional population. The different targets for failure rate are applied depending on the breeding strategy of the species: some species e.g. terns, experience breeding failure on a regular basis, others e.g. auks, rarely fail to breed.

4.2.4.2 Kittiwake breeding success

This indicator uses the regression of past measures of annual breeding success and local mean sea surface temperature (SST) in late winter of the previous year (SST^{-1}), to predict what annual breeding success should be if it is '*in line with prevailing...climatic conditions' (cf. Descriptor 1: Biological Diversity, Annex 1, MSFD 2008/56/EC)* (see Figure 1). The premise of the indicator is that any statistically significant negative deviation may indicate a detrimental anthropogenic impact, other than any climate change impacts. The indicator is based on previous work by Frederiksen *et al*. (2004; 2007a). The relationship between breeding success and SST^{-1} is thought to be related to larval sandeel survival and the subsequent availability of one year class (1-group) sandeels for kittiwakes to rear their chicks on.

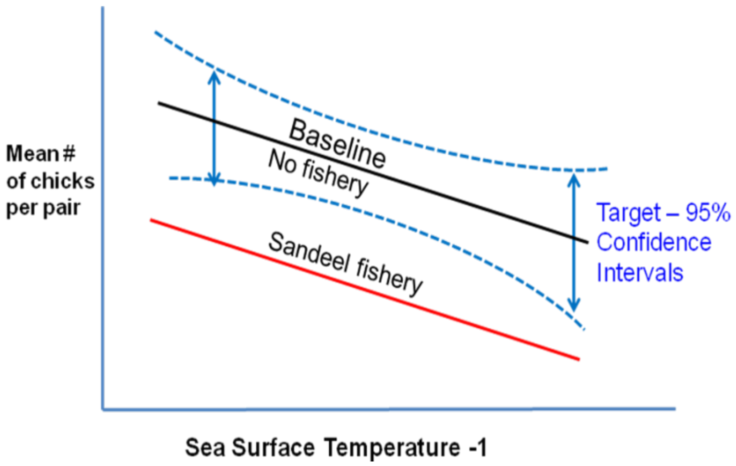

Figure 1. Stylised version of the relationship between kittiwake breeding success and SST two winters previously (from Frederiksen *et al.*, 2004; 2007a). The diagram also demonstrates how targets may be set.

The indicator has been constructed in the Greater North Sea using data from 29 kittiwake colonies in the UK (Cook *et al.*, 2014; Dadam *et al.*, 2014). Dadam *et al.* (2014) failed to find a significant negative relationship between annual breeding success and SST^{-1} at ten colonies in the Celtic Seas. Lauria *et al.* (2012) also found no long-term (1986–2007) effects of spring SST^{-1} on kittiwake breeding success in the Celtic Sea. The future implementation of this indicator will therefore be restricted to the North Sea coast of the UK. None of the other North Sea countries have sufficient data to contribute to the indicator.

4.3 JWGBIRD objectives and programme of work

4.3.1 Developing recommendations for ICES on the management of fish stocks

There have been changes over the past century in the marine community of NW European waters that have had consequences for seabird populations, and these have been documented in a sequence of meticulous long-term studies. To the extent that those changes are driven by fisheries, these studies provide insights into the ecological processes underlying changes in the seabird populations (Table 1).

We propose, as a ToR for the next meeting of the JWGBIRD to examine these and other studies in detail, in order to establish a sequence of specific recommendations for the management of fisheries, particularly LTL fisheries.

Table 1. Long-term studies of seabirds in which fisheries data are presented.

Location	Seabird species	Years of data	Reference
Norway	*R. tridactyla*	1980–2005	Barrett 2007
Norway	*U. aalge*	1987–2011	Erikstad *et al*., 2013
Wadden Sea	*S. hirundo*	1977–2009	Dänhardt and Becker, 2011
North Sea	*R. tridactyla*	1986–2002	Frederiksen *et al*., 2004; 2005
North Sea	*R. tridactyla*	1990–1998	Rindorf *et al*., 2000
North Sea	*U. aalge*	1990–1998	Rindorf *et al*., 2000
North Sea	*P. aristotelis*	1990–1998	Rindorf *et al*., 2000

4.3.2 Local fisheries management: avoidance better than cure

One priority will be to establish 'rules' for developing local management regimes for fisheries which may interact with breeding seabird populations, with consideration of the spatial and temporal scale dependence of marine processes.

4.3.3 One-third for birds - an experiment

Fish stock management for LTL species must take an ecosystem approach; such management is required even when seabird populations are not vulnerable and are not specifically a concern when protecting breeding populations. A detailed proposal for an experiment in the management of LTL fisheries will be developed following the results of Cury *et al*. (2011). Part of this proposal will be the review the data from the NE Atlantic Region to consider the extent to which we have found a similar pattern.

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Annex 1: Results of the testing of OSPAR common indicator-B1 Marine Bird Abundance

Background

This Annex 1 was produced as part of ToR (a) (see Chapter 1) on behalf of the Intersessional Correspondence Group on the Coordination of Biodiversity Assessment and Monitoring (ICG-COBAM) of the OSPAR Convention for the Protection of the Marine Environment of the Northeast Atlantic. This report describes the testing of OSPAR's Common Indicator B1 – Marine bird abundance. It was presented by the JWGBird chair to ICG-COBAM on 2 December 2014, at their meeting in Madrid. It was later submitted to OSPARs Biological Diversity Committee in March 2015, in Cork, Republic of Ireland (Paper ref: BDC 15/3/Info.2-E; summary paper ref: BDC 15/3/2).

This testing report consists of two parts: 1) Summary of the test result, and 2) Background Testing document.

Introduction

OSPAR 2013 adopted 15 biodiversity indicators as common in at least one of the OSPAR Regions. These biodiversity indicators will contribute to the 2017 Intermediate Assessment (IA 2017), as was agreed at the second meeting of the OSPAR Coordination Group in 2013 (COG(2)). It is intended that the main purpose of IA 2017 will be to support Contracting Parties who are also EU Member States in delivery of certain aspects of their 2018 MSFD reporting.

The provisional time frame sets out the indicators that will contribute to the IA 2017 that should be adopted as common by June 2015. The common biodiversity indicators should be tested in 2014. The testing results should be ready for end 2014 to enable ICG COBAM to report to BDC 2015 on the ability of the common indicators to contribute to the Intermediate Assessment at BDC 2015. COBAM needs to provide the evidence that the indicator works as intended, with a demonstration that there will be something tangible to contribute to the IA 2017. The indicator assessments will be made in the year after (up to end 2016).

Lead countries have often requested a national expert to lead the process of testing of biodiversity indicators. It is hard to track down documents outlining the OSPAR process on development of (biodiversity) indicators for people who are not intensively involved in OSPAR meetings. Therefore, a list of useful documents will be published at basecamp.

Process of testing biodiversity indicators

ICG COBAM is testing the common biodiversity indicators with the test results and conclusions reported to BDC 2015. The following template has been developed for this. It is a proposed framework to ensure consistency in the testing of all common indicators to enable comparison of the results across indicators and to demonstrate their ability to deliver the indicator assessment products, especially for the IA 2017.

This template will be forwarded to the second meeting of the Intercessional Coordination Group on the Marine Strategy Framework (ICG MSFD (2)) as a proposal for consideration and steer. ICG COBAM (2) in September 2014 will discuss the considerations of ICG MSFD and may adapt this template. Lead countries can then use the template to make their final report on testing of the biodiversity indicator concerned.

This template consists of two parts: 1) Summary of the test result, and 2) Background Testing document.

Part 1: Summary of the test results per biodiversity indicator

The test results of the biodiversity indicators concerned are summarized in the table below.

Indicator	Abbreviated name	BoB, Iberian coast	Celtic Seas	North Sea	Lead country	Conclusion of testing and advice on inclusion in IA 2017
B1	Marine Bird abundance	no	Yes	Yes	UK & DE	1) Testing results: GREEN – testing successful, no or only very minor problems encountered, indicator can be considered as sound and practicable and can thus be rolled out as fully operational 2) Common indicator B1 will be able contribute to IA 2017. B1 provides a 'state indicator' of marine bird population size (criterion 1.2) under MSFD Descriptor 1. Marine birds are a key component of marine biodiversity.

Part 2: Background Testing Documents

Introduction

Indicator B-1: Marine bird abundance

This indicator is constructed from information on marine bird species, which at some point in their annual life cycle, are reliant on coastal and offshore areas under the jurisdiction of MSFD. 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).

The indicator and its target are derived from the OSPAR EcoQO on Seabird population trends as an index of seabird community health (see ICES 2008). Abundance is used as an indicator of seabird community health because abundance is measured widely and relatively easily, is a good indicator of long-term changes in seabird community structure and is likely to change slowly under 'natural' conditions, so rapid changes might indicate human-induced impacts, thereby providing a cue for immediate management actions.

This indicator is generated using time-series of annual estimates of abundance of individual species. The indicator metric is 'relative abundance': annual abundance as a percentage of the baseline. Species –specific indicators have been generated from a) counts of seabirds at breeding colonies, and b) counts conducted from land of waterbirds during the non-breeding season (including shorebirds in intertidal areas and other waterbird species counted on the sea close to the shore).

Baselines are set as follows:

i) '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.

ii) Reference level –the population size that would be expected if anthropogenic impacts were negligible (this can be derived from known pop sizes either historically or from within the time-series).

iii) Start of the time-series – at the start: first ten years – use start point if significant trend, or mean if no trend, or mean if using non-breeding data.

Species-specific trends in relative abundance are assessed against supporting 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, 2012, 2013a–d).**

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.

GES under the criterion Population Size (1.2) for marine birds is considered to be achieved when: 'Changes in abundance of marine birds should be within individual target levels in 75% of species monitored'.

The 75% threshold is comparable to the thresholds used by the WeBS Alerts system for assessing shorebird populations in the UK (http://www.bto.org/volunteer-surveys/webs/publications/webs-alerts).

Overview of testing methodology vs. methodology for fully operational indicator

Criteria	Fully operational indicator	Testing methodology
Geographical scope	all OSPAR Subregions	OSPAR II & III
Type of data (this includes both the temporal as well as technical aspects of the data used and the data necessary for indicator implementation)	Past data and current data Up to 2014/2015 non-breeding season and 2015 breeding season Annual counts of breeding and non-breeding marine birds made from land (and at sea, possibly).	Past data (1991–2011) and will be updated with data collected more recently. Annual counts of breeding and non-breeding marine birds made from land only.
Biodiversity aspects	All marine bird functional groups	All marine bird functional groups
(Necessary) Relevant monitoring programmes	Annual monitoring of seabird breeding colonies near the coast Annual monitoring of waterbird coastal breeding sites Annual monitoring of non-breeding numbers of waterbirds at coastal sites, during migration and winter periods (Possibly) At-sea monitoring of waterbirds and seabirds	Annual monitoring of seabird breeding colonies near the coast Annual monitoring of waterbird coastal breeding sites Annual monitoring of non-breeding numbers of waterbirds at coastal sites, during migration and winter periods

Detailed analysis of testing process and results

Data utilisation and availability

Data describing the abundance of breeding and non-breeding marine birds were collated from across OSPAR subregions II and III.

The following data were requested from contracting parties:

1) Breeding seabird colonies (incl. 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.

2) Wintering and passage waterbirds (including waders): numbers of birds per species per site per year that are counted from land[2].

[2] 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.

3) 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.

4) 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.

At least some data were received from all contracting parties in OSPAR Regions II and III, except Sweden. See Table 1 for details.

The common period of time-series across the datasets was 1991–2011 inclusive.

These data were used to construct species-specific annual abundance indices during 1991–2011, for each subregion and for each of five subdivisions of OSPAR region II (see technical specification for methods).

The indicator metric is 'relative abundance' %=100 * (annual total abundance[3]/ baseline abundance).

Most CPs did not provide historic references or reference levels with which to set objective baselines. For the purposes of the testing, baselines were set at the start of the time-series as described above and in the technical specification below.

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 wigeon.

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[3] Breeding abundance was measured in pairs. Non-breeding abundance monitoring metric varied depending on the area: for the Waddenzee we used the mean number of birds present that were counted repeatedly during the annual period July to June. For all other areas we used counts conducted in January of each year. The operational indicator will use only counts obtained at the same time of year.

In order to achieve GES, species abundance should be more than 80% of baseline levels in the case of species that lay only one egg and more than 70% of baseline levels in the case of species that lay more than one egg. The abundance indicators for each subregion and subdivision were then assessed against the target that 75% or more species achieve their target abundance.

Table 1. Utilisation of data in testing from each Contracting Party in each OSPAR region and subdivision of the Greater North Sea (OSPAR IIa–e), indicated by 'Y' or 'N'. 'A' indicates data have been collected and are potentially available, but were not used in the testing. '?' 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	A	A	A
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	A	A	A
UK	II-a		Y	N	Y
Norway	II-b	Coast of western Norway	Y	Y	A
Denmark	II-c	Skagerrak/Kattegat coast	A	A	A
Norway	II-c	Norwegian Skagerrak coast	Y	Y	A
Sweden	II-c		A	A	A
Belgium	II-d		Y	A	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	A	A	A
Netherlands	II-d		Y	Y	Y
UK	II-d		Y	N	Y
France	II-e	Nord Pas de Calais & Picardie	A	A	A
France	II-e	Normandy	Y/A	A	A
UK	II-e		Y	N	Y
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	A	A	A
Portugal	IV		?	?	?
Spain	IV		A	N	A
Portugal	V	Azores	A	N	N

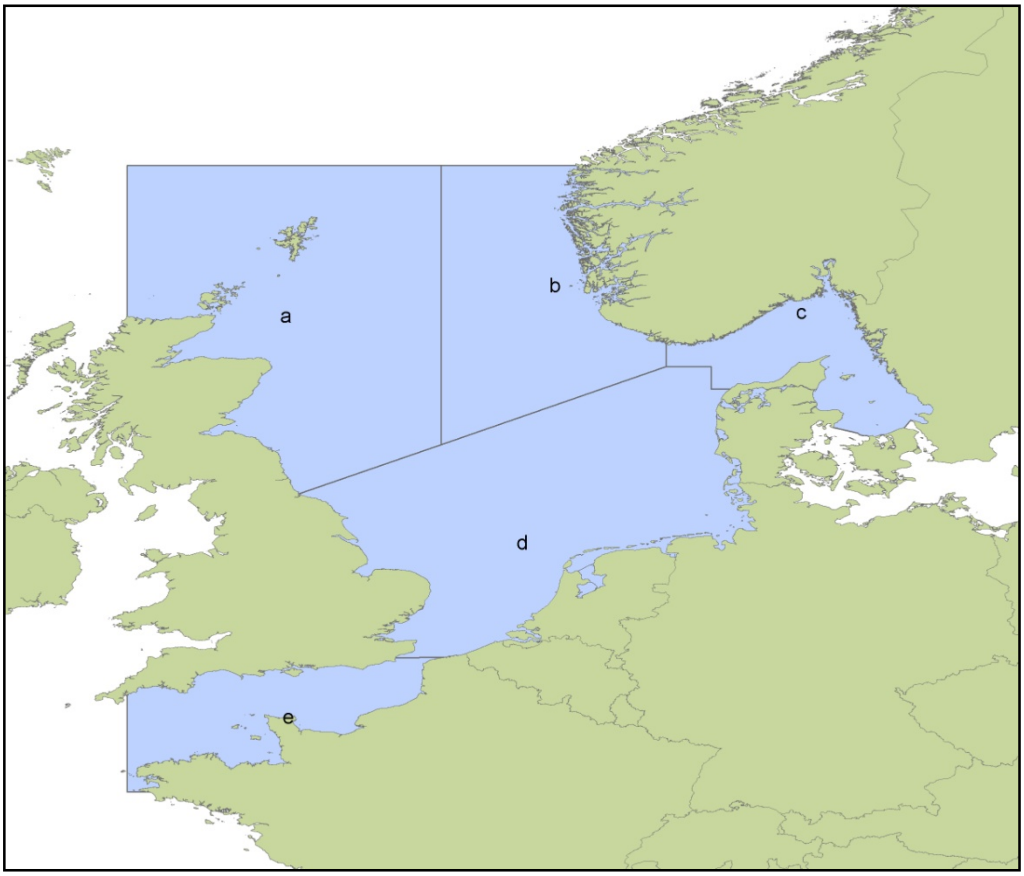

Figure 1. Proposed subdivisions of OSPAR Region II; the Greater North Sea for the assessment of indicators of relative abundance of breeding seabirds (source ICES 2013c,d).

Current Monitoring Programmes and future requirements

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 (see below). Monitoring should be conducted on a site by site basis but needs to be representative of each subregion and subdivision therein. Monitoring of breeding abundance of marine birds is conducted in all countries in the region and as part of nationally coordinated schemes. Each scheme has a central data storage mechanism (e.g. national database), except in Portugal and Sweden (North Sea coastline). 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. 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.

Data collection is currently carried out and funded by national monitoring schemes. Each national monitoring scheme has QA/QC protocols, but European standards should be developed. A minimum standard should be to follow internationally recognised monitoring methods (e.g. Walsh *et al.*, 1995; Koffijberg *et al.*, 2006). 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 in 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.

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. 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.

Barriers and gaps to availability of bird abundance data in the Celtic Seas and Greater North Sea

Table 2. Potential barriers to using marine bird data to construct operational subregional indicators for B1.

OSPAR Region	Countries	Barriers in data availability	Barriers in data formats	Barriers in data accessibility	Barriers through lack of contribution of CPs	Knowledge gaps that could hinder full implementation of indicator across whole region	Gaps in resources to implement indicator
I	Norway[1]				X		X
I	Iceland[2]	X		X		X	
I	Russia[3]	X	?	X	NA	X	Most likely
I	Greenland[3] (Denmark CP)	X	?	X	X	X	Most likely
I	Faroes[3] (Denmark CP)	X	?	X	X	X	Most likely
II	Sweden[4]			X	X		
II	Denmark[5]			X	X		
II	UK & Netherlands[6]			X		X	
III	Rep. of Ireland[7]			X	X		X
II & IV	France[8]		X	X			X
IV	Spain[9]	X		X			X
IV	Portugal[10]	X	X	X	X		Most likely
V	Azores[11] (Portugal)			X	X		?

Notes

[1] The Norwegian data for OSPAR I and for wintering birds in OSPAR II have yet not been submitted due to a lack of resources. There is however an ongoing dialog between the management authorities and the institutions that carry out the monitoring to bridge this problem in time for submission to be incorporated in the preparations for the IA 2017.

[2] 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. There are known shortcomings in the monitoring of marine birds in Iceland that are likely to restrict the full implementation of B1 in OSPAR I to Norwegian areas.

[3] 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.

[4] Sweden have available monitoring data on breeding seabirds and waterbirds and on non-breeding waterbirds (mainly mid-winter counts). These data were not accessible during the testing of B1 because of internal resource issues. These issues appear to have been resolved and hopefully, data from Sweden will contribute to the operational indicator B1 in IA2017.

[5] Data from the Danish part of the Waddenzee were included in the testing of B1, through a data submission from the TMAP Database. Data from the other parts of the Danish coast were not accessible due to lack of engagement by Danish experts in the bird indicator development. Data from Denmark, outside the Waddenzee are available (Petersen *et al*., 2014). These include annual counts of wintering geese and swans (usually September, November, January, March) along the coast and in the fjords. Midwinter counts of all other species carried once every five years, as part of a national survey. They combine land-based surveys and aerial surveys (both total counts and transects that are extrapolated). This kind of national census was carried out in 2004, 2008, 2013. They provide population totals per species on a periodic level (i.e. once every five years). Census of breeding birds in coastal areas, including offshore islands, carried out once every three years.

[6] In the southern North Sea (Subdivision IId in Figure 1) there is a high level of inconsistency in the accessibility to data on non-breeding waterbirds, in terms of the number of sites and species. This inconsistency results from differences in Member States' policies on what constitutes 'coastal waters' under the Water Framework Directive and are then subsequently included in the MSFD definition of 'marine waters' in Article 3 (1) of the Directive. Estuarine waterbodies or 'transitional waters' are generally not included by Member States under the jurisdiction of MSFD. 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. But there is stark variation in what member states consider to be transitional. Germany and Denmark both consider their parts of the Waddenzee to be mainly coastal, whereas the Netherlands considers its part of the Waddenzee to be entirely transitional. Data from the Netherlands Waddenzee were used in the testing of indicator B1, but will not be used in the assessment of B1 during the IA2017. The UK has also excluded data from transitional waters that include internationally important sites in Subdivision IId (as well as all other parts of the UK

coast) such as the Thames Estuary, The Wash and Humber Estuary. The differing policies of UK, Netherlands, Germany and Denmark will mean that the IA2017 assessment of B1 in the North Sea will be heavily biased towards the southeast. The assessments of B1 in the Danish ad German Waddenzee will contain about 10–15 more species and hundreds of thousands of birds that will have been excluded from the assessment of the UK and Netherlands North sea coasts. The pragmatic inclusion of waterbird data from sites considered to be in transitional waters in the UK and Netherlands would provide a more meaningful subregional assessment of marine bird populations.

[7] 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.

[8] 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.

[9] 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.

[10] 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.

[11] 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 – Macaroneisa. Subsequent access to these data and the operation of an indicator has not been possible due to lack of engagement of experts from the Azores and mainland Portugal.

Potential for an operational indicator B1 in other subregions of the Northeast Atlantic

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. It would be beneficial if other CPs in the subregion would mobilise 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.

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 was assessed as 'good', three were assessed as sparse, and the quality of monitoring data on little terns breeding in Portugal was unknown. Engagement is required from Portugal in order to make the indicator operational in this subregion.

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, Macaroneisa. 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.

Utilisation of other data types

Indicators could 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 could 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. Similar work is being undertaken by HELCOM and a preliminary trend analysis 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 2. 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 to calculate 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 UK, France, Belgium, The Netherlands, Germany and Sweden. Offshore monitoring is also conducted in OSPAR subregions I (Norwegian Barent’s 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.

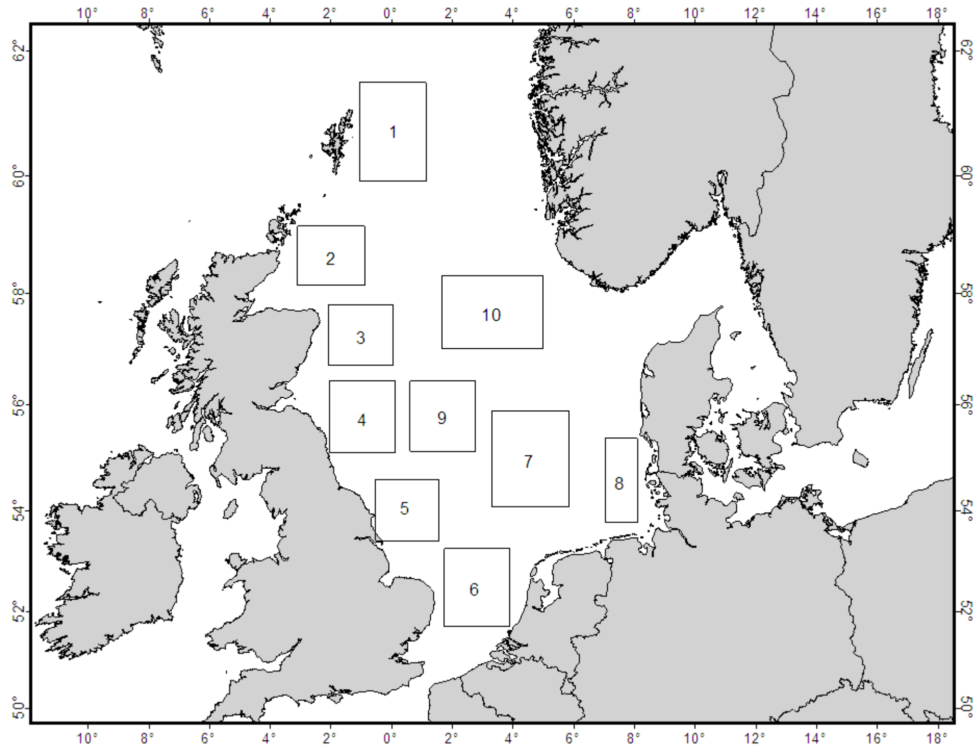

Figure 2. Trend boxes in OSPAR II designed for the preliminary analysis of seabird-at-sea trends, based on data of ship-based transect surveys (Garthe *et al.*, in prep.).

Data storage and management processes and their availability at full roll out

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.

Each CP has its own data storage mechanism. Prior to the testing, OSPAR Secretariat designed an INSPIRE-compliant format for collating data from CPs; this was trialled during the data call for the current test. The Excel data submission forms were well received by most participants in the testing. Few changes to them are required prior to full roll out, other than the addition of a form to collate spatial information of each monitoring site. In future, each CP will submit updates each year. During the testing some CPs submitted only observed counts and there were gaps in the time-series because not all breeding colonies or non-breeding sites of all species were monitored each year. The OSPAR Secretariat's contractor-the British Trust for Ornithology (BTO) later imputed these missing counts using a predictive model (see Technical Specification for details). Some CPs submitted complete time-series that contained imputed values. The reason for doing so was to maintain consistency with other national data products. JWGBird concluded that it was perfectly acceptable from CPs in future to submit pre-imputed data, even if a variety of imputation methods are used.

During testing, JNCC (UK) provided temporary storage of the data. BTO constructed a database to accommodate the data. This database has been uploaded onto the ICES

DataCentre. The database currently has restricted access. CPs need to clarify terms of this data sharing with the help of the ICES and OSPAR secretariats, before the database can be publicly accessed online.

As part of their contract to the OSPAR Secretariat, the BTO will work with JNCC to construct a data tool that will enable non-statisticians and data specialists to quickly and easily analyse data in the marine bird database and construct and assess indicator B1, annually. The results of these annual assessments will be reviewed by JWGBIRD who will report to ICES ACOM and to OSPAR BDC via ICG-COBAM.

Cost-effectiveness

Monitoring

Monitoring costs in most countries are minimised 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.

Analysis (e.g. databases, chemical analysis, etc.)

All data for this indicator B1 from every subregion (and even from other Regions e.g. Baltic) could be held in the single database hosted by the ICES DataCentre. The database also holds data on breeding success for indicator B3, which can be submitted by CPs simultaneously each year with data for B1.

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.

Reporting

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.

Next steps

1) Certain CPs to address barriers to data accessibility identified in Table 2.

2) Certain CPs to better coordinate existing monitoring activities to deliver more comprehensive data.

3) To confirm terms of data sharing between ICES DataCentre and CPs, regarding the marine bird database.

4) All CPs to submit data in the required format by a deadline to be decided (depending on IA2017 timetable).

5) All CPs to agree on baselines and target thresholds.

6) BTO and JNCC (UK) to complete build of data analysis tool, which will enable non-statisticians to construct indicators and assess them against the appropriate targets and to disseminate outputs.
7) Norway and other CPs in OSPAR Region I to work together to develop marine bird indicators for B1 in the Arctic subregion.
8) Spain, Portugal and France to work together to develop operational marine bird indicators for Bay of Biscay and Iberian coast subregion.

Summary of results and recommendations to BDC 2015

It was possible to operate the indicator B1 – marine bird abundance, based on the data that were delivered for the Celtic Seas and Greater North Sea (OSPAR regions II and III). Despite some gaps in the data, the major part of the relevant populations in most species was covered. We do not foresee any major problems in building a more comprehensive dataset from existing monitoring programmes.

Indicator B1 will be contribute to the IA2017 (for the Celtic Seas and Greater North Sea subregions at least).

Unfortunately, the IA2017 assessment of B1 in the southern North Sea will be heavily biased towards the southeast. The assessments of B1 in the Danish and German Waddenzee (considered 'non-transitional' waters) will contain about 10–15 more species and hundreds of thousands of birds that will have been excluded from the assessments of the UK and Netherlands because they were from sites considered in transitional waters. The pragmatic inclusion of waterbird data from some 'transitional waters' in the UK and Netherlands would provide a more meaningful subregional assessment of marine bird populations.

Arrangements for data storage and data submission have been established. They have been demonstrated to be effective. These will be suitable for data from all subregions of the Northeast Atlantic and for data for indicator B3 – marine bird breeding success/failure. Annual updates of indicator B1 should be possible and will be made quick, easy and inexpensive by completion of a data analysis tool by BTO and JNCC (UK).

Indicator B1 could be made operational in the Arctic subregion (OSPAR 1) but availability of data may restrict the extent of its operation within the subregion (most likely to Norwegian waters). The indicator could also be made operational in the Bay of Biscay and Iberian coast (OSPAR IV) and in Macaronesia (the Azores – OSPAR V), but depends on the engagement with Portugal in the process and on being granted access to their monitoring data.

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Appendix 1 – B1 Marine bird abundance

Technical_specifications: Criteria for assessing the results of the testing process (taken from Assessment of COBAM's Biodiversity Indicators by ICES WGBiodiv)

Category	Characteristic	Criterion	Importance Weighting	Response	Guidelines for Response
Type of Indicator	State or pressure	Is indicator a "pressure" indicator being used for want of an appropriate "state" indicator?		State	
Quality of underlying data	Existing and ongoing data	Is the indicator supported by current or planned monitoring programmes that provide the data necessary to derive the indicator. Ideal monitoring programmes should have a time-series capable of supporting baselines and reference point setting. Data should be collected on multiple sequential occasions using consistent protocols, which account for spatial and temporal heterogeneity.	Essential	Yes	Yes: long-term and ongoing data from which baselines can be derived and past and future trends determined; NB. There are geographical gaps in data collection and in data access (see above).
Quality of underlying data	Metrics should be tangible	Are the metrics easily and accurately determined using technically feasible and quality assured methods.	Essential	Yes	Yes: data and methods are technically feasible and quality assured in all aspects; Partly: potential issues with quality assurance, or methods not widely adopted; No: metric is not tangible or doubtful.

Category	Characteristic	Criterion	Importance Weighting	Response	Guidelines for Response
Quality of underlying data	Assessment of targets	Can the indicator accurately detect whether a target has been met or not.	Essential	Yes	Yes: indicator values can be calculated with sufficiently high precision (e.g. narrow confidence intervals) to be able to detect with a high-level of confidence, that a target had been met or not; Partly: precision of indicator calculation is low, but sufficient to assess the direction of travel in relation to meeting or missing the target; No: precision of indicator calculation is so low that there are likely to be false positives or negatives in assessments against targets.
Quality of underlying data	Relevant spatial coverage	Are the data derived from a large proportion of the MSFD subregion to which the metric will apply.	Essential	Partly	Yes: spatially extensive monitoring is undertaken across the subregion; Partly: monitoring does not cover the full subregion, but is considered adequate to assess status at subregional scale; No: monitoring is undertaken across a limited fraction of the subregion and considered inadequate to assess status at subregional scale.
Quality of underlying data	Reflects changes in ecosystem component that are caused by variation in any specified manageable pressures	Does the indicator reflect change in the state of an ecological component that is caused by a specific significant manageable pressure (e.g. fishing mortality, habitat destruction). If so, the indicator should respond sensitively to particular changes in a pressure. The response should be unambiguous and in a predictable direction, based on theoretical or empirical knowledge, thus reflecting the effect of change in pressure on the ecosystem component in question.	Essential	Partly	Yes: metric is responsive to a specific pressure and the pressure-state relationship is defined; Partly: metric responds to several pressures and the pressure-state relationship is defined for at least one of these; No: no clear pressure-state relationship is evident.

Category	Characteristic	Criterion	Importance Weighting	Response	Guidelines for Response
Quality of underlying data	Quantitative vs. qualitative	Quantitative measurements are preferred over qualitative, categorical measurements, which in turn are preferred over expert opinions and professional judgments.	Desirable	Fully met	Fully met: all data for the metric are quantitative; Partially met: data for metric are semi-quantitative or largely qualitative; Not met: metric is largely based on expert judgement.
Management	Cost-effectiveness	Does sampling, measuring, processing, analysing indicator data, and reporting assessment outcomes, make effective use of limited financial resources.	Essential	Partly	Yes: This is an existing indicator. No new sampling, new monitoring programs or new reporting are necessary. Partly: new sampling on already existing programmes, new (data) analysis and new reporting is required; No: additional costs. Explain which costs.
Management	Relevant to management measures	Is the Indicator linked directly to a management response. If so, the relationship between activity and resulting ecological pressure on the ecological component should be clearly understood.	Desirable	Partly[4]	Yes: Both pressure-state and activity-pressure relationships are well defined - one can advise on the direction AND extent of any change in human activity required; Partly: only the pressure-state relationship is well defined - one can only advise of the direction of change in human activity required; No: no relationship between pressure, state and activity.
Management	Comprehensible	Is the indicators easily understood by policy-makers and other non-scientists (e.g. stakeholders) alike. The consequences of variation in the indicator should be easy to communicate.	Desirable	Yes	Yes: the metric is easy to understand and communicate; Partly: a more complex and difficult to understand metric, but one for which the meaning of change in the metric value is easy to communicate; No: the metric is neither easy to understand or communicable.

[4] E.g. we know that fisheries impact on the indicator, we know direction of the relationship but not the magnitude and all mechanisms involved. Therefore it is difficult to make the link with management measures.

Category	Characteristic	Criterion	Importance Weighting	Response	Guidelines for Response
Management	Early warning	Does the indicator signal potential future change in an ecosystem attribute before actual harm is indicated by other MSFD indicators. These could facilitate preventive management, which could be less costly than restorative management.	Informative	Yes & No[5]	Yes: indicator provides early warning because of its high sensitivity to a pressure with short response time; No: relatively insensitive indicator that is slow to respond.
Conceptual	Metrics relevance to MSFD indicator	For D1 and D6, metrics should fit the indicator function stated in the 2010 MSFD Decision document. This requirement can be relaxed for D4 indicators because the Decision document stipulates the need for indicator development in respect of this Descriptor (but any newly proposed D4 indicators must still fulfil the overall goals stated for D4).	Essential	Fully met	Fully met (1): metric complies with indicator function; Not met (0): metric does not comply with indicator function.

[5] The ability of the indicator to provide an early warning of a pressure impact will depend on how the pressure impacts on the population. For example, if the pressure causes increased mortality of adult seabirds (e.g. impact of fisheries bycatch), then species-specific abundance indicators derived from counts of breeding adults, will likely show a decline immediately after the impact has occurred. But if a pressures causes a reduction in seabird breeding success and the number of young being recruited into the breeding population, there will be a lag of several years before consequent declines in indicators of adult breeding abundance occur. The lag occurs because most seabirds species on start to breed when they are several years old. For such pressures, indicator B3 - marine bird breeding success/failure would respond immediately and provide a much better early warning.

Annex 2: Results of the testing of common indicator – B3 Marine Bird breeding success/failure

Background

This Annex 2 was produced as part of ToR (a) (see Chapter 1) on behalf of the Intersessional Correspondence Group on the Coordination of Biodiversity Assessment and Monitoring (ICG-COBAM) of the OSPAR Convention for the Protection of the Marine Environment of the Northeast Atlantic. This report describes the testing of OSPAR's Common Indicator B3 – Marine bird breeding success/failure. It was presented by the JWGBird chair to ICG-COBAM on 2 December 2014, at their meeting in Madrid. It was later submitted to OSPARs Biological Diversity Committee in March 2015, in Cork, Republic of Ireland (Paper ref: BDC 15/3/Info.2-E; summary paper ref: BDC 15/3/2).

This testing report consists of two parts: 1) Summary of the test result, and 2) Background Testing document.

Introduction

OSPAR 2013 adopted 15 biodiversity indicators as common in at least one of the OSPAR Regions. These biodiversity indicators will contribute to the 2017 Intermediate Assessment (IA 2017), as was agreed at the second meeting of the OSPAR Coordination Group in 2013 (COG(2)). It is intended that the main purpose of IA 2017 will be to support Contracting Parties who are also EU Member States in delivery of certain aspects of their 2018 MSFD reporting.

The provisional time frame sets out the indicators that will contribute to the IA 2017 that should be adopted as common by June 2015. The common biodiversity indicators should be tested in 2014. The testing results should be ready for end 2014 to enable ICG COBAM to report to BDC 2015 on the ability of the common indicators to contribute to the Intermediate Assessment at BDC 2015. COBAM needs to provide the evidence that the indicator works as intended, with a demonstration that there will be something tangible to contribute to the IA 2017. The indicator assessments will be made in the year after (up to end 2016).

Lead countries have often requested a national expert to lead the process of testing of biodiversity indicators. It is hard to track down documents outlining the OSPAR process on development of (biodiversity) indicators for people who are not intensively involved in OSPAR meetings. Therefore, a list of useful documents will be published at basecamp.

Process of testing biodiversity indicators

ICG COBAM is testing the common biodiversity indicators with the test results and conclusions reported to BDC 2015. The following template has been developed for this. It is a proposed framework to ensure consistency in the testing of all common indicators to enable comparison of the results across indicators and to demonstrate their ability to deliver the indicator assessment products, especially for the IA 2017.

This template will be forwarded to the second meeting of the Intercessional Coordination Group on the Marine Strategy Framework (ICG MSFD (2)) as a proposal for consideration and steer. ICG COBAM (2) in September 2014 will discuss the considerations of ICG MSFD and may adapt this template. Lead countries can then use the template to make their final report on testing of the biodiversity indicator concerned.

This template consists of two parts: 1) Summary of the test result, and 2) Background Testing document.

Part 1: Summary of the test results per biodiversity indicator

The test results of the biodiversity indicators concerned are summarized in the table below.

Indicator	Abbreviated name	BoB, Iberian coast	Celtic Seas	North Sea	Lead country	Conclusion of testing and advice on inclusion in IA 2017
B3	Marine Bird breeding success/failure	No	Yes	Yes	UK	1) Testing results: GREEN – testing successful, no or only very minor problems encountered, indicator can be considered as sound and practicable and can thus be rolled out as fully operational. 2) Common indicator B3 will be able contribute to IA 2017. B3 provides a 'state indicator' of marine bird population condition (criterion 1.3) under MSFD Descriptor 1. Marine birds are a key component of marine biodiversity.

Part 2: Background Testing Documents

Introduction

Indicator B-3: Marine bird breeding success/failure

This indicator is constructed from information on marine bird species, which at some point in their annual life cycle, are reliant on coastal and offshore areas under the jurisdiction of MSFD. 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).

This indicator describes changes in breeding failure rates in marine birds. For the purpose of the testing we defined 'failure' was 0.1 chicks per pair, after Cook *et al.* (2012). 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 indicator is to be derived from data on annual mean breeding success (no. chicks fledged per pair) of marine bird species at colonies and in survey plots throughout the NE Atlantic.

The indicator metric is '**Annual colony failure rate'** i.e. the percentage of colonies failing per year, per species (from Cook *et al*., 2012).

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*., 2014) provides evidence of link to fishing pressure. The results of Cook *et al*. (2014) 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.

Species-specific targets are applied to the proportion of colonies failing and the frequency at which these targets are achieved:

The annual percentage of colonies experiencing breeding failure does not exceed the mean percentage of colonies failing over the preceding 15 years, or 5%, whichever value is greater, in more than three years out of six. (See Figure 2).

The aim of the target is to ensure that only a small proportion of colonies fail per year, probably due to local problems, rather than any large-scale anthropogenic impact. The aim of the target of three years out of six is to ensure that the cumulative effect of successive failures does not have a significant impact on recruitment into the regional population. Cook *et al*. (2012) tested various target thresholds on each species indicator of annual colony failure rate. They found that some species e.g. terns, experience breeding failure on a regular basis, others e.g. auks, rarely fail to breed. The threshold of the 15-year mean breeding failure rate was appropriate to species that regularly failed to breed, while a fixed threshold of 5% was appropriate to highlighting failures in species that rarely fail.

Targets should be assessed separately in the Celtic Seas and in the Greater North Sea. The overall criterion target for 1.3 population condition is assessed on the basis of the number of species achieving species-specific supporting targets:

Widespread seabird colony breeding failures should occur rarely in other species that are sensitive to changes in food availability. (See Figure 3).

Overview of testing methodology vs. methodology for fully operational indicator

Criteria	Fully operational indicator	Testing methodology
Geographical scope	all OSPAR Subregions	OSPAR II & III
Type of data (this includes both the temporal as well as technical aspects of the data used and the data necessary for indicator implementation)	Past data: 1986–2015 breeding season for IA 2017 and will be updated with more recent data subsequently. Annual counts of young fledged, per species per colony (or site) per year	Past data: 1986–2013 Annual counts of young fledged, per species per colony (or site) per year
Biodiversity aspects	All marine bird functional groups	All marine bird functional groups
(Necessary) Relevant monitoring programmes	Annual monitoring of seabird breeding colonies near the coast Annual monitoring of waterbird coastal breeding sites	Annual monitoring of seabird breeding colonies near the coast Annual monitoring of waterbird coastal breeding sites

Detailed analysis of testing process and results

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*., 2012; 2014). The applicability of the indicator and its targets (as proposed by Cook *et al*., 2012) to other parts of both subregions have been assessed by OSPARs Expert Group on Marine Birds (ICES 2013a). 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, 2013a). 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 1.

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 twelve years) of annual survival rates for 15 species – http://www.seapop.no).

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.

Data utilisation and availability

Data describing the breeding success of marine birds were collated from across OSPAR subregions II and III.

Contracting parties were requested to submit data collected at breeding seabird colonies (incl. gulls and terns) and breeding waterbirds (incl. waders) nesting close to the coast and using marine environment (e.g. for food). Data were composed of counts of young fledged, per species per colony per year.

Data for the Celtic Seas were received from the UK (including data from Republic of Ireland). Data for the Greater North Sea were received from the UK, Belgium, Netherlands and Germany (incomplete: Helgoland seabird colony only); see Table 1 for details.

The common period of time-series across the datasets was 1986–2013 inclusive.

These data were used to construct species-specific indicators of annual breeding failure rate (see Figure 2 for examples) in each subregion (see technical specification for methods); where failure rate = the percentage of colonies failing per year, per species.

There were sufficient data to construct species-specific indicators of breeding failure rate for the following 24 species: fulmar, gannet, Arctic skua, great skua, great cormorant, European shag, black-headed gull, common gull, herring gull, lesser black-backed gull, great black-backed gull, black-legged kittiwake, Arctic tern, common tern (see Figure 2), little tern, roseate tern, Sandwich tern, razorbill, common guillemot (see Figure 2), black guillemot, Atlantic Puffin, oystercatcher, avocet and common eider.

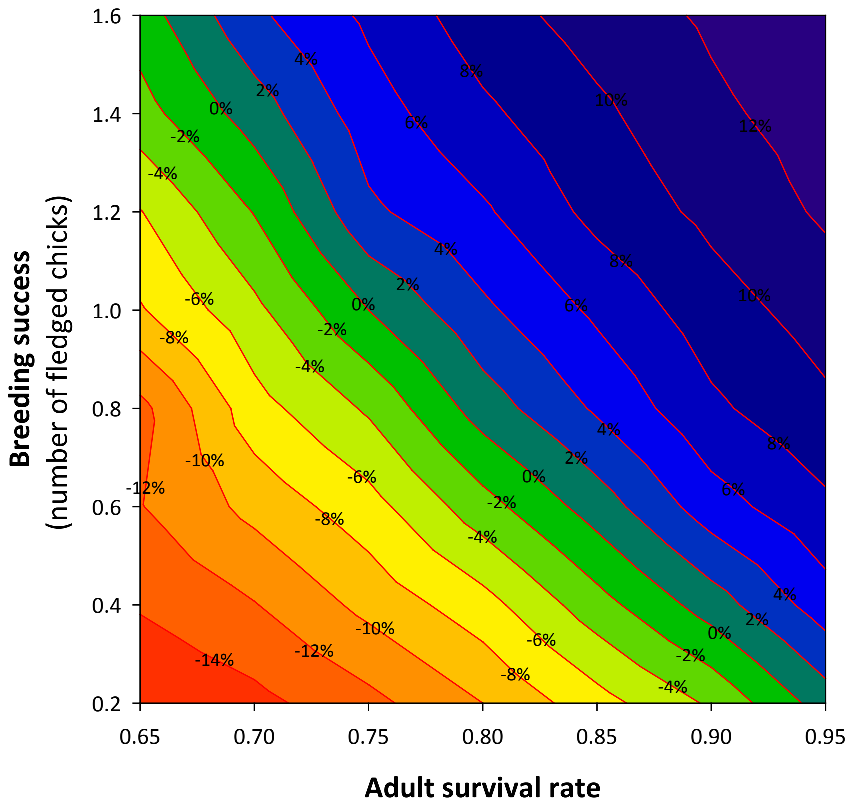


Figure 1. Annual population trends (% change) for kittiwake populations that would result from different combinations of adult survival rates and annual breeding success rates (contour lines). This plot illustrates that if survival rate falls from 0.9 to 0.85, the level of breeding success requires to 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).

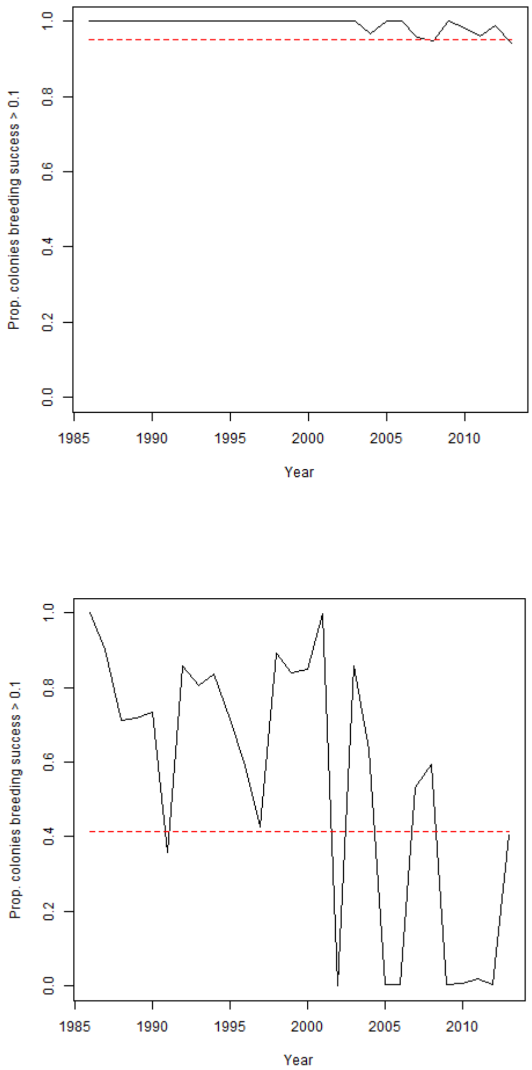
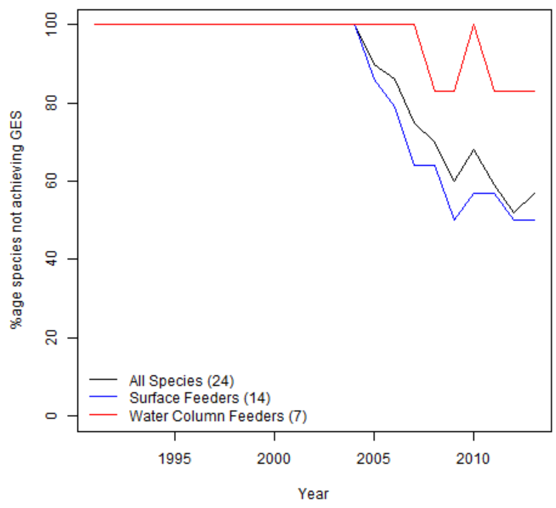
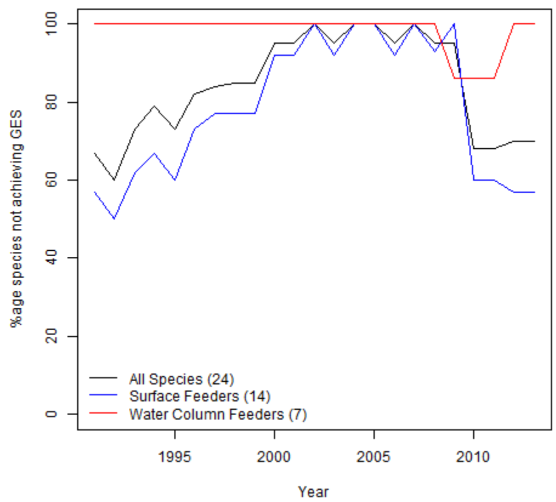


Figure 2. Examples of species-specific indicators of breeding failure in relation to different targets: trends in the probability of breeding failure of Common Tern (*Sterna hirundo*) and Common Guillemot (*Uria aalge*) in the Greater North Sea 1986–2013 As a result of species differing life-history strategies, it is necessary to account for this in setting targets. As an example we illustrate this with trends for common guillemot which only fail rarely (bottom), and are therefore assessed against the target of no more than 5% of colonies failing, and common tern which fail relatively frequently (top) and are therefore assessed against the target of the failure rate not exceeding the mean failure rate over the preceding 15 years.



Greater North Sea



Celtic Seas

Figure 3. Annual assessment of GES target 1991–2013: Changes in the proportion of marine birds achieving the target that breeding failure rates should not exceed 5% or the mean over the previous 25 years, whichever is greater, in more than three of the previous six years. Trends are shown for all species and also for surface feeders and water column feeders. Number of species included in each group shown in brackets in the figure legend.

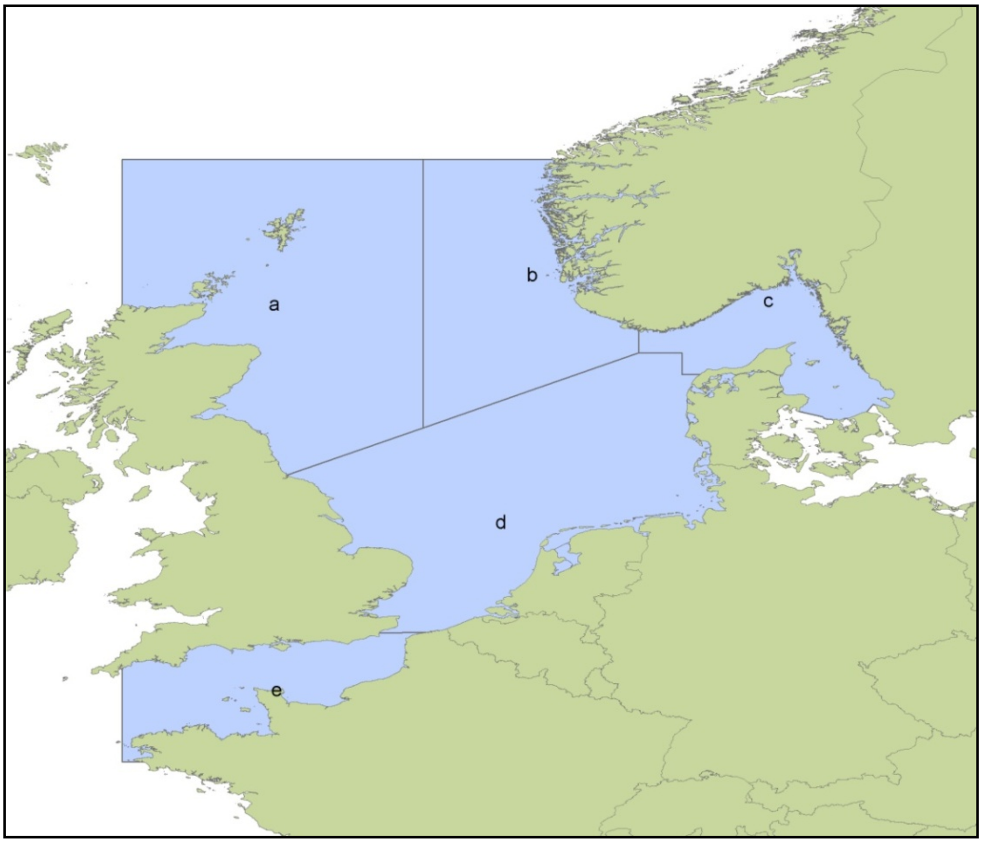


Figure 4. Proposed subdivisions of OSPAR Region II; the Greater North Sea for the assessment of indicators of relative abundance of breeding seabirds (source ICES 2013a, b).

Table 1. Utilisation of data in testing from each Contracting Party in each OSPAR region and subdivision of the Greater North Sea (OSPAR IIa–e), indicated by 'Y' or 'N'. 'A' indicates data have been collected and are potentially available, but were not used in the testing. '?' 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	A	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	A	N
UK	II-a		Y	N
Norway	II-b	Coast of western Norway	A	N
Denmark	II-c	Skagerrak/Kattegat coast	N	N
Norway	II-c	Norwegian Skagerrak coast	A	N
Sweden	II-c		?	?
Belgium	II-d		Y	N
Germany	II-d	Wadden Sea	A	
Germany	II-d	Helgoland	Y	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

Current Monitoring Programmes and future requirements

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 it was 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.

The operation of this indicator B3 and its inclusion in IA2017 depends on the monitoring listed in Table 2 continuing.

Data collection is currently carried out and funded by national monitoring schemes. Each national monitoring scheme has QA/QC protocols, but European standards should be developed. A minimum standard should be to follow internationally recognised monitoring methods (e.g. Walsh *et al.*, 1995; Koffijberg *et al.*, 2011). 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 in trends between locations. 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 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).

Elsewhere in the Northeast Atlantic, there appears to be 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 mobilise 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.

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).

Barriers and gaps to availability of bird abundance data in the Celtic Seas and Greater North Sea

Table 2. Potential barriers to using marine bird data to construct operational subregional indicators for B3.

OSPAR Region	Countries	Barriers in data availability	Barriers in data formats	Barriers in data accessibility	Barriers through lack of contribution of CPs	Knowledge gaps that could hinder full implementation of indicator across whole region	Gaps in resources to implement indicator
I	Norway[1]				X		X
I	Iceland[2]	X		X		X	
I	Russia[3]	X	?	X	NA	X	Most likely
I	Greenland[3] (Denmark CP)	X	?	X	X	X	Most likely
I	Faroes[3] (Denmark CP)	X	?	X	X	X	Most likely
II	Sweden[4]	?		X	X		
II	Denmark[5]	X		X	X		
III	Rep. of Ireland[6]			X	X		X
II & IV	France[7]		X	X			X
IV	Spain[8]	X		X			X
IV	Portugal[9]	?	?	?	X		Most likely
V	Azores[9] (Portugal)	?	?	?	X		?

Notes

[1]The Norwegian productivity data for OSPAR I and OSPAR II have yet not been submitted due to a lack of resources. There is however an ongoing dialog between the management authorities and the institutions that carry out the monitoring to bridge this problem in time for submission to be incorporated in the preparations for the IA 2017.

[2]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. There are known shortcomings in the monitoring of marine birds in Iceland that are likely to restrict the full implementation of B1 in OSPAR I to Norwegian areas.

[3]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.

[4]Sweden probably have available monitoring data on breeding success seabirds and waterbirds. These data were not accessible during the testing of B1 because of internal resource issues. These issues appear to have been resolved and hopefully, data from Sweden will contribute to the operational indicator B3 in IA2017.

[5]Productivity data have been collected in the Danish part of the Waddenzee since 2009 and are accessible via the TMAP Database. These will be included in IA2017. No productivity data are collected from the other parts of the Danish coast (Skagerrak and Kattegat).

[6]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.

[7]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. In Normandy there may be limited access to data because of a lack of authorization from the providers.

[8]Spain has limited information regarding breeding success at seabird colony monitoring. The 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).

[9]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.

Data storage and management processes and their availability at full roll out

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.

Each CP has its own data storage mechanism. Prior to the testing, OSPAR Secretariat designed an INSPIRE-compliant format for collating data from CPs; this was trialled during the data call for the current test. The Excel data submission forms were well received by most participants in the testing. Few changes to them are required prior to full roll out, other than the addition of a form to collate spatial information of each monitoring site. In future, each CP will submit updates each year.

During testing, JNCC (UK) provided temporary storage of the data. BTO constructed a database to accommodate the data, along with those for B1, marine bird abundance. This database has been uploaded onto the ICES DataCentre. The database currently has restricted access. CPs need to clarify terms of this data sharing with the help of the ICES and OSPAR secretariats, before the database can be publicly accessed online.

As part of their contract to the OSPAR Secretariat, the BTO will work with JNCC to construct a data tool that will enable non-statisticians and data specialists to quickly and easily analyse data in the marine bird database and construct and assess indicator B3 (and B1), annually. The results of these annual assessments will be reviewed by JWGBird who will report to ICES ACOM and to OSPAR BDC via ICG-COBAM.

Cost-effectiveness

Monitoring

Monitoring costs in most countries are minimised 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.

Analysis (e.g. databases, chemical analysis, etc)

All data for this indicator B3 from every subregion (and even from other Regions e.g. Baltic) could be held in the single database hosted by the ICES DataCentre. The database also holds data on marine bird abundance for indicator B1, which can be submitted by CPs simultaneously each year with data for B3.

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.

Reporting

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.

Next steps

1) Certain CPs to address barriers to data accessibility identified in Table 2.

2) Certain CPs to better coordinate existing monitoring activities to deliver more comprehensive data.

3) To confirm terms of data sharing between ICES DataCentre and CPs, regarding the marine bird database.

4) All CPs to submit data in the required format by a deadline to be decided (depending on IA2017 timetable).

5) All CPs to agree on target thresholds.

6) BTO and JNCC (UK) to complete build of data analysis tool, which will enable non-statisticians to construct indicators and assess them against the appropriate targets and to disseminate outputs.

7) Norway and other CPs in OSPAR Region I to work together to develop marine bird indicators for B3 in the Arctic subregion.

8) Spain, Portugal and France to work together to develop operational marine bird indicators for Bay of Biscay and Iberian coast subregion.

9) JWGBird 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, conduct simple population modelling to produce some preliminary estimates of the levels of breeding success required to sustain or grow the population; equivalent to GES.

Summary of results and recommendations to BDC 2015

It was possible to operate the indicator B3 - marine bird breeding success/failure, based on the data that were delivered for the Celtic Seas and Greater North Sea (OSPAR regions II and III). Despite there being limited data supplied for the testing, most of these gaps will be filled. We do not foresee any major problems in building a more comprehensive dataset from existing monitoring programmes.

Indicator B3 will be contribute to the IA2017 (for the Celtic Seas and Greater North Sea subregions at least).

Arrangements for data storage and data submission have been established. They have been demonstrated to be effective. These will be suitable for data from all subregions of the Northeast Atlantic and for data for indicator B1, marine bird abundance. Annual updates of indicator B3 should be possible and will be made quick, easy and inexpensive by completion of a data analysis tool by BTO and JNCC (UK).

Indicator B3 could be made operational in the Arctic subregion (OSPAR I) but availability of data may restrict the extent of its operation within the subregion (most likely to Norwegian waters). The indicator may also be made operational in the Bay of Biscay and Iberian coast (OSPAR IV) and in Macaronesia (the Azores - OSPAR V), but depends on the engagement with Portugal in the process and on being granted access to their monitoring data, if it exists and is suitable.

In future, R&D should be undertaken to develop, for some species, quantitative targets for breeding success levels that would be required to maintain or grow a population. These targets need to vary according to changes in other demographic characteristics of the population, such as survival rates.

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Appendix 1 – B3 Marine bird breeding success/failure

Technical specifications: Criteria for assessing the results of the testing process (taken from Assessment of COBAM's Biodiversity Indicators by ICES WGBiodiv).

Category	Characteristic	Criterion	Importance Weighting	Response	Guidelines for Response
Type of Indicator	State or pressure	Is indicator a "pressure" indicator being used for want of an appropriate "state" indicator?		State	
Quality of underlying data	Existing and ongoing data	Is the indicator supported by current or planned monitoring programmes that provide the data necessary to derive the indicator. Ideal monitoring programmes should have a time-series capable of supporting baselines and reference point setting. Data should be collected on multiple sequential occasions using consistent protocols, which account for spatial and temporal heterogeneity.	Essential	Yes	Yes: long-term and ongoing data from which historic reference levels can be derived and past and future trends determined; Partly: no baseline information, but ongoing monitoring, only locally supported by data (but not at regional scale); No: data sources are fragmented, no planned monitoring programme in future.
Quality of underlying data	Metrics should be tangible	Are the metrics easily and accurately determined using technically feasible and quality assured methods.	Essential	Yes	Yes: data and methods are technically feasible and quality assured in all aspects; Partly: potential issues with quality assurance, or methods not widely adopted; No: metric is not tangible or doubtful.

Category	Characteristic	Criterion	Importance Weighting	Response	Guidelines for Response
Quality of underlying data	Assessment of targets	Can the indicator accurately detect whether a target has been met or not	Essential	Yes	Yes: indicator values can be calculated with sufficiently high precision (e.g. narrow confidence intervals) to be able to detect with a high-level of confidence, that a target had been met or not; Partly: precision of indicator calculation is low, but sufficient to assess the direction of travel in relation to meeting or missing the target; No: precision of indicator calculation is so low that there are likely to be false positives or negatives in assessments against targets
Quality of underlying data	Relevant spatial coverage	Are the data derived from a large proportion of the MSFD subregion to which the metric will apply.	Essential	Partly	Yes: spatially extensive monitoring is undertaken across the subregion; Partly: monitoring does not cover the full subregion, but is considered adequate to assess status at subregional scale; No: monitoring is undertaken across a limited fraction of the subregion and considered inadequate to assess status at subregional scale.
Quality of underlying data	Reflects changes in ecosystem component that are caused by variation in any specified manageable pressures	Does the indicator reflect change in the state of an ecological component that is caused by a specific significant manageable pressure (e.g. fishing mortality, habitat destruction). If so, the indicator should respond sensitively to particular changes in a pressure. The response should be unambiguous and in a predictable direction, based on theoretical or empirical knowledge, thus reflecting the effect of change in pressure on the ecosystem component in question.	Essential	Partly	Yes: metric is responsive to a specific pressure and the pressure-state relationship is defined; Partly: metric responds to several pressures and the pressure-state relationship is defined for at least one of these; No: no clear pressure-state relationship is evident.

CATEGORY	CHARACTERISTIC	CRITERION	IMPORTANCE WEIGHTING	RESPONSE	GUIDELINES FOR RESPONSE
Quality of underlying data	Quantitative vs. qualitative	Quantitative measurements are preferred over qualitative, categorical measurements, which in turn are preferred over expert opinions and professional judgments.	Desirable	Fully met	Fully met: all data for the metric are quantitative; Partially met: data for metric are semi-quantitative or largely qualitative; Not met: metric is largely based on expert judgement.
Management	Cost-effectiveness	Does sampling, measuring, processing, analysing indicator data, and reporting assessment outcomes, make effective use of limited financial resources.	Essential	Partly	Yes: This is an existing indicator. No new sampling, new monitoring programs or new reporting are necessary. Partly: new sampling on already existing programmes, new (data) analysis and new reporting is required; No: additional costs. Explain which costs.
Management	Relevant to management measures	Is the Indicator linked directly to a management response. If so, the relationship between activity and resulting ecological pressure on the ecological component should be clearly understood.	Desirable	Partly	Yes: Both pressure-state and activity-pressure relationships are well defined - one can advise on the direction AND extent of any change in human activity required; Partly: only the pressure-state relationship is well defined - one can only advise of the direction of change in human activity required; No: no relationship between pressure, state and activity.
Management	Comprehensible	Is the indicators easily understood by policy-makers and other non-scientists (e.g. stakeholders) alike. The consequences of variation in the indicator should be easy to communicate.	Desirable	Partly	Yes: the metric is easy to understand and communicate; Partly: a more complex and difficult to understand metric, but one for which the meaning of change in the metric value is easy to communicate; No: the metric is neither easy to understand or communicable.
Management	Early warning	Does the indicator signal potential future change in an ecosystem attribute before actual harm is indicated by other MSFD indicators. These could facilitate preventive management, which could be less costly than restorative management.	Informative	Yes	Yes: indicator provides early warning because of its high sensitivity to a pressure with short response time; No: relatively insensitive indicator that is slow to respond.

Category	Characteristic	Criterion	Importance Weighting	Response	Guidelines for Response
Conceptual	Metrics relevance to MSFD indicator	For D1 and D6, metrics should fit the indicator function stated in the 2010 MSFD Decision document. This requirement can be relaxed for D4 indicators because the Decision document stipulates the need for indicator development in respect of this Descriptor (but any newly proposed D4 indicators must still fulfil the overall goals stated for D4).	Essential	Fully met	Fully met (1): metric complies with indicator function; Not met (0): metric does not comply with indicator function.

Annex 3: Technical specification: OSPAR Common Indicator B-1 Marine Bird Abundance

1. Indicator

Name: Marine bird abundance

Code: B-1

OSPAR Threatened and Declining Species included in indicator:

Roseate tern (*Sterna dougalii*), Arctic skua (*Stercorarius parasiticus*), Lesser black-backed gull (*Larus fuscus fuscus*), Balearic shearwater (*Puffinus mauretanicus*), black-legged kittiwake (*Rissa tridactyla*).

State of methodological development

Development step	Defined
Indicator metrics	Yes
Ecosystem components attributed (species/habitat types)	Yes
Applicability to subregions	Yes
Assessment scales	Yes
Monitoring parameter	Yes
Monitoring frequency	Yes

2. Appropriateness of the indicator

Biodiversity component: Marine Birds

MSFD criterion: 1.2 Population Size

MSFD indicator: 1.2.1 Population abundance

Sensitivity to specific pressures	Relevance to management measures	Practicable	Applicable across region	Consensus among CPs
Low Non-specific – indicator of state that responds to multiple pressures	Low	Target & indicator adopted as an EcoQO on seabird population trends can be applied to other species. At sea monitoring data might be needed.	Yes	High

This indicator is constructed from information on marine bird species, which at some point in their annual life cycle, are reliant on coastal and offshore areas under the jurisdiction of MSFD. These areas compose non-estuarine shores below HAT, including coastal lagoons and saltmarsh; inshore non-transitional waters and offshore waters.

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.

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:

- 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.

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).

In the context of MSFD, abundance indicators could be constructed from time-series data of other groups of marine birds and from data collected at sea.

3. Parameter/metric

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

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

The species assessed during the testing and the functional groups to which they were assigned, are given in the table in Appendix 1. 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.

4. 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 standardise expert judgement when selecting baselines.

1) Use historical population estimates that were recorded:

1.1) before known human impacts; and /or

   1.2) before other major declines in population; or
   1.3) at known plateaus in population trends, following increases and peaks in population size.
2) 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).
3) Use start level of time-series when no historical data or reference level are available.
4) Use recent population estimate (e.g. previous five year mean) when a species is colonising.

In the current testing for indicator B1 the start level of the time-series was used.

5. Target setting

The criterion level target for Population Size (1.2) should be identical to 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).

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.

6. Spatial scope

Prior to the current report, indicator B1 had previously 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 (ICES 2008, 2010, 2011, 2012 and 2013a–d). Further work is required to collate breeding seabird data in the Bay of Biscay and to construct the indicator for there and also for Macaronesia.

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.

Proposed subdivisions of OSPAR II; the Greater North Sea

ICES (2013c, d) suggest that subdividing OSPAR regions into smaller, more ecosystem-uniform areas will make it easier to interpret EcoQO results such as those now produced for population trends of breeding seabirds in OSPAR II and III. 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 five subdivisions (Figure 1):

a) **Northeast coast of UK**: OSPAR II/III North Boundary to Teesmouth;
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).

Not all the colonies in any of the subdivisions shown in Figure 1 are monitored. The proportion of a subdivisional population that is monitored varies between species and between subdivisions. In a given year, the trend models (see e.g. ICES 2013c) 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. There is a resultant bias, in that those subdivisions where few colonies are monitored are underrepresented in the resultant trends that those subdivisions where a larger proportion of colonies are monitored.

In future trend analyses, the annual estimates of breeding abundance in each subdivision should be weighted according to the size of the population in that subdivision.

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.

7. Monitoring requirements

SCOPE OF MONITORING	
What is the objective of the assessing the indicator; only status of the environment, or also to support identification of pressures and programmes of measures?	status of the environment and to support identification of pressures and programmes of measures
What is the type of assessment; trend or state?	Trends in state
INDICATORS AND PARAMETERS	
Which parameter needs to be measured?	Counts of breeding pairs or birds; and of birds on land and at sea during migration and over winter.
For which indicator(s) is it relevant?	B1
Spatial and temporal coverage (in relation to ecosystem components)	Throughout NE Atlantic Region; annually
What is the appropriate spatial scale of monitoring considering the natural spatial variability of the ecosystem component?	Monitoring to be conducted on site by site basis but needs to be representative of each subregion and subdivision therein.
What is the appropriate time-scale of monitoring considering the natural temporal variability of the ecosystem component and the expected response time of the indicator?	Annually
Is it suitable to apply a risk-based approach to monitoring? i.e. are there subregions within OSPAR area where the associated pressure is so low that monitoring may be unwarranted?	No. 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.
What is more relevant to the indicator in question; good spatial coverage (possibly at the expense of temporal frequency) or high temporal frequency (possibly limited to a few representative areas)?	Both but frequency could be reduced to improve spatial coverage.
SAMPLING AND ANALYSIS	
Which sampling protocol can be used (if many, specify "best" option)	For colonies and other breeding sites: Walsh *et al*. (1995); Koffijberg *et al*. (2006) - for Wadden Sea. For at-sea aerial and boat-based line transect surveys (Camphuysen *et al*., 2004)
How will the data be analysed (equipment, expertise needed, etc.)	Using existing statistical models developed in R by the UK and incorporated into their 'Seabird Trend Wizard' tool.
Which QA/QC will be used (or does it have to be developed?)	Each national monitoring scheme has QA/QC protocols, but European strandards should be developed.
What are the potential costs for data collection and analysis?	Analysis once set up (approx €20 k start up costs) is inexpensive. Data collection currently carried out and funded by national monitoring schemes.
How much time needs to be allocated to data collection and analysis?	Depends on number of survey sites and types of marine bird being surveyed (e.g. breeding seabird colonies or wintering seaduck at sea.) Each national monitoring programme currently manage time allocations.

Minimal required amount of monitoring locations.	Depends on species and the inherent variability in trends between locations, and the magnitude of change that needs to be detected with statistical confidence.
Does the required monitoring already exist?	Most countries in the region conduct annual monitoring of abundance of marine birds at breeding sites and of shorebirds in intertidal areas. Monitoring in some countries may need to be expanded to construct a robust indicator. Monitoring of marine bird abundance at sea is currently confined to certain parts of the Greater North Sea. The UK is currently scoping a monitoring scheme for inshore and offshore waters
REGIONAL ASPECTS	
How can pooling of monitoring infrastructures and resources be arranged to optimize efficiency and costs of monitoring at a regional scale?	CPs could share at-sea monitoring platforms i.e. boats and planes.
What is the proposed data flow and data management to support regional assessments?	Annual submission of national data to a central data custodian who is also responsible for analysis of data and dissemination of results. The process needs to be established for each subregion.
What is the proposed working mode for conducting regular assessments at a regional scale? (i.e. "who" or "what" should conduct the assessments?)	A CP in each subregion needs to be nominated to act as data custodian and analyst.
What is the proposed route within OSPAR for adaptive changes in assessment and monitoring of biodiversity related indicators?	Annual review of results by ICES/OSPAR WGBIRD who will report to ICES ACOM and OSPAR ICG-COBAM.

8. Reporting

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 categorised 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.

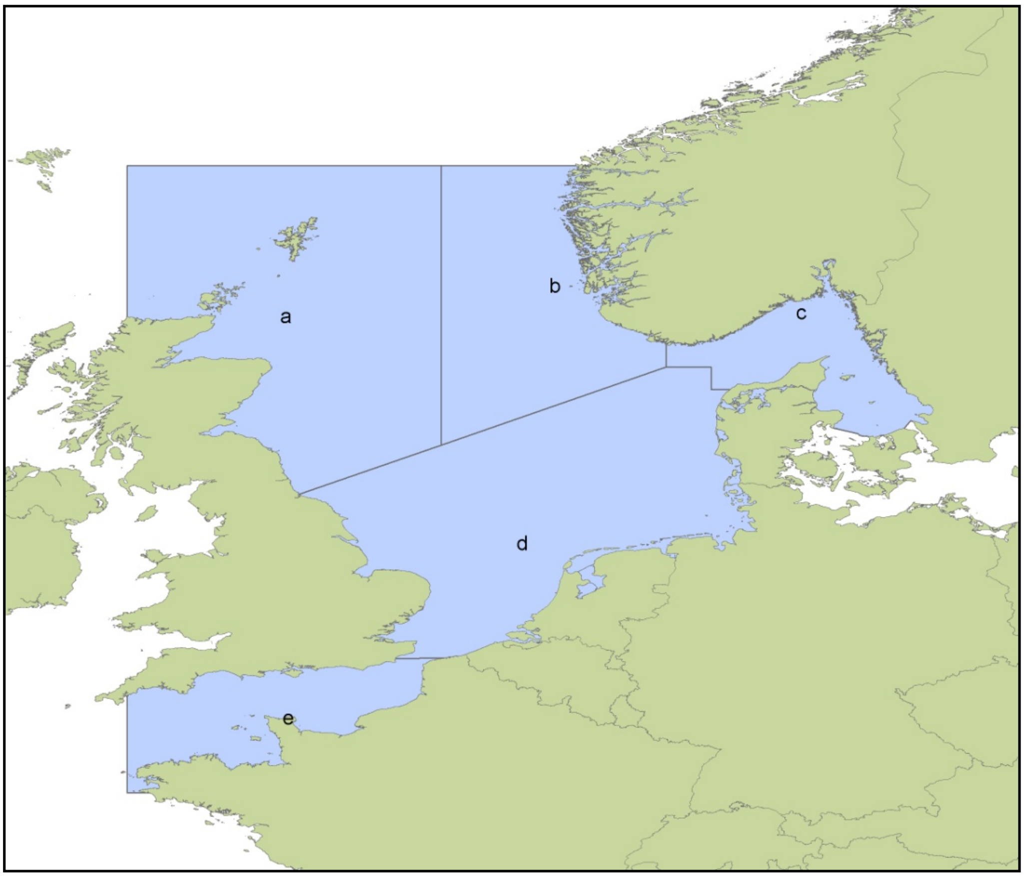


Figure 1. Proposed subdivisions of OSPAR Region II; the Greater North Sea for the assessment of indicators of relative abundance of breeding seabirds (source ICES 2013c,d).

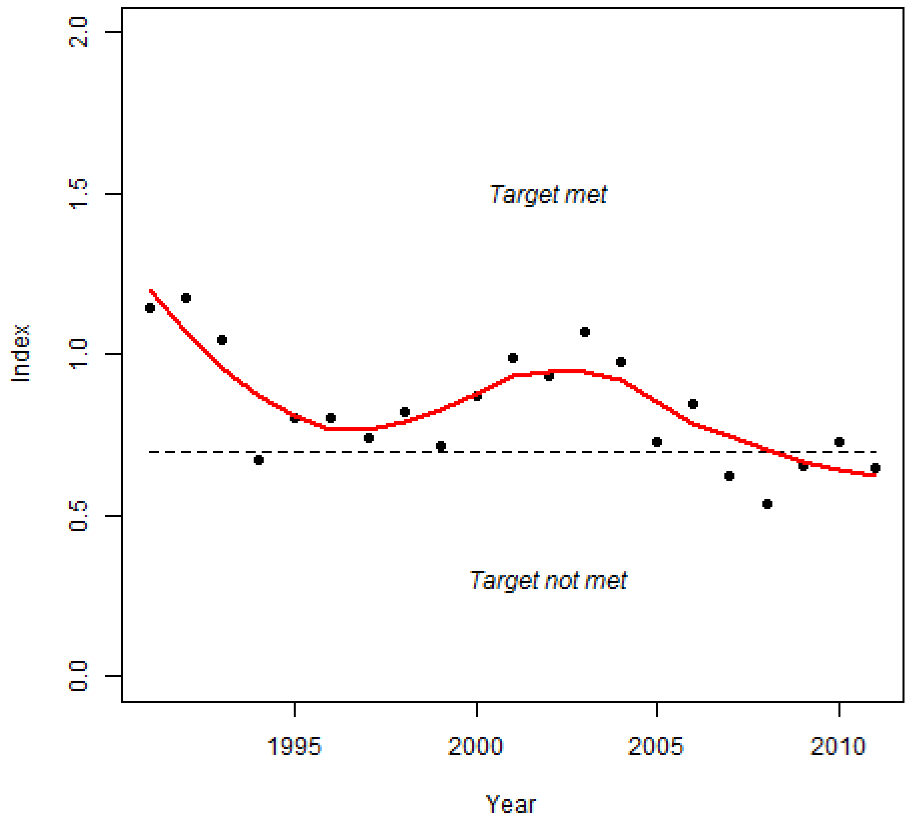


Figure 2. Example of a species indicator: Smoothed and unsmoothed trends in relative abundance of European shag (*Phalacrocorax aristotelis*) in the Greater North Sea 1991–2011.

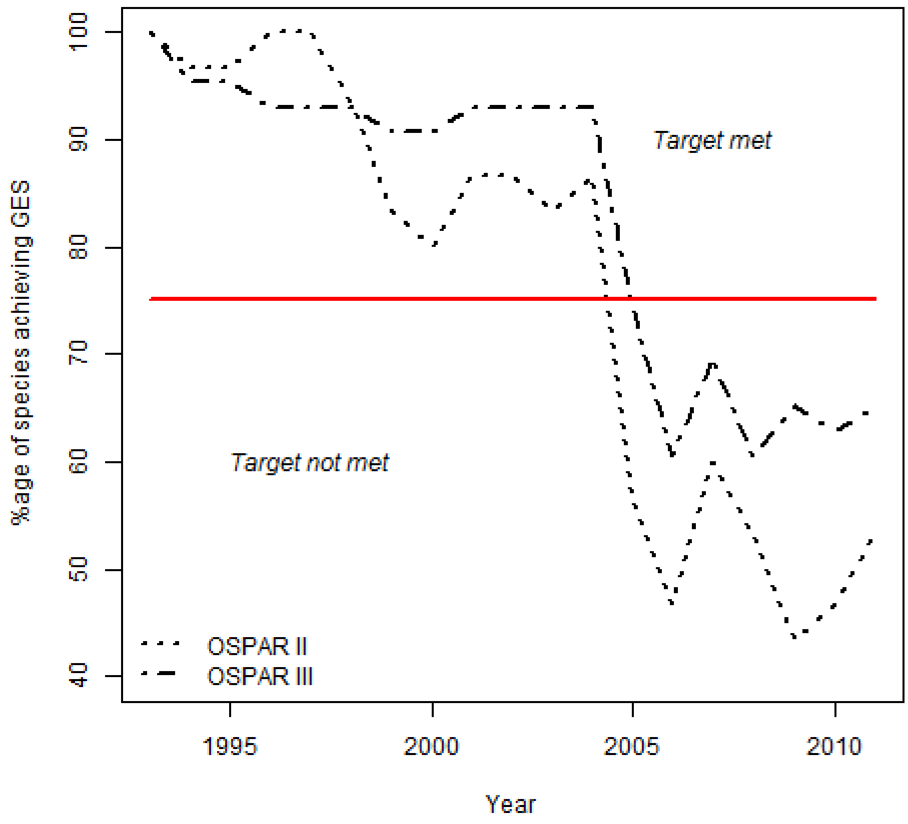
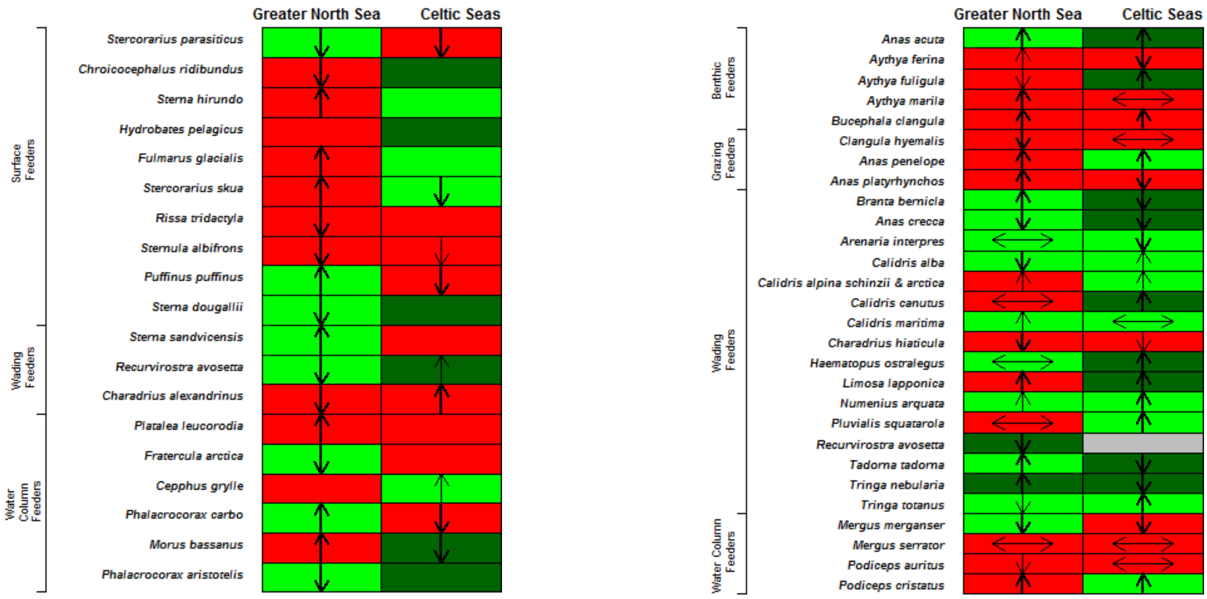


Figure 3. Annual assessment of GES target 1993–2011: ***'Changes in abundance of marine birds should be within individual target levels in 75% of species monitored';*** **based on 48 species in the Celtic Seas (target = 36 species) and on 37 species in North Sea (target= 27 species).**

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 the Celtic Seas and the Greater North Sea in 2011. Species grouped by functional group

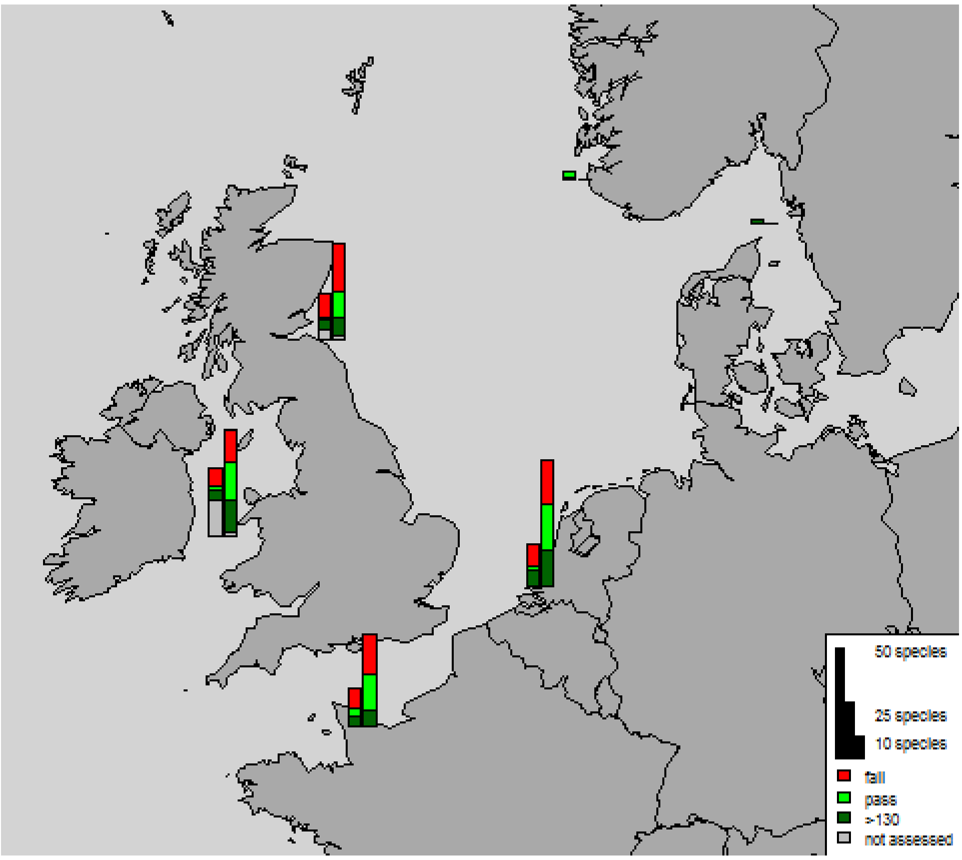


Figure 5. Spatial patterns in indicator status in 2011: Indicator status varied spatially in 2011. In each subdivision of the Greater North Sea subregion, and in the Celtic Seas a greater proportion of wintering marine birds (right hand bar) were at GES than breeding marine birds (left hand bar). Size 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.

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Appendix 1: 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.

Species (English Name)	Species (Scientific Name)	Grazing feeders	Wading feeders	Surface feeders	Water column feeders	Benthic feeders	Used in testing
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					
Pochard	*Aythya ferina*					x	x

Species (English Name)	Species (Scientific Name)	Grazing feeders	Wading feeders	Surface feeders	Water column feeders	Benthic feeders	Used in testing
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
Long-tailed Skua	*Stercorarius longicaudus*			x			

Species (English Name)	Species (Scientific Name)	Grazing feeders	Wading feeders	Surface feeders	Water column feeders	Benthic feeders	Used in testing
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	*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			
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 4: Technical specification: OSPAR Common Indicator B-3 Marine bird breeding success/failure

1. Indicator

Name: Marine bird breeding success/failure

Code: B-3

OSPAR Threatened and Declining Species included in indicator:

Roseate tern (*Sterna dougalii*), Arctic skua (*Stercorarius parasiticus*), Lesser black-backed gull (*Larus fuscus fuscus*), black-legged kittiwake (*Rissa tridactyla*).

State of methodological development

Development step	Defined
Indicator metrics	Yes
Ecosystem components attributed (species/habitat types)	Partially
Applicability to subregions	Yes
Assessment scales	Yes
Monitoring parameter	Yes
Monitoring frequency	Yes

2. Appropriateness of the indicator

Biodiversity component: Marine Birds

MSFD criterion: 1.3 Population Condition

MSFD indicator: Population demographic characteristics (1.3.1)

Sensitivity to specific pressures	Relevance to management measures	Practicable	Applicable across region	Consensus among Contracting Parties
High - Sensitive to changes in prey availability, human disturbance, contaminants and predation.	High Depends on cause of changes to prey availability (if fishing - high; if climate-low). High for human disturbance, contaminants* and predation (*in combination with TMAP-monitoring of contaminants in bird eggs)	Data on breeding success for some species widely available; for other species only available for parts of subregions (e.g. Wadden Sea).	Yes	High

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.*, 2012, 2014). The applicability of the indicator and its targets (as proposed by Cook *et al.*, 2012) to other parts of both subregions have been assessed by OSPARs Expert Group on Marine

Birds (ICES, 2013a). 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, 2013a). In some areas, where only a few colonies are monitored (e.g. in Norwegian North Sea), the group proposed alternative methods for target setting (below).

A recent analysis of the breeding failure indicator for nine species in UK North Sea waters (Cook *et al*., 2014) provides evidence of link to fishing pressure. Cook *et al*. (2014) found a significant effect on failure rate of a fishing pressure factor denoted by the interaction between the annual North Sea stock size of lesser sandeels and the proportion of the stock that was harvested. Species that showed the greatest changes in breeding failure rates were most strongly affected by fishing pressure.

The results of Cook *et al*. (2014) 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. In other parts of the North Sea, fishermen and seabirds target quite different prey and such a direct link may less evident. The use of subdivisions for assessments of GES in the North Sea (see below) would enable such differences to be accounted for. At the very least, the failure rate indicator would produce an early warning of likely failure to achieve GES with respect to the indicator B1; trends in relative abundance, or meet the EcoQO on seabird population trends.

The indicator could also provide other pressures, including human disturbance, contaminants and predation by invasive species (especially on islands).

There are strong links to management, especially with regard to food availability, human disturbance and predation.

Spatially the indicator is widely applicable for some species e.g. Common and Arctic Terns. Other species will be restricted to subregions and divisions thereof.

3. Parameter/metric

'**Annual colony failure rate'** i.e. the percentage of colonies failing per year, per species (from Cook *et al*., 2012).

The definition of 'failure' proposed by Cook *et al*. (2012) was 0.1 chicks per pair. 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.

The indicator is to be derived from data on 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: 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.

Species composition and functional groups

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).

The indicator should include all species monitored, but should group species according to the functional groups listed in the table below.

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

The species assessed during the testing and the functional groups to which they were assigned are given in the table in Appendix 1. 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.

Some species can be assigned to more than one group because they exploit different vertical zones of the marine environment depending on circumstances. For example, some gulls may switch from wading to surface feeding; some ducks may switch from wading to feeding on the seabed; and some shearwaters may take food on the surface but can dive below the surface to catch prey up to 30 m down in the water column.

4. Baseline and Reference level

Complex baseline data for species, colonies and divisions of subregions are available.

5. Setting of GES boundaries / targets

The target proposed for the indicator is:

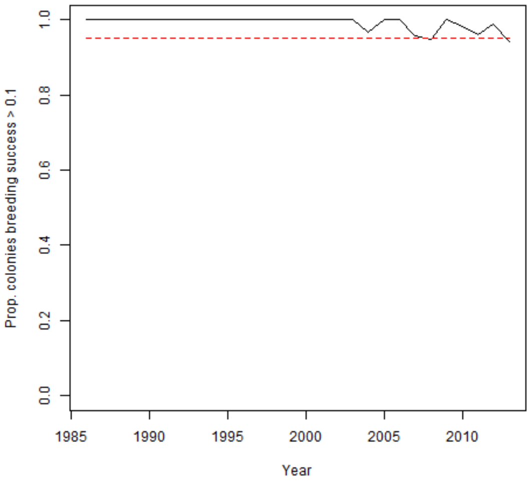
Widespread seabird colony breeding failures should occur rarely in other species that are sensitive to changes in food availability.

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%, whichever value is greater, in more than three years out of six.

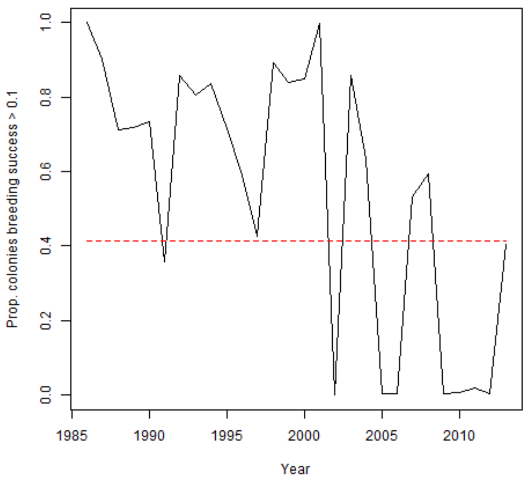
The aim of the target is to ensure that only a small proportion of colonies fail per year, probably due to local problems, rather than any large-scale anthropogenic impact. The aim of the target of three years out of six is to ensure that the cumulative effect of successive failures does not have a significant impact on recruitment into the regional population. Cook *et al*. (2012) tested various target thresholds on each species indicator of annual colony failure rate. They found that some species e.g. terns, experience breeding failure on a regular basis, others e.g. auks, rarely fail to breed. The threshold of the 15-year mean breeding failure rate was appropriate to species that regularly failed to breed, while a fixed threshold of 5% was appropriate to highlighting failures in species that rarely fail (see Figure 1).

Defining failure rate in terms of the proportion of colonies being monitored will not be practical in some areas, where only a small number of the extant colonies are monitored (e.g. west coast of Norway in the Greater North Sea). Regional or subregional failure rate would thus be biased towards areas where a larger number of colonies are monitored (e.g. UK east coast).

In areas where there are few colonies monitored, an approximate alternative assessment of breeding success could be made, as suggested by the Circumpolar Seabird Group (CSG, 2010). They suggested standardising estimates of annual breeding success (expressed as the number of chicks fledged per pair or per nest) by dividing by mean annual clutch size to produce a 'Productivity Index or PI' with a value of 0.0–1.0. They proposed the following assessment of performance: 'Poor': PI<0.1; 'Moderate': PI = 0.1–0.5; 'Good': PI >0.5. In these areas, an alternative target per species, to the one given above (from Cook *et al*., 2012) could be: *"breeding success is moderate or good in more than 50% of colonies monitored, in more than three years out of six"*.



Common Guillemot (*Uria aalge*)



Common Tern (*Sterna hirundo*)

Figure 1. Examples of species-specific indicators of breeding failure in relation to different targets: trends in the probability of breeding failure of Common Tern (*Sterna hirundo*) and Common Guillemot (*Uria aalge*) in the Greater North Sea 1986–2013 As a result of species differing life-history strategies, it is necessary to account for this in setting targets. As an example we illustrate this with trends for common guillemot which only fail rarely (bottom), and are therefore assessed against the target of no more than 5% of colonies failing, and common tern which fail relatively frequently (top) and are therefore assessed against the target of the failure rate not exceeding the mean failure rate over the preceding 15 years.

6. Spatial scope

Breeding success of seabirds is monitored at colonies of a number of species throughout the NE Atlantic (see ICES 2007). Further work is needed to determine if the development of this indicator at the subregional scale will be restricted by lack of monitoring or data availability.

Hatching and fledging success is monitored for a selection of species breeding on soft coasts and islands e.g. in the Wadden Sea region. Monitoring is carried out on survey plots in colonies and for non-colony breeding shorebirds. Further work is needed to develop this indicator at the subregional scale.

Proposed subdivisions of OSPAR II; the Greater North Sea

ICES (2013a, b) suggest that sub-dividing OSPAR regions or MSFD subregions into smaller, more ecosystem-uniform areas will make it easier to interpret assessments of this indicator. 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 five subdivisions (Figure 2):

a) **Northeast coast of UK**: OSPAR II/III North Boundary to Teesmouth;

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).

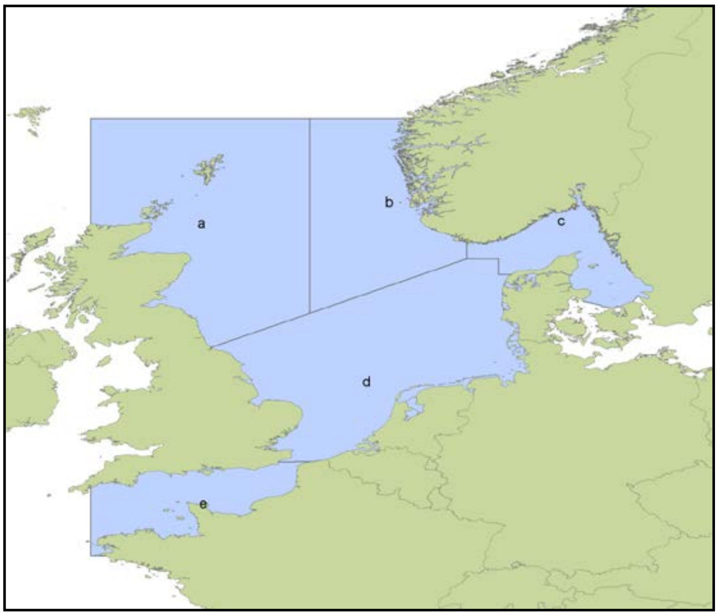


Figure 2. Proposed subdivisions of OSPAR Region II; the Greater North Sea for the assessment of indicators of relative abundance of breeding seabirds (source ICES 2013a,b).

7. Monitoring requirements

Scope of monitoring	
What is the objective of the assessing the indicator; only status of the environment, or also to support identification of pressures and programmes of measures?	status of the environment and to support identification of pressures and programmes of measures
What is the type of assessment; trend or state?	Trends in state
Indicators and parameters	
Which parameter needs to be measured?	'Annual colony failure rate' i.e. the percentage of colonies failing per year, per species
For which indicator(s) is it relevant?	B1
Spatial and temporal coverage (in relation to ecosystem components)	Throughout NE Atlantic Region; annually
What is the appropriate spatial scale of monitoring considering the natural spatial variability of the ecosystem component?	Monitoring to be conducted on site by site basis but needs to be representative of each subregion and subdivision therein.
What is the appropriate time-scale of monitoring considering the natural temporal variability of the ecosystem component and the expected response time of the indicator?	Annually
Is it suitable to apply a risk-based approach to monitoring? i.e. are there subregions within OSPAR area where the associated pressure is so low that monitoring may be unwarranted?	No. 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.
What is more relevant to the indicator in question; good spatial coverage (possibly at the expense of temporal frequency) or high temporal frequency (possibly limited to a few representative areas)?	Both.
Sampling and analysis	
Which sampling protocol can be used (if many, specify "best" option)	Walsh *et al*. (1995); Koffijberg *et al*. (2011) - for Wadden Sea.
How will the data be analysed (equipment, expertise needed, etc.)	Using existing statistical models developed in R by the UK.
Which QA/QC will be used (or does it have to be developed?)	Each national monitoring scheme has QA/QC protocols, but European standards should be developed.
What are the potential costs for data collection and analysis?	Analysis once set up (approx €20k start up costs) is inexpensive. Data collection currently carried out and funded by national monitoring schemes.
How much time needs to be allocated to data collection and analysis?	Depends on number of monitoring sites. Each national monitoring programme currently manage time allocations.
Minimal required amount of monitoring locations.	Depends on species and the inherent variability in trends between locations.

Does the required monitoring already exist?	Most countries in the region conduct annual monitoring of breeding success of marine birds.
REGIONAL ASPECTS	
How can pooling of monitoring infrastructures and resources be arranged to optimize efficiency and costs of monitoring at a regional scale?	International monitoring of breeding success is already conducted in the Wadden sea as part of TMAP. There is little scope to pool resources elsewhere.
What is the proposed data flow and data management to support regional assessments?	Annual submission of national data to a central data custodian who is also responsible for analysis of data and dissemination of results. The process needs to be established for each subregion.
What is the proposed working mode for conducting regular assessments at a regional scale? (i.e. "who" or "what" should conduct the assessments?)	A CP in each subregion needs to be nominated to act as data custodian and analyst.
What is the proposed route within OSPAR for adaptive changes in assessment and monitoring of biodiversity related indicators?	Annual review of results by ICES/OSPAR WGBIRD who will report to ICES ACOM and OSPAR ICG-COBAM.

8. Reporting

Data needs to be collated centrally from CPs (at least at a subregional scale) and then analysed to produce indices, which can then be assessed against targets. The indicator can be assessed on an annual basis.

The following two methods of presentation are recommended:

a) Traffic lights (see Figure 3)

Cook *et al*. (2012) 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 The colours are defined as follows:

"red alert" when target is exceeded in ≥4 of the preceding six years;

"amber alert" when target is exceeded in three of the preceding six years;

"green alert" when target is exceeded in <3 of the preceding six years.

b) Maps (see Figure 4)

Maps for each species showing pie charts for each colony monitored. The pie charts show the proportion of years in the time-series, in which the colony has failed or in which breeding success has been assessed as 'poor'. Each pie chart should be coloured red, amber or green according to the definitions given above.

c) Multispecies assessments (see Figure 5)

Curves representing the interannual changes in the proportion of species achieving the target that breeding failure rates should not exceed 5% or the mean over the previous 25 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.

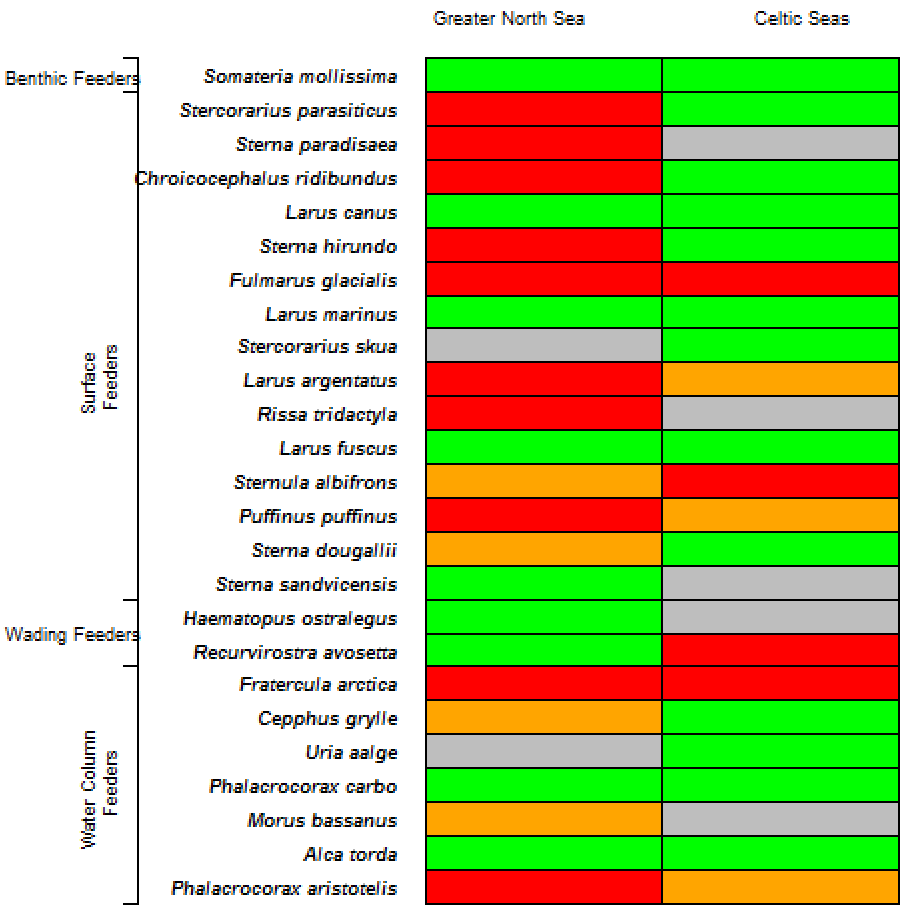


Figure 3. Species-specific assessment of breeding failure in the Celtic Seas and the Greater North Sea in 2013. Species ordered by functional group. Colour of cells indicates the number of years during the six year assessment period (2008–2013) that species-specific breeding failure rate has been outside the target previous: green = two years or less; orange cells = three years; red= four years or more.

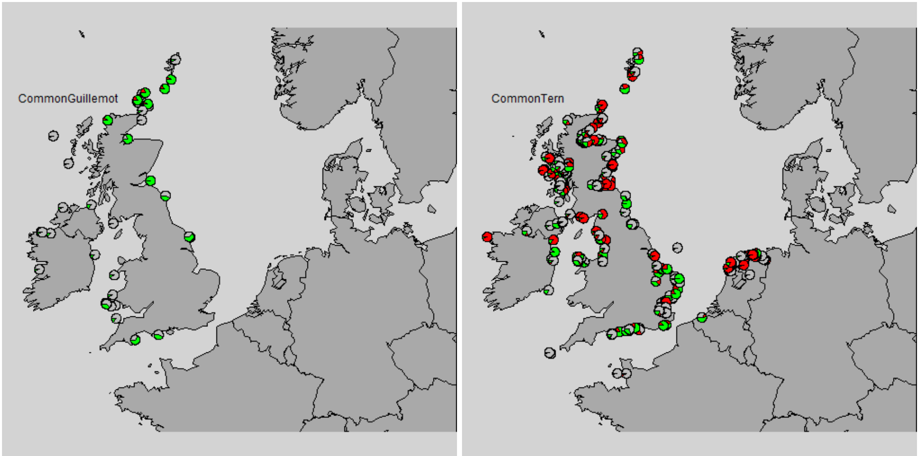


Figure 4. Spatial patterns in breeding failure between 1986 and 2013: Patterns of breeding failure between 1986 and 2013 varied spatially. Each pie chart represents a single breeding colony for common guillemot (right) and common tern (left). Green segments indicate the proportion of years between 1986 and 2013 that breeding success was >0.1 chicks/nest, red indicates the proportion of years that breeding success was <0.1 chicks/nest and grey indicates the proportion of years during which breeding success was not assessed.

Celtic Seas

Greater North Sea

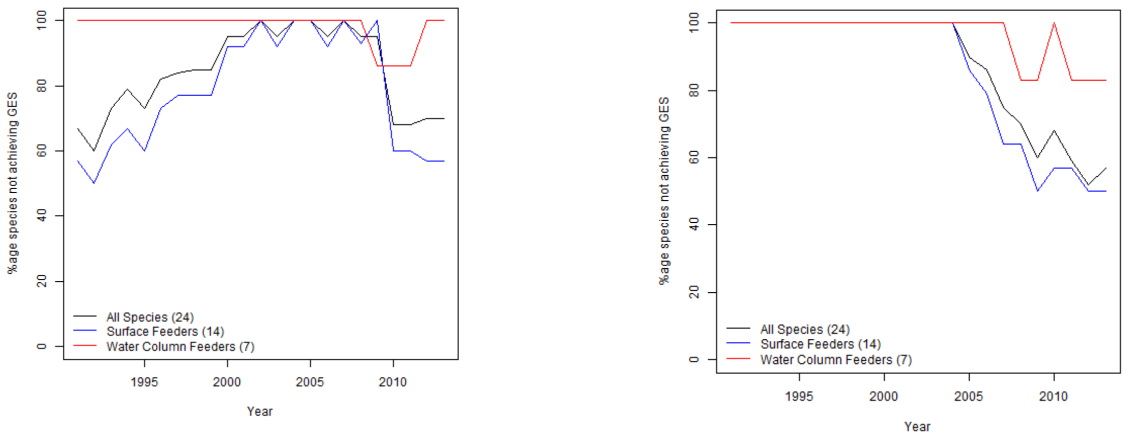


Figure 5. Annual assessment of GES target 1991–2013: Changes in the proportion of marine birds achieving the target that breeding failure rates should not exceed 5% or the mean over the previous 25 years, whichever is greater, in more than three of the previous six years. Trends are shown for all species and also for surface feeders and water column feeders. Number of species included in each group shown in brackets in the figure legend.

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Appendix 1: 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 testing 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	
Tufted Duck	*Aythya fuligula*					x	

Species (English Name)	Species (Scientific Name)	Grazing feeders	Wading feeders	Surface feeders	Water column feeders	Benthic feeders	Used in testing B3
Greater Scaup	*Aythya marila*					x	
Common Eider	*Somateria mollissima*					x	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				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				
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				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				
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 TESTING B3
Great Skua	*Stercorarius skua*			x			x
Glaucous gull	*Larus hyperboreus*						
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*						
Black Guillemot	*Cepphus grylle*				x		X
Little Auk	*Alle alle*				x		
Puffin	*Fratercula arctica*				x		x

Annex 5: Technical specification: OSPAR Candidate Indicator B4- Non-native/invasive mammal presence on island seabird colonies

1. Indicator

Name: Non-native/invasive mammal presence on island seabird colonies

Code: B-4

State of methodological development:

DEVELOPMENT STEP	DEFINED
Indicator metrics	Yes
Ecosystem components attributed (species/habitat types)	Yes
Applicability to subregions	Yes
Assessment scales	Yes
Monitoring parameter	Yes
Monitoring frequency	Yes

2. Appropriateness of the indicator

Biodiversity component: Marine Birds

MSFD criterion: 1.3 Population Condition

MSFD indicator: Population demographic characteristics (1.3.1)

SENSITIVITY TO SPECIFIC PRESSURES	RELEVANCE TO MANAGEMENT MEASURES	PRACTICABLE	APPLICABLE ACROSS REGION	CONSENSUS AMONG CPS
High - Terrestrial pressure with impact on seabirds	High Effective management measures well established	Easy to measure presence/absence of mammals	Yes	Medium

This indicator 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 that will reduce the pressure on seabird populations from depredation by non-native or invasive mammals. This pressure is not addressed by indicators or targets under Descriptor 2 on Non-indigenous species.

Seabirds that nest on the ground are vulnerable to their eggs and their young, and themselves being killed by terrestrial mammals. Most inshore and offshore islands would be naturally free of mammals, but with human intervention (both intentional and unintentional), many such islands have been invaded by both native species (e.g. fox *Vulpes vulpes*) and non-native species (e.g. brown rat *Rattus norwegicus*, American mink *Neovison vison*, domestic cat *Felis catus*). There is comprehensive evidence from around the world that the introduction of both native and non-native mammals on to previously mammal-free islands has a substantial negative impact on ground-nesting seabirds, by reducing breeding success, by reducing breeding numbers and in some cases, causing colony extinction. Some of the largest colonies of seabirds in the NE Atlantic are on mammal-free islands. The populations of species that are most vulnerable to mammal predation: shearwaters and petrels (Procellariiformes), gulls (Laridae), terns (Sternidae) and Atlantic puffin (*Fratercula arctica*), black guillemot (*Cepphus gryle)* and ground-nesting shorebirds and waterfowl tend to be aggregated on a relatively small number of mammal-free islands. This clumping makes their populations vulnerable to other small-scale impacts (e.g. from oil spills or local fish-stock collapse).

3. Parameter/metric

Number of island seabird colonies where non-native or invasive-native mammal species are present.

4. Baseline and Reference level

NA.

5. Target setting

The target on invasive mammals (see below), if met through eradication and quarantine measures, should make targets for population size (1.2) and species distribution (1.1) easier to attain, by directly removing a pressure and by creating more habitat than is currently available to breeding seabirds.

The GES Target: *No non-native or invasive-native mammal species on islands that are already free of such species. The proportion of islands where non-native or invasive-native mammal species are present or having a significant impact, should be decreasing*.

In order to achieve this target, CPs should include in their programme of measures, the following Operational (Management) Target: *Minimise the risk of invasion by non-native mammals on all island seabird colonies, where this has not already occurred (including islands from where mammals have been eradicated); and eliminate detrimental impacts caused by mammals at a prioritised list of island seabird colonies.*

The ‘islands’ referred to in the above targets must meet both criteria:

a) Be current, past or potential marine bird breeding sites.

b) Be individual islands or groups of islands that are at least 2 km from adjacent mainland or other islands.

Criterion b) is necessary to prevent invasion or reinvasion from American Mink. Employing mammal control or eradication measures on islands that could easily be reinvaded by mink, would be a waste of resources. Further details in Ratcliffe *et al*., 2009.

6. Spatial scope

NE Atlantic, but can be assessed at any smaller scale.

7. Monitoring requirements

Monitoring of mammal presence/absence required at all island colonies thought to be free of invasive non-native or native mammals, in conjunction with biosecurity measures to minimise risk of invasion. Subsequent monitoring at any other island colony where mammals are eradicated.

A list of islands to be monitored needs to be compiled by each CP; see criteria for island selection in Section 5 above. In countries such Denmark, Sweden and Norway, compiling such a list could be a daunting exercise. The use of GIS and the application of a 2 km buffer as suggested above, would greatly speed up the process and greatly narrow down the number of islands to be included in this indicator.

In the UK, for example, many of the islands that could be potentially included in this indicator are designated as protected areas under existing national and international legislation (e.g. as Special Protection Areas under the Birds Directive). As a consequence, these sites are already under active management, which would make the introduction of mammal monitoring for this indicator a realistic proposition. Likewise the introduction of quarantine measures to prevent mammal invasion could be implemented as part of existing management plans, and is already done so at some sites. The eradication of mammals from islands would require a more substantial input of resources, though many such schemes have been successfully implemented around Europe.

The frequency at which data should be collected	Frequently (e.g. annually) on islands with high risk of invasion by mammals or where mammals are already present
The monitoring method	Surveys of mammals on or near to colonies concurrent with quarantine or eradication measures
Who is responsible for the monitoring?	National Monitoring schemes
Minimal required amount of monitoring locations.	All identified island units
Does the required monitoring already exist?	No.

8. Reporting

At a local scale the indicator should be updated as frequently as possible, annually is preferable in areas where predator-free bird colonies have a high risk of invasion from mammals. There needs to be a close link between reporting the results of monitoring mammal presence and absence and the instigation of control measures. This will prevent mammals from becoming established on an island and having a significant impact on the resident birds. Prompt control measures following mammal invasion will save substantial resources in the long term, which would be required to eradicate and established population of e.g. brown rats. Frequent monitoring of a site during and after control measures have been instigated, will enable the effectiveness of the management measures to be assessed and adjusted if required.

At a national or subregional scale assessments can be reported less frequently, e.g. every six years, to be in line with MSFD and Birds Directive reporting requirements. This level of reporting will provide an update on the scale of the extent of the pressure from non-native/invasive mammals in the region and report on the progress of large-scale management strategies employed to mitigate the pressure.

9. Resources required

These will be unclear until a CP has identified how many 'island' units are to be included in its indicator.

Monitoring mammal presence is straightforward (e.g. placement of chew sticks and traps, observation of tracks and signs) but requires regular visits to islands. Resources required for these visits are dependent on the accessibility of the islands and on how much of the monitoring can be done by volunteers.

10. Further work

a) CPs to conduct GIS analysis to select 'islands' for inclusion in the indicator.

b) Coordination across CPs for reporting against the target.

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Annex 6: Participants list

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