JNCC Report

Strategic Review of the UK Seabird Monitoring Programme

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1. Introduction

1.1. History of the SMP

The Seabird Monitoring Programme (SMP) was set up in 1986 by the Nature Conservancy Council (NCC) to co-ordinate seabird monitoring on a UK wide basis. Its stated aim was: *"to ensure that sufficient data on breeding numbers and breeding performance of seabirds are collected both regionally and nationally to enable their conservation status to be assessed".*

During the mid 1980s it was realised that there was rather poor co-ordination of and focus to the monitoring of seabird populations in the UK. The NCC, in partnership with other organisations, launched a review of seabird monitoring. Four main reasons emerged why seabird populations should be monitored (Tasker 2000):

i. The intrinsic value of seabirds; they have a high public profile and wide appeal.

ii. International obligations. The UK has internationally important populations of seabirds, which we are obliged to protect under measures such as the Birds Directive, Habitats Directive and Ramsar Convention.

iii. Impact of potential threats to seabirds, such as pollution, predators and fisheries.

iv. Seabirds are indicators of the wider state of the marine environment.

With these reasons in mind the then Institute for Terrestrial Ecology was commissioned to make recommendations for the future direction of seabird monitoring, with the following conclusions (Harris, 1989):

- establish a two-tiered monitoring programme, involving four geographically spread 'key sites' at which annual and detailed monitoring would take place, complemented by monitoring of as many other colonies as possible on a more voluntary basis;
- change emphasis away from monitoring numbers towards monitoring breeding performance;
- standardise methods;
- improve coordination and reporting of activities.

By 1989, funding was secured for a full-time SMP Co-ordinator, who was then able to begin to implement the above recommendations that eventually led to the SMP in its current form.

Following the formation of the Joint Nature Conservation Committee (JNCC), HM Treasury conducted a review of the JNCC's Scientific and Secretarial Support Unit (Whittaker *et al.* 1992). This prompted an internal review in 1993 of the Support Unit's Seabird and Cetaceans Branch, followed by an external review in 1994 . The latter concluded: "*the seabird monitoring programme is a vital project which deserves continued secure and adequate funding to ensure monitoring of key seabird species, ensure monitoring of important colonies and provide input to understanding the processes affecting seabirds"* (JNCC 1994).

Subsequently the SMP did indeed continue to be funded and gradually expanded the number of colonies that were contributing data.

In 1999, *Seabird 2000* was launched – the third census of breeding seabirds in Britain and Ireland (Mitchell *et al.* 2004) , which followed on from *Operation Seafarer* in 1969-70 (Cramp *et al.* 1974) and the *Seabird Colony Register (SCR) Census* in 1985-88 (Lloyd *et al.* 1991). Following the completion of Seabird 2000 surveys in 2002, it was considered timely to initiate a strategic review of the SMP to determine whether or not the aims and aspirations of the project at its inception 16 years earlier had been realised. A review of the monitoring requirements for breeding seabirds in the UK would be facilitated by the opportunity to compare the changes measured in SMP's sample of colonies with the changes that occurred in the entire UK seabird population during the same period, between the SCR and Seabird 2000 censuses.

1.2. How is the SMP organised?

The SMP has always been led and co-ordinated by JNCC (formerly by NCC) in partnership with the statutory government conservation agencies and the Royal Society for the Protection of Birds (RSPB), Shetland Oil Terminal Environmental Advisory Group (SOTEAG), The Seabird Group, the Centre for Ecology and Hydrology (CEH, formerly Institute of Terrestrial Ecology) and most recently, in 2006, the British Trust for Ornithology (BTO). Data from seabird colonies in the Republic of Ireland are also collated by JNCC and RSPB, in collaboration with National Parks and Wildlife Service (Dept of Environment, Heritage and Local Government, Republic of Ireland) and BirdWatch Ireland.

Since 1989, JNCC has employed full-time staff to co-ordinate the fieldwork at the key sites and at JNCC's triennial sites (see below), to collate and enter data and to ensure data is disseminated annually.

Each autumn, JNCC organises a meeting of the SMP Liaison Group, made up of representatives from each partner, to report and discuss the current year's monitoring results and any other issues related to the running of the SMP.

1.3. Monitoring of breeding seabird populations

The SMP has established a UK-wide network of colonies (also in the Republic of Ireland) in which seabird numbers and other parameters (see below) are monitored regularly. The SMP covers 26 species (including red-throated diver) and each year receives data from around 200-250 sites (Table 1). This annual sample varies from year to year, depending on the activities of the contributors.

Like other biological monitoring schemes in the UK, the SMP collects abundance data as a measure of the 'state' of the populations it covers, with the view to making inferences about the state of the wider environment. However, what sets the SMP apart from these other monitoring schemes is that it also collects data on demographic parameters (i.e. breeding success and survival) and behavioural parameters (i.e. diet and phenology). The reason being that unlike some other UK vertebrates (e.g. mammals, passerine birds), abundance of seabirds is a very poor indicator of the impact of changes in the wider environment (e.g. human pressures, climate, food supply etc.). Seabirds are long-lived and display a high rate of adult survival, which combine to buffer the size of the breeding population

against perturbations in the highly variable marine environment. Furthermore, seabirds delay breeding until they are 3-9 years old (depending on species), which means that there is a considerable lag in the impacts that environmental change has on population size. However, the impacts on breeding success, survival, diet and phenology are much more acute and instantaneous, which makes these parameters much more effective indicators of impact on seabirds.

Data on survival, diet and phenology are often more difficult and labour intensive to collect than abundance and breeding success data (see Chapter 3). The monitoring of survival, diet and phenology takes place mostly at the SMP's key sites (Table 2) under contracts awarded by JNCC to the following: on Skomer, the Edward Grey Institute of Field Ornithology (Oxford University) and the Wildlife Trust of South and West Wales; on Canna, the Highland Ringing Group; on Fair Isle, the Fair Isle Bird Observatory Trust; and on the Isle of May, the Centre for Ecology and Hydrology.

Triennial monitoring of numbers and breeding success has been undertaken by JNCC staff on Orkney Mainland, on St. Kilda in the Western Isles and on the Grampian coast. In 2005, monitoring on St Kilda was taken over by the National Trust for Scotland.

Other monitoring is carried out by the SMP partners and many other organisations and individuals.

The Royal Society for the Protection of Birds (RSPB) monitors the numbers and breeding success of a range of seabird species throughout the UK on their network of reserves. RSPB has largely co-ordinated the monitoring of terns in the UK and also directed survey effort at European storm-petrels and both species of skuas.

Aberdeen University (under contract to the Shetland Oil Terminal Environmental Advisory Group) has monitored cliff-nesting species and black guillemots in Shetland. Work is funded by the Sullom Voe Association Ltd.

Cormorant colonies have been surveyed annually by the *Cormorant Breeding Colony Survey* – a voluntary scheme organised by Robin Sellers.

JNCC has provided support and encouragement to other seabird surveyors around the UK, partly by contributing to fieldwork costs of volunteers via the Seabird Group.

In the Republic of Ireland, collaborations with the Department of Environment, Heritage and Local Government and BirdWatch Ireland have enabled UK trends to be put in a wider geographical context . Fieldwork at some Irish colonies has been grant-aided by the Seabird Group.

With the exception of the key sites, triennial sites and SOTEAG sites, monitoring sites have been added to the SMP on an opportunistic basis, rather than following any strategic sampling approach.

Table 1: SMP monitoring framework showing the number of sites at which the various parameters are monitored regularly for each species.

Note: For breeding numbers, a site is included in the total only if it is counted at least triennially; annually for breeding success, survival and chick diet.

Species	Breeding numbers	Breeding success	Adult survival	Chick diet
Red-throated diver	11 sites Scotland	11 sites Scotland	0	anecdotal
northern fulmar	24 Scotland, 4 England 10 Wales, 2 N Ireland	24 Scotland, 7 England 2 Wales, 2 N Ireland	0	0
Manx shearwater	1 Wales, 1 IOM	2 Scotland, 2 Wales	1 Wales	0
European storm-petrel	2 Wales, 3 Scotland	1 Scotland	0	0
Leach's storm-petrel	0	0	0	0
northern gannet	3 Scotland	5 Scotland	0	0
great cormorant	13 Scotland, 15 England, 6 Wales, 1 N Ireland, 1 Rep. of Ireland	2 Scotland, 4 England, 2 Wales	0	0
European shag	28 Scotland, 2 England, 3 Wales	15 Scotland, 1 England, 3 Wales	1	2-3
Arctic skua	13 Scotland	27 Scotland	0	anecdotal
Great skua	13 Scotland	16 Scotland	0	limited/anecdotal
Mediterranean gull	5 England, 2 N Ireland	4 England	0	0
black-headed gull	18 Scotland, 26 England, 3 N Ireland	7 Scotland, 10 England	0	0
common gull	49 Scotland (but biased for sw coast), 3 N Ireland	57 Scotland (but biased to sw coast)	0	0
lesser black-backed gull	17 Scotland, 7 England, 10 Wales, 4 N Ireland, 1 Rep. of Ireland	13 Scotland (biased to sw coast), 3 Wales	1	0
herring gull	57 Scotland (biased to sw), 11 England, 13 Wales, 3 N Ireland, 1 Rep. of Ireland	63 Scotland (but biased to sw coast), 3 Wales	1	0

Species	Breeding numbers	Breeding success	Adult survival	Chick diet
great black-backed gull	47 Scotland (biased to sw), 11 Wales, 1 Rep. of Ireland	3 Scotland, 2 England, 3 Wales	0	anecdotal
black-legged kittiwake	55 Scotland, 13 England, 9 Wales, 1 N Ireland, 3 Rep. of Ireland	26 Scotland, 8 England, 6 Wales, 1 N Ireland, 4 Rep. of Ireland.	3	2-3
Sandwich tern	5 Scotland, 16 England, 1 Wales, 3 N Ireland, 4 Rep. of Ireland	3 Scotland, 10 England, 1 Wales, 3 Rep. of Ireland	0	anecdotal
roseate tern	1 Scotland, 3 England, 1 N Ireland, 3 Rep. of Ireland	1 Scotland, 3 England, 1 N Ireland, 1 Rep. of Ireland	0	?
common tern	47 Scotland (w coast bias), 41 England, 4 Wales, 6 N Ireland, 2 Rep. of Ireland	35 Scotland, 26 England, 2 Wales, 3 N Ireland, 2 Rep. of Ireland	0	anecdotal
Arctic tern	64 Scotland (w coast bias), 8 England, 5 N Ireland, 2 Rep. of Ireland	43 Scotland (w coast bias), 5 England, 1 Wales, 2 Rep. of Ireland.	0	anecdotal
little tern	17 Scotland, 39 England, 1 Wales, 2 Rep. of Ireland.	18 Scotland, 39 England, 1 Wales, 1 Rep. of Ireland	0	anecdotal
common guillemot	29 Scotland, 4 England, 10 Wales, 1 N Ireland	8 Scotland, 2 England, 1 Wales.	2	>3
razorbill	27 Scotland, 2 England, 10 Wales, 1 N Ireland	5 Scotland, 1 England, 2 Wales	2	2
black guillemot	17 Scotland (Shetland biased)	3 Scotland, 2 N Ireland, 1 Rep. of Ireland.	0	?
Atlantic puffin	3 Scotland, 2 England, 2 Wales.	3 Scotland, 1 England, 1 Wales	3	3

Table 2: Monitoring activities at Key Sites and JNCC/NTS triennial sites: species coverage and parameters measured.

Site	Breeding numbers –whole colony	Breeding numbers - plots	Breeding success	Adult survival	Prey analysis	Other
Canna	Ful., shag, lbbg, hg, gbbg, kitt, tystie	Shag, kitt, guill, raz. (sub-colony totals)	Ful., shag, hg, gbbg, kitt	See 'other'	% of fish species in guil diet, and mean length of fish	Timing of shag breeding (% nests with eggs in early July), plus some guill data. Return rates and age of first breeding: guil, raz, shag
Isle of May	collected by SNH outwith CEH contract to JNCC	collected by SNH outwith CEH contract to JNCC	Ful, shag, kitt, guil, raz, puff	Shag, kitt, guil, raz, puff	Diet of young shag, kitt, guil, raz and puff (inc size and % of sandeel in diet)	1st egg dates and clutch size of kitt. Adult attendance at kitt chicks. First egg dates of ful, shag, guil, raz, puff. All outwith JNCC contract.
Fair Isle	Shag, gannet, Arctic sk, bonxie, kitt, Arctic tern, raz, tystie (E coast)	Ful, shag, kitt, guil, raz	Ful, gannet, shag, skuas, Common gull, kitt, common & Arctic tern, guil, raz, puff, Tystie (now stopped due to cat pred.)	Puffin, kitt (no longer monitored)	Species comp. of shag, kitt, guil, raz, puff. Feeding rates of puff and guil.	Weights and wing-length of chicks and adults (plus some data on chick growth rates).
Skomer	Ful, lbbg, hg, gbbg, kitt, guil, raz, (puff –outwith contract)	Manx (outwith contract) Ful., lbbg, hg, guil, raz	Manx., Ful., lggb, hg, kitt, guil, raz (outwith contract), puff	Manx, Hg, lbbg, kitt, raz, puff	Feeding rates of puffins	EGI Contract included measurements of weights of raz and puffin chicks and food of puff chicks –but apparently not submitted, at least in recent 4 yrs.
Grampian	Gannet, shag, hg, kitt	Ful, guil, raz	Gannet, kitt	none	none	none
Orkney	kitt	Ful, raz, guil, kitt	Ful, guil, kitt	none	Started guil watches in 2006	none
St Kilda	kitt	Ful, guil, raz	Ful, kitt, puffin reinstated in 2005	none	Started guil watches in 2006	European storm-petrel AOS in Village Bay monitored annually since 2003

Species abbreviations: ful = northern fulmar, bonxie = great skua, gbbg = great black-backed gull, guil = common guillemot, hg = herring gull, kitt = black-legged kittiwake, lbbg = lesser black-backed gull, puff = Atlantic puffin, raz = razorbill, tystie = black guillemot

1.4. How is the SMP funded?

The value of the work carried out by the SMP each year is approximately £515,000 per year (Table 3). Of this, £185,000 is for Key Site monitoring, £200,000 for monitoring other sites and £130,000 for the day-to-day co-ordination, collation of data and dissemination of results. These estimates include staff costs based on 2006/07 figures.

JNCC contributes £170,500 per year or one third of the total value of the SMP. Most of this (i.e. 70%) funds co-ordination, data collation and results dissemination, 23% funds Key Site monitoring and 7% funds monitoring of other sites. So, most of JNCC's contribution funds three full-time staff: Seabird Colony Team Leader, SMP Co-ordinator and SMP Data Assistant. The RSPB also contribute an additional £10,000 of staff time to the collation of data and reporting of results.

Most funding for key site monitoring comes from CEH, the second largest contributor to the SMP – their monitoring on the Isle of May costs £137,000 per year over and above what they receive under contract from JNCC. JNCC contributes a total of £40,000 per year to the five contractors (including CEH) who conduct monitoring at the four key-sites (see Table 3). In addition to CEH, EGI and WTSWW also make contributions to their key site monitoring work (Table 3).

Elsewhere, RSPB and NTS conduct monitoring on their reserves, to a value of £46,000 and £16,000 per year respectively. Monitoring in Shetland by SOTEAG costs £41,000 per year and JNCC contributes a further £12,000 for its triennial monitoring and to fund volunteer expenses. Monitoring at other sites is undertaken by around 100 people, which includes volunteers and staff from a number of different of organisations (e.g. Statutory Country Conservation Agencies, Wildlife Trusts, local authorities). The value of this monitoring is around £85,000 per year, based on each person working 5 days, which would cost around £170 per day to contract out (using JNCC charging-out rates).

Table 3: Annual financial contributions to the SMP by UK partners (e.g. in 2006/07).

Organisation	Item	Total staff time (person days)	Item Cost £	Total Cost £
JNCC	Key site monitoring - all sites	na	39,600	
Fair Isle Bird Observatory Trust	Key site monitoring - Fair Isle	?	No data	
WTSWW	Key site monitoring - Skomer	Not given	2,220a	
CEH	Key site monitoring - Isle of May	Not given	137,014	
EGI	Key site monitoring - Skomer	Not given	6,016	
	Key site monitoring			**184,850**
JNCC	triennial monitoring	20	4,769	
JNCC	Common standards & volunteer contribution (via Seabird Group)	na	6,600	
RSPB	Reserve monitoring	370	46,250	
NTS	Reserve monitoring	149	16,330	
Agency staff and other organisations not listed, plus volunteers	monitoring at various sites throughout UK	500	85,000	
SOTEAG	Monitoring in Shetland	Not given	40,800	
	Monitoring at other sites			**199,749**
RSPB	Data collation and results dissemination.	101	9,913	
JNCC	Co-ordination, data collation and results dissemination.	715	119540	
	Co-ordination, data collation and results dissemination.			**129,453**
Total		**1,855**		**514,052**

1.5. Scope of the review

This review was initiated in 2002 by JNCC to assess whether the SMP's objectives have been met and how they can be best attained in the future. The review would also assess whether the existing aims and reporting of the SMP are still appropriate and how these might be modified to meet current and future demands of conservation action and legislation.

The review was led by JNCC's Seabird Colony Team Leader (PIM) and SMP Co-ordinator (MP), in consultation with the SMP Review Working Group, which consisted of the following:

Dr Jim Reid (chair)	Head of Seabirds & Cetaceans	JNCC
Prof. Sarah Wanless	Leader of Coastal Seas Ecology group	CEH
Dr Catherine Gray	Ornithologist	CCW (representing IAOWG[1])
Dr Helen Baker	Ornithological Advisor	JNCC
Dr Norman Ratcliffe	Senior Research Biologist	RSPB
Dr Chris Wernham	Senior Research Ecologist	BTO

The Group met in January 2003 and in March 2006. Minutes of both meetings are in Appendix 1.

The terms of reference for the Group were a series of key questions:

a. Has the SMP achieved its aims and are the existing aims appropriate for the future?
b. Which species and parameters should be monitored?
c. How representative is the SMP?
d. Are current monitoring methods effective?
e. Are data collated and stored effectively?
f. Is information disseminated appropriately?

From the outset, the Working Group decided that the aim of the SMP (see 1.1), needed to be amended (see below) to more fully describe the future priorities of the SMP. The revised SMP aim is as follows:

The SMP aims to contribute information to enable the appropriate agencies to maintain favourable status of seabird populations in the UK and the Republic of Ireland. It ensures that sufficient data on breeding numbers and appropriate demographic and behavioural parameters of seabirds are collected- both

[1] Inter Agency Ornithological Working Group

regionally and nationally - to enable their population and conservation status to be assessed, and to monitor the impacts of ecosystem pressures.

In addition to incorporating the views of the Review Working Group, the conclusions of this report are also heavily influenced by the recently drafted UK Strategy for Surveillance, Reporting and Research (JNCC 2006). The Surveillance Strategy aims to:

i. provide an overall framework from which a work programme could be developed.

ii. support JNCC's vision and strategic goals for nature conservation (http://www.jncc.gov.UK/page-3033).

The Strategy states the overall purpose of surveillance and reporting is to '*describe the state of the environment, and to identify, and draw attention to, weaknesses which will need to be addressed if the vision and strategic goals are to be achieved. Where changes in the state of the environment have been detected, these can be compared to known causes or pressures'.*

It is therefore important that this review determines whether the SMP currently fulfils its role as a component of that strategy or whether any changes are needed in order for it to do so.

Although the SMP collates data from both the UK and Republic of Ireland, and should continue to do so, this report assesses monitoring activities in the UK only. Since the review is heavily influenced by the UK Surveillance Strategy, it would be inappropriate to use it to make recommendations for monitoring seabirds in the Republic of Ireland. However, there may be some aspects of this review that could potentially be applied to the Republic of Ireland by the SMP's partners there.

1.6. Report structure

In the next chapter we assess whether the SMP has achieved its aims. We examine the current monitoring in terms of species, parameters and geographical coverage and determine if they are sufficient to meet the requirements of national and international obligations and of conserving the integral value of the UK's breeding seabirds.

In chapter 3, we identify additional monitoring that should take place in the future in order to:

- Fill any gaps in monitoring identified in chapter 2.
- Meet future obligations.
- Meet the requirements of the UK Strategy for Surveillance, Reporting and Research (JNCC 2006), with particular reference to monitoring the impacts of ecosystem pressures.

We will assess the feasibility of implementing the additional monitoring, based on the practicality of monitoring methods, the current scale of monitoring and the degree to which this will need to be expanded in the future.

In the final chapter, we summarise the findings of this report and describe how its recommendation should be implemented.

Not covered in this report are issues relating to data collation, storage and dissemination (see terms of reference (e) and (f) in section 1.5 above). The reason being, that since 2002, when this review was initiated, considerable improvements have been undertaken by JNCC to address problems that were identified early on in the process. These include:

- The amalgamation of seabird count data from three separate sources[2] into a single online database (www.jncc.gov.UK/smp).
- Introduction of online data entry for SMP contributors at www.jncc.gov.UK/smp.
- Improvements to the presentation of results in the SMP's annual report *Seabird numbers and breeding success in Britain and Ireland*–first published in Mavor *et al.* (2004).
- Publication by JNCC of an annual booklet *UK Seabirds* summarising the results of the SMP for a non-specialist audience; first published in 2004 – see http://www.jncc.gov.UK/default.aspx?page=3117

Further development work planned includes the improvement of the online delivery of SMP data and summarised results. JNCC's Seabird Colony Team also plan in 2007 to formulate a Communication Strategy to help direct the dissemination of information to where it is most needed.

[2] These sources were the Seabird Colony Register database (SCR – data collected from 1969 to 1998), Seabird 2000 database (1998-2002) and SMP data on spreadsheets (1986-2006).

2. Has the SMP achieved its aims?

In this chapter, we assess the adequacy of the current seabird monitoring in the UK in meeting the requirements of:

a. National and international obligations.

b. Conserving the integral value of the UK's breeding seabirds.

With respect to conserving the integral value of seabirds, we assessed conservation status and identified those species with the greatest need for conservation.

For each species, we used a simple scoring system to quantify their relevance to obligations (see section 2.1) and their conservation status (see section 2.2). The sum of these scores was used to the rank the species in order of their priority for monitoring (see section 2.3). We then examined the adequacy of the SMP at producing trends that are representative of the entire UK population of individual species (section 2.4). This enabled us to determine whether or not high priority species are currently monitored sufficiently to meet requirements a and b listed above (see section 2.5); and identify any inadequacies that will need to be remedied in the future.

2.1. National and international obligations

National and international obligations were defined as follows (cf. JNCC 2006):

- policy commitments entered into by the UK and devolved administrations;
- the provisions of national or European Union legislation;
- obligations entered into as a result of international treaties or agreements.

The obligations that are relevant to the SMP are listed in Table 4. For each, we have specified its surveillance and reporting requirements, the relevant seabird species, the frequency of reporting (and therefore monitoring) required, the geographical scope and the type of data required (e.g. population estimates, population size trends etc).

There is an obligation under UK Government legislation to monitor all species of seabird breeding in the UK. Under the UK Government's Wildlife and Countryside Act (1981) and Wildlife Order 1985 (Northern Ireland), the condition of sites and species within them, that are protected under the Act must be maintained (i.e. at Sites of Special Scientific Interest (SSSI) in Britain and Areas of Special Scientific Interest (ASSI) in Northern Ireland). In 1998, JNCC agreed with the statutory country conservation agencies (whose responsibility it was to designate and maintain the condition of SSSIs and ASSIs) to introduce Common Standards Monitoring (CSM) of the condition of SSSI/ASSI (also for SPA and Ramsar Sites, despite there being no explicit legislative requirement to monitor those).

CSM requires data on trends in abundance of qualifying species at protected sites. CSM is monitoring in the true sense, in that abundance is measured over time and compared against a bench-mark value (e.g. in most cases the abundance at the time of designation). This is used to determine whether or not the status of the listed features at a particular site are favourable (e.g. breeding numbers of a seabird species have remained either stable or increased) or not (i.e. numbers have declined). Site condition is assessed at least every six years.

The other seabird monitoring obligation to the UK Government is for the UK Biodiversity Action Plan (UK BAP – www.ukbap.org.uk). UKBAP is the Government's response to the Convention on Biological Diversity (CBD), signed in 1992. The UK BAP list currently includes two seabirds: roseate tern and red-throated diver (see http://www.ukbap.org.uk/species.aspx). The recent UK BAP Review has recommended that Arctic Skua and Herring gull, be adopted on to the UKBAP list (see http://www.ukbap.org.uk/library/brig/shrw/TerrFwSppGuidance.pdf). For simplicity, we have assumed that these two species are on the UK BAP list.

There is a general requirement from UKBAP to provide information that might help prescribe the most effective measures aimed at halting or reversing population decline as part of Species Action Plans. We have interpreted this as a requirement for UK trends in abundance and breeding success and where possible, data on survival, diet and phenology (Table 4)

The main international obligation for the SMP is the EC Birds Directive (79/409/EEC). The UK Government is required to report on the implementation of the Directive every three years. To date, 243 Special Protection Areas (SPA) have been designated in the UK under Article 4 of the Directive; 95 of these have been designated for their importance to breeding seabirds (Stroud *et al.* 2001). Colonies of all UK breeding seabird species, except black guillemot, are qualifying features of one or more SPAs in the UK, since they are either listed on Annex I of the Directive, or are regularly occurring migratory (ROM) species. As yet, there is no specific requirement to monitor the condition of SPAs, although this is carried out in the UK as part of CSM (see above).

Sites may qualify for SPA designation if they hold an assemblage of seabirds (exceeding 20,000 individuals), or if a species population size reaches a qualifying threshold: for Annex I species this equates to 1% of the national (GB or All-Ireland) population; for ROM species this equates to 1% of the international (biogeographical) population (Stroud *et al.* 2001). The Avian Population Estimates Panel (APEP) was formed with the aim of setting these thresholds using the most up to date population estimates. The most recent of these, APEP II (Baker *et al.* 2006), incorporated results from Seabird 2000 and the SMP.

The relative strength of the statutory obligations for monitoring each species was scored as follows.

1 point for species protected by the Wildlife & Countryside Act, plus an additional 1 point for species listed on Schedule 1; plus

1 point for UKBAP listed species; plus

1 point for species protected by the EC Birds Directive as either ROMS or Annex 1 – listed[3].

These obligation scores were combined with scores for conservation status (see section 2.2 below) to obtain an overall assessment of monitoring priority for each species (section 2.3).

The other obligations identified in Table 4 do not have (as yet) a statutory requirement for information on seabird populations. However, the English and Scottish Biodiversity Strategies and the UK Sustainable Development Strategy all produce indicators[4] that include national and UK seabird population trends in abundance, derived from SMP data. The trends are updated annually and consist of indices of relative abundance rather than estimates of absolute abundance. The Marine Climate Change Impacts Partnership (MCCIP) was recently set up to provide a co-ordinating framework within the UK for the transfer of high-quality marine climate change impacts evidence and advice to policy advisors and decision-makers. JNCC and CEH currently provide an annual summary of the latest evidence for the effects of climate change on the UK's seabirds (see www.mccip.org.uk/arc). However, MCCIP like some of the other obligations in Table 4 (i.e. OSPAR EcoQOs, UKMMAS MOs and the implementation of the EC Environmental Liability Directive) are still being developed. The future relevance of these obligations to the SMP is discussed below in section 3.2.

[3] Annex 1 species were scored the same as ROM species, as equal protection is provided by the EC Birds Directive and the obligations for implementing the Directive in the UK are the same for both groups of species.

[4] UK: http://www.sustainable-development.gov.uk/indicators), England: http://www.defra.gov.uk/wildlife-countryside/biodiversity/biostrat/indicators/pdf/m1-indicator0603.pdf, Scotland: Parsons et al. (2006).

Table 4: National and international obligations relevant to the SMP.

				Data required				
Driver	**Surveillance and reporting obligation**	**Seabird Species**	**Frequency of monitoring & reporting**	**Geographical scale**	**Population size estimates**	**Population size trends**	**Trends in breeding success**	**Trends in other parameters**
Wildlife & Countryside Act 1981; Wildlife Order 1985 (Northern Ireland)	Common Standards Monitoring (CSM) to assess condition of protected site features i.e. SSSI & ASSI (also includes other sites e.g. SPA, SAC, Ramsar)	All are protected as 'wild birds'; special protection afforded to Schedule 1 species: Red-throated diver, Leach's storm-petrel, Mediterranean gull roseate tern, little tern	6 year cycle, currently 2006-2011	Protected sites	Y	Y		
Convention on Biodiversity & World Summit on Sustainable Development	UK Biodiversity Action Plan (UK BAP)	red-throated diver, roseate tern (Arctic skua and herring gull have been proposed)	Ongoing	UK	Y	Y	Y	Y
EC Birds Directive.	SPA Designation	Annex 1 species: red-throated diver, European storm-petrel, Leach's storm-petrel, Mediterranean gull, all UK breeding tern species. All other species (except black guillemot) included as Regularly Occurring Migratory (ROM) species.	Triennial report to EC on progress of implementation in the UK. No monitoring programme yet specified but carried out by agencies as part of CSM.	SPAs in European Union	Y	Y		

Driver	Surveillance and reporting obligation	Seabird Species	Frequency of monitoring & reporting	Data required				
				Geographical scale	Population size estimates	Population size trends	Trends in breeding success	Trends in other parameters
Convention on Biodiversity & Ramsar Convention	Avian Population Estimates Panel (APEP)	EU Birds Directive Annex 1, Regularly Occurring Migratory Species (ROM)	Triennially, APEP III due in 2008	Britain & Ireland	Y			
UK Sustainable Development Strategy	UK Government's *Quality of Life Counts* (i.e. *Populations of wild birds*) that form the UK's Headline Indicator *H13: Wildlife*	Currently 20. Quality of time series data limits number of species.	Annually	UK		Y	?	
UK Marine Monitoring Assessment Strategy (UKMMAS)	Marine Objectives: Birds (under development)	All	Quinquennially	UK	?	?	?	?
Marine Climate Change Impacts Partnership	Annual Report Card: Climate Change Impacts On Seabirds	All	Annually	UK				
England Biodiversity Strategy (EBS)	EBS indicator *M1: Populations of coastal birds and seabirds in England*	Currently uses annual data from 9 species and census data from 15. Quality of time series data limits number of species	Annually	England		Y	?	
Scotland Biodiversity Strategy (SBS)	Natural Heritage Trends: Abundance of breeding seabirds in Scotland (proposed)	13-15 species. Quality of time series data limits number of species	Annually	Scotland		Y	Y	

Driver	Surveillance and reporting obligation	Seabird Species	Frequency of monitoring & reporting	Data required				
				Geographical scale	Population size estimates	Population size trends	Trends in breeding success	Trends in other parameters
OSPAR Ecological Quality Objective	Assess seabird population trends as an index of Seabird community health (still under development)	As many as possible? - Quality of time series data limits number of species	Annually?	NE Atlantic area incl. North Sea	?	?	?	?
EC Environmental Liability Directive	Prevent or remedy environmental damage that has a significant impact on the favourable conservation status of protected species and habitats.	EC Birds Directive Annex 1 and ROM species	No reporting obligation (see Birds and Habitats Directives)	UK	?	?	?	?

2.2. Conservation status

Current conservation status was scored for each species using four of the criteria applied by Gregory *et al.* (2002) to identify bird species of conservation concern in the UK:

a. Decline in breeding population in the last 25 years: 2 points for a rapid decline (≥ 50%) or 1 point for a moderate decline (25-49%); plus

b. 1 point for international importance (≥20% of European breeding population in the UK), plus

c. 1 point for a rare breeder (five year mean of 1-300 pairs breeding in the UK); or

d. 1 point for a limited breeding range (≥50% of the UK breeding population in 10 or fewer sites).

A rare breeder was not scored for a limited breeding range, so 4 was the maximum possible score for conservation status

Gregory *et al.* (2002) considered seabird species that met at least one of these criteria to be of 'medium' conservation concern and those with a rapid decline over the last 25 years to be of high conservation concern. They identified roseate tern to be of high conservation concern. Herring gull was also qualified as 'high' under their criteria, but was published as 'medium', with the caveat that the trend information was regarded as provisional or possibly unrepresentative of the UK at the time of publication.

In order to assess the rate of population decline (i.e. rapid or moderate), both Gregory *et al.* (2002) and ourselves used the percentage difference between UK population size between 1969-70 (Operation Seafarer) and 1998-2002 (Seabird 2000). However, we also used estimates of the annual rate of change during 1986-2006 from the SMP to determine if some species had declined by 25% or more during the last 20 years. We found that Arctic skua had undergone a rapid decline during this period in comparison to the apparent 106% increase between Operation Seafarer and Seabird 2000. Incomplete survey coverage during Seafarer most likely resulted in a considerable underestimate of the UK population in 1969-70.

2.3. Overall monitoring priority

Out of a possible maximum of 8, overall priority scores ranged from 1 for black guillemot, to 7 for roseate tern (Table 5). Species were ranked (in ascending order) by priority score and those in the 1^{st}-35^{th} percentiles were classed as 'Low' priority, those in the 36^{th}-70^{th} percentiles as 'Medium' and the 71^{st}-100^{th} as 'High'. Seven species were 'High' priority (with scores of 5-7), nine were 'Medium' (score = 4) and nine were 'Low' (score = 1-3). The high-low categorisation effectively distinguishes between those with significantly different scores for conservation status (Kruskal-Wallis rank sum test, $\chi^2_{,2} = 17.5137$, $p < 0.001$); those in the high category had a modal score of 3, medium = 2 and low =

1. The high priority category had a modal obligation score of 3 and included all UKBAP listed species and all WCA Schedule 1 species except Mediterranean gull (medium priority). This was significantly higher than the obligation scores of medium and low priority groups (Kruskal-Wallis rank sum test, $\chi^2_{,2} = 15.8879$, $p < 0.001$), which both had a mode of 2.

The conservation status of European storm-petrel and Manx shearwater may have been underestimated because there was no information on trends in the UK population of either species. The first accurate UK population estimate of both were obtained in 1999-2002 (Mitchell *et al.* 2004).

Table 5: Prioritisation of species for monitoring, compared to the adequacy of SMP sampling.

Notes: [1]Conservation priority - population decline: 1= decline of 25-49% and 2 = decline of 50% or more between censuses in 1969-70 and 1998-2002 or during SMP 1986-2005; rare breeder: 1=UK population of 1-300 pairs; limited distribution: 1= 50-100% of the UK breeding population is found in 10 or fewer sites (except rare breeders); international importance: 1=20% or more of the European population breeds in the UK.
[2] Legislative obligation - UK priority = Sum of 1 for UK BAP, plus 1 for WCA species, plus 1 for WCA Schedule 1 species (see Table 4); international priority = 1 for EC Birds directive ROM and Annex 1 species.
[3]Overall priority score = sum of scores for conservation priority and legislative obligation.
[4] Adequacy of sampling: 3 = trends derived from SMP sample are representative at a UK scale, 2 = derived trends are representative at a regional scale only, 1 = derived trends are not representative at a regional or UK scale, 0 = no monitoring is currently conducted.
* trends in abundance at Scottish SMP sites were representative of the trend across the whole of Scotland (Parsons *et al.* 2006).

	Conservation Priority[1]				Legislative Obligation[2]		Overall Priority[3]		Adequacy of sampling [4]				
Species	**population decline**	**Rare breeder**	**limited distribution**	**International importance**	**UK priority (WCA, BAP)**	**International priority (Birds Directive)**	**Priority Score**	**Priority Group**	**abundance**	**breeding success**	**survival**	**diet**	**phenology**
roseate tern	2	1			3	1	7	H	3	3	0	0	0
herring gull	2		1		2	1	6	H	2	1	1	0	0
Leach's storm-petrel	1		1	1	2	1	6	H	1	0	0	0	0
Arctic skua	2				2	1	5	H	3	3	0	0	0
Little tern	1		1		2	1	5	H	3	3	0	0	0
European shag	1		1	1	1	1	5	H	2	3	1	1	1
red-throated diver	1				3	1	5	H	1	3	0	0	0
Great skua			1	1	1	1	4	M	3	3	0	0	0
black-legged kittiwake	1		1		1	1	4	M	3	3	1	1	1

Species	Conservation Priority[1]				Legislative Obligation[2]		Overall Priority[3]		Adequacy of sampling[4]				
	population decline	Rare breeder	limited distribution	International importance	UK priority (WCA, BAP)	International priority (Birds Directive)	Priority Score	Priority Group	abundance	breeding success	survival	diet	phenology
Mediterranean gull		1			2	1	4	M	3	1	0	0	0
razorbill			1	1	1	1	4	M	3	1	1	1	1
Manx shearwater			1	1	1	1	4	M	2	2	2	0	0
northern gannet			1	1	1	1	4	M	2	2	0	0	0
black-headed gull	1		1		1	1	4	M	2	2	0	0	0
lesser black-backed gull			1	1	1	1	4	M	2	2	1	0	0
common gull	1		1		1	1	4	M	2	1	0	0	0
northern fulmar			1		1	1	3	L	3	3	0	0	1
Sandwich tern			1		1	1	3	L	3	3	0	0	0
Arctic tern	1				1	1	3	L	3	3	0	0	0
common guillemot				1	1	1	3	L	3	3	1	1	1
great cormorant			1		1	1	3	L	3	2	0	0	0
European storm-petrel			1		1	1	3	L	1	1	0	0	0
Atlantic puffin			1		1	1	3	L	1	1	1	1	1
common tern					1	1	2	L	3	2	0	0	0
great black-backed gull					1	1	2	L	2	1	0	0	0
black guillemot					1	0	1	L	2	1	0	1	0

2.4. Adequacy of SMP sampling

2.4.1. Abundance

UK population estimates are available for all species of seabird (APEP II – Baker *et al.* 2006) obtained during the Seabird 2000 census during 1998-2002 (Mitchell *et al.* 2004) and from a census of northern gannets in 2003-04 (Wanless *et al.* 2005a). Changes in population size over the previous 30 years were obtained by comparing the results of Seabird 2000 with two previous censuses conducted during 1969-70 (Cramp *et al.* 1974) and 1985-88 (Lloyd *et al.* 1991).

Since 1986, the SMP has measured trends by calculating annual indices of abundance using counts from a sample of colonies, but the sample varies from year to year and not every colony is counted annually.

Recently, Parsons *et al.* (2006) used a Bayesian approach to modelling trends in seabird abundance from the SMP sample data, rather than the chaining method that has been used in the past to measure trends in SMP data (see SMP annual reports e.g. Mavor *et al.* 2006). The main advantages of the Bayesian model over the chaining method are that it is much less wasteful of data, could incorporate both plot counts and whole colony counts from the same colonies and removed any bias due to density dependence.

However, Parsons *et al.'s* (2006) model could not be applied to data on great cormorants and terns that show low site fidelity. In such cases, chaining was the only appropriate method available. Nevertheless, it provided reasonably accurate trends for these species when compared with census data. Further development work would be desirable in order to find a robust method for describing trends in counts of terns and cormorants.

In Table 5 we scored each species on how representative the trends in abundance obtained from the current sample of colonies are of trends in the whole UK population. We based the scores for some species partly on analyses carried out by Parsons *et al*. (2006), in which they fitted trends to SMP count data from Scottish colonies during 1986-2004 and compared these trends with the changes in size of the entire Scottish population that occurred between the censuses in 1985-88 and 1998-2002. Broadly speaking, there was a close match between the trends estimated from the SMP sample data and from the census results. Therefore, in Table 5, we have indicated those species included in Parsons *et al's* (2006) study with * and gave them a score of at least 2, but increased this to 3 if the number and distribution of colonies sampled elsewhere were probably sufficient to produce trends representative of the UK. At the time of writing, funding ahs been secured that will enable Parsons *et al's* (2006) approach to be applied to SMP data from the whole of the UK (due for completion in Spring 2008) and therefore, check if our subjective assessment was correct.

For species not included in Parsons *et al.'s* (2006) analysis, we based scores solely on the number and distribution of sample sites given in Table 1. A score of 3 denotes that the number and distribution of colonies monitored are probably sufficient, in that their average trend is not significantly different (i.e.

it is representative) from the average trend across the whole of the UK. A score of 2 denotes that the distribution of monitored colonies is probably not widespread enough to be representative of the UK, but is sufficient to produce trends that are representative of certain regions. A score of 1 indicates that too few colonies are monitored to have any confidence that the average trend is representative for a wider region or the UK. A score of 0 indicates that no monitoring takes place.

The SMP's sample of colonies has produced trends (1986-2004) that were representative of the UK population trend for 13 species (Table 5). These included only three of the seven high priority species. Herring gull and European shag monitoring was representative only at a regional scale and only one Leach's storm-petrel colony – on Dun, St Kilda - has been monitored. Sampling of herring gull colonies was biased towards many small to medium sized colonies in southwest Scotland, though monitoring was more widespread in England and Wales (Table 1). Sampling of European shag colonies in Scotland has produced trends that were representative of the population throughout Scotland (Parsons *et al.* 2006); but only five colonies are monitored throughout the rest of the UK (Table 1). Red-throated diver was given a score of 1 for adequacy of sampling in Table 5, because we were unable to make any assessment of whether or not the SMP sample of breeding sites was representative of the UK population. There was no recent trend in the size of the UK population with which to compare the trend from the sample - the last UK survey was conducted in 1994 (Gibbons *et al.* 1997).

Sampling of seven other species was also biased towards certain regions (or countries) (Table 5), so probably did not produce trends that were representative across the whole of the UK. Abundance of European storm-petrel and Atlantic puffin has been monitored at too few colonies to estimate trends outwith those colonies.

2.4.2. Breeding success

Trends in breeding success during 1986-2006 were estimated for 16 species from the SMP sample of colonies in Scotland. This work was completed as part of further development to the Scottish Seabird Indicator funded by SNH and the Scottish Executive (see Parsons *et al.* 2007). All species, except black guillemot, showed significant trends in breeding success over time (calculated using general linear mixed models). There was also significant regional variation in breeding success in nine species – northern fulmar, European shag, great cormorant, great skua, black-legged kittiwake, common tern, Artic tern and common guillemot. There was no significant regional variation in breeding success of Arctic skua and little tern; and data were too sparse for any regional trends to be discerned for Manx shearwater, Sandwich tern razorbill and Atlantic puffin.

At the time of writing, funding has been secured to conduct a similar analysis of breeding success throughout the UK sample of colonies, as part JNCC's proposed development of the UK Seabird Indicator.

Frederiksen *et al.* (2006) found that regional variation in breeding success of black-legged kittiwakes breeding throughout the UK was related to

dependency on local sandeel stocks; i.e. the breeding success of adjacent colonies feeding on the same sandeel stock was more similar than at other nearby colonies that were dependant on different sandeel stocks. It is possible that other species that rely on sandeels exhibit similar patterns of variation in breeding success. Seabirds that feed on prey other than sandeels may exhibit a very different regional pattern in breeding success. However, whatever the underlying cause of regional variation in breeding success within a species, the sample of colonies monitored by the SMP needs to accurately represent this variation.

In order to assess the adequacy of sampling of breeding success, we had to adopt a different approach to the one used above to assess the adequacy of sampling abundance. It is impossible to measure the productivity of the entire UK population of a species, with which to compare estimates of breeding success from the SMP sample of colonies. However it is possible to investigate whether particular colonies produce significant bias in the sample and therefore provide a skewed estimate of the trend in breeding success across the UK. Anker-Nilssen *et al.* (1996) used Monte Carlo simulations to identify sources of bias in the Norwegian seabird monitoring programme. Unfortunately no such analysis has been possible for the UK dataset.

In the absence of such analyses, we subjectively assessed how representative trends in breeding success from monitored colonies were at a regional and UK scale. Coverage of 11 species was considered sufficient to represent trends in breeding success across the UK (Table 5) these included all the high priority species except for herring gull and Leach's storm-petrel. Breeding success is measured at very few herring gull colonies to provide estimates of trends outwith those colonies. Trends in breeding success have yet to be obtained at any colony of Leach's storm-petrels, but the first measurements are being undertaken on St Kilda by the National Trust for Scotland during 2007. For six other species, monitoring was biased towards particular regions or countries and awarded a score of 2; seven other species scored 1 (Table 5).

2.4.3. Adult Survival

Adult survival has been estimated in eight species, but only two – herring gull and European shag were considered a high priority (Table 5). For each species, only 1-3 colonies have been monitored (Table 1). Coverage was limited to the SMP key sites due to the difficulty of measuring survival rates (see section 3.5.4). Therefore, seven of the eight species were given a score of 1 i.e. derived trends are not representative at a regional or UK scale. However, trends in survival of Manx shearwaters were considered representative at a regional scale. Manx shearwater survival has been estimated only on Skomer, Pembrokeshire – the largest of four adjacent colonies that hold almost half of the UK breeding population. It is reasonable to assume that survival of shearwaters on Skomer is not significantly different from those breeding on the neighbouring islands, since the main causes of adult mortality (e.g. senescence, disease) probably operate away from the colonies.

2.4.4. Diet

Chick diet has been monitored in six species, of which only European shag was considered a high priority (Table 5). For each species, diet was recorded at only 2-3 of the key sites; although studies of common guillemot chick diet were started in 2006 at four sites on Orkney and on St Kilda (Table 1 and Table 2).

2.4.5. Phenology

Accurate phenology data have been collected only on the Isle of May (SMP key site) for six species (Table 2 and Table 5) and at Sumburgh Head, Shetland for common guillemot. In addition, on Canna (SMP key site), the percentage of shag nests containing eggs in early July has been recorded as a proximate measure of the onset of breeding that is compared from year to year. Of the six species currently monitored, only European shag was considered a high priority.

2.5. Conclusions

The statutory requirements for information from the SMP under the Wildlife & Countryside Act, UK BAP and the Birds Directive, are as follows:

a. Trends in abundance at protected sites as part of CSM – includes all UK breeding seabird species.

These data are collected, primarily by the statutory country conservation agencies, often in collaboration with the SMP and its partners.

b. UK population size estimates of all UK breeding seabird species.

The most recent estimates were obtained in 1998-2002 during the Seabird 2000 census and used to inform APEP II.

c. Trends in UK population size and breeding success, plus information on other demographic and behavioural parameters (e.g. survival, diet and phenology) of UKBAP-listed species: red-throated diver, Arctic skua, roseate tern, herring gull.

The SMP has estimated UK trends in abundance and breeding success of roseate tern and Arctic skua and in breeding success of red-throated diver. The monitoring of abundance and breeding success at herring gull colonies is currently inadequate to produce estimate s of UK trends. It is also unclear if trends in abundance of red-throated divers at sampled colonies were representative of UK trends. There has been almost no monitoring of other demographic and behavioural parameters of all four UK BAP species.

The conservation status of UK seabirds has been monitored by collecting annual data on abundance and breeding success from all 26 species. The current sample of colonies is probably adequate to produces estimates of UK trends in abundance of 13 species and in breeding success of 11 species from 1986 onwards. These include only three of the seven species considered a high priority for monitoring, in terms of statutory obligations and their conservation status. High priority

species: Leach's storm-petrel, European shag, red-throated diver and herring gull have been inadequately monitored to provide accurate UK trends in abundance and breeding success. However, an indication of long-term trends in the UK population size of all species (except Manx shearwater and storm-petrels) is provided by the comparison of three complete census of breeding seabirds in Britain and Ireland conducted in 1969-70, 1985-88 and 1989-2002. The lack of information on long-term trends in the numbers of European storm-petrel and Manx shearwater, has meant that their conservation status and therefore, their monitoring priority may have been underestimated.

Few data on survival, diet and phenology have been collected by the SMP. Most data have been collected at the SMP's Key Sites. However, these data have provided an important insight into the interaction between seabirds and the marine environment.

The main achievement of the SMP has been to maintain a wide focus on species-specific trends, while still concentrating most on those species that are priority in terms of conservation status and statutory obligations. ICES (2007) point out that *'recognition of conservation concern is dependent on monitoring of all species, and so effort should not be directed exclusively to species of current conservation concern otherwise future declines of other species may go undetected.*.' Since seabirds are long-lived, show high adult survival and low levels of productivity, impacts on seabird population may take several years before they are evident in trends in the size of the breeding population, by which time it may be too late to act to reverse the decline. Likewise, if no monitoring had been carried out previously, it would prove very difficult to determine quickly the cause of the decline. It is also possible that species currently considered of low priority may become more of a priority in the future. But, without existing long-term surveillance, even at a low level, it would be very difficult to design future monitoring strategies and conservation action.

The SMP represents good value for money. The current monitoring should be continued, but additional monitoring will be necessary to remedy the several inadequacies identified above. Further additions may be required to meet new obligations and other initiatives – these are identified and discussed in the next chapter.

3. Additional seabird monitoring

In this chapter we identify additional monitoring that should be part of the SMP from now on. The future requirements of the SMP were identified as follows:

- Remedy the current inadequacies identified in chapter 2.
- Meet future national and international obligations.
- Meet the requirements of the UK Strategy for Surveillance, Reporting and Research (In draft, JNCC 2006).

Given that resources for the SMP are limited, a degree of pragmatism is required in order to balance between what additional monitoring is required and what is feasible, given the constraints of resources and the intrinsic problems related to monitoring seabirds. We will assess the feasibility of implementing the additional monitoring, based on the practicality of monitoring methods, the current adequacy of sampling[5] and the degree to which this will need to be expanded.

3.1. Requirements for remedial action

In chapter 2, we identified several inadequacies in the monitoring conducted by the SMP. The following remedial action would be required:

- Expand coverage of annual monitoring of abundance of Leach's storm-petrel, red-throated diver (possibly), European shag and herring gull in order to obtain estimates of trends in the size of UK populations.
- Expand coverage of annual monitoring of breeding success of herring gull and continue newly instigated monitoring of Leach's storm-petrel on St Kilda in order to provide a more representative sample of the UK populations.
- Instigate monitoring of breeding numbers of European storm-petrel and Manx shearwater in the UK in order to more accurately assess their conservation status.
- Monitor survival, diet and phenology of all four UK BAP species to better inform the respective Species Action Plans.

3.2. Future requirements of national and international obligations

The Wildlife and Countryside Act, UKBAP and the EC Birds Directive will remain the key statutory drivers for the SMP, with the respective obligations remaining the same as at present (see section 2.1). The only significant change may be a statutory obligation from the Birds Directive to assess the Favourable Conservation Status (FCS) of bird species (as is currently undertaken under the Habitats Directive) and to monitor the condition of SPAs. Assessing FCS will

[5] Adequacy of sampling to produce accurate estimates of UK trends.

probably be based on trends in abundance and there may be a requirement for more representative sampling (at a UK level) of some species (i.e. those with an adequacy of sampling score of less than 3 – see Table 5). Monitoring of SPAs is already conducted in the UK by the statutory country conservation agencies as part of CSM, so this new obligation, when in force, will have little effect on current seabird monitoring.

Population estimates of all UK breeding seabirds will need to be updated in order to the requirements of the Wildlife and Countryside Act and EC Birds Directive. The Avian Population Estimates Panel (APEP) aims to update 1% threshold values every three years. However, it is unrealistic to expect seabird censuses to be conducted more frequently than at present, let alone every three years to coincide with APEP. Given the large degree of change in the numbers of some species that has occurred between censuses, it would appear that the national and international significance and vulnerability of some colonies may be underestimated. It would therefore be desirable if UK population estimates could be updated more frequently than every 15 years.

There are statutory drivers currently under development that will require objectives or targets to be set for the state of seabird populations in the UK. The SMP will need to provide trends on the state of these populations so that progress towards the targets can be assessed. These drivers include the UK Marine Monitoring Assessment Strategy (UKMMAS). One of its features will be a series of Marine Objectives (MO), some of which will require seabird population state indicators. The UK has yet to decide how it will implement the EC Environmental Liability Directive (2004/35/CE), which aims to establish a framework of environmental liability based on the 'polluter-pays' principle, to prevent and remedy environmental damage. Under article 2 of the Directive, 'environmental damage' refers to "*damage to protected species and natural habitats, which is any damage that has significant adverse effects on reaching or maintaining the favourable conservation status of such habitats or species"*. In this context, 'protected species' refers to those listed in Annex 1 or ROM Species in the EC Birds Directive (see Table 4). Favourable conservation status has yet to be defined for species of bird in the UK and will require information on population state from the SMP. On an international scale, the OSPAR Convention for the Protection of the Marine Environment of the North-East-Atlantic is currently developing an Ecological Quality Objective (EcoQO) on '*Seabird population trends as an index of seabird community health in the North Sea'*. This will also set target levels for the state of breeding seabirds populations in states bordering the North Sea (and possibly the NE Atlantic coast of Europe), including the UK. The first draft of this EcoQO is expected in spring 2008.

Trends in abundance or estimates of population size are usually used as 'state indicators' of bird populations. Indeed, the wild bird indicators for the English and Scottish Biodiversity Strategies and the UK Sustainable Development Strategy are all derived from trends in abundance including those of seabirds estimated from SMP data. These existing indicators will provide a basis from which SMP data can be used to inform the new obligations outlined above. JNCC will be conducting improvements to the current seabird indicators for the UK and England by applying the same approach we used for the Scottish Biodiversity

Strategy's Seabird indicator for Scotland (Parsons *et al.* 2006). The improved indicators will be published in Autumn 2008.

There is an expectation from policy-makers that state indicators are based on trends in abundance. However, other demographic parameters such as breeding success and survival, could be used as effective state indicators. Survival is measured at few colonies and is difficult to estimate (see below), but breeding success is much less difficult to measure and more widely monitored by the SMP in terms of number of species and number of colonies (see chapter 2). Indeed, JNCC, RSPB and CEH have recently developed an indicator for the Scotland Biodiversity Strategy composed of breeding success trends of 16 species. It is also feasible to envisage a greater role for breeding success data in the assessment of site condition for CSM and for the setting of goals/targets by initiatives such as UKMMAS and OSPAR. Indeed OSPAR is currently developing an EcoQO based on the breeding success of black-legged kittiwakes in the North Sea.

There are also obligations to provide interpretation of changes in seabird abundance. Recommending conservation action to halt declines in the size of seabird populations is a key part of CSM on an individual-site basis and of UKBAP on a UK-wide basis. Interpretation of SMP data at a UK scale will continue to form a part of MCCIP's reporting. It is also likely that as OSPAR EcoQOs and UKMMAS MOs are developed, there will be even further demand for information on the causes of change to better inform policy. This will give added weight to the drivers for monitoring the impacts of pressures described in the next section.

3.3. Requirements of the UK Strategy for Surveillance, Reporting and Research

The draft UK Strategy for Surveillance, Reporting and Research (JNCC 2006) aims to provide the necessary information to fulfil the requirements of three main drivers:

- Nature conservation objectives.
- Measuring the impact of ecosystem pressures on biodiversity in order to help influence the human activities responsible.
- National and International obligations for assessing the status of protected species and habitats.

The requirements of the SMP to monitor the conservation status of seabirds and to meet its obligations have already been discussed above. It is also desirable that the SMP meets the UK Surveillance Strategy's aim of monitoring the impacts of ecosystem pressures. The UK Surveillance Strategy uses the same five categories of ecosystem pressures as identified by the Millennium Ecosystem Assessment (www.maweb.org):

i. Habitat change

ii. Climate change

iii. Invasive species

iv. Over-exploitation

v. Pollution (nitrogen/phosphorous)

The Surveillance Strategy aims to prioritise monitoring of those species that provide an indicator of the impact of one or more of these pressures and the human activities that create them. In order to identify those seabird species that could potentially act as impact indicators, we scored each species on the magnitude of the impact of each pressure (see

Table 6). The scores were based on a review of the available evidence on the impacts of each pressure on seabirds in the UK (see Appendix 2). The scoring distinguished between impacts that are absent or negligible, proven or suspected to be low, and proven or suspected to be substantial.

Table 6 provides a guide to ensure that additional monitoring instigated to monitor pressures, concentrates on those species that are likely to provide the best indicators of impacts. In Appendix 2 each pressure is broken down into the human activities that create the pressure and each species is scored on the magnitude of impact of each activity. This provides a more detailed insight into how monitoring certain species may be used to inform specific policies and action. For example, over-exploitation of fish stocks by commercial fishing was shown to have a significant effect on the survival and breeding success of black-legged kittiwakes breeding on Scotland's North Sea coast (Frederiksen *et al.* 2004a). The information on survival and breeding success was collected as part the SMP's long-term key-site monitoring on the Isle of May. It was used to inform fisheries policy and as a result, sandeel fishing in the north-western North Sea was banned by the UK Government in 2000 and the resumption of fishing will be dependent on the recovery of kittiwake populations along the North Sea coast of Britain.

Another way of ensuring a wide range of pressure impacts are monitored, is to concentrate monitoring on species from a range of ecological niches. ICES (2007) suggested such an approach and recommended that niches be based on feeding area (i.e. pelagic or deep water versus near-shore or shallow waters) and on feeding behaviour in the breeding season (i.e. diving, plunge-diving or surface-feeding). The species within each niche are listed in Table 7.

In order to monitor the impacts of pressures on seabirds, it will be necessary to monitor changes in parameters other than abundance. While trends in abundance are effective state indicators, they are poor 'impact indicators'. The reason being, that seabirds have evolved K-selected life-history strategies, so that the size of the adult breeding population is buffered against the considerable changes that occur in the marine environment from one breeding season to the next. Like many K-selected animals, seabirds are long-lived, due to a high annual rate of adult survival, and so only low rates of annual recruitment are required to maintain the size of the breeding population. This means that seabird populations can withstand low levels of recruitment resulting from poor breeding success and/or low post-fledging survival. Therefore, any impact on breeding success and/or post fledging survival is unlikely to have a significant effect on breeding population size, unless it is sustained over a number of years. But the fact that seabirds do not reach maturity until they are 3-9 years old (depending on species) means that there is a considerable lag in such impacts becoming evident in trends in population size. Demographic parameters such as breeding success and survival, and behavioural parameters such as diet and phenology provide much more immediate indicators of impact. These demographic and behavioural parameters are not subject to the same buffering or lag effects that make trends in seabird abundance such poor impact indicators.

Collecting multiple parameters for the same species has the added value that long-term, simultaneous monitoring data can be used to interpret changes in population size that will provide better advice on the most appropriate conservation action required to halt or reverse declines.

So, in summary, other parameters should be measured as well as abundance because:

i. They are better impact indicators than abundance
ii. They provide an early warning of future possible changes in abundance.
iii. When measured along with abundance of the same species they can be used to provide interpretation of change

Table 6: The magnitude of the impacts from pressures on breeding seabird species in the UK.

Note: 0 = impact absent or negligible; 1 = proven or suspected to have a low impact; 2 = proven or suspected to have a substantial impact. **See Appendix 2 for more details of the impact assessment.**

	Impact from ecosystem pressures				
Species	**Climate change**	**Habitat transformation**	**Invasive alien species**	**Over-exploitation**	**Pollution**
red-throated diver	2	2	1	2	1
northern fulmar	1	1	0	2	1
Manx shearwater	1	0	2	1	1
European storm-petrel	1	0	2	1	1
Leach's storm-petrel	2	0	2	0	1
northern gannet	1	0	1	2	1
great cormorant	1	1	1	2	1
European shag	2	1	1	2	1
Arctic skua	2	1	2	2	1
Great skua	1	1	2	2	1
Mediterranean gull	1	1	2	1	1
black-headed gull	1	2	2	1	1
common gull	1	2	2	1	1
lesser black-backed gull	1	1	2	2	2
herring gull	1	1	2	2	2
great black-backed gull	1	1	2	2	1
black-legged kittiwake	2	1	0	2	1
Sandwich tern	2	1	2	1	1
roseate tern	2	1	2	1	1
common tern	2	1	2	1	1
Arctic tern	2	1	2	2	1
Little tern	2	2	2	1	1
common guillemot	2	0	1	2	2
razorbill	2	0	1	2	2
black guillemot	2	0	2	0	2
Atlantic puffin	2	0	2	2	1

Table 7. Seabird feeding niches.

Note: UK seabird species and taxa are grouped according to their main feeding areas (pelagic versus near-shore or deep versus shallow waters) and feeding behaviour (diving, plunge-diving or surface-feeding) in the breeding season. (Derived from Table 4.3 in ICES 2007)

	Feeding areas:	Pelagic/deep water	Near-shore/shallow water
Feeding behaviour:	**Diving**	common guillemot, razorbill, Atlantic puffin	red-throated diver, great cormorant, European shag, black guillemot
	Plunge-diving	northern gannet	terns
	Surface-feeding	Northern fulmar, Manx shearwater, storm-petrels, Black-legged kittiwake	skuas, *Larus* gulls

3.4. Summary of requirements for additional monitoring

Remedial action requires abundance and breeding success to be monitored at more colonies of some of the UKBAP-listed species (i.e. herring gull and possibly red-throated diver), and of two other 'high priority' species (i.e. European shag and Leach's storm-petrel) in order to more accurately monitor the state of these species throughout the UK. There are a number of drivers currently under development that may eventually impose a statutory obligation to monitor the state of all UK breeding seabird species. However, this will probably require little additional monitoring (other than the remedial actions described above), since some level of monitoring of both abundance and breeding success is already carried out by the SMP on all of the UK's seabirds.

There will continue to be a statutory requirement under the Wildlife and Countryside Act and the EC Birds Directive to regularly update population estimates of seabirds for APEP. These have been obtained through complete censuses of the seabirds in Britain and Ireland approximately once every 15 years. However these are very expensive to undertake and estimates may need updating more regularly. Therefore alternative methods for obtaining population estimates may need to be investigated (see below).

The UK Surveillance Strategy requires the monitoring of the impacts of ecosystem pressures. Seabirds have K-selected life history strategies, which means that trends in parameters other than abundance are much better at providing an indicator of impacts. We have identified those species whose demographic and behavioural traits can be used to monitor certain pressures. The feasibility of monitoring such traits at a UK scale in the future, depends upon how much current monitoring (if undertaken at all) will need to be expanded and how practical it is to monitor these traits in target species, given highly limited resources and other logistical constraints (see below).

3.5. Feasibility of implementing additional monitoring

The feasibility of introducing additional monitoring to estimate UK trends of a certain parameter in a particular species was considered to be a combination of:

a) practicality of monitoring methods (see below), and

b) adequacy of current monitoring (see section 2.4).

Practicality of monitoring trends in abundance, breeding success, survival, diet and phenology were assessed by a score of 1-3 (see Table 10), where 1 = difficult, 2 = moderately difficult and 3 = straightforward. The practicality scores were then added to scores for adequacy of monitoring scores (taken from Table 5) to give a feasibility score of 1-6. Below, we discuss the feasibility of expanding the current sampling of abundance, breeding success, survival, diet and phenology, that would be required to produce UK trends. Obviously, those species with a feasibility score of 6 will require no additional monitoring, as will any other species with an adequacy score of 3. Additional monitoring is less feasible for species that are currently not sampled adequately to produce UK trends and are also difficult to monitor.

3.5.1. UK population estimates

In the past population estimates have been obtained by conducting complete censuses of Britain and Ireland (see above). Censuses not only provide accurate population estimates for the whole of the UK, they are also extremely useful in providing the following:

i. Benchmarks for validating trends from annual monitoring during intervening periods (Parsons *et al.* 2006)

ii. UK trends in abundance at all spatial scales (but at a course temporal scale) for species not covered sufficiently during annual monitoring.

iii. Measures of change in distribution.

iv. Identifying new colonies.

v. Attracting large-scale effort and resources required for surveying species and sites that are difficult to survey.

However, the main problem with censuses is that they require a very large input of time and resources. They have taken 2-5 years of field surveys to complete, plus considerable time for planning, data collation and dissemination. This therefore significantly affects the feasibility of conducting regular censuses in the future.

An alternative approach would be to utilise the large input of resources that the statutory country conservation agencies allocate to CSM every 6 years. CSM could provide estimates of colony size for listed species within protected sites. SPAs, SSSIs and ASSIs hold a large proportion of the total population of most seabird species in each of the countries and provinces of the UK (see Table 8). Therefore, by surveying these sites over a short enough time-period and by using the trends at these sites to estimate the size of other colonies, it would be possible to update the UK population estimates. This would mean that for those species that SMP monitoring cannot measure annual trends in numbers,

their population estimate could be updated every 6 years during each CSM cycle and thus, coincide with every other APEP update. Furthermore, surveying a large proportion of a species' population every six years would greatly improve the precision and accuracy of trends calculated from annual monitoring using Parsons *et al.'s* (2006) modelling approach. Their Bayesian model produced an annual index of population size, with greater accuracy in years when a higher proportion of the UK population was sampled i.e. census years. The closer such years were together, the more accurate the indices are in each of the intervening years.

Table 9 shows a recommended schedule for conducting CSM of seabird features at protected sites throughout the UK. The rationale behind this schedule is that the most accurate population estimates will be derived from surveys that cover a large proportion of the total population in as short a timeframe as possible. For most species, such a timeframe would be 1-3 years i.e. each site would be surveyed once during a 1-3 year window within each of the six-year CSM reporting periods. For species that show low site fidelity between years (e.g. terns, cormorant), surveys should be limited to a single year. Therefore, species were divided up into groups, according to similarities in nesting habitat (e.g. sea cliffs) and/or survey methods and each group was assigned a specific survey period (see Table 9). It was also recommended that at a given site any other seabirds present that are within the same grouping as the listed features should also be surveyed, if resources and time allow. This should be clearly stated in guidance to field staff/contractors.

The co-operation of the SMP and CSM will require a high degree of both intra and inter agency co-ordination to ensure that a particular species is surveyed in the correct year or years throughout the whole of the UK within each CSM reporting period. JNCC will provide common guidance to agency staff for the monitoring of seabird features and collation of data. JNCC will also advise agencies on which listed features are currently surveyed as part of the SMP and so should not require any additional planning or resources to assess their condition (this has already been done for Scotland and is in progress for England). The online data entry facility for the SMP recently developed by JNCC (at www.jncc.gov.UK/smp)should be used as a central collation site for CSM seabird data by agency staff or their contractors. Agency staff will then be able to access the data via the same website. This system will maintain a single depository and source for seabird count data in the UK that will be fully accessible for agency staff conducting site condition assessments.

However, we recommend that complete censuses be continued to avoid focussing solely on protected areas, which may for instance, provide a rather biased impression of the impacts of pressures. The SMP Review Working Group supported the continuation of seabird censuses once every 15 years approximately. It would make better use of existing resources to conduct each census during a 6-year cycle of CSM. We suggest that the census be undertaken during every third cycle or at intervals of approximately 18 years. This frequency would be appropriate for measuring long-term trends in distribution and population size and would avoid overburdening the participating organisations. Therefore, we recommend the next census should take place some time during 2018-2023.

Table 8: Percentage of country/province and UK populations of seabird species contained within Special Protection Areas.

NB. All species present in an SPA were included, whether or not they are qualifying features.

Species	England	Northern Ireland	Scotland	Wales	UK
Northern Gannet	100%	-	100%	100%	100%
Leach's Storm-petrel	-	-	100%	-	100%
Manx Shearwater	100%	62%	99%	98%	98%
Mediterranean Gull	98%	50%	-	-	97%
Sandwich Tern	97%	80%	77%	100%	93%
European Storm-petrel	100%	-	89%	96%	90%
Roseate Tern	97%	0%	79%	100%	86%
Common Guillemot	91%	96%	87%	35%	86%
Razorbill	95%	89%	82%	45%	81%
Black-legged Kittiwake	76%	84%	80%	46%	79%
Atlantic Puffin	100%	89%	69%	79%	74%
Lesser Black-backed Gull	88%	50%	19%	81%	71%
Great Skua	-	-	71%	-	71%
Little Tern	72%	0%	58%	0%	67%
Common Tern	69%	74%	46%	27%	58%
Black-headed Gull	71%	51%	32%	35%	57%
Northern Fulmar	68%	53%	52%	32%	52%
European Shag	81%	46%	45%	57%	51%
Mew Gull	91%	30%	43%	-	43%
Arctic Skua	-	-	43%	-	43%
Great Cormorant	62%	94%	16%	38%	41%
Great Black-backed Gull	61%	83%	37%	51%	39%
Herring Gull	65%	52%	20%	20%	36%
Arctic Tern	67%	15%	20%	100%	26%
Black Guillemot	0%	23%	19%	7%	19%

Table 9: Seabird survey strategy for CSM 2006-2011

Grouping	Species	Survey period	Notes
Cliff-nesters	fulmar shag cormorant (coastal colonies) herring gull lesser black-backed gull great black-backed gull kittiwake guillemot razorbill puffin	2006-2008	2006 was chosen as the start year, since some large colonies containing listed features were surveyed in 2006.
Skuas	Arctic skua great skua	2008	Scotland only. 2008 was chosen to coincide with the proposed tern survey of the Northern Isles (see below)
Terns	Sandwich tern roseate tern common tern Arctic tern little tern	2008	Due to the highly variable site fidelity of terns, national population estimates are best derived from surveys conducted in a single year. c.85% of UK Sandwich tern population, >90% of roseate and c.65% of little terns are already surveyed annually. A survey of 90% of UK's Arctic terns that breed in the Northern Isles is proposed for 2008.
Inland nesters	common gull black-headed gull cormorant (English inland colonies)	2008	2008 was chosen to coincide with tern surveys, as these inland nesting species often inhabit the same sites as some tern species.
Gannets	northern gannet	2009	Almost all Scottish colonies have been selected for CSM by SNH. UK gannets were last surveyed completely in 2004/05. Surveying them again in 2009 would allow an inter-survey period of 4-5 years while leaving contingency for finishing the survey in 2010, should aerial surveys be hampered by poor weather in 2009.
Storm-petrels	European storm-petrel Leach's storm-petrel	2008-09	JNCC, CCW, SNH & RSPB are planning a pilot study in 2007 to investigate possible improvements to monitoring methods. Hence CSM of storm-petrel features should ideally wait until this study is completed.
Shearwaters	Manx shearwater	2007-09	Fixed monitoring quadrats may be installed on Rum in 2007.
Black guillemot	black guillemot	2007-09	Black guillemots are grouped separately as pre-breeding surveys must carried out in late March-early May, outwith the recommended survey period for all other species.

3.5.2. UK trends in abundance

We identified above that the current monitoring of abundance needed to be expanded to more colonies of the following species: red-throated diver (possibly), Manx shearwater, European storm-petrel, Leach's storm petrel, European shag and herring gull. But how straightforward are these species to survey and how feasible would it be to expand monitoring to such an extent that it could be used to accurately estimate trends in the size of the UK populations? In addition, what is the scope for expanding monitoring of other species?

In terms of practicality of survey methods, 'difficult species' were those that present observers with problems when identifying and counting the desired unit (e.g. apparently occupied site). Burrow-nesting species - Manx shearwater and both species of storm-petrels (and Atlantic puffin) are the most difficult to survey. Shearwaters and storm petrels are nocturnal at the colonies, as well nesting hidden under ground. Prior to Seabird 2000, when the first UK-wide census of all three species was conducted, monitoring population size of these species was impossible due to the lack of an accurate method. But, following the development of the tape-playback method it is now possible to monitor changes in colony size. However, this method is very time consuming and requires access to colonies on some of the remotest of the British Isles.

In contrast, herring gull (plus all other gull species except black-headed) and European shag, which build large conspicuous nests in colonies that can often be observed easily from a vantage point were considered 'straightforward to survey'. Red-throated divers were considered moderately difficult to survey because, like skua species, black-headed gull and northern gannet, they nest in remote areas that are difficult to observe or access. Other species in this group were terns and great cormorant that show low site fidelity and may colonise and abandon different sites within the same season; and razorbill, common guillemot and black guillemot, pairs are difficult to count so estimates are derived from counts of individuals.

Feasibility was defined as the sum of the scores for practicality of monitoring methods and current level of sampling. Five species had a maximum score of 6. Of the 13 species with a score of 5, eight had an adequate level of sampling at a UK scale despite being moderately difficult to survey, while five species that were straightforward to survey were not sampled adequately beyond the regional scale. Another three species had a score of 4 i.e. moderately difficult to survey and regional coverage only. None of the four species that are difficult to survey (see above) had adequate sampling coverage of the UK or certain regions and all featured in the bottom five species, with feasibility scores of 2 or 3.

3.5.3. UK trends in breeding success

Breeding success is measured for each colony by expressing the number of chicks fledged as a proportion of the number of pairs that attempted to breed (i.e. chicks per pair). Practicality scores were based on the ease of identifying

individual breeding pairs, observing them and following the progress of their chicks to fledging.

Only northern fulmar and black-legged kittiwake were considered to be straightforward to monitor on this basis (Table 10). Other gull species, skuas and terns were considered moderately difficult to monitor because shortly after hatching, their chicks leave the nest, making it difficult to attribute individual chicks to a specific pair. Various methods (e.g. nest enclosures, individually marking chicks soon after hatching) can be employed to overcome these problems but they require considerable time and effort. European shag and great cormorant were also considered moderately difficult to monitor because they are asynchronous in their breeding, so that in a single colony, different nests may be at very different stages with some containing newly-laid eggs whilst others contain chicks about to fledge. This means that monitoring breeding success of shags and cormorants requires many more visits to the colony compared with species that breed more synchronously.

Measuring breeding success of some burrow- and crevice nesters (i.e. storm-petrels, shearwaters, razorbills and black guillemots) is extremely difficult because of the inaccessibility of nest sites. Endoscopes can be used to investigate some burrows, but do not always produce definitive results. However, by providing artificial burrows or nest boxes, nests can be easily investigated without causing undue disturbance to the birds. Puffin burrows however, have proved easier to investigate and were classed as moderately difficult to monitor (see Table 10).

Monitoring breeding success of common guillemots is also difficult because they do not build a nest but simply lay their single egg on bare rock, often on crowded ledges. Following the fortunes of individual breeding pairs without easily identified nest sites requires intensive study involving many repeated visits, is very time consuming.

Only two species, northern fulmar and black-legged kittiwake were awarded a feasibility score of 6 out of 6. Eight species had a score of 5 i.e. they have an adequate level of sampling at a UK scale despite being moderately difficult to monitor. In addition, common guillemots were considered to be sampled adequately at a UK scale despite being difficult to monitor. These 11 species consist of most of those given a high priority for monitoring, include representatives of five of the six feeding niches given in Table 7 and can potentially be used as impact indicators for all of the five ecosystem pressures (Table 10).

Expanding monitoring of breeding success at a UK scale to more species is greatly limited by the fact that, of the remaining 15 species listed in Table 10, all are either difficult or moderately difficult to monitor and only six are currently sampled adequately at a regional scale. These 15 species contain just two high priority species – herring gull and Leach's storm petrel. Attempts to monitor breeding success of Leach's storm-petrels are underway on St Kilda. Obtaining accurate UK trends in breeding success of herring gulls will require monitoring to be expanded to many more colonies throughout the UK.

3.5.4. UK trends in survival

Adult survival is estimated by measuring the return rates each year of individually marked birds. This is extremely labour intensive (and therefore difficult – see Table 10) in all species of seabird. Each year it requires considerable catching effort to maintain a sufficient number of marked birds in study colonies, and considerable observation effort to ensure no returning marked birds are missed. Furthermore, this method is not suitable for species that show low levels of site fidelity, such as great cormorant and terns.

The feasibility of expanding monitoring using resightings of individually marked birds to obtain trends in survival at a UK scale is extremely low for all species (Table 10). While there may be some scope for measuring survival of these species at more of the key sites, the only feasible way of monitoring survival across a wider geographical area and in more species is by estimating survival rates from long-term ring-recovery data from the British and Irish Ringing Scheme. A vast amount of seabird ringing-recovery information has been collected over very many years and is still collected annually. What have not been available are resources sufficient to (i) computerise past paper ringing details for many species; and (ii) carry out the modelling required to test the power of the data to detect trends at different geographical scales across a range of species. There is scope not only to utilise past data but to encourage ringers using the existing frameworks of financial incentives to alter, if necessary, their patterns of ringing in order to generate data for certain species. However, before considering potential changes to current seabird ringing incentives, the SMP should wait for the results of a joint BTO and RSPB feasibility study into the extent to which ringing-recovery data could provide useful information on seabird survival across a range of species.

3.5.5. UK trends in diet

Assessment of diet is currently confined to recording the identity (and sometimes size) of prey fed to chicks and how often they are fed (i.e. provisioning rate). Those species that carry prey in their bills back to their nest we considered moderately difficult to monitor, while those that feed by regurgitation were considered more difficult to monitor (see Table 10). It is possible to identify prey type and sometimes assess even size by simply observing species that carry food in their bills. But much more invasive methods and detailed analyses are required to determine the diet of species that regurgitate food for their chicks. The exception being skuas, which produce pellets of indigestible material that can be reliably used to assess diet composition.

Based on existing methods and coverage, the feasibility of expanding monitoring to obtain trends in diet at a UK scale was scored low for all species (Table 10).The maximum feasibility score was just three out of six, awarded to puffin, common guillemot and black guillemot. However, recent developments in the methods used to monitor diet (see below), may provide considerable scope to expand current coverage to more species and more colonies, without a great deal more time required of existing observers.

Recently, the species and the approximate length of fish caught by common guillemots and fed to their chicks was assessed for a number of adjacent 'nesting' pairs during two-hour watches (S. Wanless, unpubl.). The diets of other species that carry single fish to their young (e.g. red-throated divers, terns and black guillemots) could be monitored using similar methods. This would ensure that the diet of more high priority species could be monitored (see Table 10).

For those species that either carry multiple prey items in their bill or regurgitate food to their chicks, more invasive methods are required to recover samples. Ringers could potentially be a source for samples i.e. some adults and chicks will regurgitate food if handled for ringing. However, these samples would need to analysed i.e. prey items identified and in some cases measured, which has significant resource implications.

3.5.6. UK trends in phenology

Accurate measurements of the onset of breeding (i.e. date of the first egg laid) requires repeated visits to a colony early on in the season outwith the period when monitoring of the other breeding parameters (e.g. numbers, breeding success, diet) is carried out. For this reason we have classified all species as at least moderately difficult to monitor (Table 10). Burrow- and crevice-nesting species were classified as 'difficult' due to the fact that nests and incubating birds are hidden from view.

Based on existing methods and coverage, the feasibility of expanding monitoring to obtain trends in phenology at a UK scale was scored low for all species (Table 10).The maximum feasibility score was just three out of six, awarded to European shag, northern fulmar, puffin and common guillemot.

The feasibility of expanding monitoring of phenology is greatly limited by the considerable time required at the start of the season to accurately record the date of the first egg laid. All colonies included in the SMP are visited by observers during the peak of breeding when other parameters are measured (e.g. abundance). Therefore, if a proximate measure of the onset of breeding is developed that could be recorded during the peak of the breeding season (e.g. as used on Canna to estimate the timing of breeding in European shags – see 2.4.5), then the number of colonies and species monitored could be increased considerably without the need for additional visits and hence, resources.

3.5.7. Key site monitoring

Key site monitoring provides the majority of data collected annually in the UK on adult survival, phenology and diet. These data when combined with simultaneous counts of breeding numbers and estimates of breeding success, provide a potentially powerful tool for measuring and interpreting the impacts of pressures and other effects. However, key site monitoring requires considerable investment to sustain it. Therefore, we need to reassess the monitoring activities of all the key sites to ensure that as a whole (rather than simply on a site-by-site basis) they are providing the most informative set of data. This reassessment should determine if the following aims are being met

under the current level of resource input and if not, determine how much additional resources are required to do so:

a. Maximise the number of key sites that monitor each species.

b. Maximise the number of species monitored at each site.

c. Maximise the number of parameters per species.

d. Where possible, provide 'joined up' monitoring of parameters for each species to increase the interpretive power of the monitoring.

An example of how this last aim is met is on the Isle of May, where monitoring of black-legged kittiwake, common guillemot, razorbill and Atlantic puffin includes measurements of population size, breeding success, adult survival, diet and phenology. This means that for each of these species it is possible to relate changes in population size to variation in breeding success and adult survival; and relate changes in breeding success to variation in diet (i.e. food availability) and phenology. Such interpretive power could be potentially used to explain similar variation in population size and breeding success elsewhere. However the more key sites to undertake such 'joined up' monitoring of species, the greater our ability to interpret changes in numbers at a UK scale

Table 10: Feasibility of monitoring UK trends in a) abundance, b) breeding success, c) survival, d) diet, e) phenology.

Notes: [1]See Table 5 for definitions of priority scores and groupings.
[2]practicality scores: 3 = straightforward, 2 = moderately difficult, 1 = difficult.
[3] adequacy of sampling scores: 3 = derived trends are representative at a UK scale, 2 = derived trends are representative at a regional scale only, 1 = derived trends are not representative at a regional or UK scale.
[4] feasibility score = practicality score + sampling score.

a) Abundance

Species	Priority Score[1]	Priority Group[1]	Practicality of monitoring methods[2]	Adequacy of sampling UK popualtion[3]	Feasibility of monitoring UK trends[4]
Mediterranean gull	4	M	3	3	6
black-legged kittiwake	4	M	3	3	6
northern fulmar	3	L	3	3	6
Sandwich tern	3	L	3	3	6
roseate tern	7	H	2	3	5
Arctic skua	5	H	2	3	5
Little tern	5	H	2	3	5
Great skua	4	M	2	3	5
razorbill	4	M	2	3	5
great cormorant	3	L	2	3	5
common guillemot	3	L	2	3	5
common tern	2	L	2	3	5
herring gull	6	H	3	2	5
European shag	5	H	3	2	5
common gull	4	M	3	2	5
lesser black-backed gull	4	M	3	2	5
great black-backed gull	2	L	3	2	5
Arctic tern	3	L	1	3	4
northern gannet	4	M	2	2	4
black-headed gull	4	M	2	2	4
black guillemot	1	L	2	2	4
Manx shearwater	4	M	1	2	3
red-throated diver	5	H	2	1	3
Leach's storm-petrel	6	H	1	1	2
European storm-petrel	3	L	1	1	2
Atlantic puffin	3	L	1	1	2

b) breeding success

Notes: Shaded rows indicate species that are monitored sufficiently to estimate UK trends in breeding success. ✓ indicates those species that may provide an indicator of impacts by ecosystem pressure i.e. are substantially affected by that pressure – see

Table 6

Species	Priority Score[1]	Priority Group[1]	Practicality of monitoring methods[2]	Adequacy of sampling UK popualtion[3]	Feasibility of monitoring UK trends[4]	Indicator of pressure impacts				
						Climate change	Habitat transformation	Invasive alien species	Over-exploitation	Pollution
black-legged kittiwake	4	M	3	3	6	✓				
northern fulmar	3	L	3	3	6				✓	
roseate tern	7	H	2	3	5			✓		
red-throated diver	5	H	2	3	5	✓	✓		✓	
European shag	5	H	2	3	5	✓		✓	✓	
Arctic skua	5	H	2	3	5	✓		✓	✓	
Little tern	5	H	2	3	5	✓	✓	✓		
Great skua	4	M	2	3	5	✓			✓	
Sandwich tern	3	L	2	3	5	✓		✓		
Arctic tern	3	L	2	3	5	✓		✓	✓	
common guillemot	3	L	1	3	4	✓			✓	✓
northern gannet	4	M	2	2	4				✓	

Species	Priority	Priority	Practicality	Adequacy	Feasibility	Indicator of pressure impacts

	Score[1]	Group[1]	of monitoring methods[2]	of sampling UK popualtion[3]	of monitoring UK trends[4]	Climate change	Habitat transformation	Invasive alien species	Over-exploitation	Pollution
black-headed gull	4	M	2	2	4		✓	✓		
lesser black-backed gull	4	M	2	2	4			✓	✓	✓
great cormorant	3	L	2	2	4				✓	
common tern	2	L	2	2	4	✓		✓		
Manx shearwater	4	M	1	2	3			✓		
herring gull	6	H	2	1	3			✓	✓	✓
Mediterranean gull	4	M	2	1	3			✓		
common gull	4	M	2	1	3		✓	✓		
Atlantic puffin	3	L	2	1	3	✓		✓	✓	
great black-backed gull	2	L	2	1	3			✓		
razorbill	4	M	1	1	2	✓		✓	✓	✓
European storm-petrel	3	L	1	1	2			✓		
black guillemot	1	L	1	1	2	✓		✓		✓
Leach's storm-petrel	6	H	1	0	1	✓		✓		

c) survival

Species	Priority Score[1]	Priority Group[1]	Practicality of monitoring methods[2]	Adequacy of sampling UK popualtion[3]	Feasibility of monitoring UK trends[4]
Manx shearwater	4	M	1	2	3
herring gull	6	H	1	1	2
European shag	5	H	1	1	2
lesser black-backed gull	4	M	1	1	2
black-legged kittiwake	4	M	1	1	2
razorbill	4	M	1	1	2
common guillemot	3	L	1	1	2
Atlantic puffin	3	L	1	1	2
roseate tern	7	H	1	0	1
Leach's storm-petrel	6	H	1	0	1
red-throated diver	5	H	1	0	1
Arctic skua	5	H	1	0	1
Little tern	5	H	1	0	1
northern gannet	4	M	1	0	1
Great skua	4	M	1	0	1
Mediterranean gull	4	M	1	0	1
black-headed gull	4	M	1	0	1
common gull	4	M	1	0	1
northern fulmar	3	L	1	0	1
European storm-petrel	3	L	1	0	1
great cormorant	3	L	1	0	1
Sandwich tern	3	L	1	0	1
Arctic tern	3	L	1	0	1
great black-backed gull	2	L	1	0	1
common tern	2	L	1	0	1
black guillemot	1	L	1	0	1

d) diet

Species	Priority Score[1]	Priority Group[1]	Practicality of monitoring methods[2]	Adequacy of sampling UK popualtion[3]	Feasibility of monitoring UK trends[4]
common guillemot	3	L	2	1	3
Atlantic puffin	3	L	2	1	3
black guillemot	1	L	2	1	3
European shag	5	H	1	1	2
black-legged kittiwake	4	M	1	1	2
razorbill	4	M	1	1	2
roseate tern	7	H	2	0	2
red-throated diver	5	H	2	0	2
Arctic skua	5	H	2	0	2
Little tern	5	H	2	0	2
Great skua	4	M	2	0	2
Sandwich tern	3	L	2	0	2
Arctic tern	3	L	2	0	2
common tern	2	L	2	0	2
Leach's storm-petrel	6	H	1	0	1
herring gull	6	H	1	0	1
Manx shearwater	4	M	1	0	1
northern gannet	4	M	1	0	1
Mediterranean gull	4	M	1	0	1
black-headed gull	4	M	1	0	1
common gull	4	M	1	0	1
lesser black-backed gull	4	M	1	0	1
northern fulmar	3	L	1	0	1
European storm-petrel	3	L	1	0	1
great cormorant	3	L	1	0	1
great black-backed gull	2	L	1	0	1

e) phenology

Species	Priority Score[1]	Priority Group[1]	Practicality of monitoring methods[2]	Adequacy of sampling UK popualtion[3]	Feasibility of monitoring UK trends[4]
European shag	5	H	2	1	3
black-legged kittiwake	4	M	2	1	3
northern fulmar	3	L	2	1	3
common guillemot	3	L	2	1	3
razorbill	4	M	1	1	2
Atlantic puffin	3	L	1	1	2
herring gull	6	H	2	0	2
red-throated diver	5	H	2	0	2
Arctic skua	5	H	2	0	2
northern gannet	4	M	2	0	2
Great skua	4	M	2	0	2
Mediterranean gull	4	M	2	0	2
black-headed gull	4	M	2	0	2
common gull	4	M	2	0	2
lesser black-backed gull	4	M	2	0	2
great black-backed gull	2	L	2	0	2
roseate tern	7	H	1	0	1
Leach's storm-petrel	6	H	1	0	1
Little tern	5	H	1	0	1
Manx shearwater	4	M	1	0	1
European storm-petrel	3	L	1	0	1
great cormorant	3	L	1	0	1
Sandwich tern	3	L	1	0	1
Arctic tern	3	L	1	0	1
common tern	2	L	1	0	1
black guillemot	1	L	1	0	1

3.6. Recommendations for additional monitoring

Our recommendations below should achieve the following:

- Remedy the inadequacies of the current monitoring.
- Meet future national and international obligations.
- Meet the recommendations of the UK Strategy for Surveillance, Reporting and Research (JNCC 2006) for monitoring the impacts of ecosystem pressures.
- Monitor a suite of species that represents all six feeding niches listed in Table 7.
- Make the best use of existing resources;
- Ensure the UK populations of species identified in Table 5 as a high priority are monitored accurately.

The implications of our recommendations for the monitoring of each seabird species are summarised in Table 11.

3.6.1. Monitoring the state of seabird populations

Recommendations 3.6.1.1 to 3.6.1.7 are for monitoring abundance. They propose how existing inadequacies should be remedied, while ensuring monitoring throughout the UK produces accurate trends that are an effective measure of the state of the UK's seabirds. In the future, there may also be a statutory requirement for such trends, in order to assess progress towards specific conservation objectives. Recommendations 3.6.1.6 and 3.6.1.7 are specifically aimed at fulfilling the ongoing statutory obligation to regularly update population estimates of all breeding seabirds in the UK.

3.6.1.1. Calculate species-specific trends in abundance across the UK using Parsons *et al.*'s (2006) Bayesian model and determine if the SMP sampling has accurately estimated UK population trends.

3.6.1.2. Develop a robust method for estimating trends in abundance of great cormorants and terns.

3.6.1.3. Investigate possible sources of bias in the current sample of colonies monitored for breeding success.

3.6.1.4. Expand annual monitoring of abundance of high priority species - Leach's storm-petrel, red-throated diver, European shag and herring gull - sufficiently to accurately estimate trends in numbers breeding in the UK.

3.6.1.5. Instigate monitoring of abundance of European storm-petrel and Manx shearwater in the UK in order to more accurately assess their conservation status.

3.6.1.6. Use CSM to update UK population estimates every six years for species that are predominantly found in protected sites.

3.6.1.7. Continue to census the UK seabird population, but coincide with every third CSM cycle (i.e. every 18 years), with the next census taking place during 2018-2023.

Recommendations 3.6.1.8 and 3.6.1.9 are for remedial measures to improve monitoring of UK BAP-listed species.

3.6.1.8. Expand annual monitoring of breeding success of herring gull sufficiently to obtain accurate estimates of trends in the UK.

3.6.1.9. Monitor survival, diet and phenology of all four UK BAP species and provide more potential to interpret trends in abundance and breeding success.

3.6.2. Monitoring the impacts of ecosystem pressures on seabird populations

Our recommendations below are aimed at providing effective indicators of pressure impacts at a UK scale. Such monitoring would also provide potential for interpreting changes in population size. However, given that resources are limited, it would be pragmatic and sensible to focus monitoring on breeding success, which, out of the four potential impact indicators, has already been monitored throughout the UK for the most number of species. Monitoring of breeding success by the SMP has provided UK trends for 11 species that collectively, provide an indicator of at least some of the impact of all five ecosystem pressures (see Table 10). However, only five of the six feeding niches are currently represented by these eleven species. Expanding the current monitoring of breeding success of northern gannets would ensure that all niches are effectively monitored throughout the UK. Breeding success is currently monitored at 5 of the 13 colonies in Scotland, but not at any of the colonies in England and Wales (Table 1). We therefore, recommend that monitoring of breeding success of gannets be reinstated at Bempton Cliffs on the English mainland and introduced on Grassholm - the only colony in Wales, the fourth largest colony in the world and the UK's only colony in the Irish Sea (**Error! Reference source not found.**).

3.6.2.1. Monitor breeding success of northern gannets at Bempton Cliffs and on Grassholm.

However, not all of the potential impacts of the five ecosystem pressures (see Table A1 in Appendix 2) will be indicated by trends in breeding success, namely:

- over-exploitation through legal/illegal culling
- over-exploitation through fisheries (i.e. bycatch)
- pollution through industrial discharge
- pollution through transport derived from fossil fuels (e.g. oil spills)

These impacts tend to occur outside the breeding season (see Appendix 2 for details) and result in elevated mortality in some species. But these impacts can potentially be reduced by changes to and implementation of relevant

policies. Therefore, data on survival rates could be used to advise policy makers on the best course of action to reduce future impacts. But as discussed above, the feasibility of increasing the amount of survival monitoring using current capture-recapture methods is low in all species. We therefore, recommend the following as the most cost effective way of ensuring at least some survival information is collected:

3.6.2.2. Estimate UK trends in survival from data collected by the British and Irish Ringing Scheme, but await the results of the RSPB and BTO feasibility study to determine if this is possible and how it can be done.

Monitoring breeding success, and to a lesser extent survival, will provide indicators of the impact of pressures, but in the past it has proved difficult to identify the precise sources of theses impacts when several pressures may be operating at once. Monitoring other parameters, such as diet and phenology, at the same sites, would provide a wider evidence base that would have more potential for identifying more precisely those pressures operating on a population. For instance, monitoring of seabird diet has been used to identify shortages in food supply, reductions in prey size and quality that have all caused reduced breeding success (see review in Appendix 2 and e.g. Frederiksen *et al.* 2004a, Rindorf *et al.,* 2000, Votier *et al.,* 2004, Wanless *et al.,*2004, 2005). The value of monitoring phenology is in providing an indicator of the impacts of climate change, since the onset of breeding in some species has been shown to be closely linked with variation in climate (Frederiksen *et al.* 2004b).

As mentioned above, diet and phenology are measured in a few species at a few sites. However, impacts on phenology and diet may operate on a variety of spatial scales scale depending on species and the pressure creating the impact. Therefore, our recommendations below on the monitoring of diet and phenology are based on obtaining data that is more representative at regional and UK scales and that sufficiently represents high priority species and representatives from each of the feeding niches and cover impacts from the whole suite of pressures. Determining exactly how many sites should be monitored and where, is impossible to determine from the variation in the data already collected by the SMP, since the sample of sites is so small (i.e. 1-2 sites for phenology and 2-3 for diet, depending on species). We therefore recommend that monitoring of target species (see below) be expanded to as many sites as available resources allow at present and then determine the optimal sample size once several years of data have been collected. We advise targeting those sites where demographic parameters are already measured to provide a clearer interpretation of impacts.

3.6.2.3. JNCC and its contractors at the SMP key sites should ensure diet and phenology are monitored in addition to abundance, breeding success and survival in as many species as is possible depending on logistical constraints.

3.6.2.4. Use newly developed methods to record fish species fed to chicks of common guillemot (pelagic diver), black guillemot (near-shore diver), red-throated diver (high priority) and Arctic tern,

roseate tern and little tern (high priority and near-shore plunge-divers).

3.6.2.5. Seek the resources required to analyse food samples collected from species that regurgitate food; ideally high priority species (i.e. European shag, Arctic and great skuas, herring gull and Leach's storm-petrel) and of northern gannet to ensure all feeding niches are represented.

3.6.2.6. Seek the resources required to develop methods for obtaining proximate estimates of the start of breeding.

4. Conclusions

4.1. Summary

The aim of the SMP is to contribute information to enable the appropriate agencies to maintain favourable status of seabird populations in the UK and the Republic of Ireland. It ensures that sufficient data on breeding numbers and appropriate demographic and behavioural parameters of seabirds are collected- both regionally and nationally - to enable their population and conservation status to be assessed, and to monitor the impacts of ecosystem pressures.

The monitoring carried out by the SMP since 1986 was assessed in terms of whether or not it has fulfilled the requirements of national and international obligations and of conserving the integral value of the UK's breeding seabirds. Species were prioritised for monitoring based on their statutory obligations and their current conservation status.

Annual monitoring of abundance and breeding success has been carried out at colonies of all 26 species of seabird breeding in the UK. The current sample of colonies has produced accurate estimate of trends in abundance and breeding success throughout the UK for13 and 11 species respectively.

The SMP has fulfilled its statutory obligations under the Wildlife & Countryside Act 1981 and EC Birds Directive. However, monitoring of UK BAP-listed species could be improved, since it does not provide UK trends in abundance and breeding success of herring gull; and data on other demographic and behavourial parameters (e.g. survival and diet) is not collected for any UK BAP species. Furthermore, two other 'high priority' species – Leach's storm-petrel and European shag were monitored at an insufficient number of colonies to produce accurate UK trends. The conservation status of European storm-petrel and Manx shearwater in the UK may have been underestimated by a lack of any accurate trend information.

Additional monitoring was recommended for the future that aimed to remedy the current inadequacies, meet future obligations and meet the requirements of the UK Strategy for Surveillance, Reporting and Research (JNCC 2006), with particular reference to monitoring the impacts of ecosystem pressures.

The SMP should meet its future obligations once the additional remedial measures in are in place.

Since seabird breeding in the UK tend to be K-strategists, trends in abundance provide a poor indicator of the impacts of pressures. Trends in other demographic parameters such as breeding success and survival, and trends in behavioural parameters such as diet and phenology provide much better indicators of impacts. The current monitoring of breeding success by the SMP was considered sufficient for monitoring most pressure impacts except those that cause increased mortality rather than reduced breeding success e.g. pollution, culling and fisheries bycatch.

Survival estimation is undertaken only at SMP key sites, since mark-recapture methods are very labour-intensive and therefore, expensive. For sufficient survival data to be collected to provide an indicator of impacts across the UK,

alternative methods are required that are less intensive and cheaper to undertake. The British and Irish Ringing Scheme could be a source of data for estimating survival of seabirds, and we await the results of a review carried out by RSPB and BTO, before making any firm recommendations re. survival estimation for the SMP.

Few data on diet and phenology are currently collected by SMP, but these data have proved valuable in the past for determining the source of impacts on breeding success and abundance. Monitoring of diet and phenology is limited by labour intensive methods currently used to collect data. We recommend that resources are invested in developing new, more easily obtained proximate measures of phenology, for analysing food samples and for training observers.

We recommend that the SMP continues to be run as a partnership with JNCC in the co-ordinating role, with active participation by the other partners through the input of manpower, expertise and funding.

4.2. Implementing the recommendations

JNCC will continue to work closely with its partners in implementing the recommendations of the review, ensuring value for money by adding value to ongoing monitoring activities.

The recommendations for species monitoring (i.e. 3.6.1.1 to 3.6.1.9 and 3.6.2.1 to 3.6.2.6, summarised in Table 11) will be discussed with partners at the SMP Liaison Group Meeting in Nov 2007. A subsequent workshop in early 2008 may be required to determine the best way of incorporating the recommendations into existing work programmes and to identify those activities that will require additional resources. JNCC will liaise directly with voluntary contributors, to determine how they could help to implement the recommendations.

An important part of implementing the recommendations will be communicating newly developed methods to contributors and ensuring that the standard methods are followed. Standardisation of methods within the SMP has been achieved thus far, largely through the Seabird Monitoring Handbook (Walsh *et al.* 1995). The Handbook brought together seabird census techniques developed for use during the SCR census work in the mid 1980s and techniques for measuring breeding success developed specifically for use in the SMP by Harris (1989). There have already been some significant developments in seabird monitoring techniques since the Handbook's publication e.g. for conducting plot counts of guillemots (Simms *et al.* 2006), monitoring guillemot diet (Wanless, unpubl.) and methods for surveying European and Leach's storm-petrels (Ratcliffe *et al.* 1998, Gilbert *et al.* 1998). The Handbook needs to be updated. Publishing the Handbook online would enable it to be more easily updated with further developments in the future.

Funding has recently been awarded by Defra to JNCC/RSPB/BTO to calculate species-specific trends in abundance for the UK using Parsons *et al.'s* (2006) Bayesian model (see 3.6.1.1) and to develop a robust method for calculating trends in abundance of terns and cormorants (see 3.6.1.2).

Additional resources will need to be sought either from within or outwith the SMP partnership for the following:

i. Investigate possible sources of bias in the current sample of colonies monitored for breeding success (see 3.6.1.3).

ii. Analyse food samples from throughout the UK (3.6.2.5).

iii. Develop proximate measures of phenology and monitor these at colonies throughout the UK (3.6.2.6)

iv. Update the Seabird Monitoring Handbook

JNCC should continue to liaise with the statutory country conservation agencies through IAOWG in order to add value to the results of CSM by updating population estimates for some species during each CSM cycle i.e. every six years (see 3.6.1.6).

JNCC should take the lead in co-ordinating the next complete census of seabirds in Britain and Ireland during 2018-2023 (see 3.6.1.7). Plans and costings for the census should be formulated by JNCC, the statutory country conservation agencies and all other SMP partners by 2017. Efforts should be made to learn from the lessons of Seabird 2000.

The SMP Liaison Group should regularly reassess monitoring priority and feasibility of individual species in order to take into account future changes in conservation status, knowledge of pressure impacts, conservation legislation, new conservation initiatives and improvements in monitoring methods.

Table 11: Summary of recommended monitoring of each seabird species.

Species	Priority Score	Priority Group	abundance	breeding success	survival	diet	phenology
red-throated diver	9	H	Investigate if expansion of coverage is necessary	continue at current level	No current monitoring, consider using ring-recovery data from British & Irish ringing Scheme.	Encourage observers to use newly developed methods to record fish species fed to chicks	Seek resources required to develop proximate measures and monitor these at colonies throughout the UK
northern fulmar	4	L	Assess if current sampling is representative at a UK level, expand if necessary	continue at current level	No current monitoring, consider using ring-recovery data from British & Irish ringing Scheme.	Not required	Continue current monitoring and seek resources required to develop proximate measures and monitor these at colonies throughout the UK
Manx shearwater	5	L	continue at current level	continue at current level	No current monitoring, consider using ring-recovery data from British & Irish ringing Scheme.	Not required	Not required
European storm-petrel	5	L	continue at current level	continue at current level	No current monitoring, consider using ring-recovery data from British & Irish ringing Scheme.	Not required	Not required
Leach's storm-petrel	11	H	monitor abundance on St Kilda	monitor nest boxes on St Kilda	No current monitoring, consider using ring-recovery data from British & Irish ringing Scheme.	Seek resources required to analyse food samples from throughout the UK	Seek resources required to develop proximate measures and monitor these at colonies throughout the UK

Species	Priority Score	Priority Group	abundance	breeding success	survival	diet	phenology
northern gannet	5	L	continue at current level	expand coverage to Bempton, England and Grassholm, Wales	No current monitoring, consider using ring-recovery data from British & Irish ringing Scheme.	Seek resources required to analyse food samples from throughout the UK	Seek resources required to develop proximate measures and monitor these at colonies throughout the UK
great cormorant	4	L	Assess if current sampling is representative at a UK level, expand if necessary	continue at current level	No current monitoring, consider using ring-recovery data from British & Irish ringing Scheme.	Not required	Not possible?
European shag	9	H	expand coverage in England, Wales and Northern Ireland	continue at current level	Continue current monitoring, consider using ring-recovery data from British & Irish ringing Scheme.	Continue current monitoring and Seek resources required to analyse food samples from throughout the UK	Continue current monitoring and seek resources required to develop proximate measures and monitor these at colonies throughout the UK
Arctic skua	9	H	continue at current level	continue at current level	No current monitoring, consider using ring-recovery data from British & Irish ringing Scheme.	Seek resources required to analyse food samples from throughout the UK	Seek resources required to develop proximate measures and monitor these at colonies throughout the UK
Great skua	6	M	continue at current level	continue at current level	No current monitoring, consider using ring-recovery data from British & Irish ringing Scheme.	Seek resources required to analyse food samples from throughout the UK	Seek resources required to develop proximate measures and monitor these at colonies throughout the UK
Mediterranean gull	6	M	Assess if current sampling is representative at a UK level, expand if necessary	continue at current level	No current monitoring, consider using ring-recovery data from British & Irish ringing Scheme.	Not required	Not required

Species	Priority Score	Priority Group	abundance	breeding success	survival	diet	phenology
black-headed gull	6	M	continue at current level	continue at current level	No current monitoring, consider using ring-recovery data from British & Irish ringing Scheme.	Not required	Not required
common gull	6	M	continue at current level	continue at current level	No current monitoring, consider using ring-recovery data from British & Irish ringing Scheme.	Not required	Not required
lesser black-backed gull	7	M	continue at current level	continue at current level	No current monitoring, consider using ring-recovery data from British & Irish ringing Scheme.	Not required	Not required
herring gull	9	H	expand coverage throughout UK	expand coverage throughout UK	continue current monitoring, consider using ring-recovery data from British & Irish ringing Scheme.	Seek resources required to analyse food samples from throughout the UK	Seek resources required to develop proximate measures and monitor these at colonies throughout the UK
great black-backed gull	4	L	continue at current level	continue at current level	No current monitoring, consider using ring-recovery data from British & Irish ringing	Not required	Not required
black-legged kittiwake	7	M	Assess if current sampling is representative at a UK level, expand if necessary	continue at current level	continue current monitoring, consider using ring-recovery data from British & Irish ringing Scheme.	Continue current monitoring and seek resources required to analyse food samples from throughout the UK	Continue current monitoring and seek resources required to develop proximate measures and monitor these at colonies throughout the UK

Species	Priority Score	Priority Group	abundance	breeding success	survival	diet	phenology
Sandwich tern	5	L	Assess if current sampling is representative at a UK level, expand if necessary	continue at current level	No current monitoring, consider using ring-recovery data from British & Irish ringing Scheme.	Not required	Not possible?
roseate tern	9	H	Assess if current sampling is representative at a UK level, expand if necessary	continue at current level	No current monitoring, consider using ring-recovery data from British & Irish ringing Scheme.	Encourage observers to use newly developed methods to record fish species fed to chicks	Not possible?
common tern	4	L	Assess if current sampling is representative at a UK level, expand if necessary	continue at current level	No current monitoring, consider using ring-recovery data from British & Irish ringing Scheme.	Not required	Not possible?
Arctic tern	8	H	Assess if current sampling is representative at a UK level, expand if necessary	continue at current level	No current monitoring, consider using ring-recovery data from British & Irish ringing Scheme.	Encourage observers to use newly developed methods to record fish species fed to chicks	Not possible?
Little tern	8	H	Assess if current sampling is representative at a UK level, expand if necessary	continue at current level	No current monitoring, consider using ring-recovery data from British & Irish ringing Scheme.	Encourage observers to use newly developed methods to record fish species fed to chicks	Not possible?
common guillemot	6	M	Assess if current sampling is representative at a UK level, expand if necessary	continue at current level	continue current monitoring, consider using ring-recovery data from British & Irish ringing Scheme.	Continue current monitoring and encourage observers to use newly developed methods to record fish species fed to chicks	Continue current monitoring and seek resources required to develop proximate measures and monitor these at colonies throughout the UK

Species	Priority Score	Priority Group	abundance	breeding success	survival	diet	phenology
razorbill	7	M	Assess if current sampling is representative at a UK level, expand if necessary	continue at current level	continue current monitoring, consider using ring-recovery data from British & Irish ringing Scheme.	Continue current monitoring	Continue current monitoring and seek resources required to develop proximate measures and monitor these at colonies throughout the UK
black guillemot	3	L	continue at current level	continue at current level	No current monitoring, consider using ring-recovery data from British & Irish ringing Scheme.	Continue current monitoring and encourage observers to use newly developed methods to record fish species fed to chicks	Not required
Atlantic puffin	7	M	continue at current level	continue at current level	continue current monitoring, consider using ring-recovery data from British & Irish ringing Scheme.	Continue current monitoring	Continue current monitoring and seek resources required to develop proximate measures and monitor these at colonies throughout the UK

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