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Report of the Workshop on Seabird Ecological Quality Indicator (WKSEQUIN)

8–9 March 2008

Lisbon, Portugal

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Executive summary

- The Workshop to develop a Seabird Ecological QUality INdicator (WKSEQUIN) was requested by OSPAR's Biodiversity Committee (BDC). The Workshop was organised by the ICES Working Group on Seabird Ecology (WGSE), in collaboration with the UK's Joint Nature Conservation Committee (JNCC) and the German Delegation on the BDC. WKSEQUIN was held in Lisbon on 8–9 March 2008 and hosted by Sociedade Portuguesa para o Estudo das Aves (SPEA), the BirdLife International Partner in Portugal.
- The aim of the workshop was to continue the development previously carried out by WGSE, of an EcoQO on *Seabird population trends as an index of seabird community health*, and in doing so, to produce at least one EcoQO with its associated indicator, target and limit, as an example of what others might look like.
- WKSEQUIN proposed a single EcoQO: *Changes in breeding seabird abundance should be within target levels for 75% of species monitored in any of the OSPAR regions or their sub-divisions.*
- The aims of the EcoQO should be to ensure the intrinsic health of seabird communities, and to provide triggers for appropriate action.
- They proposed a separate EcoQO indicator for each OSPAR region or sub-region, each consisting of species-specific trends in abundance of a number of species with good quality monitoring data available.
- Data are immediately available to construct indicators for OSPAR III and OSPAR V. Indicators for OSPAR II & IV could be constructed in the next year or two, once data collation in those regions is completed. It is unclear when an indicator will be constructed for any of the sub-divisions of OSPAR I.
- Independent reference levels and target levels should be set for each of the species-specific trends that constitute each regional indicator.
- Target levels should be set to the magnitude of change in population size compared to preset reference levels. The reference level should be set at a population size that is considered desirable for each individual species within each geographical area.
- Subsequent to WKSEQUIN, analyses were carried out on seabird monitoring data from OSPAR region III and produced trends in abundance of eight species during the period 1986-2006. Reference levels for each species were derived from previous censuses of the whole OSPAR region. An upper target level of 130% of the reference level was set for all species, while a lower target level of 80% was set for species that lay one egg and a separate lower target level of 70% for species that lay more than one egg. The EcoQO was not achieved (i.e. target levels were exceeded in 3 or more species) in seven out of 21 years: during 1988-1990, 1992 and 2003-06. Appropriate action would have been triggered in these years.
- The indicators informing the EcoQO can be updated and improved when required and when the data allows it, but the EcoQO will remain unchanged.
- WKSEQUIN recommended that WGSE adopt an annually recurrent Term of Reference: *to use the latest monitoring data available to update each species-specific trend within each regional indicator*. WGSE should report annually to OSPAR on whether or not the EcoQO has been achieved.
- Resources will need to be secured to ensure data analysis is carried out annually to update the species specific trends of each regional indicator.

1 Introduction

1.1 Background

The Workshop to develop a Seabird Ecological QUality INdicator (WKSEQUIN) has been requested by OSPAR's Biodiversity Committee (BDC). The Workshop has been organised by the ICES Working Group on Seabird Ecology (WGSE), in collaboration with the UK's Joint Nature Conservation Committee (JNCC) and the German Delegation on the BDC.

1.2 Ecological quality objectives (EcoQO)

The Fifth North Sea Conference (Bergen, Norway, 2002) agreed on the adoption of a system of Ecological Quality Objectives (EcoQO) as a means of applying the ecosystem approach to the management of human activities. OSPAR's goal is a "*healthy and sustainable marine ecosystem*". The main contributory objective of this goal is to manage "*human activities in such a way that the marine ecosystem will continue to sustain the legitimate uses of the sea and will continue to meet the needs of present and future generations*". Progress towards achieving this objective will be monitored by assessing **Ecological Quality (EcoQ).** EcoQ is *an overall expression of the structure and function of the marine ecosystem taking into account the biological community and natural physiographic, geographic and climatic factors as well as physical and chemical conditions including those resulting from human activities.*

The main components of the EcoQ assessment process are shown in Figure 1. Firstly, **Ecological Quality Issues** are identified for the marine ecosystem under consideration: these are the fields in which it is appropriate to measure aspects of EcoQ. Each issue is then divided into a series of **Ecological Quality Elements** that are the individual aspects of ecological quality, on which it is appropriate to focus. Each EcoQ element has one or more **Ecological Quality Objectives (EcoQO)** that define the desired level of ecological quality to be achieved and maintained.

For example, the Fifth North Sea Conference identified 10 EcoQ issues that constituted a total of 21 EcoQ elements (OSPAR Commission 2001). Each element and its associated EcoQOs were reviewed and assessed by the North Sea Pilot Project (OSPAR Commission 2006). Seabirds were identified as an EcoQ issue for the North Sea, and the pilot project investigated six seabird EcoQ elements. The pilot project reported in 2006 (see OSPAR Commission 2006) and recommended that five of the seabird EcoQ elements should be adopted, but only one of these - *Proportion of oiled Common Guillemots among those found dead or dying on beaches* – was considered to be sufficiently advanced to be included in the first edition of the EcoQO Handbook (OSPAR Commission 2007). The pilot project reported that the sixth seabird EcoQ element - *Seabird population trends as an index of seabird community health* – required further development.

1.3 Terms of Reference

The terms of reference for WKSEQUIN as provided by OSPAR and ICES are as follows:

A Workshop on Seabird Ecological Quality Indicator **[WKSEQUIN]** (Chair: Ian Mitchell, UK) will be established and will meet immediately before the meeting of the ICES Working Group on Seabird Ecology (WGSE) in Lisbon, Portugal on 8-9 March 2008 to:

a) develop an ecological quality objective on seabird population trends, through work to complete previous ICES work on:
- compiling meta-data on monitoring across the OSPAR Maritime Area (see ICES 2007);
- developing standardised monitoring methods and protocols (see ICES 2006, 2007);
- standardising interpretation of monitoring results;

b) initiate the development of seabird population related indicators of ecological quality comprised of "objectives," "targets" and "limits." At least one EcoQO and indicator with its associated objective, target and limit, should be prepared as an example of what others might look like.

[WKSEQUIN interpreted the last sentence as *At least one EcoQO with its associated indicator, target and limit, should be prepared as an example of what others might look like.*]

WKSEQUIN will report by 15 April 2008 to the attention of the Living Resources Committee and Advisory Committee (ACOM) of ICES. Initial outputs from the workshop should be made available for the WGSE meeting that will follow the workshop.

1.4 Participation

The chair of WKSEQUIN invited members of the ICES WGSE and co-ordinators of seabird monitoring schemes from the countries within the OSPAR Maritime Area (see Figure 1) to attend the workshop. The following participated in WKSEQUIN (see Appendix 1 for full contact details and affiliations).

Tycho Anker-Nilssen Adam Butler	Norway UK	Bergur Olsen Matt Parsons	Faroes UK
Rob Barrett	Norway	Iván Ramírez	Portugal
Peter Becker	Germany	Norman Ratcliffe	UK
Ian Burfield	UK	Jim Reid	UK
Bernard Cadiou	France	Eric Stienen	Belgium
Bernard Deceuninck	France	Mark Tasker	UK
Morten Frederiksen	Denmark/Greenland	*Apologies were received from:*	
Arnþór Garðarsson	Iceland	Pep (J. M.) Arcos	Spain
Pedro Geraldes	Portugal	Arend Van Dijk	NL
Ommo Hüppop	Germany	Stefan Garthe	Germany
Svein-Håkon Lorentsen	Norway	Juan Carlos del Moral	Spain
Ian Mitchell (Chair)	UK	Ævar Petersen	Iceland
Verónica Neves	Azores	Ib Krag Petersen	Denmark
Steve Newton	Ireland	Grigori Tertitski	Russia
Leif Nilsson	Sweden	Alberto Velando	Spain

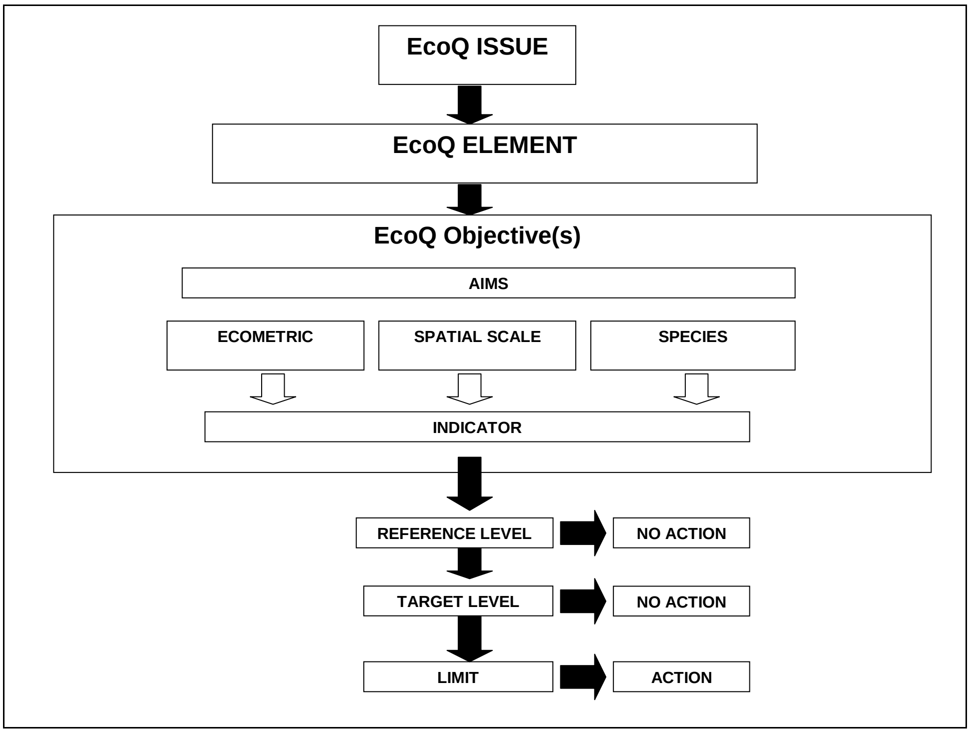

Figure 1: Schematic of the Ecological Quality (EcoQ) assessment process.

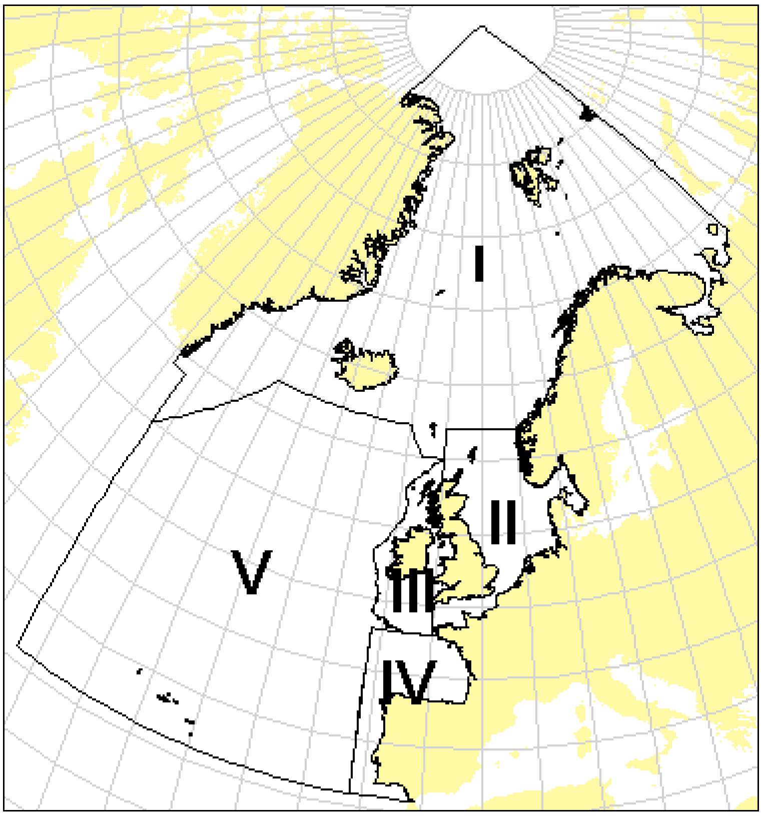

Figure 2: OSPAR maritime area and five regions: I = Arctic Waters, II = Greater North Sea, III = Celtic Seas, IV = Bay of Biscay and Iberian Coast, V = Wider Atlantic.

2 WKSEQUIN rationale and approach

In order to meet the terms of reference (see Section 1.3), WKSEQUIN aimed to produce one or more EcoQOs on *Seabird population trends as an index of seabird community health,* and identify the components of the EcoQ assessment process shown in Figure 1, namely:

- aims of the EcoQO;
- ecometric of the EcoQO[1];
- geographic scale of the EcoQO;
- species of seabird on which the EcoQO will be based;
- the indicator used to assess the status of seabird populations with respect to the EcoQO; and
- associated reference levels, targets and limits.

WGSE has previously carried out work to develop EcoQOs on *Seabird population trends as an index of seabird community health* (see ICES 2002, 2003, 2004, 2005). Based on this work, WGSE made a series of recommendations for each of the components listed above. WKSEQUIN assessed each of these recommendations and either endorsed them or suggested alternatives.

WKSEQUIN was divided into five sessions (see below). The aims of each session and the approach to be taken are described in detail below. Some of the sessions involved break-out discussions, during which participants were divided into three groups, either at random or according to OSPAR Region (i.e. OSPAR I, OSPAR II & III, OSPAR IV & V) depending on the session.

3 SESSION 1: Aims and ecometric of the EcoQO on Seabird population trends

3.1 Background

WGSE recommended the following aims (see ICES 2002, 2003):

- Provide an adequate EcoQO for the intrinsic health of seabird communities. The main rationale for this EcoQO is the general public concern for declining seabird populations.
- To provide alarm signals to trigger more specialised studies when the absolute rate of population change crosses the threshold set[2]. These more specialised studies could be targeted at revealing the underlying causes; if these relate to human activities, useful mitigation measures should be identified and implemented.

WGSE recommended that the EcoQO should be based on trends in abundance of breeding seabirds. They justified their recommendation as follows:

Abundance is measured widely and relatively easily; but is a poor short term indicator of environmental change due to lag effect of delayed breeding; nevertheless, it is a good indicator of important long-term changes in seabird community structure,

1 Eco-metric = the attribute that is being considered as a quantitative measure of the EcoQ (OSPAR Commission 2001)

2 Alarm triggers and targets are not supposed to be used as the basis for concluding the seabird community is undergoing unacceptable changes

where density dependent effects may easily reduce the usability of other population parameters (ICES 2003).

Seabirds are generally long-lived and reproduce slowly. Consequently, rapid changes in their numbers are not expected and might indicate that some human-induced factor(s) is affecting the population to an extent that is not associated with a healthy seabird community and require(s) immediate management actions (ICES 2004a).

3.2 Aim of session

- To inform participants of WGSE's recommended aims and ecometric for the EcoQO (see above).
- To either accept WGSE's recommend aims, or to make appropriate amendments and agree on a new set of aims for the EcoQO.
- To obtain participants' opinions on WGSE's rationale for using abundance trends and to recommend if necessary, the use of additional ecometrics.

3.3 Discussion

3.3.1 Aims of the EcoQO on Seabird population trends

Participants agreed that the rationale for the EcoQO should be the intrinsic health of the seabird community and not the general public concern for declining seabird populations (cf. WGSE suggested aims – above). But public concern was acknowledged as an important factor affecting the political profile of the EcoQO. WGSE's second recommended aim (see above) was considered inaccurate because the causes of a significant change in seabird communities would not always be unknown and require research before suitable management could be carried out. Hence, WGSE replaced 'research' with 'appropriate action' that would include both research and/or management, depending on how well the causes of change are understood at the time.

WKSEQUIN concluded that the EcoQO should be based on the following aims:

1) To provide an adequate EcoQO for the intrinsic health of seabird communities.

2) To provide triggers for appropriate action.

3.3.2 Ecometric of the EcoQO on Seabird population trends

Participants agreed that WGSE's rationale for using abundance trends (see above) were valid. Abundance is currently used in other national and international indicators (e.g. the European Wild Bird Indicator) and as a result is understood and recognised by politicians and the public. However, some changes in abundance of breeding seabirds would not be mitigated by 'appropriate action' carried out by OSPAR signatory states, since they may be caused by factors operating outside the OSPAR Maritime Area. Changes in breeding success would provide a more 'local' indicator of conditions, but breeding success would be a much more difficult ecometric to communicate via the EcoQO and, would not necessarily be the driver of population change; other demographics such as survival may be more important. WKSEQUIN recommended that demographic parameters, such as breeding success, should be included in seabird monitoring programmes in order to potentially provide interpretation of changes in seabird abundance.

4 SESSION 2: Does seabird monitoring provide sufficient data for the EcoQO?

4.1 Background

Forty seven species of seabird breed (BirdLife International 2004) within the OSPAR Maritime Area. Prior to the workshop, data on the abundance of common seabird species breeding at individual colonies were collated from 13 of the 16 countries in the OSPAR Maritime Area. No data were available for WKSEQUIN from the Netherlands and Portugal; data were supplied from only one of the colonies in Germany (see section 4.4 for more details). Only data from coastal[3] colonies were included. These data were used by Adam Butler (Biomathematics and Statistics Scotland - BioSS) to estimate species-specific trends over the last 20 years or more, within each country and within each of the five OSPAR Regions. These species-specific trends were used by participants during Session 2 to determine for which species there is sufficient monitoring data to provide a basis for setting an appropriate EcoQO and to construct an accurate indicator of progress towards the EcoQO. Later, during Session 4, participants selected which species trends should contribute to the indicator – either singularly or as a group.

4.2 Aims of the session

- To obtain the views of delegates on the analytical approaches taken to estimate trends in abundance in each OSPAR region.
- To assess the accuracy of modelled intra-specific trends within each OSPAR region.
- To identify the cause of poor accuracy and determine if accuracy can be increased by an alternative analytical approach.
- Identify those species for which accurate trends can be determined.
- Assess if sustainable monitoring is in place to enable trends to be regularly updated in the future.

4.3 Approach

There are inherent features of seabird monitoring data that create problems when one attempts to measure year to year changes in the abundance of seabirds at large spatial scales (e.g. within an OSPAR region). These problems mainly stem from the fact that in most countries only a sample of colonies have been surveyed each year, with some colonies being monitored less frequently than others. Hence, comparing counts from one year to the next is less than straightforward, and requires some assumptions about the underlying spatial synchroneity of trends in abundance. To overcome these problems, we applied a modelling approach that, for each species, used observed counts to predict numbers present at colonies during years in which no surveys were conducted. Details of the modelling approach are given in Appendix 3. The annual observed and predicted counts from each colony were summed to produce an estimate of trends in each country and in each OSPAR region.

The trend analysis used for WKSEQUIN was preliminary, and based on a relatively simple approach, with a number of important drawbacks and caveats (see Appendix 3). Crucially, it relied on the assumption that all colonies have been recorded at least once, which is unrealistic for many of the species that have been analysed. In all cases

3 'Coastal' was defined as within 5km from the high water mark (cf. Mitchell et al. 2004).

further statistical modelling, supplementary data, and expert knowledge would be required to provide trend estimates that would be sufficiently accurate and robust to provide an indicator for the EcoQO. However, the outputs of the trend analysis (see an example in Figure 3) proved very useful in helping participants to determine whether or not the monitoring data available from each country and for each species was sufficient to potentially provide an accurate estimate of trends in abundance.

During Session 2, participants were divided into the three groups consisting of those from countries within OSPAR I, OSPAR II & III and OSPAR IV & V. Each group was provided with plots of trends in abundance of individual species in the whole of the OSPAR region and within each constituent country (see Figure 3). Participants within each group provided an assessment of the quality of the monitoring data using the categories and criteria given in Table 1.

Table 1: Categories for the quality assessment of species-specific monitoring data within each OSPAR region and constituent countries.

ASSESSMENT CATEGORY	DEFINITION
Good	Data produces reasonably accurate trends at country or OSPAR regional level, with little evidence of regional bias due to a combination of the following: a) the distribution of sampled colonies is representative of the range of a speceis; b) a high proportion of the population has been sampled regularly; c) there is close agreement between modelled trends and census data.
Xa	Inaccurate trends due to temporally and/or spatially sparse monitoring data.
Xb	Inaccurate trends due to spatially biased sampling.
NP	Not present as a breeder.
NP*	Present as a breeder in very low numbers
No data	No data on breeding numbers have been collected during two or more years, therefore trend analysis was not possible.
(Data)	Data on breeding numbers have been collected during two or more years, but were not made available to WKSEQUIN.

Rare breeding species (categorised as NP*) were not included in the trend analysis because their trends are usually not an indicator of overall seabird community health.

Quality assessment categories were entered against each species in each constituent country of each OSPAR Region (see Tables in Appendix 4) and then an overall assessment of data quality for the whole OSPAR region was entered in to Table 2.

The accuracy of the modelled trends was assessed as follows:

a) By examining the level of uncertainty around the modelled trends (see Figure 3).

b) By comparing modelled trends with actual changes in total breeding numbers that have occurred between successive complete censuses conducted in the countries within each OSPAR region. (NB. These census data were available only for France[4], Republic of Ireland[5] and the UK[5]).

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4 Cadiou *et al.* (2004)
5 Mitchell *et al.* (2004)

c) By examining the proportion of the sampled population that had been counted in each year (see Figure 3).

d) By using expert knowledge to assess whether or not the distribution of sampled colonies accurately represents the range of the population.

Regarding point a) above, it is important to note that the confidence intervals about the estimates obtained using the imputation procedure were typically very wide (see Figure 3). This reflected the fact that the method used to produce the trends (see Appendix 3) is empirical, and that the intervals were based on a form of nonparametric resampling that makes only weak assumptions regarding the structure of the data. For many species, log-linear models could be used (e.g. through the software package TRIM) to provide more precise estimates of trend without any substantial loss of accuracy, and this was often taken into account when scoring data quality as 'good' (see Table 2).

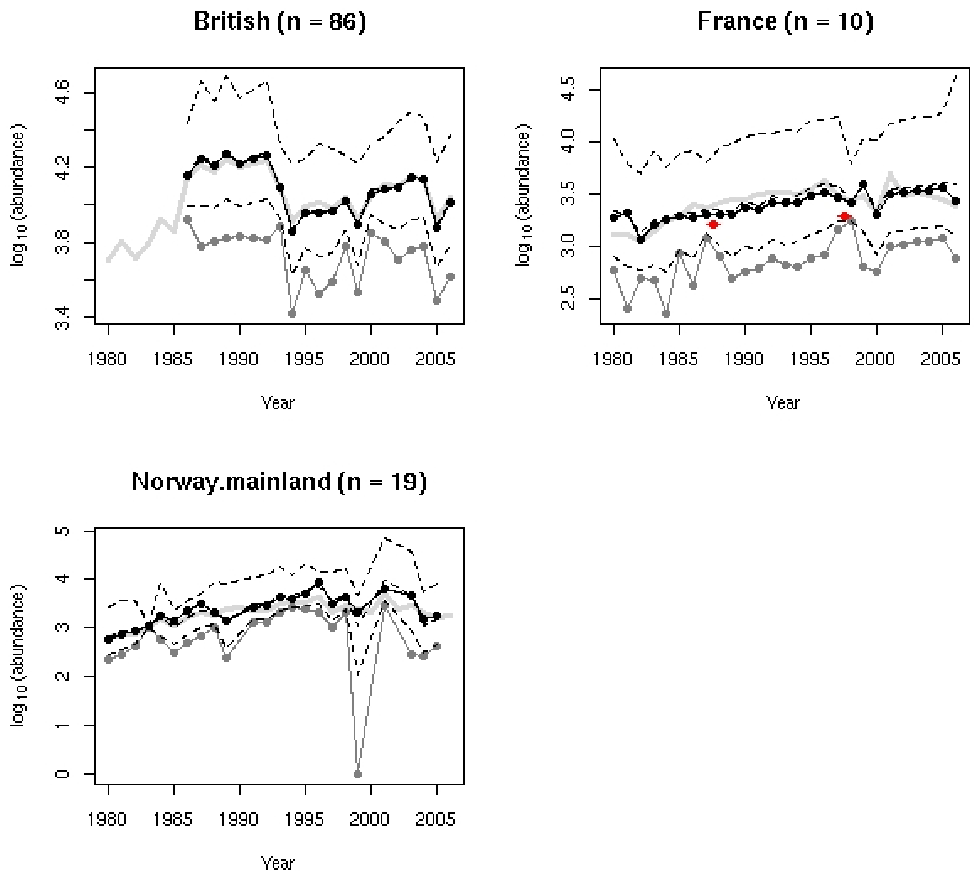

Figure 3: Example of outputs of trend analysis: European shag (*Phalacrocorax aristotelis*) in OSPAR Region II and constituent countries and ICES areas. Continued

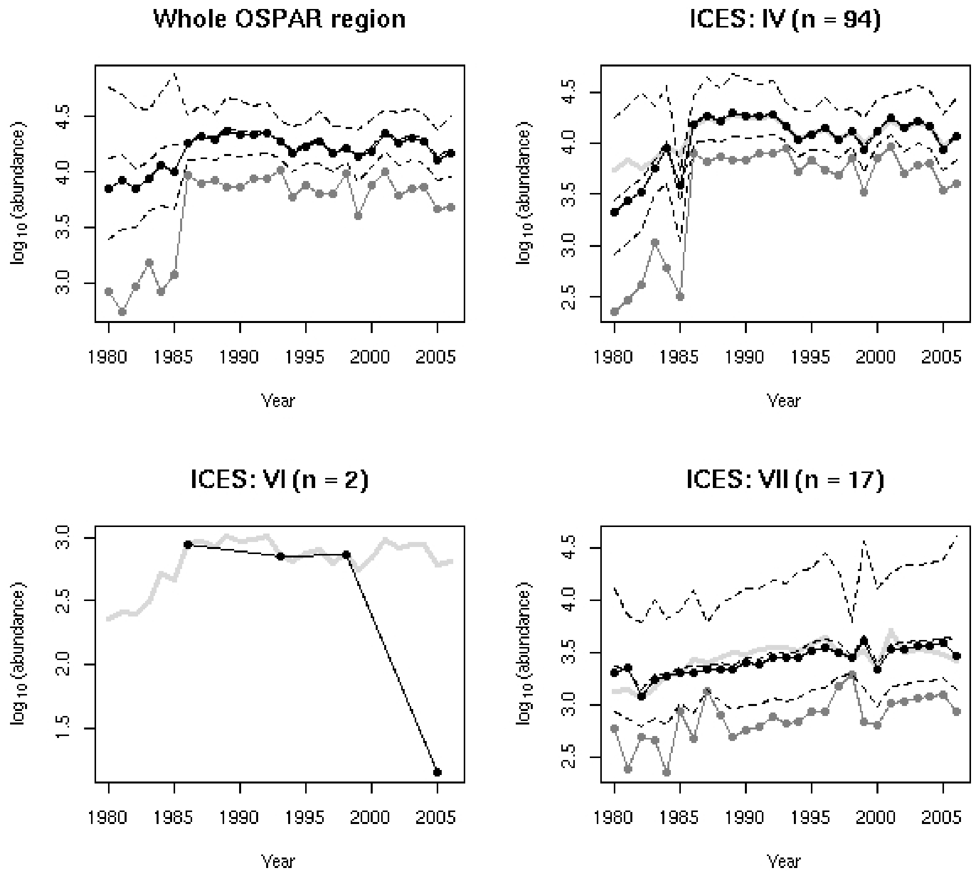

Figure 3 Continued: Example of outputs of trend analysis: European shag (*Phalacrocorax aristotelis*) in OSPAR Region II and constituent countries and ICES areas.

Black dots & black solid lines denote estimated total abundance i.e. the sum of observed and imputed counts.

Dark grey dots and dark grey solid lines denote the sum of observed counts only. When compared to estimated total abundance, these indicate the proportion of counts that were observed and imputed by the model.

Dotted lines denote the distribution (i.e. median, 2.5th and 97.5th percentiles) of the imputed counts, based on simulation (bootstrapping over the set of colonies/plots).

Red dots and lines indicate total abundance of all colonies in OSPAR Region II of France during two censuses carried out in 1987-89 and in 1997-2000. If the sample of French colonies is unbiased, the rate of change in estimated total abundance should be similar to that during the intervening period between the two censuses.

Thick light grey line denotes the national or ICES Area trend in total estimated abundance computed using the rates of change estimated from the data from the whole OSPAR region. Comparing the light grey and black lines should indicate whether the trends in the country or ICES area are similar to those in the OSPAR region, but discrepancies may result either from a lack of data at the ICES area or country level or from asynchroneity with trends at the OSPAR region level.

4.4 Results

The assessment of data quality for each species in each OSPAR region provided by the break-out groups is shown in Table 2. More detailed assessments of each constituent country are shown in Appendix 4. The main findings regarding data quality in each OSPAR region are described separately below.

4.4.1 OSPAR Region I

Monitoring data have been collected for 18 of the 29 seabird species breeding in OSPAR I, but were considered good enough for trend modelling in only two species

– northern gannet and great cormorant (Table 2). Data were considered too sparse (i.e. Xa) in 13 species and regionally biased for European shag. Monitoring data have been collected for ivory and glaucous gull, but were not available for analysis for WKSEQUIN. In addition, data for other gull species have been collected in Iceland but were unavailable for analysis (see Table A4.1, Appendix 4). There, is a general expansion of seabird monitoring activities within the region, so it is expected that the quantity and quality of the data collected from within the region will increase in future years.

However, all participants from countries within OSPAR I considered there to be too much geographic variation in the trends of abundance within individual species for regional trends to provide any meaningful information that could be used to assess seabird community health in relation to the EcoQO. OSPAR I 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. They suggested that the EcoQO indicator should be based on trends within sub-regions of OSPAR I. They recommended sub-regions similar to the eco-regions 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 2004b, see Figure 4).

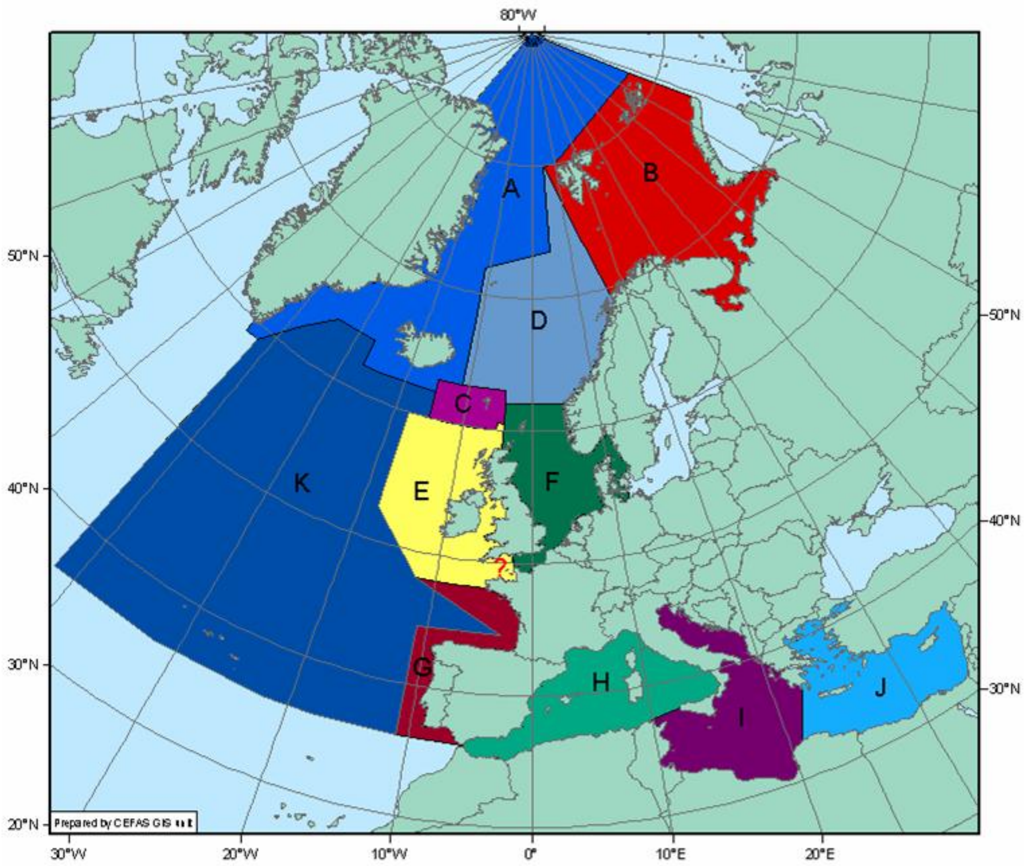

Figure 4. Proposed eco-regions for the implementation of the ecosystem approach in European waters (Source ICES 2004b). WKSEQUIN proposed that OSPAR Region I should be divided into eco-regions A-D for the purposes of an ECOQO on seabird population trends as an indicator of seabird community health. The eco-regions in OSPAR I are Greenland and Iceland Seas (A), Barents Sea (B), Faroes (C), Norwegian Sea (D).

4.4.2 OSPAR Region II

Data collation prior to WKSEQUIN was incomplete. No data were provided from the Netherlands or from Germany (apart from on Helgoland). The quality of data potentially available from these countries was assessed by a combination of expert knowledge from Peter Becker, Ommo Hüppop and Eric Stienen, and by referring to published trends of birds breeding in the Wadden Sea during 1991-2001 (see Koffijberg *et al.* 2006). Data for some species of gull and tern breeding in Denmark were not provided (See Table A4.2, Appendix 4). Data from Normandy and northern France were not provided because permission for WKSEQUIN to use these data had not been given by the owners.

Of the 30 species breeding in OSPAR II, data for 10 species were considered of good enough quality to provide accurate trends (see Table 2). The data on 10 other species were considered too sparse or spatially biased, while no monitoring data have been collected on Leach's storm-petrel. Data for great and Arctic skua breeding in the UK were not available, but when modelled by Parsons *et al.* (2007), did produce accurate trends.

Data from Sweden for all species were sparse before 2000, but from then on, random annual sampling of colonies has produced annual estimates of total numbers of each species breeding in the two counties bordering the west coast of Sweden.

Most of the breeding seabird data from OSPAR II has been collected by co-ordinated national monitoring schemes. Therefore, the likelihood of continued data collection in the future is high. Data that was not provided for WKSEQUIN from the UK, Germany and the Netherlands will be available for input into the EcoQO indicator if required. Further negotiations with the relevant data custodians need to be carried out to secure the use of additional data from France and from Denmark.

Providing these missing data are made available, then accurate trends in the number of 10-12 seabird species breeding within OSPAR II could be used in the EcoQO indicator.

4.4.3 OSPAR Region III

Data for OSPAR III were obtained from the UK and Ireland's Seabird Monitoring Programme (SMP) and included counts conducted as part of annual sampling during 1986-2006 and as part of complete censuses during 1985-88 and 1998-2002. Of the 26 species that breed in OSPAR III, data for 14 species were considered of good enough quality to provide accurate trends (see Table 2). Data were considered too sparse or spatially biased in a further eight species, while no monitoring data exist for Leach's storm-petrel and Arctic skua. All data from OSPAR III for the period 1986-2006 has been collated and is available for immediate use by the EcoQO indicator. The SMP is ongoing so annual updates of the indicator will be available.

4.4.4 OSPAR Region IV

The data from OSPAR IV provided for WKSEQUIN included all species that have been monitored in France, but included only black-legged kittiwake and European shag in Spain. There were no participants from Spain, so the assessment of data quality for other species breeding in Spain was not possible. No data were provided from Portugal since, although monitoring of seabird colonies has been conducted there, these data have not properly collated. In the absence of modelled trends, Iván Ramírez and Pedro Geraldes provided expert knowledge on the monitoring coverage in Portugal. Of the 21 species breeding in OSPAR IV, nine occur in very low numbers and no monitoring data has been collected on Cory's shearwater and band-rumped storm-petrel. The quality of data for six of the ten remaining species were assessed as 'good', three were assessed as sparse, and the quality of monitoring data on little terns breeding in Portugal was unknown (Table 2).

Before trends of seabird abundance could be included in the EcoQO indicator for OSPAR IV data from Portugal need to be collated and data on species other than kittiwake and shag need to be obtained from Spain.

A further problem was highlighted: gulls from colonies in the north of the region, in some years also breed in colonies in northern Brittany, within OSPAR II. As a result, numbers of gulls breeding in these areas can vary greatly from one year to the next. This can lead to problems when imputing missing values and calculating trends (see Annex 3). A solution may be to include the data from French gull colonies in the northern part of OSPAR IV in OSPAR II instead.

4.4.5 OSPAR Region V

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 (Table 2 and Table A4.5, Appendix 4). Of the remaining species, Fea's petrel breeds in very small numbers and no monitoring data are available for Manx shearwater. Data on Macronesian shearwater were regionally biased since only one colony (on Vila islet) has been monitored, yet they breed on all the islands of the Azores, except Terceira. Monitoring data on Yellow-legged gull and Cory's shearwater were considered too sparse to be included in the EcoQO indicator. All colonies of yellow-legged gulls in the Azores have been surveyed twice during 1984 and 2004, but no monitoring was conducted in the intervening years or since. Some colonies of Cory's have been monitored frequently, but they were small in size and represented a very small proportion of the total population breeding in the Azores.

Data for roseate tern, common tern, Bulwer's petrel and band-rumped storm-petrel have been collated and are ready to be included in the EcoQO indicator.

4.5 Conclusions

Good quality monitoring data have been collated in OSPAR Regions III and V for 14 and 4 species respectively and are ready for immediate inclusion in the EcoQO indicator if required.

In OSPAR Regions II and IV, good quality monitoring data have been collected for 10 and 5 species respectively, but not all of these data have been collated. Further data need to be collated from the Netherlands, Germany, France, Portugal and Spain. Further resources for data collation are required in Portugal and permission needs to be obtained from data custodians in France before their data can be used.

Monitoring data in OSPAR I is spatially and temporally sparse. Monitoring of only two species has been sufficient to produce good quality trend data across the entire region. The region should be split in to four subdivisions (see Figure 4) to take account of the large amount of geographical variation in trends. Further investigation needs to be conducted into the quality of trends produced from data collected within each sub-division.

Table 2: Quality assessment of data available for each species in each OSPAR Region.

Definitions of quality categories are given in Table 1.

SPECIES	ENGLISH NAME	OSPAR I	OSPAR II	OSPAR III	OSPAR IV	OSPAR V
Fulmarus glacialis	Northern Fulmar	Xa	good	good	NP*	NP
Pterodroma feae	Fea's Petrel	NP	NP	NP	NP	NP*
Bulweria bulwerii	Bulwer's Petrel	NP	NP	NP	NP	Good
Calonectris diomedea	Cory's Shearwater	NP	NP	NP	(data)	Xa
Puffinus puffinus	Manx Shearwater	No data	Xb	Xb	NP*	No data
Puffinus baroli	Macronesian Shearwater	NP	NP	NP	NP	Xa
Hydrobates pelagicus	European Storm-petrel	No data	Xb	Xb	NP*	NP
Oceanodroma leucorhoa	Leach's Storm-petrel	No data	no data	No data	NP	NP
Oceanodroma castro	Band-rumped Storm-petrel	NP	NP	NP	No data	Good
Morus bassanus	Northern Gannet	good	good	good	NP	NP
Phalacrocorax carbo	Great Cormorant	good	good	good	NP*	NP
Phalacrocorax aristotelis	European Shag	Xb	good	good	good	NP
Stercorarius pomarinus	Pomarine Jaeger	No data	NP	NP	NP	NP
Stercorarius parasiticus	Parasitic Jaeger	No data	(data)	(data)	NP	NP
Stercorarius longicaudus	Long-tailed Jaeger	No data	NP	NP	NP	NP
Stercorarius skua	Great Skua	No data	(data)g	Xb	NP	NP
Larus melanocephalus	Mediterranean Gull	NP	NP*	NP*	NP*	NP
Larus minutus	Little Gull	NP	NP*	NP	NP	NP
Xema sabini	Sabine's Gull	NP	NP	NP	NP	NP
Larus ridibundus	Common Black-headed Gull	No data	Xa	Xb	good	NP
Larus canus	Mew Gull	Xa	Xb	Xb	NP	NP
Larus audouinii	Audouin's Gull	NP	NP	NP	NP	
Larus fuscus	Lesser Black-backed Gull	Xa	Xb	Xb	Xa	NP
Larus cachinnans	Caspian Gull	NP	NP*	NP	NP	NP
Larus michahellis	Yellow-legged Gull	NP	NP*	NP*	Good	Xa
Larus argentatus	Herring Gull	Xa	good	good	Xa	NP
Larus glaucoides	Iceland Gull	No data	NP	NP	NP	NP
Larus hyperboreus	Glaucous Gull	(data)	NP	NP	NP	NP
Larus marinus	Great Black-backed Gull	Xa	Xa	good	Xa	NP
Rhodostethia rosea	Ross's Gull	NP*	NP	NP	NP	NP
Rissa tridactyla	Black-legged Kittiwake	Xa	good	good	good	NP
Pagophila eburnea	Ivory Gull	(data)	NP	NP	NP	NP
Sternula albifrons	Little Tern	NP	Xb	good	(data)	NP
Sterna nilotica	Gull-billed Tern	NP	NP	NP	NP	NP
Chlidonias hybrida	Whiskered Tern	NP	NP	NP	NP	NP
Chlidonias niger	Black Tern	NP	Xa	NP	NP	NP
Chlidonias leucopterus	White-winged Tern	NP	NP*	NP	NP	NP
Sterna sandvicensis	Sandwich Tern	NP	good	good	Good	NP
Sterna hirundo	Common Tern	No data	Xb	good	Good	Good
Sterna dougalliii	Roseate Tern	NP	good	good	NP*	Good
Sterna paradisaea	Arctic Tern	Xa	Xa	good	NP*	NP
Uria aalge	Common Murre	Xa	good	good	NP*	NP

SPECIES	ENGLISH NAME	OSPAR I	OSPAR II	OSPAR III	OSPAR IV	OSPAR V
Uria lomvia	Thick-billed Murre	Xa	NP	NP	NP	NP
Alca torda	Razorbill	Xa	good	good	NP	NP
Cepphus grylle	Black Guillemot	Xa	Xb	Xb	NP	NP
Alle alle	Dovekie	Xa	NP	NP	NP	NP
Fratercula arctica	Atlantic Puffin	Xa	Xa	Xa	NP	NP

5 SESSION 3: Setting EcoQO reference/target levels and limits

5.1 Introduction

The meaning of EcoQO reference/target levels and limits were defined as follows by OSPAR Commission (2001):

Reference level = the level of EcoQ at which the anthropogenic influence on the ecological system is minimal. The criteria on which the reference level is set can change from EcoQ to EcoQ, or over time, leading to changes in the reference level as well. The reference level may refer to a range of possible points that allows for natural variation around a point.

Target Levels = values of the EcoQ that management should be trying to maintain with high probability.

Limit = a value of the EcoQ that, if violated, is taken as *prima facie* evidence of a conservation concern i.e. there is an unacceptable risk of serious or irreversible harm to the EcoQ.

Three options for setting for target setting were presented to the workshop:

5.1.1 Option 1:

This was recommended by WGSE (see ICES 2003, 2004).

APPLICABILITY	REFERENCE LEVEL	TARGET LEVEL	LIMIT
all species	changes of -10% to +15% during ≥20 years	changes of -20% to +30% during ≥20 years	>20%decline, or >30% increase during ≥20 years

The levels and limits were based on Tucker & Heath (1994) and Anker-Nilssen *et al*. (1996). The 20% target level for declines was considered to be realistic in the context of variation in seabird trends in the North Sea (see ICES 2002). This target level was also justified by the fact that seabird species are generally long-lived and reproduce slowly. Consequently, more rapid or more severe changes in their numbers are not expected and might indicate that some human-induced factor(s) is affecting the population to an extent that is not associated with a healthy seabird community and require(s) immediate management actions. Increases of >30% should also be addressed in species that could conflict with other seabird populations that are falling under the target level. The reference level was thought to be typically less than half the maximum long-term target level (ICES 2004a).

5.1.2 Option 2:

Subsequently WGSE amended Option 1 to distinguish between high and low fecundity species.

APPLICABILITY	REFERENCE LEVEL	TARGET LEVEL	SHORT-TERM LIMIT
Low fecundity species	changes of -10% to +15% during ≥20 years	changes of -20% to +30% during ≥20 years	>20% decline or >30% increase in 4-19 years
High fecundity species	changes of -15% to + 25% during ≥20 years	Changes of -30% to +50% during ≥20 years	>30% decline or >50% increase in 4-19 years

The reference/target levels and limits defined in Option 1 above were recommended for low fecundity species only. Less conservative long-term target levels and limits were recommended for the species with the highest fecundity potential (e.g. in the North Sea: great cormorants, European shag, gulls, common tern and black-legged kittiwake), on the basis that these species were more likely to exhibit larger fluctuations in population size. Option 2 also specifies that limits should be set to trigger more detailed studies to explore the underlying reasons for the change when a long-term target level has been surpassed in a period of between four[6] and 19 years. For low fecundity species, ICES (2005) recommended such studies to be triggered only when there is a statistically significant decrease of <-20% or an increase of >30% in breeding numbers (in >50% of the population breeding on the monitoring sites) over a period of 4–19 years The corresponding levels for high fecundity species would be a significant drop of <-30% or increase of >50% in >50% of their population on the monitoring sites.

5.1.3 Option 3:

An alternative to the recommendations of WGSE (i.e. Options 1 and 2) would be to adapt the IUCN Red List Criteria used to assess extinction risk (IUCN 2001). These take into account 'generation length', which is the average age of breeding adults within a species. Generation length therefore reflects the turnover rate of breeding individuals in a population, and is greater than the age at first breeding and less than the age of the oldest breeding individual. Generation length is used to put declines in population size into context with respect to the rates at which individuals of species reproduce and die. Option 2 above aims to do this to some extent, but simply groups species into those of low or high fecundity, whereas generation length could be used to set different limits for each species (see below).

The generation lengths for seabird species were calculated by BirdLife International using estimates of the following published in Schreiber & Burger (2002):

- the age at which 50% of total reproductive output is achieved
- time taken for most (>50%) individuals to reach maximum reproductive output
- age of maturity + 0.5*(length of reproductive period in life cycle)
- 1/adult mortality + age of first breeding (if fecundity and survival are independent of age above the age at maturity)

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6 It is important not to react to a decrease in breeding numbers of more than 20% in less than four years, particularly in species that have a history of mass non-breeding events (e.g. shags) (ICES 2004a).

Under the IUCN criteria, a species would be considered 'Vulnerable' or facing a high risk of extinction if there has been an observed, estimated, inferred or suspected population size reduction of ≥30% over the last 10 years or three generations, whichever is the longer.

Hence, Option 3 for setting reference/target levels and limits would be as follows.

APPLICABILITY	REFERENCE LEVEL	TARGET LEVEL	LIMIT
All species NB. levels and limits are set individually for each species depending on the generation length of that species	Sustained declines must not exceed a rate equivalent to a change of 15% over 3 generations (i.e. half the target level)	Sustained declines must not exceed a rate equivalent to a change of 30% over 3 generations	A sustained rate of decline equivalent to a change of ≥30% over 3 generations

The suggested limit - equivalent to a change of ≥30% over 3 generations – is derived from the IUCN criteria to identify Vulnerable species; but is this too high a rate to be used in the EcoQO to trigger further research and management action? Furthermore, WKSEQUIN would need to determine over what number of years this rate of decline would need to be sustained before such action should be taken.

5.2 Aims of the session

- Determine which of the three options presented for setting target/reference levels and limits are most appropriate for the EcoQO.
- If none of the options presented are appropriate, devise an alternative approach.
- Test the effectiveness of the preferred levels and limits by applying them to the intra-specific trends in abundance in each region.

5.3 Approach

Participants were randomly divided into three groups. Each group considered the three options presented for setting levels and limits and produced a list of pros and cons for each and selected their favoured option. If none of the options were deemed appropriate, they were required to suggest an alternative approach. Each presented their conclusions to the rest of the participants and, based on the collective conclusions of all three groups, consensus was eventually reached.

5.4 Discussion

Option 3 was rejected because generation length is not fixed and will vary with changing rates of survival; it also covaries with population growth rate. Survival varies within species both temporally and spatially. This would mean that generation length would need to be updated as frequently as data are collated on survival rates, which could be annually. It would also mean that different generation lengths may need to be calculated for different meta-populations of the same species. As a result, incorporating generation length into limit- and level-setting within the EcoQO would be extremely complicated and prone to error, particularly in the longer-lived species.

Option 2 was considered to be a significant improvement on Option 1, as it takes into account (albeit quite broadly) the different rates at which the population size of low and highly fecund species could potentially recover from a decline. Clutch size was suggested as a possible proxy for differentiating between high and low fecund species because it is phenotypic, and indicates the maximum number of chicks an individual of a species could fledge given ideal conditions. Productivity is less useful in this context as an indicator of fecundity, since it is more greatly affected by environment and is consequently highly variable within a species over space and time. The greatest differences in fecundity and survival occur between species that lay one egg compared to those that lay more than one egg (Croxall & Rothery 1991). Therefore, it would appear appropriate to set different limits and target levels for those species with a clutch size of 1 and those with a clutch size of >1.

Concerns were raised about setting target levels and limits that specify a proportional change over a certain time period, as per all three options presented. Such limits would alert us to a high rate of change in population size, and thus whether a species/population is at a relatively high risk of extinction, but they may not necessarily alert us to a substantial absolute change in population size that has occurred at a much slower rate. For example, if Option 2 was used to set target levels for the EcoQO, a population of black-legged-kittiwake (max. clutch size = 4) could undergo a sustained but slow decline over a long period (say 30 years or more) that eventually leads to a 25% reduction in population size – and yet no alert would be triggered.

A further problem with this type of target/limit-setting concerns the shifting time-window, within which population change is assessed. It is often the case that a population of species will decline rapidly to a new equilibrium level, so as the time window of change assessment shifts forward, such a population would considered to be stable and no longer in decline. As a result, the species would be omitted from any alert mechanism, even though no recovery to the original population size has occurred. BirdLife International (2004) recognised this problem and introduced the 'Depleted' category when assessing the status of birds in Europe, in order to highlight the fact that despite many species have stopped declining since the 1970s/80s, their population remain significantly lower than historical levels, so they cannot currently be considered to be in a 'Favourable Conservation Status'.

As an alternative, WKSEQUIN suggested setting target levels to the magnitude of change in population size compared to preset reference levels. For instance, if a lower target level was set at minus 25%, then every time a population declined to 75% or less of the reference population size, an alert would be triggered. Similar target levels could also be set for increases in population size. The reference level should be set at a population size that is considered desirable for each individual species within each geographical area. OSPAR recommend setting reference levels of EcoQ at points at which anthropogenic influence is minimal (see above). However, the majority of seabird population monitoring within the OSPAR Maritime Area has been conducted for less than 30 years, so it is highly unlikely that at any point in this period seabird populations were not subjected to some sort of human influence. Therefore, a degree of pragmatism is required in setting reference levels using the limited available historical data. They should ideally be set at a level previously observed, preferably prior to any major population change, particularly those that resulted from anthropogenic pressures. However, as further monitoring data are collected, and as long-term perturbations in population size are better understood, reference levels could be adjusted to reflect the latest scientific understanding of species' population dynamics.

While setting reference levels inevitably involves a degree of subjectivity, participants favoured this option over the others presented, since it is independent of both population trend (unlike Options 1, 2 and 3) and of variation in survival (unlike

Option 3). It also shares much in common with the monitoring and reporting obligations developed under the EC Habitats Directive, under which all EU Member States are required to assess the conservation status of listed species and habitats[7] . Further strong parallels are likely to emerge from the requirements being developed under the new EC Marine Strategy Directive, which will define 'good environmental status' at regional level and establish clear environmental targets and monitoring programmes[8].

Upper and lower target levels were suggested by participants: 130% and 80% of the reference level for species that lay one egg, and 130% and 70% for species that lay more than one egg. However, there was insufficient time at the workshop to set reference levels for each species in each OSPAR area and then test the effectiveness of these targets. Subsequent to the workshop, reference levels were set for species in OSPAR III and target levels were tested in relation to these (see Section 8 below).

WKSEQUIN considered it appropriate to trigger action if species-specific trends in abundance where outside target levels i.e. *those values of* [abundance] *that management should be trying to maintain with high probability (*cf. OSPAR Commission 2001). It would therefore, be unnecessary to set limits beyond these target levels i.e. values of abundance that indicate there is *an unacceptable risk of serious or irreversible harm to* [seabird community health] *(*cf. OSPAR Commission 2001). Setting such limits would add nothing more to the EcoQO process as far as providing triggers is concerned. Accurately setting limits of breeding seabird abundance would be very difficult without a very clear understanding of the key demographic processes involved and without accurate measurements of the key demographic parameters. These data have not been collected for most species at a regional scale.

5.5 Conclusions

Participants rejected all three options presented for limit and target setting and proposed an alternative approach:

APPLICABILITY	REFERENCE LEVEL	TARGET LEVEL
All species NB. Different target levels are set for species with a clutch size of one or more than one.	Unique to each species in each OSPAR region or sub-region. Set at a population size previously observed, prior to any major population change	within +x% and –y% of the reference level

6 Session 4: Selecting 'Key species' for EcoQO

6.1 Introduction

WGSE recognised that not all species have been monitored sufficiently in the past to produce accurate trend data. Therefore, they recommended identifying 'target species' that could be used as a proxy for the wider seabird community and should be included in the EcoQO (ICES 2004a). Furthermore, simply including all the species for which we can accurately estimate regional trends in abundance, would possibly bias the EcoQO towards certain ecotypes. Target species should, therefore, be selected to equally represent as many ecotypes as possible.

7 http://biodiversity.eionet.europa.eu/activities/Natura_2000/pdfs/MONITORING.pdf
8 http://ec.europa.eu/environment/water/marine/index_en.htm

WGSE (see ICES 2005) recommended that ecotypes should be defined by feeding niche and prey type.

For the North Sea seabird community WGSE identified the following feeding niches:

i) pelagic surface-feeders,

ii) pelagic divers,

iii) pelagic plunge-divers,

iv) near-shore surface-feeders,

v) near-shore divers,

vi) near-shore plunge-divers;

and prey types:

a) large fish (>~15cm)

b) small fish (<~15cm)

c) discards

d) planktonic invertebrates

e) benthic invertebrates

f) inter-tidal invertebrates

g) terrestrial food items

However, since these feeding niches and prey types were based on the North Sea, seabird communities in other OSPAR regions may need to categorised differently.

6.2 Aim of session

To select a suite of species from each OSPAR region for which abundance trends can be estimated accurately and that represent as may ecotypes as possible (i.e. defined by feeding niche and prey type, or other characteristics suggested by the breakout groups).

6.3 Approach

Delegates were divided into OSPAR regional groups. Each group assigned to one or more feeding niches and prey types (see above), each species in their region that were identified during Session 2 as having 'good' quality time-series data on abundance (see Table 2). Where necessary, suggestions were provided for alternative ecotypes that would more appropriately reflect the feeding niches and prey types in each OSPAR region.

6.4 Discussion

The distinction between plunge divers (i.e. northern gannet and terns) and surface feeders was considered unnecessary since some surface-feeders can duck-dive to similar depths as plunge-divers. Plunge-divers were therefore subsumed into the two 'surface-feeder' niches.

Distinction based on how far different species travel from colonies to feed would be better described by 'inshore' and 'offshore' rather than 'pelagic' and 'near-shore'. Furthermore 'inshore' and 'offshore' are more widely understood terms and much less ambiguous in their meanings. Inshore and offshore were defined as within 10km and greater than 10km, respectively, from the colony (or from the nearest high water mark to those colonies situated inland from the coast).

The feeding niches recommended by WKSEQUIN were therefore:

i) Inshore surface-feeders (ISF)

ii) Inshore divers (ID)

iii) Offshore surface-feeders (OSF)

iv) Offshore divers (OD)

The food types suggested by WGSE (see above) were considered applicable to other OSPAR regions, but should also include cephalopods. Rather than also classify species according to food type, it was considered more expedient to link food types with each of the four feeding niches (see Table 3).

The species that were identified during Session 2 as having 'good' quality time-series data on abundance are assigned to one of the four feeding niches in Table 4. Species whose data were considered too sparse or spatially biased were also included, given that future expansion of monitoring may improve the quality of the data produced.

In OSPAR III, where 'good' quality trend data exist for the greatest number of species (14), these data represented species from each of the four feeding niches. However, the data from OSPAR III was weighted towards inshore surface-feeders, of which there were seven species, compared to just two from each of the other three niches.

The representation of feeding niches within the 'good' quality data from OSPAR II was more balanced, with three species in each of the surface-feeding niches, and two species in each of the diving niches.

In OSPAR IV, no offshore-diving species breed in significant numbers, and in OSPAR V, there are no offshore or inshore diving species breeding on the Azores. In both regions the 'good' quality data available represented all niches from which breeding species were present.

IN OSPAR I, good quality data exists for only two species, but if data collection is improved in other species, there is potential to represent all four feeding niches.

Table 3: Food types associated with each of four seabird feeding niches

FOOD TYPE	INSHORE SURFACE-FEEDERS	OFFSHORE SURFACE FEEDERS	INSHORE DIVERS	OFFSHORE DIVERS
large fish (>~15cm)			X	X
small fish (<~15cm)	X	X	X	X
cephalopods		X	X	X
discards	X	X		
planktonic invertebrates	X	X		
benthic invertebrates			X	
inter-tidal invertebrates	X		X	
terrestrial food items	X			

Table 4: Feeding niches of species in each OSPAR Region that have 'good' quality time-series data on abundance.

SCIENTIFIC NAME	ENGLISH NAME	OSPAR I	OSPAR II	OSPAR III	OSPAR IV	OSPAR V
Fulmarus glacialis	Northern Fulmar	(OSF)	OSF	OSF		
Bulweria bulwerii	Bulwer's Petrel					OSF
Calonectris diomedea	Cory's Shearwater				(OSF)*	(OSF)
Puffinus puffinus	Manx Shearwater		(OSF)	(OSF)		
Hydrobates pelagicus	European Storm-petrel		(OSF)	(OSF)		
Oceanodroma castro	Band-rumped Storm-petrel					OSF
Morus bassanus	Northern Gannet	OSF	OSF	(OSF)		
Phalacrocorax carbo	Great Cormorant	ID	ID	ID		
Phalacrocorax aristotelis	European Shag	(ID)	ID	ID	ID	
Stercorarius parasiticus	Parasitic Jaeger		(ISF)*	(ISF)*		
Stercorarius skua	Great Skua		(OSF)*	(OSF)		
Pagophila eburnea	Ivory Gull	(OSF)*				
Rissa tridactyla	Black-legged Kittiwake	(OSF)	OSF	OSF	OSF	
Chroicocephalus ridibundus	Black-headed Gull		(ISF)	(ISF)	ISF	
Larus canus	Mew Gull	(ISF)	(ISF)	(ISF)		
Larus fuscus	Lesser Black-backed Gull	(OSF)	(OSF)	(OSF)	(OSF)	
Larus argentatus	Herring Gull	(ISF)	ISF	ISF	(ISF)	
Larus michahellis	Yellow Legged Gull				ISF	(ISF)
Larus hyperboreus	Glaucous Gull	(ISF)*				
Larus marinus	Great Black-backed Gull	(ISF)	(ISF)	ISF	(ISF)	
Sternula albifrons	Little Tern		(ISF)	ISF	(ISF)*	
Chlidonias niger	Black Tern		(ISF)			
Sterna sandvicensis	Sandwich Tern		ISF	ISF	ISF	
Sterna hirundo	Common Tern		(ISF)	ISF	ISF	ISF
Sterna dougalliii	Roseate Tern		ISF	ISF		ISF
Sterna paradisaea	Arctic Tern	(ISF)	(ISF)	ISF		
Uria aalge	Common Murre	(OD)	OD	OD		
Uria lomvia	Thick-billed Murre	(OD)				
Alca torda	Razorbill	(OD)	OD	OD		
Cepphus grylle	Black Guillemot	(ID)	(ID)	(ID)		
Alle alle	Dovekie	(OD)				
Fratercula arctica	Atlantic Puffin	(OD)	(OD)	(OD)		

OSF = Offshore surface-feeder, ISF = inshore surface-feeder, ID = inshore diver, OD = offshore diver. Parentheses indicate time-series data that are sparse or geographically biased and * indicates time-series data unavailable for WKSEQUIN (see Table 2 for details).

7 SESSION 5: Constructing the EcoQO and indicators

7.1 Aim of the session

The aim of the final session of the workshop was to use the outputs of the previous sessions to meet the terms of reference of WKSEQUIN (see Section 1), namely, *'at least one EcoQO indicator with its associated objective, target and limit, should be prepared as an example of what others might look like.'*

7.2 Approach

By this stage in the workshop, for each OSPAR region, the following had been produced and agreed upon:

- Aims of the EcoQO(s) on Seabird population trends as an index of seabird community health (see Section 3)
- A list of species in each OSPAR Region for which accurate trends could be produced and an indication of the ecotypes each species represents (see Sections 4 & 6).
- A method for setting reference and target levels for changes in abundance for each of the selected species (see Section 5).

These outputs were used to construct an EcoQO and associated indicator(s) through a series of discussions, involving all participants, who were directed to answer a series of questions; their answers are given in the following section.

7.3 Discussion

7.3.1 Should the EcoQO be used to make inferences about the intensity of human pressures, as well as indicating the state of seabird populations?

The aims of the EcoQO listed in Section 3 are very clear, in that the EcoQO should be linked to the intrinsic health of seabird communities and provide triggers for appropriate action; therefore, it should not be used to make inferences about the intensity of human pressures.

7.3.2 Should the EcoQO be based on a group of species or should there be a separate EcoQO for each individual species?

For the EcoQO to be linked to the health of seabird communities, it needs to be based on population trends of a group of species rather than on individual species. One way to do this would be to calculate the geometric mean trend of a group of species and then set target levels to this multi-species trend. This approach has been taken with other indicator initiatives based on trends in bird abundance and has worked particularly well when the trends of most of the species are similar i.e. all decreasing or all increasing. However, when there are divergent trends within a group of species, the mean trend is likely to obscure species-specific trends that may be important and require further action. For instance, the mean trend would hide the fact that divergent trends may be correlated, e.g. increases in one species are leading to the decline of another, through depredation or competition.

WKSEQUIN therefore decided to base the EcoQO on the number of species that were within target levels of abundance:

Changes in breeding seabird abundance should be within target levels for 75% of species monitored in any of the OSPAR regions or their sub-divisions.

The indicators for the EcoQO will be species-specific trends in abundance on which individual reference levels and target levels will be set. If the trends of one quarter of these species exceed the respective target levels in any given year, action will be triggered.

7.3.3 Which species will compose the EcoQO?

Species-specific trends from all 'good' quality data-sets will be used in the indicators. As monitoring data is collected and the quality of time-series is improved, other species could be added to the indicator. The aim should be to obtain a balance of species that represent each of the four feeding niches described in Section 6.

7.3.4 Should the EcoQO be specific to an OSPAR region, or to a sub-section of an OSPAR region, or to the whole OSPAR Maritime Area, or a combination of these?

The EcoQO applies to any of the five OSPAR regions (or sub-divisions of OSPAR I as proposed in Section 4). The indicator for each region will consist of a suite of species-specific trends for species with good quality monitoring data available (see Section 4).

7.3.5 How will the indicator be linked to the EcoQO?

WKSEQUIN recommended that the ICES WGSE adopt an annually recurrent Term of Reference: *to use the latest monitoring data available to update each species-specific trend within each regional indicator*.

WGSE should report annually to OSPAR on whether or not the EcoQO has been achieved.

7.3.6 How will the EcoQO be linked to action?

If abundance of 25% or more of species within any of the OSPAR regions have exceeded target levels, WGSE should recommend to OSPAR the best course of action required to reverse those trends. In years when the EcoQO has been achieved, WGSE should take note of any species-specific trend that is outside target levels and consider recommending remedial action to OSPAR. WGSE should utilise monitoring data on demographic parameters, such as breeding success, to provide interpretation of changes in seabird abundance.

7.3.7 Are there any further developments required?

Further collation of data is required for OSPAR II and OSPAR IV, before an indicator could be constructed for these two regions. Expansion of monitoring and the sub-division of OSPAR I is required before sufficient data will be available to construct an effective indicator (see Section 4).

Reference levels and target levels need to be set for each individual regional species-specific trend. Section 8 below describes how these were set for each constituent trend of the indicator for OSPAR III.

WGSE would need to adopt the term of reference recommended above in 7.3.5.

Resources will need to be secured to ensure data analysis is carried out annually to update the species specific trends of each regional indicator.

7.4 Conclusions

The EcoQO on *Seabird population trends as an index of seabird community health* is as follows:

Changes in breeding seabird abundance should be within target levels for 75% of species monitored in any of the OSPAR regions or their sub-divisions.

There will be a separate EcoQO indicator for each OSPAR region, consisting of species-specific trends in abundance for those species with good quality monitoring data available.

Data is immediately available to construct indicators for OSPAR III and OSPAR V. Indicators for OSPAR II & IV could be constructed in the next year or two, once data collation in those regions is completed. It is unclear when an indicator will be constructed for any of the sub-divisions of OSPAR I.

Independent reference levels and target levels will be set for each of the species-specific trends that constitute each regional indicator (see example in Section 8).

8 An example of a regional indicator for the EcoQO on seabird population trends as an index of seabird community health: OSPAR Region III

8.1 Introduction

The aim of this section is to use actual seabird trend data from OSPAR III to construct an indicator of the proposed EcoQO: *Changes in breeding seabird abundance should be within target levels for 75% of species monitored in any of the OSPAR regions or their sub-divisions.*

Following the preliminary analysis that were conducted for WKSEQUIN, data from 14 of the 26 species of seabird breeding in OSPAR III were considered good enough to produce accurate trends in abundance (see Section 4). These data will be re-analysed in this section in order to produce more accurate trends for as many of the 14 species as possible. Target levels of changes in abundance will be set in relation to species-specific reference levels (cf. Section 5). The proportion of species trends that remain within these limits will be used to assess how frequently in the past the proposed EcoQO has been achieved.

8.2 Methods

Data for OSPAR Region III were collected as part of the UK and Ireland's Seabird Monitoring Programme (SMP). The SMP is co-ordinated by the UK Government's advisor on nature conservation – the Joint Nature Conservation Committee (JNCC) - in partnership with other government agencies and non-governmental organisations. SMP data collection is conducted by professional and volunteer observers using standardised methods (Walsh *et al.* 1995). Data can be entered and viewed online at www.jncc.gov.uk/smp. The time-series of most species in the dataset are from 1986 to 2006; but for the five species of tern, data has been regularly collected since 1969 - largely by the Royal Society for the Protection of Birds and BirdWatch Ireland.

8.2.1 Trend estimation

Following WKSEQUIN, the data for the 14 key species in OSPAR region III were re-analysed in order to improve the accuracy of species-specific trends in abundance compared to the preliminary analyses conducted prior to the workshop (see Section 4).

These re-analyses improved upon the preliminary analyses in three significant ways:

i) For species datasets that did not exhibit high rates of colonisation and extinction and displayed some degree of spatial synchroneity (i.e. all species except great cormorant and all the tern species), we used TRIM (Pannekoek & van Strien 2001) to estimate trends. This provided more precise estimates of annual abundance than the Thomas method (see Annex 3).

ii) For each species, separate trends models (either TRIM or Thomas method) were produced (where data allowed) for western Britain and for Ireland, and these national estimates were then summed to produce estimates for OSPAR III. This improved the accuracy of trends at the OSPAR regional level since, for most species, changes in abundance over the last 20-35 years have not been synchronous between the populations in western Britain and in Ireland (see Mitchell *et al.* 2004).

iii) Total population counts of western Britain and of Ireland, obtained during complete censuses (see Table 5), were used to weight estimated national trends (where the latter were obtainable) when computing trends at the OSPAR regional level, and so helped to avoid bias due to differences in sampling intensity between the two countries.

TRIM was used to produce estimates of annual total abundance, y (and s.e.), separately for the sample of colonies monitored in Britain and in Ireland of great black-backed gull, herring gull and black-legged kittiwake; for razorbill, common guillemot northern fulmar and European shag data were too sparse to produce separate estimates for Britain and Ireland separately, in which cases data were pooled for OSPAR region III. TRIM was run for each species using time effects and stepwise deletion of change-points in order to obtain the most parsimonious model. No weighting or co-variates were used and over-dispersion and serial correlation were accounted for. The imputed values were used as the estimates of total abundance of the sample of each geographical area. The data on northern gannet proved too sparse for meaningful trends to be produced using either TRIM or the Thomas method. Plot counts, as well as total counts had been conducted at some colonies and were present in the data for fulmar, shag, kittiwake, razorbill and guillemot. However, plot data were excluded from the TRIM analysis to avoid double-counting. The Thomas method was adapted to analyse plot and total counts from the same colonies without double counting (see Appendix 3). However, trends estimated from the Thomas method were qualitatively similar to those derived using TRIM.

Total abundance in OSPAR III, y, in year j was calculated as follows:

$$y_j = (y_{GBj} / p_{GB}) + y_{IREj} / p_{IRE})$$

where p is the proportion of the population in western Britain (*GB)* or Ireland (*IRE*) contained within the sample of sites that were monitored in each country. The size of the populations in western Britain and Ireland were taken from the results of complete censuses (see Table 5). If the census was conducted in a single year, then p was calculated using the abundance in the sample of colonies estimated in the same year, using either TRIM or the Thomas method. If the census was conducted over more than one year, then p was calculated by computing a weighted average of the ratios of census to estimated values for each year of the census period, with the weights set equal to the proportions of the census counts that were conducted in each of those years.

When using TRIM, the standard error of the estimate of total abundance in OSPAR III, *se*, in year *j* was calculated as follows:

$$se_j = \sqrt{(se_{GBj} / p_{GB})^2 + (se_{IREj} / p_{IRE})^2}$$

We had intended to use the Thomas method to produce estimates of annual abundance of those species that exhibit high rates of colonisation and extinction; i.e. great cormorant and all five tern species. However, with the exception of the Sandwich tern data, we encountered problems in the datasets of these species that prevented the Thomas method from producing meaningful and accurate estimates of annual abundance in OSPAR III. These problems are not insurmountable, but will require further investigation, beyond the scope of this report.

The Thomas method was used to produce estimates of annual abundance, y, separately for the sample of colonies monitored in Britain and in Ireland of Sandwich terns only. Estimates were produced only for years in which at least one colony in each of Britain and Ireland was surveyed. Total abundance of Sandwich terns in OSPAR III, y, in year j was calculated as above. However, uncertainty around the estimates of total abundance in OSPAR III, was estimated using the same bootstrapping procedure that was performed during the preliminary analyses (see Appendix 3).

Estimates of annual abundance of all species were plotted in Figure 5 as a percentage of the respective reference level (see Table 5).

8.2.2 Assessing trend accuracy

The accuracy of the annual estimates of Total abundance in OSPAR III were assessed for each species by comparing the modelled estimates with observed total numbers during years in which censuses were conducted. Close agreement between the modelled data and census data would support the assumption that the sampled colonies provide an unbiased representation of regional trends.

8.2.3 Reference levels

Reference levels were set using population size estimates from Ireland and from western Britain that were obtained during complete censuses (see Table 5). Most species of seabird breeding in Britain and Ireland have been censused three times: during *'Operation Seafarer'* in 1969-70 (Cramp *et al.* 1974), the *'Seabird Colony Register'* census (SCR) in 1985-88 (Lloyd *et al.* 1991) and *'Seabird 2000'* in 1998-2002 (Mitchell *et al.* 2004).

Each species-specific reference level was set by following the recommendations of WKSEQUIN (see Section 5.4): '*They should ideally be set at a level previously observed, preferably prior to any major population change, particularly those that resulted from anthropogenic pressures.*' Justification for choosing each of the reference levels for OSPAR III is given in Table 5.

8.2.4 Setting target levels

In Section 5, WKSEQUIN advised that an upper target of 130% of the reference level should be set for all species, while a lower target level of 80% be set for species that lay one egg and a separate lower target level of 70% for species that lay more than one egg. To each species trend, we applied a series of target levels between 50% and 200% and examined how many years during 1986-2006 each of the targets was exceeded (see Figure 6).

Table 5: Species-specific reference levels for the constituent countries in OSPAR III.

Species Name		Britain Reference levels		Ireland reference levels			
English	Scientific	abundance1	year	abundance1	year	source	Justification for reference level
Northern fulmar	*Fulmarus glacialis*	153385	1998-2000	38910	1999-2000	a	Numbers increased and range expanded throughout most of 20th Century, but plateaued during Seabird 2000 in NW Scotland where there are the largest colonies in OSPAR III; though appears to be still increasing in Wales and possibly in SW England and Ireland.
Herring gull	*Larus argentatus*	73599	1986-87	32816	1985-87	b	Numbers were probably artificially elevated during the 1960s by uncontrolled discarding and offal discharge by fisheries. Subsequent controls were probably responsible for a large decrease during the 1970s and early 1980s. During the 1990s numbers in Ireland were severely reduced during outbreaks of botulism. The population size during the SCR was probably the least impacted by human pressures.
Great black-backed gull	*Larus marinus*	7063	1986-88	3198	1985-88	b	Similar scenario to the herring gull.
European shag	*Phalacrocorax aristotelis*	17246	1986-88	5116	1985, 1987-88	b	Numbers were increasing throughout most of Britain and Ireland, until large mortality event (or 'wreck') as a result severe weather during the winter of 1992/93 severely reduced breeding numbers. Therefore, the SCR provides the best reference level.
Black-legged kittiwake	*Rissa tridactyla*	74002	1985-87	44220	1985, 1987	b	Increased in number between the censuses in 1969/70 and 1985-88, but subsequent food shortages in NW Scotland may have reduced numbers there. Therefore, the SCR provides the best reference level.
Sandwich tern	*Sterna sandvicensis*	1143	1986-88	3467	1984	b, c	The number of birds attempting to breed are highly variable from one year to the next and greatly affected by local conditions (e.g. predation). However, mortality of birds on wintering grounds in W. Africa appears to have increased in late 1980s and early 1990s, partially through trapping. Therefore, the SCR and All-Ireland tern survey (1984) appear to provide the best reference levels.

Species Name		Britain Reference levels		Ireland reference levels			
English	Scientific	abundance1	year	abundance1	year	source	Justification for reference level
Razorbill	*Alca torda*	84133	1998-2001	51530	1999-2000	a	Numbers have steadily increased throughout the 1970s, 1980s and 1990s, and continue to do so throughout most of OSPAR III. Seabird 2000 provided the most recent population estimate, but depending on future changes in population size, subsequent censuses may provide a more appropriate reference.
Common guillemot	*Uria aalge*	380321	1998-2000	236654	1999-2000	a	As for razorbill.

Source: a) Seabird 2000 (Mitchell *et al.* 2004), b) Seabird Colony Register Census (Lloyd *et al.* 1991, Mitchell *et al.* 2004), c) All-Ireland Tern Survey (Whilde 1985). [1]Unit of abundance is pairs for all species except *Alca torda* and *Uria aalge*, which are listed as the number of birds.

8.3 Results

Figure 5 shows the trends of eight species: northern fulmar, European shag, herring gull, great black-backed gull, black-legged kittiwake, Sandwich tern, razorbill and common guillemot. All the trends except for great black-backed gull and sandwich tern showed close agreement with the census data. The trend of both species over-estimated the observed numbers present in OSPAR III during the Seabird 2000 census in 1998-2002. It may be possible, through resampling these data, to derive more representative samples of great black-backed gull and Sandwich tern, but such analysis was not possible within the time-frame of this report. However, for the purposes of demonstrating how the proposed EcoQO will operate, we have retained the trends of these two species in the indicator for OSPAR III.

The annual estimates of abundance of all eight species over the time-series spanning 21 years (1986-2006) were examined in relation to possible target levels in Figure 6. Figure 6 plots the total number of years in from all eight datasets, in which annual estimates of abundance were outside target levels. As the lower target level reduces and the upper target level increases, the number of years in which the target levels were exceeded, decreases sharply, before levelling out. Figure 6 allows us to make a pragmatic assessment of where target levels should be set to ensure that the EcoQO is not triggered too often, still provide an effective trigger for action when substantial changes to the seabird community occur. Examination of Figure 6 suggests that WKSEQUIN's proposed lower target level of 70-80% (depending on clutch size) and upper target level of 130% may both be suitable in the context of OSPAR III (assuming that the variation in abundance in the future is similar to that during 1986-2006)

A lower target level of 70% for species that lay one egg and of 80% for species that lay more than one egg, and an upper target level of 130% for all species, were applied to the eight species specific trends shown in Figure 5. The proportions of species in each year during 1986-2006 that did not exceed either the upper or lower target levels are plotted in Figure 7. The EcoQO was not achieved when the plotted proportion dropped below 75% (= 6 species). Figure 7 shows that the EcoQO was not achieved in seven out of 21 years: during 1988-1990, 1992 and 2003-06. According to the aims of the EcoQO (see Section 3), 'appropriate action' (i.e. research and/or management) would have been triggered. When the lower target level was set more conservatively at 70% for all species, the EcoQO was not achieved in only five years, but this increased to six and nine years respectively when the lower target level was raised to 75% and 80%.

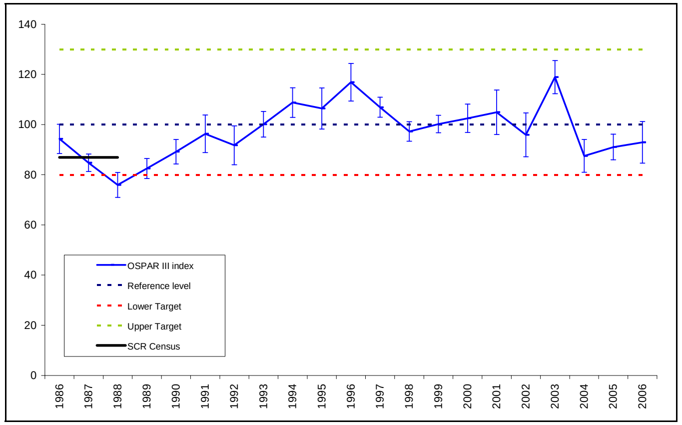
8.4 Discussion

Computing trends in seabird numbers can be analytically challenging, as demonstrated during this exercise. However, there are sufficient monitoring data collected within OSPAR III and in other regions to provide adequate indicators for the proposed EcoQO. The main advantage of the proposed EcoQO is that as new data and improved trend analyses become available, more species can be added to the indicator without having to make any changes to the EcoQO. Likewise target levels can be altered if they prove ineffective, and reference levels can be updated if appropriate, with new census data. Therefore, the indicators informing the EcoQO can be updated and improved when required and when the data allows it, but the EcoQO will remain unchanged. This is an important feature of the EcoQO in enabling consistent communication on its future progress.

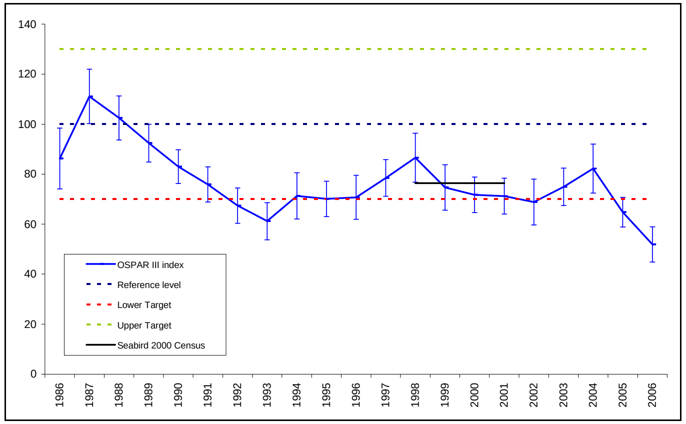
For the OSPAR III indicator, reference levels were derived from census results. In countries where censuses are infrequent or have never been conducted, then reference levels can be derived from estimates of total abundance in the sample of colonies that are regularly monitored.

Figure 7 demonstrates how simply the health of seabird communities in relation to the EcoQO can be communicated. Furthermore, the process of assessing and updating seabird trends annually for the EcoQO will ensure that important changes in individual species do not go unnoticed, even if the EcoQO is achieved in a given year.

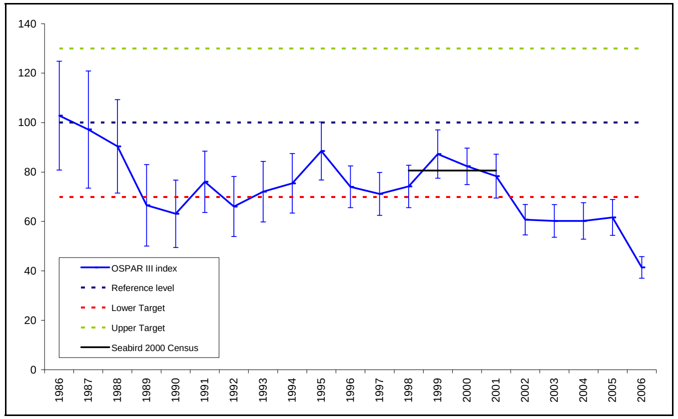
a) Northern fulmar



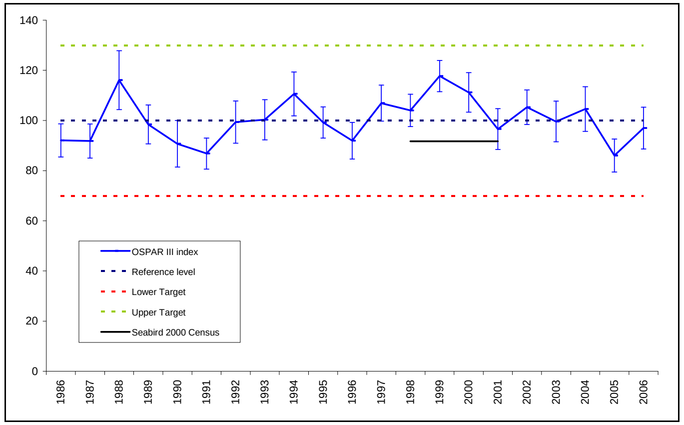
b) European shag



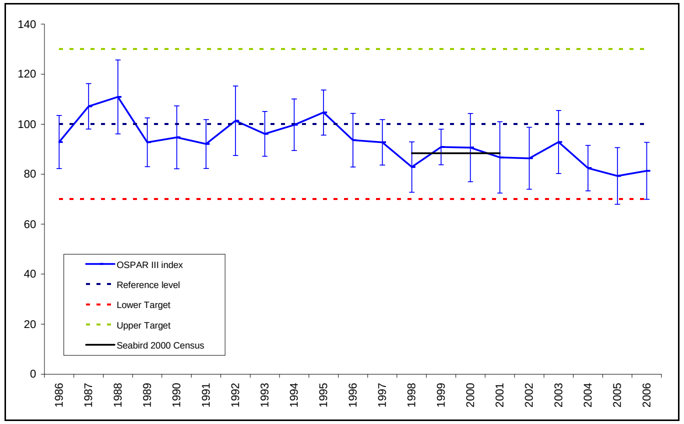
c) herring gull



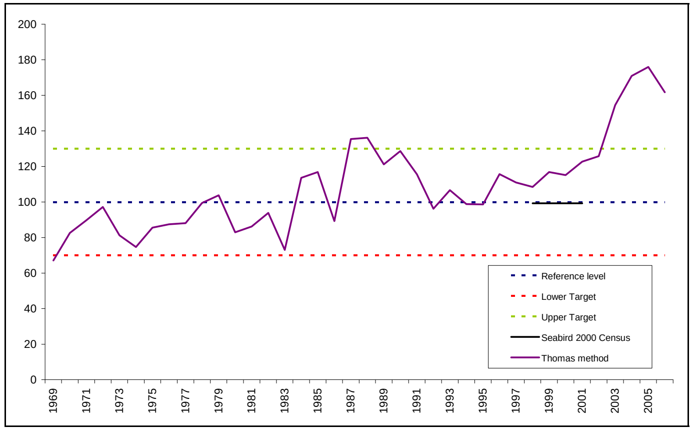
d) great black-backed gull



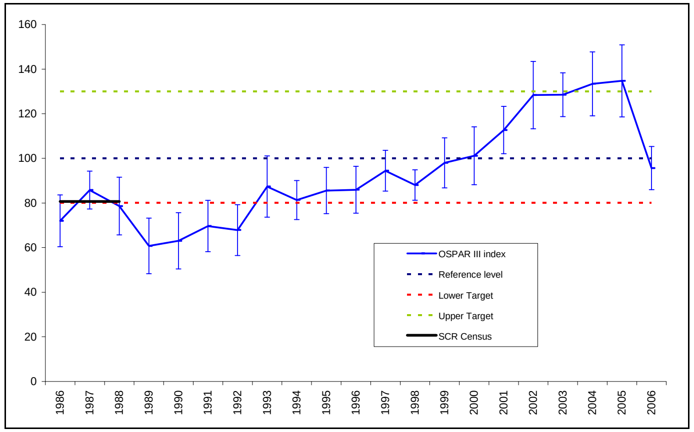
e) black-legged kittiwake



f) Sandwich tern



g) razorbill



h) common guillemot

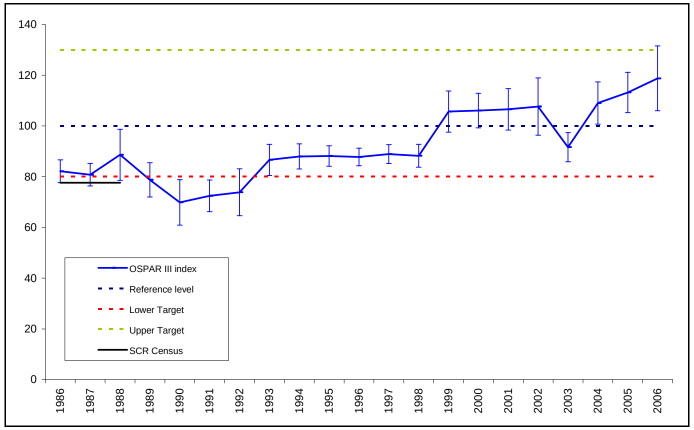
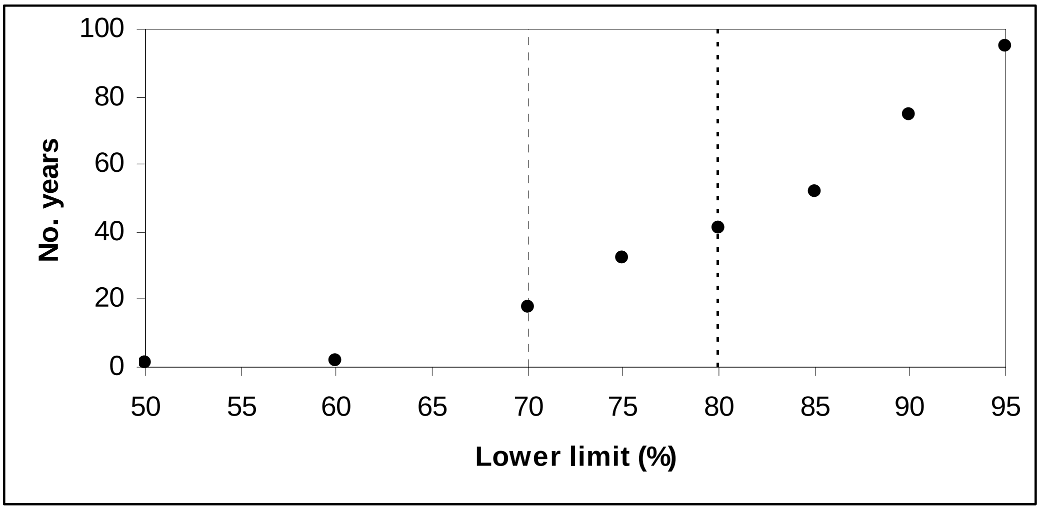


Figure 5: Trends in abundance in OSPAR Region III



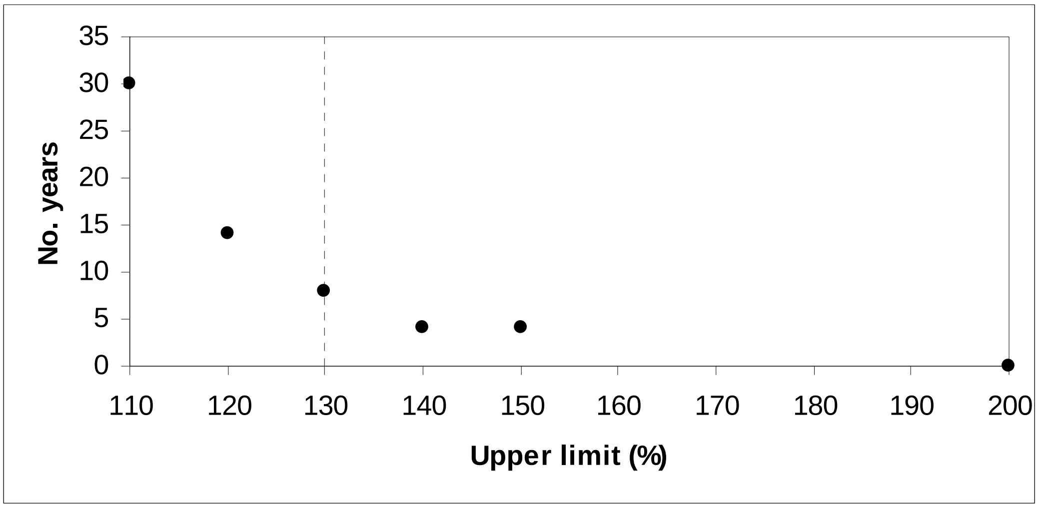


Figure 6: The number of -years in which annual estimates of abundance exceeded a range of lower and upper target levels in a dataset comprising eight species during 1986-2006.

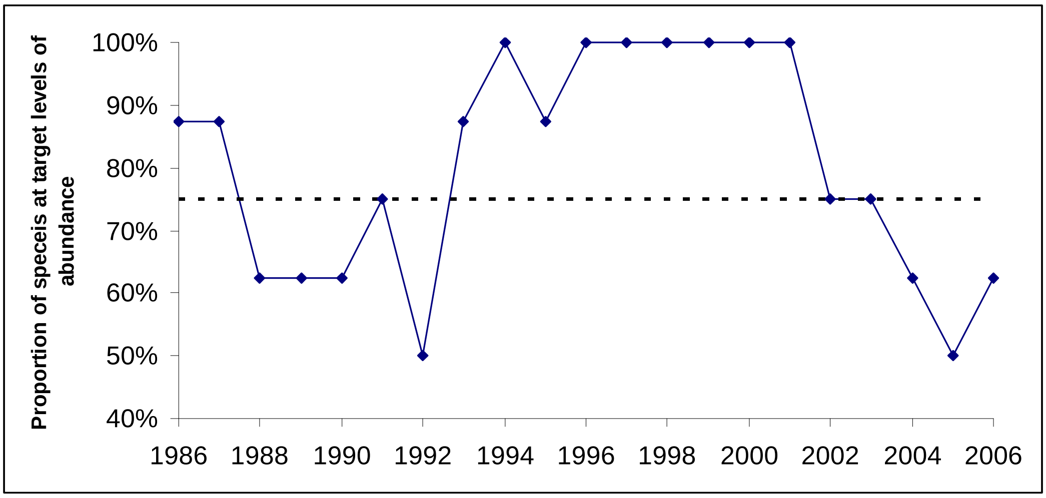


Figure 7: The proportion of species (n=8) in OSPAR III that were within target levels of abundance during 1986 – 2006. The EcoQO was not achieved in years when the proportion dropped below 75%.

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Greenland: extracted from the Greenland Seabird Colony Database by David Boertmann, National Environmental Research Institute, Denmark

Iceland: collated by Arnþór Garðarsson, Institute of Biology, University of Iceland.

Faroe Islands: extracted from the Nordic Seabird Colony Database by Bergur Olsen, Faroese Fisheries Laboratory.

Russia: extracted from the COLONY database by Grigori Tertitskiy, Collaborative Product of Russian-Norwegian seabird network in the Barents Sea Region.

Norway: extracted from the SEAPOP database by Svein-Håkon Lorentsen, Norwegian Institute for Nature Research.

Sweden: collated by Martin Green, Dept. Animal Ecology, University of Lund.

Denmark: collated by Thomas Bregnballe, National Environmental Research Institute, and Mikkel Willemoes, DOF - BirdLife Denmark

Germany: data for Helgoland supplied by Stefan Garthe, Forschungs- und Technologiezentrum Westküste (FTZ), Universität Kiel.

Belgium: collated by Eric Stienen, Research Institute for Nature and Forest (INBO).

France: collated by Bernard Cadiou, GISOM - Groupement d'Intérêt Scientifique Oiseaux Marins (i.e. French Seabird Group) and provided by BV-SEPNB, CEMO, GEOCA, LPO, ONCFS, SEPANSO and the University of Toulouse.

UK & Ireland: extracted from the Seabird Monitoring Programme database by Matt Parsons and Roddy Mavor, Joint Nature Conservation Committee.

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Annex 2: Agenda

DAY 1

09.00 Welcome & house-keeping – Ivan Ramirez (WKSEQUIN Host)
09.15 WKSEQUIN terms of reference, objectives and format – Ian Mitchell (WKSEQUIN Chair)

SESSION 1: Introduction to the EcoQO on Seabird population trends

09.30 Aims of the EcoQO
09.45 Ecometric of the EcoQO – trends in seabird abundance

SESSION 2: Does seabird monitoring provide sufficient data for the EcoQO?

10.00 Computing trends in seabird abundance in each OSPAR region - Ian Mitchell
10.15 Break-out groups[1] – How representative are trends in each OSPAR region?
11.00 *Coffee Break*
13.00 *Lunch*
14.30 Break-out groups continued.

SESSION 3: Setting EcoQO target/reference levels and limits

15.30 – Introduction: What are target/reference levels & limits? How should levels and limits be set? (IM)
15.45 - Break-out groups[2]: What is the best method for setting levels and limits?
16.30 – *coffee break*
16.50 – Feedback from break-out groups re. what is the best method for setting levels and limits?
18.00 – Taxis leave for Hotel Olissipo

DAY 2

09.30 – Review of conclusions from Day 1.

SESSION 4: Selecting 'Key species' for EcoQO

10.00 Break-out groups[1]
11.00 - Coffee break
11.20 - Feed back from break-out groups re. selecting key species.

SESSION 3 continued: Setting EcoQO target/reference levels and limits

12.00 – Break-out groups[1]
13.00 – Lunch

SESSION 5: Constructing the EcoQOs and indicators

14.30 – Discussion involving all delegates
15.30 – Coffee break
15.45 – Break-out groups[1]
16.30 – Final summing up
17.00 – Close

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1 Three breakout groups based on OSPAR regions
2 Three breakout groups of randomly selected participants

Annex 3: Trend analysis methods

Overview

We applied a common, imputation-based, analysis to all species and regions for which data were available at a reasonable number of colonies.

The overall approach was as follows:

- Extracted count data for each colony or plot.
- Converted count data into the "preferred unit" for each species, using a fixed ratio of individuals-to-pairs.
- Combined counts across sites using the Thomas method (see technical details, below), which dealt with missing data by imputing values on the basis of a statistical model. Imputed and observed counts were then summed within each year in order to derive national and regional estimates of abundance.
- Quantified uncertainty using a simulation-based procedure ("bootstrapping").

The trend analysis used for WKSEQUIN was preliminary, and based on a relatively simple approach, and has a number of important drawbacks and caveats (see below). For most, if not all, species further statistical modelling would be required to provide trend estimates that would be sufficiently accurate and robust to provide an indicator for the EcoQO.

It is important to note that the confidence intervals about the estimates obtained using the imputation procedure were typically very wide. This reflected the fact that the method is empirical, and that the intervals were based on a form of nonparametric resampling that makes only weak assumptions regarding the structure of the data. For many species, log-linear models could be used (e.g. through the software package TRIM) to provide more precise estimates of trend, but note that such models are inappropriate for species in which (a) trends exhibit little or no spatial synchroneity or (b) a fair proportion of colonies have undergone extinction or colonisation events. For the UK, plot count and colony-level data are often available at the same location. Parsons *et al.* (2006) combined whole-colony and plot data from colonies in Scotland using a form of Bayesian hierarchical modelling. Bayesian approaches are likely to also be appropriate for other regions, since they provide a powerful and natural approach for dealing with different levels of uncertainty and diverse sources of data, but it would require further work to develop appropriate models.

Important caveats

Our analyses were relatively crude, and based on some fairly strong assumptions, so that the results should be treated with a good deal of care. Here are the main caveats:

1) The Thomas method is based on the assumption that all active colonies have been surveyed at least once. For previous applications (Marchant *et al.*, 2004; Newson *et al.*, 2006) this appeared to be valid, but for some areas of Europe (e.g. northern Russia) we know that there are many unsurveyed colonies. The confidence intervals of the resultant trend estimates did not reflect uncertainty about colonies that have never been surveyed.
2) We assumed that counts were observed exactly and without error. This is clearly untrue, but, except for data from Iceland, we had no reliable estimates for the standard error associated with each count.

3) Both the simple chaining and Thomas methods rely on an assumption that trends at sites with missing data will be synchronous with trends at sites for which data are available. Standard model-based approaches (e.g. Poisson regression models, as implemented in the TRIM package) make broadly similar assumptions, but quantify the uncertainty associated with their estimates in a different way.

4) For a good number of region-by-species combinations the data were very sparse, so that reliable estimates of trends simply could not be obtained.

5) For the Norwegian plot count data, we completely ignore those parts of the colony that had not been included in a plot. A better approach would be to regard them as samples from the whole colony, but this would rely on knowing the proportion of the colony that was represented within each plot – such data were not available for the current analysis.

6) For the UK and Ireland, plot count data were available at colonies for which colony count data were also available, but for the current analysis we treated the plots as distinct sites (although not in the subsequent re-analysis for OSPAR region III – see Section 8). This led to a degree of double counting, and is also likely to have created some difficulties with the estimation of uncertainty

7) We did not deal with uncertainty associated with the ratio of individuals to pairs.

8) We were unable to estimate the proportion of unrecorded colonies that are extinct or uncolonised (p_j), so our results were contingent on assuming a particular value for p_j. We assumed that the proportion of extinct colonies was zero.

Technical details

The data constituted counts taken for each species at each "site" (colony or plot), in each year from 1980 to 2006. These counts were sometimes available, and sometimes missing. For a particular species, let y_{ij} denote the observed count made at site i in year j, where this is available. Where it is unavailable – because the data are missing – we let Y_{ij} denote the corresponding unknown value (which, from a statistical perspective, is a random variable).

The aim of the statistical analysis was to estimate trends in abundance at aggregate scales (provincial, national or international), based on data collected at individual sites. For any pair of years, j and q, our analyses were based on calculating the ratio of overall abundance in year q to that in year j, denoted by -

$$r_{jq} = \frac{\sum_{i \in S_{jq}} y_{iq}}{\sum_{i \in S_{jq}} y_{ij}}.$$

Overall abundance was computed by summing across the set of sites (colonies or plots), S_{jq}, for which counts were recorded in both years j and q.

Simple chaining

The "simple chaining" approach involves summing across the log-ratios associated with consecutive pairs of years, so that

$$I_j = \sum_{q=2}^{j} \log r_{q-1,q}$$
.

The resulting quantity, I_j, is an index of relative abundance, which provides information about trends but tells us nothing about absolute abundance By definition, the value of the index is zero in the first year (so that $I_1 = 0$).

Thomas method

There are various difficulties associated with the simple chaining method. Most importantly, it makes highly inefficient use of the data, since it ignores sites that have not been recorded in consecutive years. If the data are sparse – as they are for many species within OSPAR region I – then the resulting indices will either be incalculable or highly uncertain. More precise estimates can be obtained by also incorporating information from non-consecutive years (Mountford, 1982; Thomas, 1993).

We adopted the approach of Thomas (1993), which begins by imputing each missing data point, Y_{ij}, using the formula

$$Y_{ij} = \sum_{q \in T_i} w_{jq} r_{jq} y_{iq}$$
,

where T_i denotes the set of years for which data are available at site *i*. The weights w_{jq} determine the degree of temporal smoothing.

An estimate of *total* abundance for year *j* was then found by summing both across the observed data (where available) and across the imputed counts (where the data are missing), so that

$$Y_j = \sum_{i \in S_j} y_{ij} + \sum_{i \notin S_j} Y_{ij}$$
,

where *Sj* represents the set of sites that were recorded in year *j*.

Sites that were recorded as extinct or uncolonised (i.e. have a recorded count of zero) were excluded from the calculation. An unknown number of the unrecorded colonies will also be extinct/uncolonised. Marchant *et al*. (2004) and Newson *et al*. (2006), who use the approach of Thomas (1993) to analyse UK heron and cormorant populations respectively, dealt with this issue by including a term p_j which represents the proportion of unrecorded colonies that are actually extinct or yet-to-colonised in year *j*, so that

$$Y_j = \sum_{i \in S_j} y_{ij} + (1 - p_j) \sum_{i \notin S_j} Y_{ij}$$
.

They were able to estimate p_j through the use of auxiliary data on the status of unrecorded colonies. Such data were not available for seabird populations in OSPAR region I. Instead, we fixed this probability at zero, following some exploratory work in which we briefly assessed the sensitivity of our results to a range of possible values for p_j.

Assessment of uncertainty

The imputation process introduced uncertainty. We quantified this uncertainty using a form of bootstrapping (Marchant *et al*., 2004), in which we resampled with replacement across the set of sites. This procedure allowed us to generate confidence intervals for the estimated total abundance Y_j in each year j. We used 1000 bootstrapped samples.

Levels of aggregation

In order for the Thomas method to perform well – in the sense of producing relatively robust and precise results – the calculated ratios r_{jq} should be based on a relatively large amount of data. If the data for the region of interest are sparse then it is possible to use the ratios associated with a larger spatial area – for example, to estimate trends in Greenland we could use the ratios calculated at the level of OSPAR region I. This approach leads to more precise estimates, but it does so by relying on the assumption that trends in the region of interest are synchronous with trends for the remainder of the larger region.

Annex 4: Quality assessment of time-series data on seabird abundance in each constituent country of each OSPAR Region

Table A4.1 OSPAR Region I

SPECIES	ENGLISH NAME	GREENLAND	ICELAND	FAROE ISLANDS	NORWAY	RUSSIA	SVALBARD	FRANZ JOSEF LAND	OSPAR I	NOTES
Fulmarus glacialis	Northern Fulmar	Xa	Xa	Xa	Xa	Xa	Xa	Xa	Xa	data poor but sp. showing widespread declines, so need to increase monitoring effort
Puffinus puffinus	Manx Shearwater	NP	No data	No data	NP	NP	NP	NP	No data	
Hydrobates pelagicus	European Storm-petrel	NP	No data	No data	No data	NP	NP	NP	No data	
Oceanodroma leucorhoa	Leach's Storm-petrel	NP	No data	No data	No data	NP	NP	NP	No data	
Morus bassanus	Northern Gannet	NP	good	(data)	Good[1]	good?	NP	NP	good	
Phalacrocorax carbo	Great Cormorant	NP	good	NP	good	Good[2]	good	good	good	
Phalacrocorax aristotelis	European Shag	NP	(data)	Xb	Xb	Xb	Xb	Xb	Xb	much intraregional variation but low proportion of colonies sampled
Stercorarius pomarinus	Pomarine Jaeger	NP	NP	NP	NP	NP	NP	No data	No data	
Stercorarius parasiticus	Parasitic Jaeger	No data	No data	No data	(data)	No data	No data	No data	No data	
Stercorarius longicaudus	Long-tailed Jaeger	No data	NP	NP	NP	NP	NP*	No data	No data	
Stercorarius skua	Great Skua	NP	(data)	No data	data	data	(data)	No data	No data	
Chroicocephalus ridibundus	Black-headed Gull	NP	No data	No data	No data	NP	NP	NP	No data	
Larus canus	Mew Gull	NP	(data)	no data	Xa	Xa	NP*	NP*	Xa	
Larus fuscus	Lesser Black-backed Gull	NP*	(data)	No data	Xa	Xa	NP	NP	Xa	
Larus argentatus	Herring Gull	NP	No data	No data	Xa	data	NP*	NP*	Xa	plots need to be weighted according to colony size
Larus glaucoides	Iceland Gull	No data	NP	NP	NP	NP	NP	NP	No data	
Larus hyperboreus	Glaucous Gull	(data)	(data)	NP	NP	NP	(data)	No data	(data)	
Larus marinus	Great Black-backed Gull	NP*	(data)	No data	Xa	Xa	NP*	NP*	Xa	
Rissa tridactyla	Black-legged Kittiwake	Xa	Xa	good?	good	Xa	good	Xa	Xa	OSPAR trend depends upon relatively scant data from Iceland, as its numerically dominant

SPECIES	ENGLISH NAME	GREENLAND	ICELAND	FAROE ISLANDS	NORWAY	RUSSIA	SVALBARD	FRANZ JOSEF LAND	OSPAR I	NOTES
Pagophila eburnea	Ivory Gull	NP*	NP	NP	NP	NP	NP*	(data)	(data)	
Sterna hirundo	Common Tern	NP	NP	NP	No data	NP	NP	NP	No data	
Sterna paradisaea	Arctic Tern	data	No data	good	Xa	Xa[3]	No data	data	Xa	
Uria aalge	Common Murre	NP	Xa[4]	Xa	Good	Xa	Xa	No data	Xa	
Uria lomvia	Thick-billed Murre	Xa	Xa[4]	NP	data	data	Good	Xa	Xa	
Alca torda	Razorbill	NP*	Xa[4]	No data	Xa	Xa	NP*	NP*	Xa	
Cepphus grylle	Black Guillemot	Xa	Xa	Xa	Xa	Xa	Xa	Xa	Xa	
Alle alle	Dovekie	No data	NP	NP	NP	NP	No data	Xa	Xa	
Fratercula arctica	Atlantic Puffin	NP*	No data	No data	Good[5]	Xa	No data	No data	Xa	

[1] Increase in trend in Norway at end of time series is 'odd' - look into why this is.

[2] Russian proportion is unknown, so its proper influence on total unknown

[3] Russia mainland looks good, but v restricted to S White Sea

[4] Trends would be more accurate if data from 2007 were included in the trend analysis.

[5] Norway data good but possibly unrepresentative: can't assess.

Table A4.2 OSPAR Region II

SPECIES	ENGLISH NAME	NORWAY	SWEDEN	DENMARK	GERMANY	NETHERLANDS	BELGIUM	FRANCE	UK	OSPAR II	NOTES
Fulmarus glacialis	Northern Fulmar	Good[1]	NP	NP*	good	NP*	NP	Xb[2]	good	good	
Puffinus puffinus	Manx Shearwater	no data	NP	NP	NP	NP	NP	Xb	No data	Xb	
Hydrobates pelagicus	European Storm-petrel	NP?	NP	NP	NP	NP	NP	Xb	No data	Xb	
Oceanodroma leucorhoa	Leach's Storm-petrel	NP?	NP	NP	NP	NP	NP	NP	No data	no data	
Morus bassanus	Northern Gannet	NP	NP	NP	good	NP	NP	good	good	good	
Phalacrocorax carbo	Great Cormorant	good	data	good	good	(data)	NP*	good	good	good	
Phalacrocorax aristotelis	European Shag	good	NP	NP	NP	NP	NP	good	good	good	
Stercorarius parasiticus	Parasitic Jaeger	no data	data	NP	NP	NP	NP	NP	(data)	(data)	
Stercorarius skua	Great Skua	no data	NP	NP	NP	NP	NP	NP	(data)	(data)	
Chroicocephalus ridibundus	Black-headed Gull	no data?	data	(data)	good	good	data	(data)	Xa	Xa	
Larus canus	Mew Gull	Good[9]	Good[3]	(data)	good	good	good	NP*	Xa	Xb	
Larus fuscus	Lesser Black-backed Gull	good	Good[3]	(data)	good	good	good	good	Xa	Xb	
Larus argentatus	Herring Gull	Good	Good[3]	(data)[4]	Data[4]	(data)	good	good	Good[5]	good	Problem separating divergent trends in natural vs. urban.
Larus marinus	Great Black-backed Gull	Good	Good[3]	(data)	NP*	(data)	NP	good	Xa	Xa	
Larus melanocephalus	Mediterranean Gull	NP	NP	NP*	NP*	NP*	NP*[6]	NP*	good	NP*	
Larus minutus	Little Gull	NP	NP	NP*	NP	NP*	NP	NP	NP	NP*	
Larus cachinnans	Caspian Gull	NP	NP	NP	NP	NP*	data	NP	NP	NP*	
Rissa tridactyla	Black-legged Kittiwake	no data?	NP*	NP*	good	(data)	NP	good	good	good	
Sterna hirundo	Common Tern	Xa[7]	Good[3]	(data)	good	(data)	good	good	good	Xb	Need Danish, Dutch and German data
Sterna paradisaea	Arctic Tern	Xa[7]	Good[3]	(data)	good	(data)	NP	NP	Xa	Xa	Missing countries and UK data unreliable

SPECIES	ENGLISH NAME	NORWAY	SWEDEN	DENMARK	GERMANY	NETHERLANDS	BELGIUM	FRANCE	UK	OSPAR II	NOTES
Sterna sandwicensis	Sandwich Tern	NP*	NP	good	good	good	good	good	good	good	Need Waddensee data
Sterna dougalliii	Roseate Tern	NP	NP	NP	NP	NP*	NP	good	good	good	
Sternula albifrons	Little Tern	NP	NP	good	good	good	good	Xb	good	Xb	Need to include Waddensee data
Chlildonias niger	Black Tern	NP	NP	data	NP	(data)	NP	NP	NP	Xa	
Chlidonias leucopterus	White-winged Tern	NP	NP	NP	NP	NP*	NP	NP	NP	NP*	
Uria aalge	Common Murre	Xa	good	NP	good	(data)	good	good	good	Xb	
Alca torda	Razorbill	no data	good	NP	NP*	NP	NP	good	good	good	
Cepphus grylle	Black Guillemot	no data	Xa	good	NP	NP	NP	NP	Xb	Xb	not common outside NE Scotland
Fratercula arctica	Atlantic Puffin	Data[8]	NP	NP	NP	NP	NP	Good[10]	Xa[11]	Xa	Insufficient sampling

[1] Good until 1995.

[2] Brittany counts only; data exist for Normandy but not yet made available.

[3] Good since 2000.

[4] Needs inclusion of Danish and German data, which are good quality, to be reliable.

[5] Requires more detailed inspection of sampling patterns

[6] Inland breeder

[7] Needs to be checked

[8] No data since 1988

[9] Good for coastal colonies

[10] One colony only

[11] Most data from Isle of May

Table A4.3 OSPAR Region III

SPECIES	ENGLISH NAME	IRELAND	UK	OSPAR III
Fulmarus glacialis	Northern Fulmar	data	good	good
Puffinus puffinus	Manx Shearwater	No data	Xb	Xb
Hydrobates pelagicus	European Storm-petrel	No data	Xb	Xb
Oceanodroma leucorhoa	Leach's Storm-petrel	No data	No data	No data
Morus bassanus	Northern Gannet	good	good	good
Phalacrocorax carbo	Great Cormorant	data	data	good
Phalacrocorax aristotelis	European Shag	data	data	good
Stercorarius parasiticus	Parasitic Jaeger	NP	No data	No data
Stercorarius skua	Great Skua	NP*	Xb	Xb
Chroicocephalus ridibundus	Black-headed Gull	Xa	Xb	Xb
Larus canus	Mew Gull	Xa	Xb	Xb
Larus fuscus	Lesser Black-backed Gull	Xa	Xb	Xb
Larus argentatus	Herring Gull	good	good	Good
Larus marinus	Great Black-backed Gull	good	good	good
Larus melanocephalus	Mediterranean Gull	NP*	NP*	NP*
Larus michalellis	Yellow-legged Gull	NP*	NP*	NP*
Rissa tridactyla	Black-legged Kittiwake	good	good	good
Sterna hirundo	Common Tern	good	good	good
Sterna paradisaea	Arctic Tern	good	good	good
Sterna sandwicensis	Sandwich Tern	good	good	good
Sterna dougallii	Roseate Tern	good	NP*	good
Sternula albifrons	Little Tern	good	good	good
Uria aalge	Common Murre	good	good	good
Alca torda	Razorbill	good	good	good
Cepphus grille	Black Guillemot	Xb	Xa	Xb
Fratercula arctica	Atlantic Puffin	Xa	Xa	Xa

Table A4.4 OSPAR Region IV

SPECIES	ENGLISH NAME	FRANCE	SPAIN	PORTUGAL	OSPAR IV	NOTES
Calonectris diomeda	Cory's Shearwater	NP*	?	No data	No data	Mainland Portugal –one complete count in IBA book
Fulmarus glacialis	Northern Fulmar	NP*	?	NP	NP*	
Puffinus puffinus	Manx Shearwater	NP*	?	NP	NP*	
Hydrobates pelagicus	European Storm-petrel	NP*	?	NP	NP*	
Oceanodroma castro	Band-rumped Storm Petrel	NP	?	No data	No data	
Phalacrocorax carbo	Great Cormorant	NP*	?	NP	NP*	
Phalacrocorax aristotelis	European Shag	good	good	No data	good	Widespread in region. Probably no time series for Portugal.
Chroicocephalus ridibundus	Black-headed Gull	good	?	NP	good	But quite small pop; driven by one colony; weight?
Larus fuscus	Lesser Black-backed Gull	Xa	?	(Data)	Xa	Interaction with OSPAR II?
Larus argentatus	Herring Gull	Xa	?	NP	Xa	
Larus marinus	Great Black-backed Gull	Xa	?	NP	Xa	Interaction with OSPAR II?
Larus melanocephalus	Mediterranean Gull	NP*	?	NP	NP*	
Larus michalellis	Yellow-legged Gull	good	No data	(Data)	Good	But small pop; driven by one colony; weight? Bias toward Spain
Rissa tridactyla	Black-legged Kittiwake	NP*	good	NP	good	
Sterna hirundo	Common Tern	good	No data	NP*	Good	Restricted coverage
Sterna paradisaea	Arctic Tern	NP*	?	NP	NP*	
Sterna sandwicensis	Sandwich Tern	good	No data	NP	Good	The majority of the population is in France.
Sterna dougallii	Roseate Tern	NP*	?	NP	NP*	
Sternula albifrons	Little Tern	NP	No data	(Data)	(data)	Ca. 40% of Portugal population monitored annually for last decade
Uria aalge	Common Murre	NP	NP*	NP*	NP*	

Table A4.5 OSPAR Region V

SPECIES	ENGLISH NAME	AZORES/OSPAR V	NOTES
Pterodroma fea	Fea's Petrel	NP*	
Bulweria bulwerii	Bulwer's Petrel	good	One colony counted represents c. 80% of regional pop; but it is small pop at limit of species' distribution
Calonectris diomeda	Cory's Shearwater	Xa	Some data from rafting points counts, so representivity disputed; small colony counts also not representative
Puffinus puffinus	Manx Shearwater	No data	
Puffinus baroli	Macronesian Shearwater	Xa	Macronesian shearwaters are widely distributed in the Azores - breeding in all the islands of the Azores, except Terceira, but only one colony (on Vila islet) has been monitored.
Oceanodroma castro	Band-rumped Storm Petrel	good	Data reflect artificial nest creation (but now ceased, so future trends should reflect sea 'state'?); complicated by taxonomic uncertainty; but well and easily monitored; large % of population monitored; would complement use of terns in basket of species
Larus michalellis	Yellow-legged Gull	Xa	Good spatial coverage, poor temporal
Sterna hirundo	Common Tern	Good	Less volatile than Roseate (at least recently, since most big colonies monitored annually); pretty reliable and stable since mid 1990s
Sterna dougallii	Roseate Tern	Good	Large natural variation; intermittent breeding; fluctuations possibly reflect what is happening in local waters better than e.g. shearwaters; difficult to set limits/targets, so may be better to look at productivity data?

Annex 5: Technical Minutes from the Seabirds Review Group

- RGBIRD
- By Correspondence 14–18 April 2008
- Participants: Nicole le Boeuf, USA (NB), Henrik Skov, Denmark (HS), Kees Camphuysen, the Netherlands (KC)

Overview:

HS: *Given the time and data available and the framework set by the previous work undertaken by WGSE both TORs seem to have been dealt with comprehensively by the workshop. It is, however, clear that the report should be seen as a first attempt to develop indicators based on the Seabird Community Health EcoQO.*

KC: *Overall: compliments, major steps forward have been made.*

NB: *I concur with Henrik's comments regarding viewing this document as a first attempt to develop indicators based on the Seabird Community Health EcoQO.*

Aims and Ecometric of the EcoQO

NB did not understand how declines in populations due to non-human related impacts would be considered by the proposed EcoQO. NB also recommends defining more precisely what 'appropriate action' triggered by the EcoQO would consist of.

ICES response: The EcoQO refers to changes in seabird abundance that may be caused by either anthropogenic or non-anthropogenic factors or both. ICES advice defines 'appropriate action' as research and/or management. It would be inappropriate at this stage to be more precise about the research or management that would be required, since they would be case-specific and highly dependent upon how well the causes of change are understood at the time.

HS described at length why breeding abundance alone would be an inadequate indicator of seabird community health and strongly advocated the use of trends in numbers of seabirds at sea to account for non-breeders during the breeding season and all birds during the non-breeding season. NB also supported the use of such data.

ICES response: the following was included in the advice: *ICES recognises that breeding abundance represents only one aspect of seabird community health, and only partially reflects the state of non-breeding populations. Insufficient data exist to enable trends in non-breeding abundance to be estimated. Data on breeding abundance have been widely collected and trends can be estimated relatively easily.*

KC felt discussion in the WKSEQUIN report on the most suitable ecometric was inadequate and that the arguments for and against the use of breeding success were not fully described.

ICES response: WKSEQUIN recognised that there had been extensive debate on a suitable ecometric for the EcoQO in the past – see WGSE reports 2002, 2003, 2004. Participants of WKSEQUIN agreed with WGSE's recommendation to use breeding seabird abundance. All relevant points raised during discussions are included in section 3.3.2 of the WKSEQUIN report. ICES addressed the use of breeding abundance as the ecometric rather than breeding success in its advice: *ICES recognises seabirds to be generally long-lived and slow to reproduce. Changes in their breeding numbers are a poorer indicator of short term environmental change than are other breeding parameters (e.g. breeding success). Abundance is a good indicator of long-term changes in seabird* *community structure where density dependent effects may reduce the usability of other population parameters.*

Does seabird monitoring provide sufficient data for the EcoQO?

The regional indicators include trends only from species for which good quality monitoring data exist. NB commented: *there seems to be no way to ensure that: species that are at risk of extinction are explicitly included.* NB suggested: *have a feedback mechanism for nations to collect good data, spatially representative data, and perhaps data particular to species that are of highest conservation concern.*

ICES response: Availability of good quality monitoring data does indeed which species can be included in each regional indicator. Species that have been monitored ineffectively or not monitored at all cannot be included in the indicator if there are no data to compute trends from. Identifying gaps in monitoring, though worthwhile, was not within the ToR of WKSEQUIN. Encouraging monitoring is not an explicit function of an EcoQO. As monitoring is expanded to more species, their trends can be included in the indicator without changing the EcoQO.

HS: *Detailed time-series analyses are recommended when undertaking the investigations recommended by the workshop to be conducted into the quality of trends produced from data collected within each sub-division* [of OSPAR Region I]. *Further, it is recommended to test the extrapolations from individual colonies in relation to the ecological heterogeneity across sub-regions.*

ICES response: as demonstrated in section 8, trends derived from a sample of colonies will be tested for geographical bias before being included in any of the regional or sub-regional indicators of the EcoQO.

NB: *There doesn't appear to be a way to estimate and consider how comprehensive the existing "good" data are across the presumed total population of the species. The spatial distribution of the good data relative to the overall population would also need to be considered.*

ICES response: Both these aspects were considered by WKSEQUIN participants when assessing the quality of species-specific trends within each country and each OSPAR Region (see Table1 in section 4.3 of the WKSEQUIN report.)

KC did not agree with the sub-divisions of OSPAR Region I suggested by WKSEQUIN and shown in Figure 4 of their report: *This is a substantial deviation from the traditional ICES sub-areas (note for example that the North Sea is treated as one unit; including extremes as the Shetlands and Belgian shorelines with very different characteristics and ecosystems).* This could result in severing *direct links with data collections on fish and fisheries within ICES. The tiny Faeroese sub-region is not warranted in my view, other than the potential for data collection. I would like to know what makes Jan Mayen be shared with Norway and not Iceland or East Greenland for that matter and how the spike in that sub-region west of Svalbard is to be regarded.*

ICES response: The WKSEQUIN report presented the views of those experts present. As the report points out, further investigation of the use of these sub-divisions is required.

Selecting 'Key species' for EcoQO

KC suggested *a minimum subset of species for each proposed region that would make a balanced indicator and provide availability information with these species for that region.*

ICES response: The approach recommended by WKSEQUIN was to include in each regional indicator all species with accurate trends, while highlighting where bias towards certain ecological niches may occur. The four ecological groups described by WKSEQUIN are very general and most seabird species occupy their own unique niche in the ecosystem. WKSEQUIN concluded that the indicator would be more representative of seabird community health, the more species it included from that community.

Setting EcoQO reference/target levels and limits:

HS advocated the use of dynamic reference levels, which *would have strengthened the assessment of data quality if the workshop had looked into the possibility to separate short-term fluctuations from longer term environmental changes in seabird breeding data, distinguish between local noise versus a larger-scale fluctuating baseline and determine over which timescales significant changes in population structures and distributions are occurring.*

ICES response: ICEs considers that fixed reference levels are sufficient at providing baseline against which target levels can be set. If enough trends are outside the target levels the EcoQO will not be fulfilled and action will be triggered. This action may include research, which will aim to tease out short term perturbations from chronic long-term changes. The use of dynamic reference levels will over-complicate the indicators of the EcoQO. As section 8.4 of WKSEQUIN points out, it is possible to make changes to reference levels without altering the EcoQO. These changes may be required as new information is obtained from future monitoring about the long term population dynamics of individual speceis and certain geograohical populations. This aspect of the EcoQO was recognicsed by NB: *The adaptive nature of the EcoQO is ideally suited to take on new information, while leaving the foundation of the EcoQO intact.*

NB questioned the likliehood of 30% declines in the abundance of species with OSPAR Regions with respect to the target levels set for each regional indicator.

ICES response: the frequency at which species-specific population size in OSPAR III (relative to preset reference levels) declined or increased by specified amounts is included in Figure 6 in section 8.3 of the WKSEQUIN report.

An example of a regional indicator for the EcoQO on seabird population trends as an index of seabird community health: OSPAR Region III

KC: A Section 9: a lovely example, well worked out, but I fear the quality of the underlying data is more unique than is suggested in the report. Not many countries other than the UK and Ireland (perhaps Norway) have long-term datasets available that would make this possible. The method is insightful, however, and it would call for immediate attention now as well as for a period in the past to see what underlies the problems. Note that fluctuations in breeding success "recommended to be monitored" is again behind the horizon, managers will have skipped the parameter years ago with these criteria in hand.

ICES response: It is true that some inadequacies in the UK and Ireland data only came to light when they were analysed fully. The preliminary analyses suggest that we should be able to compute trends in OSPAR IV, V and II as long as all the data are made available. Excluding breeding success from the EcoQO should not discourage managers from monitoring this parameter.