Healthy & Biologically Diverse Seas Evidence Group
Technical Report Series:

Evaluation and gap analysis of current and potential indicators for seals

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Preface

The UK Marine Monitoring and Assessment Strategy (UKMMAS) aims to provide coordinated and integrated marine monitoring programmes which support periodic assessments of the state of the UK marine environment. The strategy aims to provide vital data and information necessary to help assess progress towards achieving the UK's vision of clean, healthy, safe, productive and biologically diverse seas. The overarching strategy is supported and delivered by four evidence groups; Clean and Safe Seas Evidence Group (CSSEG); Productive Seas Evidence Group (PSEG); Healthy and Biologically Diverse Seas Evidence Group (HBDSEG) and Ocean Processes Evidence Group (OPEG). These groups are responsible for implementing monitoring and observations programmes to contribute to ecosystem-based assessments of marine environmental status.

As part of the HBDSEG programme of work, a series of reviews of environmental indicators was undertaken for the following marine ecosystem components:

1. Rock and biogenic reef habitats
2. Sediment habitats
3. Deep sea habitats
4. Seabirds and waterbirds
5. Cetaceans
6. Seals
7. Plankton
8. Microbes

The aim of the reviews was to evaluate a wide range of currently available and potential indicators for marine biodiversity monitoring and assessment. This task was undertaken particularly to inform future needs of the EU Marine Strategy Framework Directive (MSFD). The work was carried out by a group of consultants and contributors and was managed by JNCC.

Each review included a process to evaluate indicator effectiveness against a set of specified scientific and economic criteria. This process identified those indicators of activity, pressure, state change/impact and ecosystem structure and function that were considered to be scientifically robust and cost effective. The indicators which met these criteria were then assessed for inclusion within an overall indicator suite that the reviewers considered would collectively provide the best assessment of their ecosystem component's status. Within the review, authors also identified important gaps in indicator availability and suggested areas for future development in order to fill these gaps.

This report covers one of the ecosystem components listed above. It will be considered by HBDSEG, together with the other indicator reviews, in the further development of monitoring and assessment requirements under the MSFD and to meet other UK policy needs. Further steps in the process of identifying suitable indicators will be required to refine currently available indicators. Additional indicators may also need to be developed where significant gaps occur. Furthermore, as the framework within which these indicators will be used develops, there will be increasing focus and effort directed towards identifying those indicators which are able to address specific management objectives. There is no obligation for HBDSEG or UKMMAS to adopt any particular indicators at this stage, based on the content of this or any of the reports in this series.

This report has been through a scientific peer review and sign-off process by JNCC and HBDSEG. At this time it is considered to constitute a comprehensive review of a wide range of currently available and potential indicators for this marine ecosystem component.

Summary

- Indicators provided by monitoring programmes of UK grey and harbour (common) seal populations are reviewed as a contribution to the Healthy and Biologically Diverse Seas Evidence Group (HBDSEG) and to the OSPAR / UKMMAS assessment framework. This review focuses on indicators currently in use in policy and regulatory mechanisms and identifies other indicators that could provide useful additional information on seals and their use of the seas around the UK.

- There are three indicators currently in use for UK seals. Two are based on existing, long-term monitoring of UK populations of grey and harbour seals. The third is based on long-term studies of grey seal population demography at two important breeding colonies in Scotland. The three existing indicators do not show the direct responses of seals or seal populations to anthropogenic pressures. Instead, they are indicators of state, showing the responses of seals (in terms of numbers of pups born, moulting population size and female body condition) to the condition of their marine environment over the preceding year (or years). Four additional indicators that are not assessed routinely but are useful as indicators of the marine environment around the UK are identified. These suggested indicators respond more directly to specific anthropogenic pressures.

- All three currently used indicators were developed to satisfying NERC's statutory obligations under the Conservation of Seals Act 1970. They provide the information required by the Countryside Agencies and JNCC to satisfy EU habitats Directive requirements for Special Areas of Conservation designated for grey and harbour seals in the UK. Two of these indicators are used by OSPAR as EcoQO's for assessing North Sea grey and harbour seal population status.

- In the assessment, all three existing indicators scored 'highly' in terms of their scientific value and 'poorly' in terms of economic value. This is because the monitoring programmes cover a very large component of the UK population of each species and require aerial platforms to conduct surveys. The programmes are designed to determine annual changes in local populations and, necessarily, it takes weeks or months to collect, analyse and assess the results. The same is true for the longitudinal demographic studies, where individual breeding females are sampled in successive years to determine changes in breeding performance over their lifetime.

- The evaluation process undertaken here resulted in all three seal indicators as being judged to be 'Not recommended'. This is despite the fact that the OSPAR's EcoQOs for grey and for harbour seals were based on two of these same monitoring programmes.

- Four potential indicators for seals, which are more directly linked to specific pressures, are identified. These are: seal diet; contaminant and toxins in seals; seal at-sea foraging distribution and seal bycatch. Although the first three potential indicators have been studied, there is no established or formal long-term programme to assess these indicators over time. The last, seal bycatch, has never been assessed formally and only recently (within the past year) has it been monitored in limited areas.

- Information from the three existing seal monitoring programmes described can be used as indicators of the state or structure of seal populations.

- Seal populations do not respond directly to individual pressures in a manner that can be easily assessed but reflect the responses of seals (or seal populations) to a combination of pressures, many of which may not be identifiable. The four potential indicators are more tightly linked to definable (and possibly manageable) anthropogenic pressures.

Contents

1 Introduction

1.1 Aims & objectives of this report

There is a requirement to monitor and assess effectively the state and condition of the marine environment around the UK and there are various national and international policy drivers designed to meet these requirements. One aim of this report is to determine whether existing information on UK seals can be used as indicators to provide information on the state or condition of the marine environment around the UK. Another aim is to identify any gaps in the existing programmes of work on seals that could usefully contribute additional relevant and effective indicators. Ultimately, the suite of indicators provided by seals will contribute to scientifically robust assessments of the UK's marine environmental status.

This report notes that the scientific evaluation of indicators developed for this review is based on the Ecological Quality Objectives (EcoQOs) developed for OSPAR (the Convention for the Protection of the Marine Environment of the Northeast Atlantic) (see section 5). Indicators were assessed by means of an on-line database application, developed by the Joint Nature Conservation Committee (JNCC).

This report should be considered in conjunction with the chapter on seals in Charting Progress 2 (UKMMAS 2010), both of which contribute information to the Marine Strategy Framework Directive (MSFD; see section 3.4.4). The information presented in CP2 demonstrates how seal population indicators are currently used.

Three existing monitoring programmes for grey and harbour seals are used here as indicators of the condition of the marine environment. It is important to bear in mind that this use is not the primary function of these three monitoring programmes.

1.2 Work undertaken in this report

This report was written in conjunction with and using information presented in the Seals chapter of Charting Progress 2.

To achieve the aims of this report, the following was undertaken:

- A review of existing indicators for seals, in particular from existing national monitoring programmes.
- An evaluation of the effectiveness of indicators against predefined scientific and economic criteria (as defined by JNCC).
- An assessment of how existing indicators can address relevant anthropogenic pressures and important aspects of ecosystem structure and function.
- Identification of conspicuous gaps and any indicators that could fill these gaps to improve the suite of indicators provided by UK seals.
- Assessing the importance of seals as indicators and recommending an effective suite of indicators for seals that could be used within a future integrated monitoring and assessment programme.

1.3 Introduction to the ecosystem component of interest: seals

This report is concerned with UK seals only. There are two seal species resident in the UK: grey seals (*Halichoerus grypus*) and harbour (or common) seals (*Phoca vitulina*). A number of Arctic seal species occasionally visit UK waters (Hall, 2008) but are not considered further in this report. As long-lived, top predators with a varied diet (e.g. grey seals: Hammond *et al* 1994 (a) & (b); harbour seals: Pierce & Santos, 2003; Sharples *et al* 2009), seals are reasonably buffered against short-term changes in their marine environment.

Seals must haul ashore onto land to give birth to and rear their pups, to moult and at other times, to rest out of the water. This requirement to spend time on shore enables population size to be estimated by aerial survey or by counting from land. Both grey and harbour seals regularly use the same haulout sites outside their breeding seasons (McConnell *et al* 1999) and both species also show a high degree of philopatry, returning repeatedly to breed at the same location in successive years, often to the location at which they were born (Pomeroy, 2000; Mackey, 2004).

Differences in the annual cycle of grey and harbour seals and in their behaviour during their breeding seasons determine the methods used to estimate the abundance of each species. Grey seal females aggregate to breed at traditional colonies where they give birth to their white-coated pups. Although grey seal pups are quite capable of swimming, they remain at their natal site and do not begin to forage on their own until they are approximately four to five weeks old.

In marked contrast, harbour seal females tend to disperse to give birth and pups are usually born below the high water mark, having moulted their white coat while in their mother's uterus. Necessarily, pups can and do swim with their mothers at the next incoming tide. Although harbour seals return to breed at the same locations, they do not aggregate in the same manner as grey seals but remain dispersed around the coastline.

Monitoring programmes for grey and harbour seals in most parts of the UK have been well established for many years. Annually updated summary information on most of the routine monitoring programmes can be found on the Sea Mammal Research Unit's (SMRU) website at: http://www.smru.st-andrews.ac.uk/pageset.aspx?psr=411.

1.4 Policy background

1.4.1 National policy

i Conservation of Seals Act 1970

Under the Conservation of Seals Act 1970 (CoSA), the Natural Environment Research Council (NERC) has a statutory obligation to provide the Secretary of State (now the Scottish Government (SG) and the Department for the environment, food and rural affairs (Defra)) with '*…scientific advice on matters related to the management of seal populations*'. A primary component of this advice is information on the size and distribution of seal populations around the UK. The advice is compiled annually by SMRU and is reported to UK Government via the NERC's Special Committee on Seals (SCOS). The latest advice can be found on the SMRU website: http://www.smru.st-andrews.ac.uk/pageset.aspx?psr=411.

Under the CoSA, seals are protected during a defined close season (the months around the breeding season). The close season for grey seals is between 1 September and 31 December and for harbour seals, between 1 June and 31 August. Section 9(1)c of the CoSA (commonly referred to as the Netsmen's Defence) permits unregulated shooting of seals that cause damage to fishing net or tackle, or to fish in a fishing net, or that are in the vicinity of such a net or tackle. There is no requirement to report seals that are shot under section 9(1)c. Licences may be issued to shoot a predefined number of seals during the appropriate close season under certain circumstances. One of the conditions of the Licence is that the number of seals shot must be reported to the Licence-issuing authority. Outside the close season, unless otherwise protected under a Conservation Order, seals may be shot without any reporting requirement.

Under the CoSA, Conservation Orders may be introduced to provide further protection to seals outside the close seasons. In England, the Conservation of Seals (1999) Order provides year-round protection to both species between the Scottish border and Newhaven Pier. This Order was placed as a consequence of the mortality caused by phocine distemper virus (PDV) to harbour seals in east England during 1988 (50% died) and 2002 (20% died; Thompson *et al* 2005). There are two Conservation Orders in place in Scotland: the Conservation of Seals (Scotland) Order 2004 and the Conservation of Seals (Scotland) Order 2007. Both Scottish Conservation Orders will be replaced with the introduction of the Marine (Scotland) Bill (see below).

In Northern Ireland, both species of seal are protected at all times under Schedule 5 of the Wildlife (Northern Ireland) Order 1985, supplemented by the Conservation (Natural Habitats, etc) Regulations (NI) 1995 (as amended). Seals are also protected through the Environment (Northern Ireland) Order 2002, if they are listed as a feature within an Area of Special Scientific Interest.

Seal conservation and the implementation of the CoSA is a devolved issue. Currently, only Northern Ireland has independent legislation protecting grey and harbour seals. In Scotland, where over 85% of the UK's grey and harbour seal population are found, the CoSA will be repealed under the Marine (Scotland) Bill in 2010. In England, the CoSA was not amended under the Marine and Coastal Access Act and there is no future plans to amend the CoSA. The only potential addition under consideration is the designation of marine protected areas for seals. The Welsh Assembly Government does not have any immediate proposals to update or alter the CoSA.

ii Marine (Scotland) Bill

Under the Marine (Scotland) Bill, which is currently before the Scottish Parliament, the Conservation of Seals Act 1970 will be repealed as the legislation is not considered to be sufficiently up-to-date or compatible with European seal conservation regulations. One of the main changes under the Marine (Scotland) Bill will be that the shooting of any seal in Scotland will require a licence and must be reported. In consequence, the Marine (Scotland) Bill should provide the first opportunity to assess the impact of seal shooting across the whole of Scotland.

1.4.2 International policy

i Habitats Directive

The 1992 Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (92/43/EEC), otherwise known as the 'Habitats Directive' requires that Special Areas of Conservation be designated for species of community interest. Grey and harbour seals are both listed in the Directive's Annex II (require designation of Special Areas of Conservation) and Annex V (animal and plant species of community interest whose taking in the wild and exploitation may be subject to management measures) but are not listed in Annex IV (European protected species). As a result, Special Areas of Conservation (SACs) have been designated for both species (grey seals on: http://www.jncc.gov.uk/ProtectedSites/SACselection/species.asp?FeatureIntCode=S1364; harbour seals on: http://www.jncc.gov.uk/ProtectedSites/SACselection/species.asp?FeatureIntCode=S1365).

1.4.3 Biodiversity Convention and the UK Biodiversity Action Plan

Harbour seals are included in UK Biodiversity Action Plan under the Convention for Biological Diversity (CBD or Biodiversity Convention), ratified by the UK in 1994. Grey seals are not included.

1.4.4 Marine Strategy Framework Directive (MFSD) and Good Environmental Status (GES)

The MSFD requires Member States to develop marine strategies that apply '*an ecosystem-based approach to the management of human activities while enabling a sustainable use of marine goods and services, priority should be given to achieving or maintaining good environmental status in the Community's marine environment, to continuing its protection and preservation, and to preventing subsequent deterioration*'.

Each Member State is required to develop a marine strategy by 2012 that ensures '*integration of conservation objectives, management measures and monitoring and assessment activities*' with the conservation element focused on protected areas. These marine strategies must include '*an assessment of the current environmental status and the environmental impact of human activities thereon'* and the establishment '*of a series of environmental targets and associated indicators'*. By 2014, establishment and implementation of a monitoring programme for ongoing assessment and regular updating of targets is required.

The MSFD is being transposed into national legislation through the Marine Bill and other equivalent pieces of legislation for the Devolved Administrations. Consideration is being given to the definition of GES and possible indicators that could be used to measure it. Although seals have not been identified specifically, Annex III of the MSFD identifies pressures such as physical disturbance through underwater noise, contamination by hazardous substances and biological disturbance that need to be included within the national marine strategy.

1.4.5 The Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR)

OSPAR developed one Ecological Quality Objective (EcoQO) for grey seals and one for harbour seals (OSPAR, 2007). Both seal EcoQOs were developed for areas bordering the North Sea and were based on the UK's monitoring regime for each species (see: http://www.ospar.org/documents/DBASE/Publications/p00318_EcoQO%20brochure%20Towards%20a%20Healthy%20North%20Sea.pdf).

2 OSPAR/UKMMAS assessment framework background

The assessment framework developed by JNCC was first presented to the OSPAR Convention's Biodiversity Committee in February 2007 and has since gained wide support across OSPAR as a tool to guide the development of a strategic approach to biodiversity monitoring. It has been particularly welcomed for its potential benefit in meeting the needs of the Marine Strategy Framework Directive (MSFD).

The framework takes the form of a matrix which relates ecosystem components (e.g. deep-seabed habitats) to the main pressures acting upon them (e.g. physical disturbance to the seabed). The ecosystem components have been correlated with components used by OSPAR and the MSFD. The columns of the matrix are a generic set of pressures on the marine environment, which are based on those used by OSPAR, MSFD and the Water Framework Directive (WFD). A 3-point scale of impact (low, moderate, high) reflects the degree of impact each pressure has on an ecosystem component. Each cell of the matrix has additionally been populated with a set of known indicators[1], derived from statutory and non-statutory sources, which are used to monitor and assess the state of that ecosystem component. The assessment matrix helps to highlight priorities for indicator development and monitoring programmes, based on the likely degree of each impact on the ecosystem component in question.

Since 2007 this approach has also been introduced to the UK's Marine Monitoring and Assessment Strategy (UKMMAS) and is being further developed by the Healthy and Biologically Diverse Seas Evidence Group (HBDSEG). The intention has been to have parallel development at UK and OSPAR levels which will help ensure similar biodiversity strategies are developed at national and international levels. It is also envisaged that the development process will benefit from wide input across OSPAR Contracting Parties.

The overall goal of the UKMMAS is to implement a single monitoring framework that meets all national and international multiple policy commitments (UKMMAS, 2007). This will identify if there are any significant gaps in the current monitoring effort and aim to minimise costs by consolidating monitoring programmes. To help meet this goal, the assessment matrix has been developed with HBDSEG to provide a useful framework that analyses components of an ecosystem and their relationships to anthropogenic pressures. The framework aims to encompass three key issues: an assessment of the state of the ecosystem and how it is changing over space and time, an assessment of the anthropogenic pressures on the ecosystem and how they are changing over space and time, and an assessment of the management and regulatory mechanisms established to deal with the impacts.

The further development of the assessment framework has been divided into five shorter work packages: 1) assessment of pressures, 2) mapping existing indicators to the framework, 3) review of indicators and identification of gaps, 4) modifying or developing indicators and 5) review of current monitoring programmes. The following work will contribute to work package 3 and will critically review indicators, identify gaps and recommend an overall suite of the most effective indicators for the ecosystem component in question.

[1] Note: cells of the matrix where impacts have been identified currently contain a number of species and habitats on protected lists (OSPAR, Habitats Directive), which could potentially be used as indicators of the wider status of the ecosystem component which they are listed against. Should this be appropriate, certain aspect of the species or habitat (eg its range, extent or condition) would need to be identified to monitor/assess.

2.1 Definitions used within the report and analysis

Definitions of activity, pressure, state change/ecological impact and ecosystem structure and function are used as follows (adapted from the 2008 CP2 methodology[2]):

Activity – Human social or economic actions or endeavours that may have an effect on the marine environment e.g. fishing, energy production.

Pressure - the mechanism (physical, chemical or biological) through which an activity has an effect on any part of the ecosystem e.g. physical disturbance to the seabed.

State change/ecological impact – physical, chemical or biological condition change at any level of organisation within the system. This change may be due to natural variability or occurs as a consequence of a human pressure e.g. benthic invertebrate mortality.

Ecosystem structure and function – ecosystem level aspects of the marine environment (i.e. structural properties, functional processes or functional surrogate aspects) which are measured to detect change at higher levels of organisation within the system (i.e. changes at ecosystem scales), that is not attributable to any pressure or impact from human activity e.g. natural changes in species' population sizes. Please see Annex 4.

Pressures list:

The standard list of pressures against which indicators for this ecosystem component are reviewed is taken from the generic pressures list in the latest version (v11) of the UKMMAS / OSPAR assessment framework / matrix. Those pressures which are relevant to the ecosystem component (i.e. those that cause any impact on it) are used within the critical review and report.

[2] Robinson, L.A., Rogers, S., & Frid, C.L.J. 2008. *A marine assessment and monitoring framework for application by UKMMAS and OSPAR – Assessment of Pressures and impacts* (Contract No: C-08-0007-0027 for the Joint Nature Conservation Committee). University of Liverpool, Liverpool and Centre for the Environment, Fisheries and Aquaculture Science, Lowestoft.

3 Methods and data sources

Most of the monitoring studies and the additional work programmes described here are or would be carried out and/or collated by SMRU. The main exceptions are the assessment of grey seal pup production in Wales (Countryside Council for Wales) and the monthly surveys of grey and harbour seals in Northern Ireland (Northern Ireland Environment Agency). This report, including the analysis and interpretation, was by the primary coordinator of the UK's grey and harbour seal monitoring programmes in consultation with colleagues in SMRU.

3.1 Monitoring grey seal pup production

Grey seal pup production is monitored annually at approximately 60 breeding colonies around the UK and less frequently at approximately 40 smaller colonies (Duck, 2009; Duck & Thompson, 2007). In Scotland, the main breeding colonies are annually surveyed between three and six times during the breeding season. Total pup production for each colony is estimated from a maximum likelihood model, using the counts of white coated and moulted pups. In England, total pup production at the four main breeding colonies is estimated directly by counting from the ground. In Wales, where grey seals breed on remote rocky coast and in caves and are particularly difficult to survey, pup production is monitored annually at Ramsay and Skomer Islands (part of the Pembroke Coast grey seal SAC) and when weather and funding permits at other colonies (Baines & Evans, 2009).

3.2 Monitoring harbour seal populations

Harbour seals are usually monitored during their annual moult when they form larger and more consistently-sized groups. In Scotland, harbour seals are concentrated in Shetland, Orkney, the Outer Hebrides, the Inner Hebrides and west coast, Strathclyde, the Moray Firth and the Firth of Tay. In England, harbour seals are concentrated on the east coast, between the Humber Estuary and east Norfolk (Duck & Thompson, 2009). In Northern Ireland, most harbour seals are found between Carlingford and Belfast Loughs.

Harbour seals inhabiting the sandy estuaries on the east coast of Scotland and England are monitored annually during their moult (one or two surveys in August). Elsewhere in Scotland, survey frequency is approximately once every five years, although this may vary according to the demand for information from different areas. In the Moray Firth (four or five surveys) and in east England (one or five surveys), harbour seals are also monitored annually during their breeding season (June and July). In Northern Ireland, local populations are monitored monthly. With the exception of monthly monitoring in Northern Ireland, all harbour seal population monitoring is carried out by SMRU.

3.3 Grey seal demography

Grey seal demography is studied at two breeding colonies in Scotland. Both colonies are National Nature Reserves and Special Areas of Conservation for breeding grey seals. Demographic studies focus on the breeding success of individually recognised females, between-year differences in maternal post-partum mass, differences in pup growth rate (within and between years), pre-weaning pup mortality (Pomeroy *et al* 1999; Pomeroy *et al* 2000; Twiss *et al* 2003; Pomeroy *et al* 2005) and habitat use by breeding females. Maternal post-partum mass, pup growth rate and pre-weaning pup survival are dependent on the

condition of females returning to the colony to breed. Female condition is determined by her foraging success over the preceding months and will determine the rate at which her pup grows and whether it will survive or not.

4 A review and critical evaluation of the existing indicators

4.1 Current indicators summary

The indicators described are based on monitoring programmes for grey and harbour seals that have been in place for at least two decades and on long-term studies of grey seal demography at two important breeding colonies in Scotland. These monitoring programmes are required to satisfy existing legislative requirements (see section 3.4). The monitoring programmes provide information on the state of seal populations and can be used to indicate their response to indicate changes in their marine environment. Existing indicators are:

JNCC ID 1305: Grey seals: annual estimates of pup production (changes in);
JNCC ID 1306: Harbour seals: regional counts during annual moult and breeding seasons (changes in);
JNCC ID 1317: Grey seal demography (at two breeding colonies).

These are all indicators of either state or structure, providing information (the primary reason for the monitoring programmes) on grey and harbour seal population size, their range and distribution in the UK and, for grey seals, some aspects of reproduction and longevity. In all instances, the parameters measured (grey seal pup production, grey and harbour seal numbers on shore, grey seal female condition and growth rates of pups) reflect the responses of individual seals or seal populations to the condition of the marine environment since the previous monitoring event. For grey seals, this is the previous year; for harbour seals, this is between one and five or more years previously, depending on location. There is no direct assessment of any change in the marine environment or of the direct effects of any anthropogenic pressures to which seals (or seal populations) might be responding. Instead, these three statistics show the responses of individuals and of local populations to an unknown (and probably diverse) suite of pressures.

4.2 Evaluation of the effectiveness of indicators against standard scientific and economic criteria

4.2.1 Criteria used to evaluate indicators

In order to achieve a consistent critical appraisal of all indicators, the indicators for this ecosystem component have been reviewed and scored against the following set of criteria. These criteria have been built into the online indicators database application and the data has been stored electronically.

***A. Scientific criteria*:**

The criteria to assess the scientific ‘effectiveness’ of indicators are based on the ICES EcoQO criteria for ‘good’ indicators. The scoring system is based on that employed within the Netherlands assessment of indicators for GES (Langenberg & Troost 2008). A confidence score of: 3 - High, 2 - Medium, 1 - Low is assigned for each question. A comment is given on the reasons for any low confidence ratings in the comment box provided within the database. All efforts have been made to seek the necessary information to answer criteria questions to a confidence level of medium or high.

INDICATOR EVALUATION:

1. Sensitivity: Does the indicator allow detection of any type of change against background variation or noise?

Score	3	2	1	Confidence
Options	Usually	Occasionally	Rarely	

2. Accuracy: Is the indicator measured with a low error rate?

Score	3	2	1	Confidence
Options	Usually	Occasionally	Rarely	

If the indicator scores 1 or 2 for question 1 or 2, conclude that it is ineffective and do not continue with the evaluation –the indicator will still be stored within the database as considered but will be flagged as 'insensitive, no further evaluation required'

3. Specificity: Does the indicator respond primarily to a particular human pressure, with low responsiveness to other causes of change?

Score	3	2	1	Confidence
Options	Usually	Occasionally	Rarely	

4. Performance:

For questions 4a-f, if a score of 1 is given, please consider if the indicator is of real use. Please justify (within the report) continuing if a score of 1 is given.

The following criteria are arranged with descending importance:

a) Simplicity: Is the indicator easily measured?

Score	3	2	1	Confidence
Options	Usually	Occasionally	Rarely	

b) Responsiveness: Is the indicator able to act as an early warning signal?

Score	3	2	1	Confidence
Options	Usually	Occasionally	Rarely	

c) Spatial applicability: Is the indicator measurable over a large proportion of the geographical to which the indicator metric it to apply to e.g. if the indicator is used at a UK level, is it possible to measure the required parameter(s) across this entire range or is it localised to one small scale area?

Score	3	2	1	Confidence
Options	Usually	Occasionally	Rarely	

d) Management link: Is the indicator tightly linked to an activity which can be managed to reduce its negative effects on the indicator i.e. are the quantitative trends in cause and effect of change well known?

Score	3	2	1	Confidence
Options	Usually	Occasionally	Rarely	

e) Validity: Is the indicator based on an existing body or time series of data (either continuous or interrupted) to allow a realistic setting of objectives?

Score	3	2	1	Confidence
Options	Usually	Occasionally	Rarely	

f) Relatively easy to understand by non-scientists and those who will decide on their use:

Score	3	2	1	Confidence
Options	Usually	Occasionally	Rarely	

Thresholds for scientifically poor, moderate and good indicators:

Combine indicator evaluation scores for:

1. Sensitivity
2. Accuracy
3. Specificity
4. Performance

Evaluation Score	Indicator 'Effectiveness' Category
22-27	**Good**
16-21	**Moderate**
9-15 OR not all questions completed due to expert judgement not to continue	Poor

} **Further economic evaluation required - see section B below**

B. Economic criteria:

Having identified the most scientifically robust indicators using the above stated criteria, a further economic evaluation of those most effective indicators (i.e. those falling in the good or moderate categories) is carried out using the criteria stated below.

1. Platform requirements

Score	4	3	2	1
Options	None e.g. intertidal sampling	Limited e.g. coastal vessel	Moderate e.g. Ocean going vessel or light aircraft	Large e.g. satellite or several ocean going vessels

2. Equipment requirements for sample collection

Score	4	3	2	1
Options	Simple equipment requirements e.g. counting number of organisms	Limited equipment requirements e.g. using quadrats on the shoreline	Moderate equipment requirements e.g. measuring physiological parameters	Highly complex method e.g. technical equipment operation

3. Amount of staff time required to plan collection of a single sample

Score	4	3	2	1
Options	Hours	Days	Weeks	Months

4. Amount of staff time required to collect a single sample

Score	4	3	2	1
Options	Hours	Days	Weeks	Months

5. Amount of staff time required to process a single sample

Score	4	3	2	1
Options	Hours	Days	Weeks	Months

6. Amount of staff time required to analyse & interpret a single sample

Score	4	3	2	1
Options	Hours	Days	Weeks	Months

7. Amount of staff time required to QA / QC data from a single sample

Score	4	3	2	1
Options	Hours	Days	Weeks	Months

Thresholds for economically poor, moderate and good indicators:

Evaluation Score	Indicator 'Effectiveness' Category
24-28	**Good**
19-23	**Moderate**
7-18	Poor

Those indicators which fall within the **'Good'** or **'Moderate'** economic category will then be tagged within the summary database as 'Recommended' indicators. Indicators can also be 'recommended' via expert judgement even if the evaluation of the indicator does not score well enough to be automatically recommended. This judgement will be justified within the report text.

4.2.2 Additional information on the critical analysis of indicators

The three currently used indicators for seals – which are all indicators of state or structure – scored highly under the scientific evaluation but poorly under the economic evaluation (see Table below). As a consequence of the 'poor' economic evaluation, all three indicators were 'not recommended' under the rules of the assessment procedure. Yet they provide virtually all the information on seals required to comply with the EU Habitat's Directive and OSPAR's EcoQOs.

No.	Indicator	Scientific evaluation	Economic evaluation	Recommended	Established EcoQO
1305	Grey seal pup production	24 Good	15 Poor	No	Yes
1306	Harbour seal counts	25 Good	17 Poor	No	Yes
1317	Grey seal demography	24 Good	17 Poor	No	No

This is somewhat surprising, given that OSPAR's EcoQOs (the scientific criteria for identifying good EcoQO indicators formed the basis for the scientific criteria used in this review, but not for the economic evaluation) for both grey and harbour seals were developed on the basis of these same UK population monitoring programmes (OSPAR, 2007). The main reason for the failure of these indicators to be recommended is economic. The methodology required to provide the information is expensive (aircraft are used to survey the widely dispersed populations of both species of seal) and analysis of the data takes a considerable amount of time. However, this is unsurprising considering that over 80% of the UK populations of both species is being assessed. Furthermore, the same population monitoring programmes provide all the information required by Scottish Natural Heritage, Natural England and JNCC to comply with the six-yearly assessment of the conservation status of grey and harbour seals within all bar one (grey seals on the Pembrokeshire coast in Wales) of the SACs designated for grey and harbour seals in the UK (and for UK populations as a whole) as required by the EU's Habitats Directive.

5 Gap analysis. A review of indicators against relevant pressures and important aspects of ecosystem structure and function

5.1 Review of indicators against pressures and identification of gaps

Please refer to the associated spreadsheet 'Annex 1 Seals Pressures.xls'. This gap matrix was produced as a tool to aid authors in identifying significant gaps in current or potential indicators i.e. where relevant and important pressures on the ecosystem component do not have any suitable indicators associated with them. All recommended indicators have been prefixed with [R] and the cells containing them are coloured green.

It should be noted that if a single indicator is associated with more than one pressure within the pressures gap matrix, it may mean that this indicator responds to a range of pressures or the synergistic effects of a combination of pressures. Such an indicator would not necessarily be able to detect change which can be attributed to each individual pressure.

5.1.1 Pressures faced by UK Seals

Seals are affected by a number of different anthropogenic pressures, the impacts of which are not assessed directly by existing indicators but are inferred. For example, the fishing industry exerts a pressure on seal populations through the removal of fish from the sea. The effect of this pressure is not assessed directly but may result in seals in some areas having difficulty in finding an adequate supply of food. Female seals in poor condition are unlikely to successfully wean their pups or, in extreme cases, to continue with their pregnancy. Thus changes in the numbers of pups born at breeding colonies, the extent of pre-weaning pup survival and variation in maternal post-partum mass may be responding to fishing pressure.

At present it is impossible to distinguish between the impacts that different anthropogenic pressures have on seals but it is possible to observe and monitor the overall response of seals (and seal populations) to these pressures.

Four suggested indicators are described that indicate, more directly, the effects of anthropogenic pressures on seals. There are no formal monitoring programmes for these suggested indicators. Three (seal diet, contaminant and toxin levels in seals and seal at-sea foraging distribution) are assessed whenever research programmes are in place. The fourth (seal bycatch) has never been assessed across the UK and a monitoring programme has only recently been instigated.

Seals are generally considered to be major competitors by the fishing industry, even though cetaceans and seals consume fish of similar size and species and the numbers of small cetaceans around the UK greatly exceeds the numbers of seals (of both species). Perhaps this difference in perception by the fishing industry is because seals haul ashore and are highly visible while cetaceans are infrequently seen.

Until the implementation of the Marine (Scotland) Bill, seals may legitimately be shot in the UK without licence, except at specific times of the year (except in Northern Ireland where both seal species are protected). In contrast, all cetaceans are European protected species.

The Marine (Scotland) Bill addresses this issue but there are no imminent plans by either Defra or the Welsh Assembly to alter existing legislation.

There is no requirement, legal or other, to assess the numbers of seal that are by-caught by the fishing industry.

5.2 Four potential indicators using information from seals

There are four additional indicators that would considerably improve our understanding of the extent and effect of anthropogenic pressures on grey and harbour seals. These suggested indicators are more focussed on specific pressures and are therefore more likely to provide information on the direct responses of seals and seal populations to these pressures. Currently, the four suggested indicators are monitored occasionally, according to funding and research opportunities; there is no formal or routine monitoring programme.

The detailed scientific and economic evaluation scores for each potential indicator are given below. Please see section 5.2.1 for a description of what each score given for each evaluation question relates to.

Summary assessment of four suggested indicators for seals:

	Suggested Indicator	**Scientific evaluation**	**Economic evaluation**	**Recommended**	**Recognised EcoQO**
1353	Seal diet (grey and harbour seals)	25 Good	19 Moderate	Yes	No
1354	Contaminants and toxins	24 Good	20 Moderate	Yes	No
1362	At-sea foraging distribution	25 Good	17 Poor	No	No
1363	Seal bycatch	25 Good	25 Good	Yes	No

5.2.1 Seal diet

Although there have been a number of specific studies assessing the diet of grey and harbour seals around the UK, there is no formal monitoring programme that routinely identifies regional differences or changes in prey consumption by either grey or harbour seals over time.

A monitoring programme of grey and harbour seal diet at key locations would provide information on seasonal changes in seal diet and, in time, provide information on longer-term changes. Changes in diet would reflect alterations in fish distribution and abundance that might be a consequence of changes in sea temperature around the UK. Regular studies seal diet could provide information on where commercially important fish species were being consumed. This information could be used to define where fishing operations were exerting pressures on seal populations and, conversely, where seal populations were exerting pressure on commercially important fish stocks. Diet studies would also show which non-commercial prey species were important in their diet.

Seal diet is usually determined through examination of hard parts (bones and otoliths) extracted from seal faeces. Digestion coefficients have been calculated for many prey species and recent studies of grey seals have shown changes in diet compared with a previous study. Grey seal diet in Scotland and the North Sea has been investigated in detail twice, in 1985 and in 2002 (Hammond *et al* 1994(a) and (b); Grellier & Hammond, 2005; Hammond & Grellier, 2006; Hammond & Harris, 2006. See also Ridoux *et al* 2007). There has been no formal assessment of harbour seal diet across the UK as a whole, only occasional assessment at specific localities (e.g. east England: Hall *et al*. 1998; Shetland: Brown & Pierce, 1998; Moray Firth: Tollit & Thompson, 1996, Tollit *et al* 1998; Mull and Skye: Pierce & Santos, 2003; Firth of Tay: Sharples *et al* 2009).

1. Sensitivity: Does the indicator allow detection of any type of change against background variation or noise?

Seal diet: Score 3; Confidence High

2. Accuracy: Is the indicator measured with a low error rate?

Seal diet: Score 3; Confidence High

If the indicator scores 1 or 2 for question 2 or 3, conclude that it is ineffective and do not continue with the evaluation –the indicator will still be stored within the database as considered but will be flagged as 'insensitive, no further evaluation required'

3. Specificity: Does the indicator respond primarily to a particular human pressure, with low responsiveness to other causes of change?

Seal diet: Score 2; Confidence Medium

4. Performance:

For questions 4a-f, if a score of 1 is given, please consider if the indicator is of real use. Please justify (within the report) continuing if a score of 1 is given.

The following criteria are arranged with descending importance:

a) Simplicity: Is the indicator easily measured?

Seal diet: Score 3; Confidence High

b) Responsiveness: Is the indicator able to act as an early warning signal?

Seal diet: Score 3, Confidence High

c) Spatial applicability: Is the indicator measurable over a large proportion of the geographical area to which the indicator results will apply to e.g. if the indicator is used at a UK level, is it possible to measure the required parameter(s) across this entire range or is it localised to one small scale area?

Seal diet: Score 3; Confidence High

d) Management link: Is the indicator tightly linked to an activity which can be managed to reduce its negative effects on the indicator i.e. are the quantitative trends in cause and effect of change well known?

Seal diet: Score 2; Confidence Medium

e) Validity: Is the indicator based on an existing body or time series of data (either continuous or interrupted) to allow a realistic setting of objectives?

Seal diet: Score 2; Confidence High

f) Relatively easy to understand by non-scientists and those who will decide on their use:

Seal diet: Score 3; Confidence High

Thresholds for scientifically poor, moderate and good indicators:

Combine indicator evaluation scores for:

1. Sensitivity
2. Accuracy
3. Specificity
4. Performance

Evaluation Score	Indicator 'Effectiveness' Category
22-27	**Good**
16-21	**Moderate**
9-15 OR not all questions completed due to expert judgement not to continue	Poor

Further economic evaluation required – see section B below

Seal diet: Scientific score: 25

A. Economic criteria:

Having identified the most scientifically robust indicators using the above stated criteria, a further economic evaluation of those most effective indicators (i.e. those falling in the good or moderate categories) is carried out using the criteria stated below.

1. Platform requirements

Seal diet: Score 2

2. Equipment requirements for sample collection

Seal diet: Score 4

3. Amount of staff time required to plan collection of a single sample

Seal diet: Score 3

4. Amount of staff time required to collect a single sample

Seal diet: Score 3

5. Amount of staff time required to process a single sample

Seal diet: Score 2

6. Amount of staff time required to analyse & interpret a single sample

Seal diet: Score 2

7. Amount of staff time required to QA / QC data from a single sample

Seal diet: Score 3

Seal diet: Economic Score: 19

5.2.2 Contaminants and toxins in seals

As top predators, seals accumulate ingested persistent organochloride contaminants in their blubber (O'Shea, 1999; Landsberg, 2002). These compounds have been shown to interrupt immune system function and fertility (Reijnders, 1986) and are passed from mother to offspring during lactation (Pomeroy *et al* 1996). There is increasing evidence that algal toxins may be responsible for mortality in seals (e.g. Hernandez *et al* 1998). Contaminants can be introduced into the marine ecosystem through industrial discharge, fertilisers, waste disposal

Samples are easily obtained from live-caught seals but Home Office Licensing regulations state that samples cannot be taken from live animals unless they will be processed as part of an existing programme of work. This means that samples of blubber (contaminants) and urine (toxins) cannot be collected in perpetuity. The absence of a continuous study or monitoring programme has resulted in many seals being captured but not sampled.

Assessment of toxin levels in seals' urine and faeces will provide information on the responses of seals to factors that cause toxic algal blooms such as eutrophication and changes in sea temperature.

1. Sensitivity: Does the indicator allow detection of any type of change against background variation or noise?

Seal Contaminant/Toxin: Score 3; Confidence High

2. Accuracy: Is the indicator measured with a low error rate?

Seal Contaminant/Toxin: Score 3; Confidence High

If the indicator scores 1 or 2 for question 2 or 3, conclude that it is ineffective and do not continue with the evaluation –the indicator will still be stored within the database as considered but will be flagged as 'insensitive, no further evaluation required'

3. Specificity: Does the indicator respond primarily to a particular human pressure, with low responsiveness to other causes of change?

Seal Contaminant/Toxin: Score 3; Confidence Medium

4. Performance:

For questions 4a-f, if a score of 1 is given, please consider if the indicator is of real use. Please justify (within the report) continuing if a score of 1 is given.

The following criteria are arranged with descending importance:

a) Simplicity: Is the indicator easily measured?

Seal Contaminant/Toxin: Score 3; Confidence High

b) Responsiveness: Is the indicator able to act as an early warning signal?

Seal Contaminant/Toxin: Score 2; Confidence Medium

c) Spatial applicability: Is the indicator measurable over a large proportion of the geographical area to which the indicator results will apply to e.g. if the indicator is used at a UK level, is it possible to measure the required parameter(s) across this entire range or is it localised to one small scale area?

Seal Contaminant/Toxin: Score 3; Confidence High

d) Management link: Is the indicator tightly linked to an activity which can be managed to reduce its negative effects on the indicator i.e. are the quantitative trends in cause and effect of change well known?

Seal Contaminant/Toxin: Score 2; Confidence Medium

e) Validity: Is the indicator based on an existing body or time series of data (either continuous or interrupted) to allow a realistic setting of objectives?

Seal Contaminant/Toxin: Score 2; Confidence Medium

f) Relatively easy to understand by non-scientists and those who will decide on their use:

Seal Contaminant/Toxin: Score 3; Confidence High

Thresholds for scientifically poor, moderate and good indicators:

Combine indicator evaluation scores for:

1. Sensitivity
2. Accuracy
3. Specificity
4. Performance

Evaluation Score	Indicator 'Effectiveness' Category	
22-27	**Good**	**Further economic evaluation required – see section B below**
16-21	**Moderate**	
9-15 OR not all questions completed due to expert judgement not to continue	Poor	

Seal Contaminant/Toxin, Scientific Score: 24

B. Economic criteria:

Having identified the most scientifically robust indicators using the above stated criteria, a further economic evaluation of those most effective indicators (i.e. those falling in the good or moderate categories) is carried out using the criteria stated below.

1. Platform requirements

Seal Contaminant/Toxin: Score 3

2. Equipment requirements for sample collection

Seal Contaminant/Toxin: Score 2

3. Amount of staff time required to plan collection of a single sample

Seal Contaminant/Toxin: Score 3

4. Amount of staff time required to collect a single sample

Seal Contaminant/Toxin: Score 3

5. Amount of staff time required to process a single sample

Seal Contaminant/Toxin: Score 3

6. Amount of staff time required to analyse & interpret a single sample

Seal Contaminant/Toxin: Score 3

7. Amount of staff time required to QA / QC data from a single sample

Seal Contaminant/Toxin: Score 3

Seal Contaminant/Toxin, Economic Score: 20

5.2.3 At-sea foraging distribution of seals

At-sea foraging distribution of UK seals can be determined through the use of telemetry devices attached to seals. These devices locate the areas where seals spend more time (presumably foraging) and the routes they take to reach foraging grounds (e.g. McConnell *et al* 1999). When combined with data on commercial fishing effort, areas of overlap would be identifiable. New techniques have recently been developed to combine aerial survey data on seal distribution with telemetry data to create at-sea usage maps (Matthiopoulos *et al* 2004). This type of analysis is likely to be used to define offshore areas that may be suitable for protection as will be required under the Marine and Coastal Access Act

1. Sensitivity: Does the indicator allow detection of any type of change against background variation or noise?

Seal foraging distribution: Score 3; Confidence Medium

2. Accuracy: Is the indicator measured with a low error rate?

Seal foraging distribution: Score 3; Confidence High

If the indicator scores 1 or 2 for question 2 or 3, conclude that it is ineffective and do not continue with the evaluation –the indicator will still be stored within the database as considered but will be flagged as 'insensitive, no further evaluation required'

3. Specificity: Does the indicator respond primarily to a particular human pressure, with low responsiveness to other causes of change?

Seal foraging distribution: Score 3; Confidence Medium

4. Performance:

For questions 4a-f, if a score of 1 is given, please consider if the indicator is of real use. Please justify (within the report) continuing if a score of 1 is given.

The following criteria are arranged with descending importance:

a) Simplicity: Is the indicator easily measured?

Seal foraging distribution: Score 3; Confidence High

b) Responsiveness: Is the indicator able to act as an early warning signal?

Seal foraging distribution: Score 2; Confidence Medium

c) Spatial applicability: Is the indicator measurable over a large proportion of the geographical area to which the indicator results will apply to e.g. if the indicator is used at a UK level, is it possible to measure the required parameter(s) across this entire range or is it localised to one small scale area?

Seal foraging distribution: Score 3; Confidence High

d) Management link: Is the indicator tightly linked to an activity which can be managed to reduce its negative effects on the indicator i.e. are the quantitative trends in cause and effect of change well known?

Seal foraging distribution: Score 2; Confidence Medium

e) Validity: Is the indicator based on an existing body or time series of data (either continuous or interrupted) to allow a realistic setting of objectives?

Seal foraging distribution: Score 3; Confidence Medium

f) Relatively easy to understand by non-scientists and those who will decide on their use:

Seal foraging distribution: Score 3; Confidence High

Thresholds for scientifically poor, moderate and good indicators:

Combine indicator evaluation scores for:

1. Sensitivity
2. Accuracy
3. Specificity
4. Performance

Evaluation Score	Indicator 'Effectiveness' Category
22-27	**Good**
16-21	**Moderate**
9-15 OR not all questions completed due to expert judgement not to continue	Poor

} **Further economic evaluation required - see section B below**

Seal foraging distribution, Scientific Score: 25

B. Economic criteria:

Having identified the most scientifically robust indicators using the above stated criteria, a further economic evaluation of those most effective indicators (i.e. those falling in the good or moderate categories) is carried out using the criteria stated below.

1. Platform requirements

Seal foraging distribution: Score 3

2. Equipment requirements for sample collection

Seal foraging distribution: Score 1

3. Amount of staff time required to plan collection of a single sample

Seal foraging distribution: Score 3

4. Amount of staff time required to collect a single sample

Seal foraging distribution: Score 2

5. Amount of staff time required to process a single sample

Seal foraging distribution: Score 3

6. Amount of staff time required to analyse & interpret a single sample

Seal foraging distribution: Score 2

7. Amount of staff time required to QA / QC data from a single sample

Seal foraging distribution: Score 3

Seal foraging distribution, Economic Score: 17

5.2.4 Seal bycatch

Although existing monitoring programmes have recorded seal bycatch in UK fisheries, so far this has not been addressed in a systematic manner and sampling levels are not directed towards the efficient estimation of seal bycatch, largely because there is currently no statutory obligation to do so in UK waters. In marked contrast, OSPAR has developed an EcoQO on harbour porpoise bycatch in the North Sea, despite their being over three times as many harbour porpoises in the North Sea as there are seals (of both species combined). This EcoQO was developed because monitoring of porpoise and other cetacean bycatch is mandated by a European Directive (Habitats Directive) and a Council Regulation (CR 812/2004). Obviously, there is no similar mandate to monitor seal bycatch.

1. Sensitivity: Does the indicator allow detection of any type of change against background variation or noise?

Seal bycatch Score 3; Confidence High

2. Accuracy: Is the indicator measured with a low error rate?

Seal bycatch Score 3; Confidence High

If the indicator scores 1 or 2 for question 2 or 3, conclude that it is ineffective and do not continue with the evaluation –the indicator will still be stored within the database as considered but will be flagged as 'insensitive, no further evaluation required'

3. Specificity: Does the indicator respond primarily to a particular human pressure, with low responsiveness to other causes of change?

Seal bycatch Score 3; Confidence High

4. Performance:

For questions 4a-f, if a score of 1 is given, please consider if the indicator is of real use. Please justify (within the report) continuing if a score of 1 is given.

The following criteria are arranged with descending importance:

a) Simplicity: Is the indicator easily measured?

Seal bycatch Score 3; Confidence High

b) Responsiveness: Is the indicator able to act as an early warning signal?

Seal bycatch Score 3; Confidence High

c) Spatial applicability: Is the indicator measurable over a large proportion of the geographical to which the indicator metric it to apply to e.g. if the indicator is used at a UK level, is it possible to measure the required parameter(s) across this entire range or is it localised to one small scale area?

Seal bycatch Score 3; Confidence High

d) Management link: Is the indicator tightly linked to an activity which can be managed to reduce its negative effects on the indicator i.e. are the quantitative trends in cause and effect of change well known?

Seal bycatch Score 3; Confidence High

e) Validity: Is the indicator based on an existing body or time series of data (either continuous or interrupted) to allow a realistic setting of objectives?

Seal bycatch Score 1; Confidence High

f) Relatively easy to understand by non-scientists and those who will decide on their use:

Seal bycatch Score 3; Confidence High

Thresholds for scientifically poor, moderate and good indicators:

Combine indicator evaluation scores for:

1. Sensitivity
2. Accuracy
3. Specificity
4. Performance

Evaluation Score	Indicator 'Effectiveness' Category
22-27	**Good**
16-21	**Moderate**
9-15 OR not all questions completed due to expert judgement not to continue	Poor

} **Further economic evaluation required - see section B below**

Seal bycatch, Scientific Score: 25

B. Economic criteria:

Having identified the most scientifically robust indicators using the above stated criteria, a further economic evaluation of those most effective indicators (i.e. those falling in the good or moderate categories) is carried out using the criteria stated below.

1. Platform requirements

Seal bycatch Score 3

2. Equipment requirements for sample collection

Seal bycatch Score 4

3. Amount of staff time required to plan collection of a single sample

Seal bycatch Score 3

4. Amount of staff time required to collect a single sample

Seal bycatch Score 3

5. Amount of staff time required to process a single sample

Seal bycatch Score 4

6. Amount of staff time required to analyse & interpret a single sample

Seal bycatch Score 4

7. Amount of staff time required to QA / QC data from a single sample

Seal bycatch Score 4

Seal bycatch, Economic Score: 25

5.3 Review of indicators against ecosystem structure and function aspects and identification of gaps

Three existing monitoring programmes for grey and harbour seals provide information on changes in pup production (grey seals), numbers during their moult (harbour seals), female body condition (grey seals) and pup growth rates (grey seals). These statistics vary according to seals' response to conditions in their marine environment (such as food availability) and therefore can be used as indicators of the state of the marine environment and of seal population structure (in terms of population size and distribution for both species and of reproductive performance for grey seals).

The four suggested indicators are able contribute to addressing some important functional aspects such as trophic complexity and secondary production (Seal diet, At sea foraging distribution, Seal bycatch) or primary production and movement of water masses (Contaminants and toxins). The matrix of alternatives is provided in Annex 2 Seals StructureFunction.xls.

No.	Existing Indicator	Variable of interest	Primary aspect of Ecosystem Structure/Function addressed
1305	Grey seal pup production	Between year variability at individual colonies	Population size, reproductive performance, breeding distribution
1306	Harbour seal counts	Regional change in abundance	Population size, distribution
1317	Grey seal demography	Between year variation in maternal post-partum mass Between year variation in pup growth rates	Reproductive performance, inter-annual variation
No.	**Suggested Indicator**	**Variable of interest**	
1353	Seal diet	Regional and seasonal change over time	Abundance and distribution of prey species
1354	Contaminants and toxins	Change in contaminant burden over time Levels of toxins	Response of seals to dispersed pollution Eutrophication, climate change
1362	At-sea foraging distribution of seals	Preferred foraging areas; routes to and from these areas	Abundance and distribution of prey species
1363	Seal bycatch	Number of seals killed	Abundance and distribution of prey species

5.3.1 Conspicuous gaps in the suite of indicators provided by seals

The most obvious gap in the seal 'indicator suite' is that there is no overall assessment of harbour seal pup production for most of the UK. This is because harbour seals tend to be more dispersed when breeding, new born pups do not have a white coat and new pups can, and do, swim with their mothers within hours of birth. While information on pup production would be very useful, it would be difficult and extremely time consuming to collect these data over large areas. Instead, harbour seal pups are monitored annually in the Moray Firth and in Lincolnshire and Norfolk, around The Wash (Duck & Thompson, 2009).

Another conspicuous gap, which could be used as an indicator, is information on the number of seals that are shot, either legally or illegally, in the UK. It is extremely difficult, perhaps impossible, to obtain reliable information on numbers shot in order to assess the impact of this pressure, locally and nationally, on seal populations. The Marine (Scotland) Bill will address this issue in Scotland only. Under this Bill, any seal shooting will require a licence from the Scottish Government and must be reported. There are no moves to alter or amend the Conservation of Seals Act 1970 in England or in Wales. Grey and harbour seals are protected in Northern Ireland. It will always be very difficult, if possible, to determine the numbers of seals that are shot illegally around the UK.

6 Conclusions and recommendations

6.1 Database report table

Database report tables are presented in two excel spreadsheets that accompany this report. For documentation of indicators against pressures and identification of gaps, please see the spreadsheet Annex 1 SealsPressures.xls; for documentation of indicators against ecosystem structure and function, please see the spreadsheet Annex 2 Seals StructureFunction.xls.

6.2 Identification of an effective indicator suite

Please see the excel spreadsheet 'Seal Indicators Conclusions.xls' which accompanies this report. The 'Accepted (Yes or No)' column identifies whether the indicator is recommended for inclusion within the overall indicator suite for seals and the reasons for the decision made are provided in the following column.

A combination of the current seal state indicators and the potential, more pressure-responsive indicators suggested here is recommended as an overall indicator suite for seals. This combined suite would more successfully address those pressures which are relevant to UK seal populations whilst still being able to accurately assess the status of those populations with respect to important ecosystem structure aspects such as population size and distribution and ecosystem function aspects such as trophic complexity.

6.3 Recommendation for areas of development to address significant gaps

As described above, the existing three indicators do not directly assess the impact of specific pressures on seals or on seal populations. Instead, the indicators provide an assessment of the response of seals and seal populations to a combination of pressures. The most important pressures affecting seals are those that impact the abundance and distribution of their prey species. For example, harbour seal numbers in Shetland, Orkney and the north-east of Scotland have declined by over 50% since 2001 (Lonergan *et al* 2007). While the extent of the decline has been assessed, the causes of the decline have not yet been determined.

There is no UK-wide assessment of harbour seal pup production, primarily due to the difficulty in obtaining this information. Harbour seals are very widely dispersed, especially around Scotland, and the cost of undertaking an appropriate monitoring programme would be prohibitive but not impossible.

Four indicators are suggested that would provide better information on the direct effects of a number of pressures on seals. Three of these (seal diet, at-sea foraging distribution and seal bycatch) are closely connected and provide information on the relationship between seals, commercial fishing and the distribution and abundance of fish prey species. The extent of seal bycatch has only recently been monitored locally around the UK. Development of all of these suggested indicators would improve our understanding of the relationship between seals and fisheries, would help to define important marine areas used by seals and would provide vital information on the response of seals to changes in abundance and distribution of prey populations.

In the UK, there is a requirement to increase the amount of energy produced from renewable sources. Marine renewable energy production is from both wave action and tidal streams. This is a developing area and the potential impact of tidal or wave turbine arrays on seals is unknown but under investigation. The existing seal population monitoring programmes are being used to assess the impact, if any, of marine energy production on seal populations and their distribution. Currently, harbour seals numbers around Scotland are monitored approximately every five years, primarily due to limitations on funding. The frequency of monitoring could very usefully be increased, at least for areas with development potential.

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