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Developing Guidance on Ornithological Cumulative Impact Assessment for Offshore Wind Farm Developers

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Definitions

Baseline conditions - The measured conditions which exist at the time when the project would be constructed/operated/decommissioned, and against which potential effects are assessed.

EIA Regulations - The Statutory Instruments which implement EC Directive 97/11/EC (amending Directive 85/337/EEC) 'The assessment of the effects of certain public and private projects on the environment' (The EIA Directive) in UK law. They define the types of projects which require an Environmental Impact Assessment and the content to be included in the Environmental Statement. This includes the consideration of a range of likely significant effects including cumulative effects. Specific EIA Regulations apply in different countries and to different types of development. Table 1 of this report summarises the Regulations which most often apply to offshore wind farm construction with further detail in Appendix 5.

Habitats Regulations - The Statutory Instruments which implement EC Directive 92/43/EEC 'The conservation of natural habitats and of wild fauna and flora' (The Habitats Directive) in UK law. *Inter alia* they define the circumstances where an Appropriate Assessment is required ie where a project 'is likely to have a significant effect on a European site…either alone or in combination with other plans or projects' but 'is not directly connected with or necessary to the management of the site'.

For offshore projects, UK Regulations differ depending on whether sites are within or outside territorial waters. In England, Wales and Scotland, within territorial waters (ie less than 12 nm) The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended) apply; from the 12 nm limit to the edge of the continental shelf at 200.nm (Renewable Energy Zone), The Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 apply. See Table 1 and Appendix 5 for further details.

Project - the offshore wind farm being consented.

Round 3 - The latest Crown Estate licensing round for zones for offshore wind energy generation. Announced on 10 December 2007 with the potential to provide a further 25 GW (Gigawatts) of additional UK offshore generation capacity by 2020.

Acronyms

BERR	(Department for) Business, Enterprise and Regulatory Reform (formerly DTI)
BTO	British Trust for Ornithology
BWEA	British Wind Energy Association
CCW	Countryside Council for Wales
CIA	Cumulative Impact Assessment
COWRIE	Collaborative Offshore Wind Research Into the Environment
CPA	Coast Protection Act
CRM	Collision Risk Modelling
DECC	Department of Energy and Climate Change (formed from the Energy Group of BERR and the Climate Change Group of DEFRA)
Defra	Department for Environment, Food and Rural Affairs
DTI	Department of Trade and Industry
EcIA	Ecological Impact Assessment
EIA	Environmental Impact Assessment
ES	Environmental Statement
FEPA	Food and Environment Protection Act
IEEM	Institute of Ecology and Environmental Management
JNCC	Joint Nature Conservation Committee
MCEU	Marine Consents and Environment Unit
MFA	Marine and Fisheries Agency
NE	Natural England
NGO	Non-Governmental Organisation
REZ	Renewable Energy Zone
RSPB	Royal Society for the Protection of Birds
SAC	Special Area of Conservation
SEA	Strategic Environmental Assessment
SNCA	Statutory Nature Conservation Advisor
SNH	Scottish Natural Heritage
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
TCE	The Crown Estate

Executive Summary

- This project has developed guidelines on the processes, methods and techniques to be utilised for cumulative impact assessment for birds and offshore wind farms. The guidelines build on recommendations made at an earlier COWRIE workshop held in 2007
- The need for guidance arises from the limited advice currently available and the increasing number of operational offshore wind farms, together with those under construction, consented or in planning which means that the issue of cumulative impact is becoming more prominent. Offshore wind farm development is likely to become the largest single engineering intervention in the UK's marine environment over the next decade
- A review of current practice illustrates the wide range of approaches used by developers in which assessment has often been qualitative rather than quantitative leading to uncertain conclusions and often major delays in project determination. Key issues have included: inadequate scoping, lack of understanding of the species involved, difficulties in assigning the range of projects which should be included within the assessment and the methods by which CIA should be undertaken
- The current guidelines were developed by review and discussion of two specially commissioned position papers at an expert workshop held in Peterborough in October 2008
- The process of scoping was agreed to be essential to the provision of robust CIA and requires regular communication and iterative information exchange between developers, statutory bodies and stakeholders. The detailed guidance points which have been developed focus on the completion of 'key features' documents. These are checklists of key facts that will be used to inform cumulative impact assessment ie species, conservation designations, projects and proposed surveys and analyses, and include a record of communications. It is hoped that these documents or similar can be endorsed by SNCAs in order to standardise the scoping phase of CIA. It was also agreed that there was a need for increased guidance and more certainty in policy coming from regulators and their statutory advisors
- The recommendations relating to the tools and techniques used for CIA are divided into two parts: data gathering and cumulative effects. Data gathering and analysis currently suffer from a lack of standardisation therefore guidelines are given for selection of species for consideration, projects to be included in the assessment and the spatial scale of the bird reference population to be used. An overarching recommendation is for the provision of quantitative data on raw numbers, densities and population estimates for all species and that, wherever possible, impacts are assessed in a quantitative rather than a qualitative way
- The cumulative effects of collision risk and displacement should be assessed by summing the impacts from each component project
- Where collision mortality is likely to be significant, more detailed population modelling studies may be required
- Disturbance and barrier-effects may accrue in a non-linear manner. They should, therefore, firstly be considered in a qualitative manner and, if thought likely to be significant, then a more detailed quantitative study of bird bioenergetics in relation to the effect should be carried-out
- In general, all analyses should interpret the significance of mortality in relation to the species' background mortality rate to enable its life history parameters and ecology to be taken into account
- The guidelines summarised below are the first stage of an iterative process. They will need to be refined on the basis of evidence gathered from the monitoring of wind farms both during and post-construction and as our understanding of the impacts of cumulative effects on birds improves. Their adoption will require engagement from all parties involved in the process of impact assessment

RECOMMENDATIONS

Scoping, communications and policy recommendations

1. Initiation of early stakeholder liaison to inform scoping should always take place
2. Scoping should utilise approaches which include tools similar to the 'key features' document set out at Appendix 3
3. Developers should provide as much background information as possible in scoping requests
4. Regulators and statutory advisors should provide as much information as possible in scoping responses
5. Ongoing and frequent communication between developers, regulators, SNCAs and stakeholders should take place in respect of CIA

Methods and techniques

6. A comprehensive 'long list' of species to undergo CIA should be compiled at the scoping stage
7. The 'long-list' should be screened using expert judgment and a range of resources eg Appendix 7: List of species potentially at risk of cumulative impacts in Round 3
8. A list of all local SPA (Ramsar and SSSI) species together with predicted impacts, including cumulative, should be included in the ES. Reasons should be given for any species screened out of CIA
9. Quantitative data on number and density for all species at a project site should be included in the ES to enable quantitative CIA to be undertaken retrospectively if necessary
10. To provide the context of CIA, where quantitative information is available, the baseline conditions relevant to study features (eg relevant populations) should be appraised to assess the significance of the effect (positive or negative) that existing (including unregulated) activities or environmental trends (including climate change) might have upon those conditions during the lifetime of the project
11. CIA should include those:
    a. Projects that have been consented but which are yet to be constructed
    b. Projects for which application has been made
    c. Projects that are reasonably foreseeable
    d. Relevant non-wind farm projects subject to EIA
    e. Existing projects which have yet to exert a predicted effect (ie an effect that is not covered in the baseline)
12. For SPA species, the reference population to be used is that cited in the SPA documentation at designation. Reference should be made to more recent population data and trends if available
13. With non-SPA species or those whose 'home' SPA cannot be assigned, best available expert judgement should be used to define the area and regional population and agreed 'up front' with SNCAs at the scoping stage on a project-by-project basis
14. The default boundary of the CIA study area for defining regional populations should be considered as the relevant strategic area, Round 3 zone or equivalent, unless there is reliable evidence to support the definition of an alternative discrete biogeographic region eg area incorporating onshore breeding colony; Regional Sea, etc. Boundaries should be agreed with SNCAs at an early stage
15. Depending on the reference population(s) identified, impacts may need to be considered at different population scales at different times of year

16. In general, CIA should be based on data gathered for EIA and not require the collection of additional data except in special circumstances
17. Where additional data gathering is required, it should be agreed with stakeholders as early as possible, preferably at the scoping stage
18. Data should be collected using standard methods eg Camphuysen 2004, by trained/experienced observers. New recommendations or refinements should be taken into account eg Maclean *et al* 2009
19. For Round 3 zones and other adjacent projects, data collection should be standardised as far as possible across projects
20. Raw bird numbers (including survey dates) density estimates and population estimates should be reported for all species together with a description of their methods of calculation
21. All data analysis should be presented as clearly as possible, identifying any parameters used and assumptions made

Cumulative effects

22. Cumulative collision impact should be calculated as the sum of collisions from component projects unless evidence indicates that this approach would result in significant inaccuracy giving rise to a material difference in the assessment of the significance of the potential impact
23. To ensure data compatibility between projects, an ES should include data on
    a. Bird numbers by date/season
    b. Density/passage rate for each species by date/season
    c. Population estimate for each species by date/season
    d. A description of how the above values are derived
    e. A spreadsheet showing each stage of the collision risk calculations for each species
    f. Collision risk should be calculated on a month by month basis where there is seasonal variation in a species population
24. Cumulative collision effects should be:
    a. Shown as raw numbers of individuals
    b. Reported as a proportion of the relevant population
    c. Represented as a percentage change in background mortality rate
    d. Considered against the life history of the species eg age at first breeding, brood size, productivity, demography, age-related survival rates, and its ecology
25. Where collision mortality is likely to be significant, more detailed population modelling may be required
26. Where disturbance impacts are likely to be minimal, subjective/qualitative treatment of the effect is adequate
27. For projects or species where potential impacts are likely to be significant, a quantitative assessment, including information on energy budgets should be carried out. In some cases, modelling may be appropriate
28. Areas should be assumed to be at carrying capacity, unless there is evidence to the contrary, and displacement values should be summed
29. The default assumption is that all birds that are displaced die
30. Any differences in assumptions about species sensitivity to displacement should be explained in the ES.

31. Where potential barrier effects are likely to be minimal, subjective/qualitative treatment is adequate
32. For wind farm projects or species where impacts are likely to be significant, a quantitative treatment focusing on the energetic implications of avoiding barriers should be carried out
33. The need for quantitative treatment should be identified using expert judgment and agreed as early as possible with SNCAs
34. Significance of any cumulative impact on a species should include a consideration of its life history parameters and ecology
35. Alternately, consideration should be given to life history parameters and habitat/resource use flexibility when defining a species' sensitivity with long-lived species and specialists considered to be more sensitive
36. Potential impacts on species which 'narrowly miss' being assessed as significant impact at the individual project level should not be excluded from CIA
37. Conclusions on impacts should be derived from standard EIA matrix tables supported by discussion to reach a conclusion as to whether the impact is significant or non-significant
38. The results of both EIA and CIA should be presented in the ES in as clear a way as possible identifying any parameters used and assumptions made. The preference should always be for results to be quantitative rather than qualitative

Outstanding guidance requirements which are outside the scope of this report

39. Joint regulatory and SNCA guidance is urgently required in respect of EIA, including CIA
40. Joint regulatory and SNCA guidance is urgently required on the application of the precautionary principle to decisions made under the Habitats Directive; such guidance should be based on the principles of transparency, proportionality, the consideration of social and economic benefits and the adoption of adaptive management approaches when high levels of certainty are not available
41. A system of standardised results reporting for ESs should be developed to ensure compatible outputs
42. The preparation of a specific guidance note by SNCAs in association with industry and stakeholders on collision risk calculations for offshore projects, incorporating acceptable avoidance rates, flight speeds and other key elements, would be of long term benefit to the CIA process
43. Standardisation of the presentation of collision risk calculations (for example through the adoption of a template) would also be beneficial
44. A 'rapid assessment' collision risk tool for species using a generalised data set based on evidence of bird numbers, behaviours eg flight height and turbine dimensions should be developed
45. The bioenergetics report commissioned by BERR in 2008 should be given wide circulation once available
46. SNCAs may wish to consider defining conservation objectives for widespread species which are not associated with existing or proposed SPAs (eg Little Gull)

1. Introduction and Background

Consideration of the cumulative effects of plans and projects is a key component of Environmental Impact Assessment (EIA) and, in UK law, this is clearly defined in the EIA Regulations. The Habitats Regulations also require an assessment of the in-combination effects of plans or projects on features of European sites ie the interest features of Special Protection Areas (SPAs) and Special Areas of Conservation (SACs).

This report provides guidance for the assessment of cumulative/in-combination environmental effects on bird populations in relation to offshore wind farm developments and refers to the generic process as Cumulative Impact Assessment (CIA).

1.1 CIA of offshore wind projects to date

A review of Environmental Statements to date illustrates that developers have taken a wide range of approaches to CIA in which assessment has often been qualitative rather than quantitative. This has led to uncertainty about their conclusions, which, in some cases, have not been considered robust. Key issues have been identified in a number of previous documents (eg Norman *et al* 2007) as: inadequate scoping, lack of understanding of the species involved, difficulties in assigning the range of projects which should be included within the assessment and the methods by which CIA should be undertaken.

1.2 CIA in the context of future UK offshore wind projects

The increasing number of operational offshore wind farms, together with those under construction, consented or in planning, means that the issue of cumulative impact is becoming more prominent. Offshore wind farm development is likely to become the largest single engineering intervention in the UK's marine environment over the next decade.

Most notably the Round 3 proposals for 25 GW of offshore wind and the round for wind farms in Scottish Territorial Waters are likely to at least quadruple the planned offshore wind capacity in UK waters.

CIA is particularly relevant in relation to Round 3. The nine proposed development zones will nearly all contain multiple projects each comprising hundreds of turbines.

The Crown Estate has identified unresolved cumulative impacts on birds as a key issue and is promoting their early identification as a way of expediting the consenting process in relation to Round 3 (The Crown Estate 2008). Zonal development should in theory permit a more strategic approach to the identification and assessment of cumulative impacts compared to previous rounds of development.

1.3 The need for guidance

There has been a lack of robust and relevant guidance for CIA for birds arising from proposed offshore wind farm development. Where guidance does exist it is directed mainly at onshore projects (eg SNH 2008, Entec 2008, 2009) and has been relatively limited in scope. Specific limitations include a lack of guidance on the scale of the assessment required and a lack of clearly defined methodologies. This may have contributed to an inconsistent approach to CIA with, as discussed above, assessments varying considerably in scope and quality.

The consequences of inadequate CIA may include a failure to identify potentially significant impacts and, more commonly, cause delays arising from discussions and disagreements with stakeholders. A robust methodological approach is therefore needed to support the consents process.

1.4 COWRIE work on CIA

COWRIE has recognised that CIA is a key priority for further attention. An initial stage in addressing this need was the funding of a workshop in 2007 (Norman *et al* 2007). The current project takes this work forward.

2. Aims of the Project

The aim of this project is to develop written guidance for developers to assist in the process of the assessment of cumulative impacts of wind farms on bird populations.

The project, managed by a steering group, determined that the guidance should be based on scientific principles, recommend methodologies robust enough to meet statutory requirements and be practicable for developers within the time frames and resources normally available for environmental impact assessment.

The workshop held in October 2008 endorsed these general principles.

2.3 Objectives

The objectives of the guidance are to:

- In relation to bird species:
    - Scope a list of species which may be considered for CIA
    - List parties to be consulted at the scoping stage
    - Endorse an evidence-based approach to define the main impacts to which each species is most susceptible
    - Recommend the scale at which CIA should be undertaken at the species level
- In relation to data:
    - Recommend species-specific data/information sources
    - Develop recommendations for data sharing
    - Identify data gaps and potential research needed
- In relation to processes:
    - Define key processes for CIA
    - Develop simple generic tools to aid the above processes
    - Define key parameters for use with analytical tools eg avoidance rates for collision risk modelling
    - Provide simple case studies to illustrate the above
- In relation to reporting:
    - Recommend reporting methods for developers
    - Provide a summary/checklist of the above.

3. Project Methodology

The current project builds on and refines the conclusions and recommendations of the previous COWRIE workshop (Norman *et al* 2007) which provided a much needed opportunity to debate CIA in detail.

The guidelines presented here were developed at a workshop held in October 2008. This comprised an expert group of stakeholders including: scientists, ornithologists, consultants, developers, regulators and statutory advisors. A list of delegates and a summary of the workshop discussions is included in Appendix 1.

In advance of the workshop two position papers were commissioned both of which included a series of questions to be addressed.

The first paper produced by Andrew Prior (PMSS) outlines the regulatory context of CIA and particularly the process of scoping. The paper stresses both the importance of scoping and the need for regular communication and iterative information exchange between developers, statutory bodies and stakeholders. It provides a number of 'key features' documents to assist this process. These are checklists of key facts that will be used to inform cumulative impact

assessment ie species, conservation designations, projects and proposed surveys and analyses and include a record of communications. It is hoped that these documents or similar can be endorsed by SNCAs in order to standardise the scoping phase of CIA. The original paper is provided in full in Appendix 2. Its conclusions, as derived from the workshop are summarised in Section 5, while revised 'key features' documents can be found at Appendix 3.

The second paper produced by Ilya Maclean and Mark Rehfisch (BTO) discusses the methods and techniques used by developers to carry out CIA based on case studies of a number of successfully consented Round 2 wind farms. The paper draws together recommendations on data gathering, methods of analysis, tests of significance and reporting based on current best practice. It is reproduced in full in Appendix 4. The conclusions, which incorporate the outcomes of the workshop, are summarised in Section 6.

The following guidelines therefore are a synthesis of information from the 2007 report, the two position papers including a review of current practice, the 2008 workshop and further discussion of the draft report between workshop members and the COWRIE Bird Sub-group. It is a working document which is expected to evolve as new evidence becomes available.

4. Existing Legislation and Guidance

4.1 European Legislation

The assessment of cumulative effects is a requirement in European law of the Strategic Environmental Assessment Directive (2001/42/EC) and the Environmental Impact Assessment Directive (97/11/EC). It is also a requirement of the Habitats Directive (92/43/EEC), Article 6 (3) of which states in relation to Special Areas of Conservation that:

'*Any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or* ***in combination*** *with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives*'

Article 7 extends the above requirements to Special Protection Areas by incorporating Article 4 (4) of the Birds Directive 79/409/EC.

4.2 National Legislation

The European Directives are transposed into UK law via a range of legislation. This is summarised in Table 1 and presented in detail with the relevant text relating to cumulative effects in Appendix 5.

Strategic Environmental Assessment (SEA) is the responsibility of Government and is not considered here in detail. DECC carried out an integrated UK Offshore Energy SEA relating to further rounds of offshore oil and gas licensing and wind leasing in UK waters which reported in January 2009. Additionally the SEA for Scottish Territorial Waters is due to report in 2010. A summary of literature relating to the assessment of cumulative effects for SEA can be found in a report to the Offshore Renewables Energy Environment Forum (OREEF) (Hartley Anderson Ltd 2007).

The EIA Regulations, which implement the EIA Directive in the UK, cover a wide range of different development types. The Regulations relating to an individual offshore wind farm application will depend on the location of the site (ie within territorial waters (up to 12 nm) or further offshore in waters up to a limit of 200 nm (the Renewable Energy Zone)), the export cable route and landfall, and the consent route which has been chosen. Full guidance on the offshore wind farm consents process can be found on the BERR website. All EIA Regulations define the content of an Environmental Statement (ES) and require that it considers any significant cumulative effects.

The Habitats Regulations, which implement the Habitats Directive in the UK, relate specifically to European sites, including SACs and SPAs and require that where a project, either alone or 'in-combination' with other projects, may have a significant effect on the features of a European site, the 'competent authority' must carry out an 'appropriate assessment'

Table 1: European Directives and equivalent UK legislation in relation to cumulative impact assessment

European Legislation	**National Legislation**
EIA Directive	**EIA Regulations**
The assessment of the effects of certain public and private projects on the environment Council Directive **97/11/EC** of 3 March 1997 amending Directive **85/337/EEC**	The requirements of the EIA Directive to consider cumulative effects are transposed into UK law within the context of the content of an Environmental Statement for offshore wind farms in a range of EIA Regulations. The following are most relevant to offshore wind farms:
Article 3 defines the general content of the environmental impact assessment with further details in Articles 4 to 11	**The Electricity Works (Environmental Impact Assessment) (England and Wales) Regulations 2000** (as amended) Statutory Instrument 2000 No. 1927 Schedule 4 Part I (3)
Article 4 defines projects which must be considered with reference to Annex II which states in part 3 (1)	**The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000** Scottish Statutory Instrument 2000 No. 320 Schedule 4 Part I (3)
'*Installations for the harnessing of wind power for energy production (wind farms)*'.	**The Offshore Electricity Development (Environmental Impact Assessment) Regulations (Northern Ireland) 2008** Schedule 4 Part I (4)
Article 4 (3): requires the use of 'criteria' for assessment of defined projects and Annex III defines these criteria including the significance of their effect in '***cumulation***' with other projects	**Marine Works (Environmental Impact Assessment) Regulations 2007** Statutory Instrument 2007 No. 1518 Schedule 3 Part 3 (2) c
	Town & Country Planning (Environmental Impact Assessment) Regulations 1999 Statutory Instrument 1999 No. 293 Schedule 4 Part I (4)
Article 5 (1) gives details of the information required in the environmental impact assessment which are expanded in Annex IV and include the:	**Environmental Impact Assessment (Scotland) Regulations 1999** Schedule 4 Part I (4)
'*description of the likely significant effects*' described in footnote (1) as '*direct effects and any indirect, secondary, **cumulative**, short, medium and long-term, permanent and temporary, positive and negative effects of the project*'.`	**Transport and Works (Assessment of Environmental Effects) Regulations 1995** amends section 14 of the Transport and Works Act 1992 to require an ES via the **Transport and Works (Applications and Objections Procedure) Rules 1992** Statutory Instrument 1992 No. 2902. Schedule 1 Part 2 (e) NOTE: not applicable outside 12 nm.
Habitats Directive	**Habitats Regulations**
The conservation of natural habitats and of wild fauna and flora Council Directive **92/43/EEC** of 21 May 1992 Article 6 (3) states '*Any plan or project not directly*	The requirements of the Habitats Directive to consider in-combination effects in the context of an Appropriate Assessment are transposed into UK law in:
	The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended) Statutory Instrument 1994 No. 2716 Part IV: 48

*connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or **in combination** with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives*' Article 7 extends the above requirements to SPAs by incorporating the requirements of Article 4 (4) of the Birds Directive 79/409/EC A useful document interpreting the above requirements is: European Communities (2000) Managing NATURA 2000 sites: The provisions of Article 6 of the 'Habitats' Directive 92/43/EEC.	**The Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007** Statutory Instruments 2007 No.1842 Wildlife Part 2: 25.—(1)
	The Conservation (Nature Habitats, etc.) Regulations (Northern Ireland) 1995 Statutory Rule 1995 No. 380: Part IV: 43

4.3 Existing Guidance

There is little guidance on CIA particularly in relation to bird populations. What guidance there is tends to be general in nature and embedded in guidance focussed more widely on EIA.

A list of currently available guidance documents plus a short review of each one can be found in Appendix 6. It should be noted that many of these documents (eg those from MFA, BERR (now DECC) and SNH) are currently being revised and updated. New SNH guidance for offshore wind farms is currently in draft format. Guidelines from professional bodies such as the draft IEEM Guidelines for Marine and Coastal Ecological Impact Assessment are included as they provide excellent guidance on EIA in general and are likely to become 'industry standard'. A number of reviews, some of which relate particularly to the United States, are included which may form useful background reading.

5. Guidance on regulatory issues affecting cumulative impact assessment

As discussed above, two position papers were drafted to inform the production of this guidance paper. The first, by Andrew Prior (PMSS), attached at Appendix 2, considered the regulatory context of CIA.

It was agreed at the October 2008 workshop that the process of scoping and the need for regular communication and iterative information exchange between developers, statutory bodies and stakeholders were both essential to the provision of robust CIA. It was also agreed that there was a need for increased guidance and more certainty in policy coming from regulators and their statutory advisors.

These three processes: scoping, communication and guidance; are discussed in greater detail below.

5.1 Scoping

The EIA Regulations provide for a statutory scoping process by which information on methodologies and issues concerning proposed EIA activities can be requested from regulators and statutory advisors There is, therefore, an established route (with a defined timetable) by which information on CIA can be exchanged at an early stage in project development.

However although many offshore wind farm project developers have sought scoping information, often scoping requests have contained only limited background data and formal scoping responses have lacked comprehensive information to inform cumulative impact assessment at an early stage in the process. In some cases developers have proposed dispensing with scoping altogether.

It is possible, through the statutory scoping process, to identify and focus on a number of key issues at an earlier stage in the EIA timeline, rather than, as has been the case with Round 2 projects, concentrating on cumulative impact towards the end of the process. Such issues could include:

- Agreement on key species likely to be at risk
- Identification of key sites and their interest features which may be affected (SPA, Ramsar, SSSIs and their populations likely to be affected by offshore wind farm development)
- Definition of relevant populations and the geographical area over which cumulative impacts are to be considered
- Agreement of approaches to, and methods of, data collection
- Agreement of data analysis methods and impact assessment, particularly in respect of treatment of risk and the precautionary principle (see below).

A standardised approach to scoping would provide consistency across and between projects and would define parameters for early discussion. A 'key features' document could accompany a scoping request and form the basis for subsequent discussions. An example 'key features' document, as amended following the October 2008 workshop, is attached at Appendix 3 for consideration.

Consequences of using the 'key features' during scoping will include:

- Requirement for early data acquisition and provision of detailed information to inform scoping request

Generally scoping requests have only included limited ornithological information. Developers will need to consider providing detailed information or even commissioning small scale, site characterisation surveys or risk assessments to inform scoping. This would entail additional front end costs but may deliver a premium in terms of reducing time to consent. Early consultation with key stakeholders (most notably the RSPB) could also assist in this process.

- Fuller engagement in the scoping process

The delivery of more detailed information by developers at the scoping stage would give rise to an expectation of full engagement from the regulators (currently DECC and MFA) and statutory advisors (Natural England, Scottish Natural Heritage, Countryside Council for Wales, Council for Nature Conservation and the Countryside (Northern Ireland) and JNCC). Although informal scoping does take place, the focus is currently on the statutory process by which DECC collates scoping responses from various consultees. Historically such responses in respect of bird issues have been relatively concise statements on key features and policies. The provision of detailed information could facilitate more useful scoping responses, capable of resolving problematic issues, such as CIA, more easily.

- Resourcing

An increased focus on early and fully informed scoping is likely to require additional resources. Developers may need to acquire additional data ahead of their main EIA programme, ecological and other specialist consultancy input may be required to produce outputs based on the 'key features' document and the emphasis on more detailed scoping responses will inevitably lead to an increased level of casework within public sector bodies. In particular, significant resources may be needed to propose, validate and agree the application of innovative approaches early in the process rather than relying solely on standard methodologies.

While it is acknowledged that environmental impact assessment is firmly the responsibility of the developer, technical expert feedback from statutory bodies on cumulative impact has, in many cases, not been easy to access, even though many of the ornithology experts in the country reside within those organisations.

5.2 Communication

Generally it is felt that open communication between regulators, statutory advisors, stakeholders, developers and consultants about CIA could be improved. Round 2 has seen only limited information flowing between developers and statutory bodies during the early stages of the consenting process and the history of collaborative working between developers (essential for assessing cumulative impacts) is limited. It is not the purpose of this paper to discuss the reasons for this situation. However it is notable that, generally speaking, the failure of all parties to fully address cumulative impacts at an early stage in the process has tended to result in entrenched positions. This has the potential for causing conflict rather than promoting a collaborative approach. Generally speaking cumulative impacts have tended to be addressed towards the end of the consenting process once data collection has occurred, rather than in a strategic manner at the start of the process.

It should be noted that often the industry has not assisted in the process, with reluctance among some developers to share data capable of assisting in the assessment of cumulative impacts across strategic areas. There is little evidence to suggest that sharing bird data is likely to prejudice a development and, indeed, in cases where collaborative approaches to cumulative impact have taken place (for example in respect of marine mammal projects in the Thames strategic area, the consideration of Common Scoter by the North-west developers or as part of the BERR aerial survey programme) consenting times have generally been decreased. It would be prudent for the industry as a whole to secure more collaboration between developers (perhaps by means of a requirement within The Crown Estate leases to share data) in respect of cumulative impacts. As an example, interactions between Round 3 and Round 2 projects may be better assessed due to The Crown Estate lease requirement that all environmental records and information generated under the second licensing round are held on the COWRIE website.

A number of parties, including a key NGO and a statutory advisor, have highlighted an example of good communication which could be utilised as a case study for future work. The London Array project was one of the first Round 2 wind farms to be consented. The regulatory process assessing potential cumulative impacts there, and in the wider Thames strategic area (in this case on Red-Throated Diver), was generally perceived to have been robust with all the main parties on the London Array project engaging each other in a positive and effective manner.

Key features of the approach adopted in respect of the London Array project include:

- Regular and frequent meetings with all parties
- Transparent and open exchange of information
- Proactive and positive approach of the statutory advisor (Natural England) and key stakeholder (RSPB) to wind development at the site
- Willingness of the developer to resolve potential conflict through binding agreements with key stakeholders
- Adoption of adaptive management process to allow consenting of the scheme
- Sufficient safeguards to address concerns about uncertainty

In addition to the emphasis on early and informed scoping discussed above, the ‘key features’ document (at Appendix 3) builds upon the London Array case study by adopting an iterative process providing a schedule for regular and frequent meetings to give updates on data acquisition and analysis and discussion of significant challenges.

5.3 Need for policy and guidance to provide context and certainty

Developers and consultants have to some extent been working in an uncertain regulatory environment where the approach to cumulative impact assessment has tended to be *ad hoc* and on a case-by-case basis. Clear guidance on EIA from the agencies (which the authors of this paper understand is currently being commissioned by DECC and MFA) would assist in providing greater certainty as to the approach taken by the agencies when balancing the environmental impacts of offshore wind (including cumulative impacts) against the climate change and biodiversity benefits of renewable energy.

In particular there is an urgent need to place the precautionary principle into a firmer context. It is clear from both guidance and case-law that the philosophy behind the precautionary approach is not one of risk elimination but rather one of risk minimisation taking into account both the likelihood and magnitude of potential risks. In the context of cumulative impact assessment this is particularly relevant because a series of extremely conservative scenarios (for example in respect of collision risks with consecutive wind farms along a flyway) can rapidly act as multipliers of risk, giving rise to a potentially inappropriate and extremely negative assessment.

It is thought that agreed guidance on the application of the precautionary principle would be of benefit to all parties involved in the EIA and CIA process. As a first step it is recommended that regulators and SNCAs consider IUCN guidelines (The Precautionary Principle Project, 2005) on applying the precautionary principle to biodiversity conservation. These recommend, *inter alia*, that:

- All relevant stakeholders are included in a transparent process of assessment, decision-making and implementation
- That in adopting the precautionary principle measures are adopted which are proportionate to the potential threat
- That social and economic benefits be considered when applying the precautionary principle
- That adaptive management approaches, including monitoring and evaluation, be adopted when a high level of certainty is not available.

6. Methods and Techniques

This section considers methods and techniques which could be applied to the CIA of offshore wind farms. It follows the structure of the second paper considered by the October 2008 workshop, produced by Ilya Maclean and Mark Rehfisch (BTO) and discusses:

- Selection of species for consideration
- Selection of projects for consideration
- Consideration of relevant population and reference area
- Methods of data gathering
- Methods of data analysis.

6.1 Which species should be considered?

6.1.1 Key issues

There are no guidelines for species to be considered in CIA apart from the Habitats Regulations requirement to consider in-combination effects for features of European sites. Current practice is generally to focus on individual species of concern eg the interest features of nearby SPAs or to include only those species for which a significant impact has been identified at more than one of the contributing projects. Alternative approaches could include CIA for all species in the development area or the use of some form of screening process for species selection.

6.1.2 Current practice and workshop discussion

In relation to SPA species, SNCAs must satisfy themselves that no feature of a protected site will suffer significant cumulative effects. It was therefore recommended that CIA should include a systematic analysis of all local SPA (plus Ramsar and SSSI) species. Where wide-ranging species such as Gannet or Manx Shearwater are present, early discussion with SNCAs may require the consideration of SPAs which are further afield. A useful addition to an ES would be a summary of the SPA species list together with a description of predicted impacts, including any cumulative effects. Any species screened out of CIA should be listed with reasons.

In relation to other, non-SPA species, the pragmatic conclusion of the workshop was that cumulative assessment of all species at a site was unmanageable. However, in terms of

considering only sensitive receptors, the group was aware that it was important to avoid a situation where a significant cumulative effect was overlooked because there was no indication of an effect from any one, individual project. Species for which this may be a concern are, for example, those that narrowly miss being classed as sensitive receptors.

This led to two recommendations: firstly, that a long-list of species to be considered for CIA is compiled at the scoping stage as one of the 'key features' documents. This should then be screened eg by using survey data collected at a later date. Secondly, the ES should include quantitative data on numbers and density for all species derived from aerial and boat-based surveys. This will enable quantitative CIA to be carried out retrospectively for species not previously classified as sensitive receptors.

Long Listing of Species

Data sources to assist with the compilation of the long-list include:

- Species for which SPAs and other sites such as Ramsar and SSSI, are designated
- Species of conservation importance eg Annex 1 of the EU Birds Directive, Wildlife and Countryside Act 1981 (or Wildlife (Northern Ireland) Order 1985) Schedule 1 species and Birds of Conservation Concern red list species (BirdLife International *et al* 2008)
- Species whose population within the study area at any time exceeds 1% of the national population including breeding, passage and wintering species
- Species which are known/thought to be at particular risk from wind farms (Appendix 7)

Additional sources might include:

- European Seabirds at Sea (ESAS) data
- UK Offshore Energy Strategic Environmental Assessment (SEA)
- JNCC aerial survey data
- BTO Migration Atlas and ringing schemes
- Wetland Bird Surveys (WeBS)
- RSPB
- Species identified in Local Biodiversity Action Plans
- County bird reports/recorders/biological records centres
- Bird observatory data
- ESs for Round 2 offshore wind farms
- Preliminary site surveys
- Expert judgment.

For Round 3 development zones, a provisional list of species potentially susceptible to cumulative impacts is included in Appendix 7, including an indication of their likelihood of occurrence in each zone. It was compiled using European Seabirds at Sea (ESAS) data (Tasker *et al* 1986; 1990) and information on SPA features presented in Stroud *et al* (2001). A definition of the species biogeographic population can be found in the literature source cited in the relevant column. Species sensitivities to various wind farm-associated impacts are also presented in this Appendix with scoring based on a range of sources including Garthe and Huppop (2004). As more information becomes available, this list will require expert review and may need to be updated. Similar tables can be found in Langston (2009) and the UK Offshore Energy SEA (DECC 2009). The latter includes an assessment of species' vulnerability to cumulative impacts.

With thorough scoping the chance of new species emerging as the process of site survey and data analysis proceeds will be reduced. Nevertheless developers should be alert to that possibility.

6.1.3 Recommendations

- A comprehensive 'long list' of species to undergo CIA should be compiled at the scoping stage
- The 'long- list' should be screened using expert judgment and a range of resources eg Appendix 7: List of species potentially at risk of cumulative impacts in Round 3
- A list of all relevant SPA (Ramsar and SSSI) species together with predicted impacts, including cumulative, should be included in the ES. Species screened out of CIA should be listed with reasons
- Quantitative data on number and density for all species at a project site should be included in the ES to enable quantitative CIA to be undertaken for species retrospectively if necessary

6.2 Which projects should fall within the scope of the CIA?

6.2.1 Key issues

The assessment of cumulative (or in-combination) impacts tends to be limited to the proposed scheme along with other projects in the following categories:

- Projects that have been consented but which are yet to be constructed
- Projects for which an application has been made, and
- Projects that are reasonably foreseeable – ie those for which an application has yet to be made but where such application is known to be imminent. This will apply particularly to projects which are likely to be brought forward in the context of an existing plan.

Workshop participants discussed the adequacy of the scope of a CIA based on this approach. They noted that an obvious category of project that is excluded from this list is existing projects, notably those for which effects have yet to be manifest because of a time lag. Discussions focused primarily on which existing projects ought to be included and whether account should be taken of unregulated or unplanned activities and other environmental trends eg effects of climate change.

6.2.2 Inclusion of regulated and planned projects

It was argued that existing projects (ie those that are consented, built and operational) could be excluded from the scope of a CIA because any effect arising from them should already be integrated into the baseline conditions that form the basis for the assessment. Including these effects again eg as recommended by DTI and MCEU (2004) in any calculation of cumulative impact would, therefore, amount to a form of double counting.

Participants were concerned that this approach could inadvertently lead to an incremental change of the baseline. If each new project is assessed against a new but slightly altered baseline then, over time, the baseline bird population could incrementally decline (or increase). Although each individual step might be considered insignificant, collectively they may lead to a change in the baseline that would be considered to be significant if viewed in the round.

In addition, it was highlighted that there may be delayed effects arising from previous consented schemes that would act concurrently with new proposals. These might be underestimated if existing projects were excluded from the scope of the cumulative impact assessment.

There is limited indication in legislation about the scope of cumulative impact assessment, although relevant guidance documents do indicate that consideration may need to be given to the effects of existing projects. For example, Circular 02/99 'Environmental Impact Assessment' indicates that local planning authorities should always have regard to the possible cumulative effects with any existing or approved development.

Again, with respect to features of European importance, Article 6(3) of the Habitats Directive does not require already completed plans and projects to be included in an assessment, although guidance on the interpretation of the Directive does indicate that '…it is important that

some account is still taken of such plans and projects in the assessment, if they have continuing effects on the site and point to a pattern of progressive loss of site integrity' (EC 2000).

Participants in the workshop emphasised that this should be considered as a minimum requirement and expressed concerns about any approach that excludes the effects of existing projects.

On this basis it is considered that a failure in all cases to include the potential ongoing effects of existing projects could lead to an incomplete assessment of cumulative effects. Some judgement is required, however, to determine which existing projects should be considered. In exercising this judgement the key test will be whether any existing project is exerting an effect that is not fully reflected in the measured baseline. Useful information to inform this judgement may be contained in construction and post-construction monitoring reports. Where these are a condition of a project's FEPA licence, they are available from the MFA website at http://www.mfa.gov.uk/environment/energy/monitoring.htm

There was agreement that it is appropriate to include in CIA those reasonably foreseeable projects that may arise in the near future ie the sequential (building block) approach was no longer favoured. However, it is noted with respect to the Habitats Directive, that the report: Managing Natura 2000 sites (EC 2000) indicates that '…it would seem appropriate to restrict the combination provision to other plans or projects which have been actually proposed'. It was agreed, therefore, that whilst it was appropriate to include those projects foreshadowed in any plan, this should only extend to those projects that were actually proposed. It was acknowledged that there might be difficulties with the inclusion of foreseeable projects where data collection was not yet completed.

Projects which were unlikely to be brought forward or dormant should be excluded.

6.2.3 Unregulated and unplanned projects

There was agreement that CIA should include other wind farms, regardless of size, and other regulated projects which were subject to environmental impact assessment.

Participants queried to what extent the effects of other unregulated or unplanned activities, for example, shipping and fishing, could or should be included in any CIA. In most cases it was agreed that the effects of ongoing activities such as fishing are likely to be well integrated into any measured baseline. Nevertheless it is appropriate that some consideration is given, when describing baseline conditions, to whether the effects of unregulated or unplanned activities are reflected in the measured baseline. This approach could be extended to include major environmental trends that might have a significant influence on baseline conditions over the lifetime of the project. Participants highlighted, for example, the effects that might arise from climate change. It was recognised though that these effects may be difficult to predict and quantify.

6.2.4 Recommendations

Rather than expand the categories of project that should be included in the CIA to simply include all existing projects (in which case - how far back would you need to go?) or unregulated activities that have not been subject to any form of environmental impact assessment (eg fishing), it was agreed instead that the focus should be on developing a better description of the baseline conditions of potentially affected features.

On this basis we propose:

- Where quantitative information is available, in order to better assess the context of CIA, developers should appraise the baseline conditions relevant to study features (eg relevant populations) and seek to assess the significance of the effect (positive or negative) that existing (including unregulated) activities or environmental trends (including climate change) might have upon those conditions during the lifetime of the project. In cases where data are not available qualitative consideration may be appropriate.

CIA should include those:

- Projects that have been consented but which are yet to be constructed

- Projects for which application has been made
- Projects that are reasonably foreseeable
- Non-wind farm projects subject to EIA
- Existing projects which have yet to exert a predicted effect (ie an effect that is not covered in the baseline).

6.3 How should the spatial scale of the reference population be defined?

6.3.1 Key issues

The only statutory guidance on the spatial scale of the reference population to be used for impact assessment relates to SPA species. Here, the EU Habitats Directive and Natura 2000 guidance (EC 2000) are specific. They define the relevant area as that which is used by the designated bird features of the site and the reference population as that supported by the site.

Complications in interpreting this for CIA may arise in circumstances eg where:

- The area used by the protected features is not known
- The species only use part of the area to be assessed
- The area of the project supports a known population of a species but the same marine area is also used by birds of the same species with a different provenance eg a passage population
- The 'home' SPA of a species cannot be determined eg for species with large foraging ranges such as gannets
- Species distributions are changing
- Species are not associated with SPAs

6.3.2 Current practice and workshop discussion

Current practice is varied but has often been limited to considering cumulative effects on local SPA populations. However, some developers have also evaluated cumulative impacts at a range of population scales ie regional, national and international in relation to both SPA and non-SPA species.

Where SPAs represent the reference population, the impacts should be assessed against the numbers at designation (Natura 2000 Standard Data Form) but also in relation to any more up-to-date population estimates and known trends eg from SPA review.

In relation to SPAs, participants discussed whether it is reasonable to ask developers to consider cumulative impacts on a wider regional network of SPAs. It was concluded that very strong evidence would be needed in relation to the issue of linkage/connectivity between sites and it was likely that demonstrating these connections would be beyond the remit of developers. For some species eg pink footed geese or whooper swans, dedicated research programmes may be required.

For other species, at the national and international scale, bird population data are more readily available. However, the problems of defining an ecological region and the availability of data to define a population for such an area are more intractable.

The main approach used to define 'regional' areas to date has been either to calculate the population within the local strategic wind farm area or area covered by the projects included in the CIA, or to define a 'discrete biogeographical area' or 'functional unit' utilised by a specific species population.

The workshop agreed that the area occupied by a 'regional population' is often species specific and, in some instances, a biogeographic region can be easily identified using an evidence-based approach. For other species, the definition of a regional population requires expert judgment. The use of Round 2 strategic areas or Round 3 zones, as a basis for calculating the reference

population, although not always ecologically appropriate, represents the default position. Where feeding birds within a zone may originate from non-contiguous, onshore breeding colonies, expert judgement may be required to determine the appropriate extent of the regions. Another useful definition might be the system of Regional Seas defined by JNCC and utilised in the UK Offshore Energy SEA (2009).

Owing to the complexity of the issue, it is recommended that spatial scale of reference populations are discussed 'up front' and agreed with SNCAs at the scoping stage. Assessment of cumulative impacts at a range of spatial scales may be appropriate where different populations use the area at different times of year.

6.3.3 Recommendations

- For SPA species, the reference population to be used is that cited in the SPA documentation at designation. Reference should also be made to more recent population data and trends if available
- With non-SPA species or those whose 'home' SPA cannot be assigned, best available expert judgement should be used to define the area and regional population and agreed 'up front' with SNCAs at the scoping stage on a project-by-project basis
- The default boundary of the CIA study area for defining regional populations should be considered as the relevant Round 2 strategic area, Round 3 zone or equivalent, unless there is reliable evidence to support the definition of an alternative discrete biogeographic region eg area incorporating onshore breeding colony; Regional Sea etc. Boundaries should be agreed with SNCAs at an early stage
- Depending on the reference population(s) identified, impacts may need to be considered at different population scales at different times of year.

6.4 Data Gathering

6.4.1 Key Issues

In most instances to date, the data used to calculate cumulative impacts have been those collected, following standard guidance for the purposes of EIA (Camphuysen *et al* 2004). However, in some instances additional data gathering has occurred specifically for CIA. This may be necessary if, for example:

- Data relating to a specific development are inadequate and it is thought likely to significantly add to the overall cumulative effects
- Cumulative effects on designated features of protected areas are likely to be significant and cannot be assessed due to lack of knowledge about a species use of a wider area eg Sandwich terns in Greater Wash
- Disturbance or barrier-effects are likely to be significant eg red throated diver in Thames

6.4.2 Current practice and workshop discussion

Participants agreed that the current situation reflected the fact that CIA issues were often identified and analyses carried out 'post hoc', at a point where additional data collection was not possible.

In general, the principle was agreed that the standard methods of data collection for EIA eg Camphuysen *et al* 2004, should be adequate for CIA unless specific requirements were identified at an early stage. Data should be collected by trained/experienced observers and new recommendations or refinements should be taken into account eg Maclean *et al* 2009. In future, the completion of the 'key features' scoping documents should identify data gaps early on and enable additional data collection to be incorporated into the programme of EIA surveys.

Nevertheless, it was acknowledged that in some cases, where knowledge about species and their use of a project site was limited, issues might arise after the scoping stage as further information eg bird survey data, became available. Similarly, new species might emerge where project details such as the site boundary or export cable route change post-scoping. Regular

communication with SNCAs is particularly important in this case so that any further data requirements can be agreed as early as possible.

It is thought likely that for Round 3, where a zone may contain multiple projects, the zonal approach will facilitate CIA as data gathering is likely to be coordinated across projects. Further coordination with adjacent projects eg sites in Scottish Territorial Waters is recommended wherever possible. There is, potentially, a role for organisations such as The Crown Estate in this.

6.4.3 Recommendations

- Data should be collected using standard methods eg Camphuysen *et al* 2004, by trained/experienced observers and new recommendations or refinements should be taken into account eg Maclean *et al* 2009
- In general, CIA should be based on data gathered for EIA and not require the collection of additional data except in special circumstances
- Where additional data gathering is required, it should be agreed with stakeholders as early as possible, preferably at the scoping stage
- For Round 3 zones and other adjacent projects, data gathering should be standardised as far as possible across projects

6.5 Compatibility of data and data analysis

6.5.1 Key Issues

Methods for analysing cumulative impacts typically involve combining environmental information on bird impacts from a number of projects. It was noted during the previous workshop (Norman *et al* 2007) that where different approaches were taken to the assessment and reporting of impacts at different projects, it was difficult to find a consistent quantitative basis for CIA.

This issue could be addressed by providing explicit guidelines to standardise outputs from EIA and making these a requirement of the EIA process. The alternative would be to make all raw bird data eg from boat-based surveys, publicly available so that compatible outputs could be calculated from first principles.

6.5.2 Current practice and workshop discussion

Currently the only data that have been gathered in a standard way and in the same time frame over large areas and made publicly available for analysis are the aerial surveys carried out for CCW and wind farm developers in Liverpool Bay, and then by BERR (now DECC) as part of the SEA (eg Cranswick *et al* 2007). DECC will shortly be making similar aerial data, collected for the UK Offshore Energy SEA (DECC 2009), available on its website. These data make it possible to gain insight into potential effects on populations that forage across the wider area and to assess the likely impacts of developments occurring within the same region. Workshop participants observed that this was an excellent model.

Members of the workshop were challenged to explain the barriers to data sharing as, in principle, this would solve many CIA problems. Commercial sensitivity was regarded as the major issue for developers, particularly if there was a chance that the same data could be analysed in different ways to give different results (the 'duelling scientists' phenomenon). It was concluded that data-sharing represented an ideal situation but data were unlikely to be made available by developers before a project was submitted. For this reason CIA will normally have to be carried out using the results of data analysis provided in the ES and this may lead to incomplete CIAs except by the last in a series of applicants.

The principle of presenting the results of analysis in a standard way to aid comparability was well received. For Round 3 zones containing multiple projects, standardised data analysis and presentation of results should facilitate CIA. However, if CIA is to incorporate more than one zone or to require consideration of nearby Round 1, Round 2 or Scottish Territorial Waters projects, the issue of data compatibility may still arise. The issue may be exacerbated by

inadequate or poor quality data from some earlier projects which may make robust analysis problematic.

Raw numbers (including dates of raw data collection), density estimates and population estimates for all bird species recorded at the project site form the basis of impact assessments. They should therefore be reported in the ES, together with a clear description of how they were calculated. Unless this approach is adopted, then the status quo will be maintained and qualitative assessments will continue to be carried out where quantitative assessments are not possible.

COWRIE has recently published a 'Review of Assessment Methodologies for Offshore Windfarms' and this should be consulted for further recommendations on data presentation and analysis (Maclean *et al* 2009).

The SNH representative reported that, as a result of the difficulties of trying to compare data from different ESs, SNH are considering a standard template for the presentation of results. This will summarise all the findings of the impact assessment and is likely to become a required addendum for onshore wind farm ESs. It will make them both more transparent and easier to assess in a standard fashion and will simplify the process of CIA. It was suggested that a similar procedure would be extremely useful in all parts of the UK and that the SNH procedure could be usefully adopted, with amendments if necessary, by other SNCAs.

Pending this, developers should present the results of analysis as clearly as possible and define all assumptions made and parameters used so that combining data for CIA becomes more practicable.

6.5.3 Recommendations

- Raw bird numbers (including survey dates), density estimates and population estimates should be reported for all species together with a description of their methods of calculation
- All data analysis should be presented in as clear a way as possible, identifying any parameters used and assumptions made
- In the long term, a system of standardised results reporting for ESs should be developed to ensure compatible outputs.

7. Cumulative Effects to Be Considered

The environmental impacts of wind farms have been reviewed by a number of authors and birds, in particular, have been identified as a group which may be affected in the offshore environment (Exo *et al* 2003). Potential effects, all of which may act cumulatively, include: disturbance, displacement, barrier effects, mortality due to collisions and indirect effects on prey. Each of these effects is reviewed in the following section.

7.1 Cumulative collision mortality

7.1.1 Key Issues

Cumulative impacts due to collision arise primarily because of the development of more than one wind farm in an area. Although other types of development may also cause collision, in practice, such developments are rare and collision estimates difficult. It is also possible that a development could elicit a behavioural response from birds making them either more or less likely to collide with other developments in the area.

If a standard response to each wind farm is assumed and other developments are ignored, cumulative collision impacts may be calculated by summing the effect from each individual wind farm. This is likely to lead to an insignificantly small error in relation to other sources of error incorporated within collision risk calculations eg avoidance rates.

7.1.2 Current practice and workshop discussion

The workshop discussed the proposal to simply sum effects for CIA and it was agreed in principle, providing that the method of collision risk calculation for each development is consistent or unless evidence indicates that this approach would result in significant inaccuracy giving rise to a material difference in the assessment of the significance of the potential impact.

Few post-construction studies of existing developments allow the calculation of reliable avoidance rates. Therefore, evidence-based avoidance rates exist for only a few species under a restricted range of circumstances. In the absence of empirical data, high rates of avoidance are generally assumed. In this case, even a small variation in the estimated rate of avoidance can lead to very large variations in mortality estimates (Chamberlain *et al* 2006). The net result is a high degree of uncertainty in relation to the output. Typically, this is incorporated by using a precautionary approach.

In relation to this, the feeling of the group was that summing would compound the precautionary assumptions involved in calculations for each project, potentially leading to the overestimation of collision impacts.

Most developers use a variation of the Band model (SNH 2000) to calculate collisions. However, the method was designed for onshore wind farms where bird vantage point surveys are used to observe the whole project area and record species' flight lengths (or passage rate) and flight height. These form the basic data for collision risk modelling (CRM).

The difference in the offshore environment is that the whole project area cannot generally be observed and surveys are carried out from a moving platform. Offshore surveys record raw bird numbers (or passage rate), as opposed to flight lengths and flight height along the survey transect.

From these different starting points, different methods are used to derive the input parameters for CRM.

To increase data compatibility from different developments, it was agreed that each ES should contain a clear description of the input parameters used in CRM and that all methods of calculation, including density and population, should be clearly explained. This would also enable cumulative collision risk to be re-calculated from first principles if necessary. If necessary, any seasonal variation in bird presence should be incorporated by carrying out collision risk modelling on a month-by-month basis.

In terms of standardising the collision risk calculations themselves, participants felt it would be useful if guidance on CRM for offshore was available in a similar way to the SNH guidance note for onshore CRM. It could specifically include:

- Advice on input parameters including the calculation of flight activity ie density or passage rate
- A note on avoidance rates including a table of those already agreed
- A template in the form of a spreadsheet for completion to standardise methods and results presentation.

SNH are currently refining their collision risk guidance to include a list of standard parameters such as flight speed etc and are publishing information on avoidance rates as evidence accrues. The group agreed that this was extremely useful.

In relation to interpreting the significance of cumulative collision impacts, some ESs have simply discussed the additional mortality as a proportion of the regional population. However, this approach does not take into account a species' life-history parameters or its habitat/resource use ie whether it is a specialist or a generalist. This information is necessary to determine the population level effect. Cumulative collision mortality should therefore be reported both as a specific number of individuals representing a percentage of the population and as a percentage change in background mortality and its implications discussed at the relevant population scale (local, regional, national and international as appropriate). Where collision mortality is likely to be significant, further population modelling may also be required.

The group agreed that a useful future approach to CRM might be to devise some form of rapid assessment. This could involve the development of generalised collision rates for key species likely to be susceptible to cumulative impacts. This could be used as a 'ready reckoner' to calculate collisions based on a range of factors for example, on the number of turbines present within a project area and the average number of birds thought to occupy or fly through it at rotor height. This approach has the advantage of speed but it would be more difficult to take into account different spatial and temporal bird distribution. It was noted that other factors may influence collision risk eg behaviour, weather conditions etc. These are not currently incorporated into modelling. However, they should be borne in mind in the consideration of impacts.

Post construction monitoring was stressed as a vital means of providing evidence-based parameters for avoidance rates. Post construction monitoring of collisions or a requirement to verify statements made about collisions in the ES is now a frequent requirement of the FEPA licence. Methodologies for this in the offshore environment are currently unclear but they are likely to include some sort of targeted monitoring. Reports of all monitoring carried out as a FEPA licence condition are published on the MFA website.

7.1.3 Recommendations

- Cumulative collision impact should be calculated as the sum of collisions from component projects unless evidence indicates that this approach would result in significant inaccuracy, giving rise to a material difference in the assessment of the significance of the potential impact
- To ensure data compatibility, an ES should include data on:
    - Bird numbers by date/season
    - Density/passage rate for each species (date specific)
    - Population estimate for each species (date specific)
    - A description of how the above values are derived
    - A spreadsheet showing each stage of the collision risk calculations for each species
    - Collision risk should be calculated on a month by month basis where there is seasonal variation in a species population.
- Cumulative collision effects should be:
    - Shown as raw numbers of individuals
    - Reported as a percentage of the relevant population
    - Represented as a percentage change in background mortality rate
    - Considered against the life history of the species eg age at first breeding, brood size, productivity, demography, age-related survival rates, and its ecology.
- Where collision mortality is likely to be significant, further population modelling may also be required
- The preparation of a specific guidance note by SNCAs in association with industry and stakeholders on collision risk calculations for offshore projects, incorporating acceptable avoidance rates, flight speeds and other key elements, would be of long term benefit to the CIA process
- Standardisation of the presentation of collision risk calculations (for example through the adoption of a template) would also be beneficial
- A 'rapid assessment' collision risk tool for species using a generalised data set based on evidence of bird numbers, behaviours eg flight height and turbine dimensions should be developed. However, this is beyond the remit of this report

7.2 Cumulative Disturbance

7.2.1 Key Issues

Disturbance effects may be caused by noise, visual intrusion or physical disturbance and can amount effectively to habitat loss. They may occur during both the construction and operational phases of wind farms. The scale and degree of disturbance will vary according to site- and species-specific factors and is usually assessed on a site-by-site basis (Drewitt and Langston 2006).

The accumulation of disturbance effects is likely to be non-linear for several reasons. Firstly, a single disturbance event can influence the behaviour of the bird subsequently. Secondly, the relationship between energy expenditure, foregone energy intake and mortality risk is likely to be sigmoidal (see Appendix 4) and events may be synergistic. With increasing energy expenditure or loss of time for feeding, a critical threshold may be crossed where a bird cannot meet its energy-requirements and mortality is likely to occur (Stevens and Krebs 1986). This threshold will vary depending on the condition of the bird, temperature, food-availability and other factors.

Where expert judgment determines that disturbance effects are likely to be significant, detailed study of energy-budgets of birds within the area may be required. These are likely to be costly and time-consuming, but the only way in which cumulative disturbance impacts can be quantified. In some cases, where logistical difficulties make such studies impossible, modelling may be helpful, providing parameters and assumptions can be agreed with relevant SNCAs.

Where disturbance impacts are minimal, subjective treatment of the issue is adequate.

7.2.2 Current practice and workshop discussion

The group discussed the difference between disturbance and displacement and agreed that they were different effects. Although the end result of disturbance might be displacement from an area, there may be greater implications for bird bioenergetics from disturbance and any mortality arising from this source had a different cause. The magnitude of the effect depends on a species' ability to compensate for elevated energetic demands versus the availability of alternative undisturbed feeding areas. There may also be a time lag before any effect is manifested if disturbance causes reduced condition and productivity or reduced survival on migration etc, rather than increased mortality during the season in which the disturbance takes place.

It was agreed that subjective treatment is adequate where displacement effects are likely to be minor or less but that it is difficult to determine when cumulative disturbance impacts are likely to be significant. For this reason expert judgment should be used to inform decisions at an early stage as to whether quantitative assessment is likely to be necessary.

It was reported that BERR have commissioned a bioenergetics report and that this would be available shortly on the DECC website.

7.2.3 Recommendations

- Where disturbance impacts are likely to be minimal, subjective/qualitative treatment of the effect is adequate
- For projects or species where potential impacts are likely to be significant, a quantitative assessment, including information on energy budgets should be carried out. In some cases modelling may be appropriate
- The bioenergetics report commissioned by BERR in 2008 should be given wide circulation once available.

7.3 Cumulative displacement / habitat loss

7.3.1 Key Issues

The way in which effects associated with habitat loss and/or displacement accumulate is complex. It depends mainly on the extent to which the area of the wind farm development is at carrying capacity, ie to what extent numbers are limited by the availability of resources.

Where numbers are not constrained by resource availability, then cumulative displacement effects will be negligible. However, where they are, displacement will result in increased competition and hence higher mortality in the remaining habitat (Burton *et al* 2006). In this case cumulative effects may be assessed simplistically by summing the effects from component projects.

To assess whether an area is at carrying-capacity is time-consuming and difficult. It may also vary from location to location as well as through time. It requires survival estimates to be calculated before and after displacement (eg Burton *et al* 2006) or the development of individual-based models (eg Kaiser *et al* 2002). In fact, there is ample evidence, (Wooller *et al* 1992; Frederiksen *et al* 2004; Harris *et al* 2005, Wanless 2005) to suggest that many, if not most marine areas are at or close to carrying capacity.

7.3.2 Current practice and workshop discussion

As there is no suitably simple method for determining whether an area is at carrying capacity, workshop participants agreed that this should be assumed unless there is evidence to the contrary. Cumulative displacement may therefore be calculated by summing the effects from each of the contributing developments. The default assumption is that all birds that are displaced die. This may however lead to inflated/highly precautionary estimates of mortality. In some cases, where displacement leads to reduced condition or productivity, the effect may take longer to become apparent.

As displacement may be of greater consequence for some species than for others, any differences should be discussed in the ES

There was a plea from the workshop group that post-construction monitoring is used to verify the impacts predicted by CIA. In this way an evidence base would be developed and 'value for money' achieved by the monitoring.

7.3.3 Recommendations

- Areas should be assumed to be at carrying capacity, unless there is evidence to the contrary, and displacement values should be summed
- The default assumption is that all birds that are displaced die
- Any differences in assumptions about species sensitivity to displacement should be explained in the ES.

7.4 Cumulative barrier effects

7.4.1 Key Issues

Wind farms may impose an effect on birds by altering their migration flyways or local flight paths to avoid them. This effect is of concern because of the possibility of increased energy expenditure when birds have to fly further and the potential disruption of linkages between distant feeding, roosting, moulting and breeding areas otherwise unaffected by the wind farm (Drewitt and Langston 2006). As with other impacts, barrier effects are dependent on a whole range of factors including the species, the type of bird movement, flight height, the layout of turbines and wind force and direction.

Bird movements around a wind farm have been assessed using radar (eg Desholm & Kahlert 2005) but due to cost, limited radar range and the difficulties of providing a stable platform at sea, the number of offshore wind farm sites where this technology has been deployed is limited. A further issue is the difficulty of interpreting the radar target to differentiate between species.

However, barrier effects can only be assessed directly after a wind farm has been built and thus only quantitative measures using radar can feed into EIAs and ESs.

A review of the literature suggests that none of the barrier effects identified so far have had significant impacts on populations (Drewitt and Langston 2006). However, it is possible that several wind farms, including both onshore and offshore developments, could act cumulatively to create an extensive barrier, which could lead to diversions of many tens of kilometres, thereby incurring increased energy costs. This may be particularly important if birds cannot compensate by increasing intake.

The manner in which barrier effects accumulate, will depend on the geometry of developments within an area and the way in which birds fly through/around the wind farm site. Since the relationship between energy expenditure/foregone energy-intake and mortality risk is non-linear (see section on disturbance), the cumulative impact of developments may be greater than the sum.

If cumulative barrier effects are likely to be significant, it is recommended that a detailed assessment of flight-directions, energetics and the source and destination of birds be assessed, informed for example, through the use of radar. However, if the cumulative barrier-effects are likely to be minor or negligible, then it is recommended that summing the individual impacts is a reasonable alternative. Although, in some instances, the cumulative impacts will be less than the sum of the individual impacts, in others it will be more, therefore, on average, the results should be accurate.

7.4.2 Current practice and workshop discussion

Some members of the workshop expressed the opinion that barrier effects were overemphasised in terms of their significance for most species. Others thought that effects were potentially more likely if the wind farm intercepts, for example, flights between breeding colony and main foraging areas causing frequent diversionary passages. On longer distance flights, birds may be able to make flight adjustments at a distance, thereby actually incurring only relatively small additional flight distances, if at all. It was also observed that if they do act as a block to an area then the habitat, whatever its quality would become unavailable and that this is a potential issue considering the scale of some future developments.

Nonetheless, the group concluded that qualitative treatment is adequate where barrier effects are not likely to be significant. However, as before, this raises the difficult question of how to determine when the effects are likely to be significant, particularly when a judgment can only be based on qualitative information.

Once again, this was agreed to be the province of expert judgement and where barrier effects may be significant, the procedure for CIA should be agreed with SNCAs as early as possible during the EIA process.

7.4.3 Recommendations

- Where potential barrier effects are likely to be minimal, subjective/qualitative treatment is adequate
- For wind farm projects or species where impacts are likely to be significant, a quantitative treatment focusing on the energetic implications of avoiding barriers should be carried out
- The need for quantitative treatment should be identified using expert judgment and agreed as early as possible with SNCAs

7.5 Indirect effects

It was felt by the group that cumulative indirect effects of eg piling on prey, may be significant especially in areas where foundation installation may continue at a number of projects over several years. Owing to the lack of information on the subject it was felt that no firm recommendations could be made. However, good CIA requires a consideration of the issue including, for example, the effects of noise and vibration on prey species incorporating spawning, egg, larval and adult stages.

7.6 Tests of significance and reporting

It is recommended that the significance of most cumulative effects is assessed by summing the impacts from each component development. The exception to summing should be in assessing cumulative impacts of disturbance and barrier-effects where the impacts accrue in a non-linear manner. We propose that these are first considered in a qualitative manner making best-use of available information. If the cumulative impacts are subsequently thought to be significant, then a more detailed quantitative study should be carried-out.

In relation to significance, we recommend that the significance of mortality be assessed using mortality-rates expressed as both the numbers of individuals lost as a proportion of the population and as a change in background mortality. This will enable the life history parameters of the species to be utilised to interpret significance as long-lived species with low reproductive rates are considered more sensitive to effects. For a more detailed discussion of demographic factors and the factors that influence them, see Maclean *et al* 2007.

There was also a proposal to incorporate life history parameters and flexibility in habitat/resource use when assigning species sensitivity with long lived species and/or those which are specialist rather than generalist being considered more sensitive. Although this was not discussed further, the approach used by Garthe & Huppop (2004), which includes these considerations, has some merit and could be extended and modified for UK waters, incorporating more information about sensitivity at different life cycle stages and relevant expert opinion. A preliminary version of such an analysis is included In Appendix 7 Table 7.2 and the UK Offshore Energy SEA (2009).

The general difficulties of assigning the value or sensitivity of a species population are discussed in the draft IEEM guidelines. They conclude that:

'*the best available method (of assigning sensitivity) remains that of professional judgment and consensus through peer review. It should be based on available guidance and information, together with advice from experts who know the locality of the project and/ or the distribution and status of the species or features that are being considered. The assumptions on which that judgment is based should be clearly set out in the Ecological Impact Assessment report*.' (IEEM 2008 draft)

Consideration of cumulative impacts should not only be given to those species for which there is a significant impact at any one of the component developments, but should also include species that narrowly miss this category as it is entirely plausible that the accumulation of non-significant impacts could, over time, become significant.

It is also recommended that the significance of cumulative impacts is initially assessed using the same matrix approach as that routinely used for EIA. This should be supported by detailed discussion of the predicted impact to substantiate the conclusion of a significant or non-significant effect, as recommended by the IEEM guidelines.

In this context, it was agreed that the task of deciding whether an impact (cumulative or otherwise) is potentially significant is simpler when there is a clearly stated conservation objective for a feature. For this reason, it is often easier to assess whether a predicted level of mortality is significant for an SPA species compared to a non-SPA species. This is driven by legal requirement and because, for SPA features, the integrity of that feature is generally more clearly defined.

This point led to a discussion on how to determine the thresholds at which any effect becomes significant at the population level. Currently, a generic increase of more than 1% above background is often used in ESs, regardless of the population scale considered. However, the origins of that value are unknown. More accurate guidance from SNCAs on the levels of population change that can be tolerated for different species would be helpful.

In circumstances where significant cumulative impacts are predicted on widespread or common species and populations which are not SPA features, the task of assessing the significance of cumulative impacts is extremely difficult. It would be more straightforward, therefore, if there were clearly articulated conservation objectives for these populations. Participants did not underestimate the difficulty in agreeing such conservation objectives and did not seek to make

this guidance contingent on their availability, nevertheless, it was generally agreed that moves to develop these objectives should be supported and encouraged.

7.6.1 Recommendations

- Significance of a cumulative impact on a species should include a consideration of its life history parameters
- Alternately, consideration should be given to life history parameters and habitat/resource use flexibility when defining a species' sensitivity with long-lived species and specialists considered to be more sensitive
- Potential impacts on species which 'narrowly miss' being assessed as significant impact at the individual project level should not be excluded from CIA
- Conclusions on impacts should be derived both from standard EIA matrix tables supported by discussions to reach a conclusion as to whether the impact is significant or non-significant
- The results of both EIA and CIA should be presented in the ES in as clear a way as possible identifying any parameters used and assumptions made. The preference should always be for results to be quantitative rather than qualitative
- SNCAs may wish to consider defining conservation objectives for widespread species which are not associated with existing or proposed SPAs (eg Little Gull)

8. Summary

This project has developed guidelines on the processes, methods and techniques to be utilised for cumulative impact assessment for birds and offshore wind farms. The guidelines build on recommendations made at an earlier COWRIE workshop (Norman *et al* 2007).

The current guidelines were developed by the review and discussion of two specially commissioned position papers at an expert workshop held in Peterborough in October 2008.

The process of scoping was agreed to be essential to the provision of robust CIA. It requires regular communication and iterative information exchange between developers, statutory bodies and stakeholders.

Detailed guidance points for scoping have been developed which focus on the completion of 'key features' documents. These are checklists of key facts that will be used to inform cumulative impact assessment ie species, conservation designations, projects and proposed surveys and analyses and include a record of communications. It is hoped that these documents or similar can be endorsed by SNCAs in order to standardise the scoping phase of CIA.

It was also agreed that there was a need for increased guidance and more certainty in policy coming from regulators and their statutory advisors.

A review of the methods and techniques currently used for CIA led to two main areas of recommendation. The first focussed on data gathering and analysis. Guidelines are given for selection of species for consideration, the projects to be included in the assessment and the spatial scale of the bird reference population to be used. An overarching recommendation was for the provision of quantitative data on raw numbers, densities and population estimates for all species and that, wherever possible, impacts were assessed in a quantitative rather than a qualitative way

In relation to the assessment of cumulative effects, for collision risks and displacement, the effects should be assessed by summing the impacts from each component project. In some cases, further population modelling may be required.

Disturbance and barrier-effects accrue in a non-linear manner, these should, therefore, firstly be considered in a qualitative manner making best-use of available information. If the cumulative impacts are thought to be significant, then a more detailed quantitative study of bird bioenergetics in relation to the effect should be carried-out.

In general, the significance of mortality should be expressed by presenting the number of individuals as a proportion of the population and also interpreted as a change in background mortality to enable the life history parameters and ecology of the species to be taken into account.

The guidelines presented here are the first stage of an iterative process. They will need to be refined on the basis of evidence gathered from the monitoring of wind farms both during and post-construction and as our understanding of the impacts of cumulative effects on birds improves. Their adoption will require engagement from all parties involved in the process of impact assessment.

Further outstanding guidance requirements, which are outside the scope of this report, have also been identified.

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Appendix 1

Notes of COWRIE CIA Workshop 2nd October 2008, Natural England Offices, Peterborough

1. Attending

Colin Barton (Cork Ecology), Craig Bloomer (Joint Nature Conservation Committee), Phil Bloor (BERR), Rhys Bullman (Scottish Natural Heritage), Peter Cranswick (Wildfowl and Wetlands Trust), Sue King (AMEC), Rowena Langston (Royal Society for the Protection of Birds), David MacArthur (Scottish Power Renewables), Ilya Maclean (British Trust for Ornithology), Elizabeth Masden (University of Glasgow), Rachael Mills (Marine & Fisheries Agency), Tim Norman (Crown Estate), Martin Perrow (ECON Ecological Consultancy), Andrew Prior (PMSS), Mark Rehfisch (British Trust for Ornithology), Edwina Sleightholme (AMEC), Gero Vella (Renewable Energy Systems), Sian Whitehead (Countryside Council for Wales).

2. Introduction – Sue King

3. Chair – Tim Norman

Consideration of CIA is timely in context of R3 as there may be 50-60 new OWF sites within the R3 zones for which a robust consenting process is needed.

4. Scoping paper and key features documents - Andrew Prior

a) The paper describes a framework. Representatives of organisations may not be able to approve it today but should take it back and pass it up through organisation for discussion.
b) The aim is the approval of a common process looking forward.
c) There are delays and frustrations with the lengthy EIA process and CIA is often reactive and not planned.
d) There is little management of expectations and entrenched positions are often adopted.
e) Often a very conservative approach to risk is taken.
f) There is minimal innovation.
g) Scoping documents are limited, often speculative and cursory with little data.
h) Responses often mechanistic, little project-specific thinking involved, consultation is seen as public relations exercise. Responses may be unhelpful eg requirement of 2 years data with no further consultation until data collected. SNCAs should provide more detail of what's required earlier in the process.
i) Full engagement of the SNCAs is needed as this is where expertise resides. This needs to be accessible.
j) Resourcing of SNCAs is crucial – is what we need really possible with the available resource?
k) Cost of responding to scoping is an issue, as there are budget limitations.
l) There is limited communication between developers who may be rather paranoid about data sharing. Entrenched position has led to formalised responses written before discussion has taken place.
m) Policy and guidance must be robust and needs to be more detailed.
n) Currently, MFA, BERR (DECC) and SNCAs are developing guidance.
o) Is there a real conflict between conservation and renewables. Can we actually deliver the targets?

p) SNCAs may need to disagree with Government targets. But, if they acknowledge the benefits they must engage with the process. Sometimes there will be hard internal decisions which mean that a project may not be viable. However, SNCA's treatment of risk must be proportional and policy and guidance must address this. This is also a resourcing issue.
q) Current policy and guidance rather insubstantial.

5. General Discussion and Questions re Presentation 1 - Scoping

a) Scoping is critically important.
b) Often badly done, indeed, sometimes it would be hard to be worse!
c) Early communications between developers and SNCAs crucial, first at a strategic level, then at a project level. As we're still on a learning curve re CIA we need to build relations and recognise other peoples positions and build up trust at an early stage.
d) Developers are not always aware how decisions are made. Scoping documents need to go to the correct person. SNH have a system of renewable energy casework advisers. The casework officer in SNH case is always the first point of contact for the project.
e) SNCA staff, especially at local level (eg casework officers) need to recognise that they are part of a national process within a specific time frame. They often feel they will have to feedback quickly (often very formulaic response) and deal with comments at a later stage which isn't very helpful. They need to feed back more information at an earlier stage but this is difficult if the scoping report is poor in the first place.
f) Scoping documents are poor and scoping responses are poor. The process needs to be iterative as, initially there may not be much knowledge about a certain feature. It's rarely possible to scope something out completely due to lack of knowledge so tendency to look at everything. Offshore environment very different to onshore as much less information. Focus develops as surveys proceed.
g) CCW responses have been good. Some developers have been 'lazy' at scoping stage and not looked at available data eg ESAS
h) Scoping documents may arrive after surveys have started!
i) Scoping is a formal process with a deadline to publish. Need to emphasise that fact.
j) Developers may be reluctant to change their scoping procedures as no sites have been refused yet so 'why bother?'
k) Emphasis on the word 'yet'!
l) Basically we're asking people to be personally responsible. Development zones aren't actually scoped (in entirety?)
m) Whose job is it to scope them? Scoping is critical to any project to identify issues.
n) We have more information now than at the start of R2. SEA won't be at the correct resolution to focus on key scoping issues. In some ways we've all worked towards making useless scoping documents when they should be useful.
o) The developer is required to submit the document and to raise issues. BERR consults and returns comments. Therefore there's a duty on BERR to get consultees to think about the process and identify best practice.
p) Pre-scoping meetings with consultees very important to have collective discussion, pool data and identify data gaps.
q) More surveys before scoping document issued might be useful.
r) Information in the CE bid is pre-scoping and requires a statement considering the 'consentability' of the site. We need a way of capturing the work done at the bidding stage and incorporating information and advice from this eg such info as used to inform site revisions.

s) Is CCW/SNH approach more consistent than NE? Sometimes hard to get the relevant people but good when they are identified.
t) The nature of R3 zones means may be able to have a more productive discussion with CE. Their MaRS system is useful. For CE money is the driver to get wind farms developed therefore there's an interest from CE and developers to move this forward. CIA is holding up the consenting process. There may be a long time before leases are assigned.
u) Would be interesting to know if the same issues identified at the pre-scoping stage were still there at the end.

6. Specific comments on 'Key Features' scoping documents

a) Extremely useful documents. Add a column for evidence to justify concern/non-concern for species to 'avoid ticking all the boxes'
b) Chair: Would generic 'risk tables' tools eg for CRM be useful to help discriminate sensitive species? ie likely to be near a significant effect?
c) Would like to make sure that early comments provided are without prejudice to the final decision.
d) Chair: Is there a risk to European Designation?
e) Could be a danger of going in to too much detail. Don't want to commit too much effort at the start as may have to go back to it.
f) Is the purpose of the 'key features' sheets to use the information to design surveys?
g) AP: Yes
h) Onshore wind has addressed this before by use of a separate ornithological scoping document produced before the full scoping document. This includes suggested surveys. Might be useful to do initial surveys then meet again to decide whether further surveys needed.
i) The key issue is that the document should be useful to the statutory consultees and the developer.
j) Key features approach will ensure consistency across developers.

7. Summary of discussions on Paper 1

a) There was a general agreement that scoping and communications are key issues in interests of all parties.
b) Lack of good scoping currently probably not an institutional problem but may be due to 'laziness'. The process needs to be worked at. Key features documents may break the cycle and standardise procedures.
c) Entrenched positions can be overcome with better communications.
d) If we tick all the boxes in scoping, it's a waste of time and the wrong application of the precautionary principle.
e) With 50-60 individual sites within all the Round 3 zones, will need to speed up the consenting process.
f) Is there a possibility if including data-sharing requirements into CE leases? This is probably less of an issue for R3 as zones will have exclusive development agreements. Not sure whether sharing data between zones is relevant/possible.

8. Methods paper – Ilya Maclean

a) Aim: Identification of range of techniques used for CIA. Drawing up of guidelines to ensure consistency
b) Key points:
c) **Data compatibility:** need clear guidelines on format of outputs
d) **Data gathering:** For CIA often 'post hoc'. Should additional data be collected?

e) **Which species to include?** All, but then screen them to focus on those that are significant?
f) **Area to be considered?** Functional biogeographic unit? How to delineate area – may be subjective. Use R3 zones? What if the population is 50 % in zone and 50 % out of zone?
g) **Which developments to include?** Wind farms only or other developments? Existing and/or proposed wind farms? Inclusion of ongoing guards against the degradation of the environment. Should existing developments be included as part of the baseline?
h) **Collision:** Sum mortality and compare it as an impact on the size of the population or present it as a rate to compare against population life history.
i) **Cumulative displacement:** assume the area is at carrying capacity and sum impacts? – Precautionary.
j) **Cumulative disturbance:** addition of effects not simple – devise a screening process.
k) **Barrier effects:** sum (not as bad as summing disturbance effects)
l) There are difficulties in summing qualitative effects.
m) Data quality is also an issue

9. General Discussion and Questions re Presentation 2 – Methods

a) A small displacement could be a large effect
b) Should we assume that all birds that are displaced die?
c) Should include indirect effects eg of piling on prey though very difficult to assess.
d) Chair: Disturbance and displacement – are they the same or different?
e) The habitat is not accessible; it's not that it is not suitable ie the entrance to the area is blocked.
f) Importance in terms of relevance to developers in relation to installation methods
g) May be piling for years on R3 sites
h) Barrier effect overemphasised in terms of its significance
i) Energetics report from BERR imminent
j) Indirect effects should be pulled out separately as are very different.
k) Chair: Assess indirect effects in same way as displacement effects. They are very different issues but actually the assessment should be the same because you are looking at the same points.
l) Compatibility of data – qualitative versus quantitative
m) Do developers 'mischievously bury' data?
n) Reports that SNH receive are impossible to compare. SNH may request use of templates for data so can assess in a standard fashion.
o) Post construction monitoring data needs to be more accessible
p) Chair: Is PCM supplying truly comparable data (Is PCM a good return on investment?). The questions asked during PCM are different to the questions asked before ie getting info on bird count etc but not monitoring the effect of the wind farm ie displacement. Should state in ES what exactly is proposed. Data is there but it is not being analysed properly ie stating if significant effect or not.
q) Liverpool Bay was good example.
r) It would be really helpful if data were available but it must actually answer useful questions eg is displacement occurring.
s) Aerial data gathering is an excellent mode for data storage. Could it be used as a model?
t) Chair: Other reporting issues/format
u) Why don't we all use a standard model?

v) Chair: Which plans should be considered in CIA: building block – complete plan? In European context it could be argues that the assessment of the plan is the SEA.
w) Consider all projects whose application is submitted.
x) If there's information available, whether submitted or not, it should be considered.
y) Don't include submissions which haven't (wouldn't be?) considered in the AA
z) In Round 3, the regulator must consider the zone as a whole.
aa) Chair: CE may be able to develop procedure between zones but the decision could come down to the regulator.
bb) No quality control on data makes them difficult to compare. If surveys are scoped out it will mean data are not compatible as they're not comparable ie if surveys are focussed presumable same species will not be considered.
cc) Is it data or results which require template?
dd) Data
ee) Due to the size of zones in R3 the standardisation of data collection is impossible.
ff) Chair: Need to standardise the analysis not the survey methods.
gg) Survey data is vital to getting result.
hh) Building block approach should exist as it is the only fair way.
ii) Standard template for analysis so put all the information into one place ie on one table and therefore calculations can be re-done if needed.
jj) Chair: That could lead to problems as developers could re-analyse other project's data and disagree with the EIA conclusions.
kk) Chair: Sometimes important to guard against competitive analysis of data. Whole process easier for SPA spp where there are conservation objectives.

10. Summary of discussions on Paper 2

a) There was a debate as to what is actually the issue.
    a. method for assessing the cumulative risk
    b. survey methods as they feed into the cumulative risk
    c. how can you compare data if the answers received are in totally different format?
    d. what will SEA provide?
    e. when there are 50/60 sites for R3 can you do a first come first served basis?
b) R1
    a. should this be included?
    b. is this the baseline now?
    c. what else should be included that's not wind farm?
c) Spatial and temporal scales are important metrics for CIA i.e. where to draw the line of project history and what to include.
d) How should data be presented – raw data or results
e) For collisions -combine data and numbers
f) Pre-scoping meeting should be used to inform the scoping process
g) Should we develop a strategic tool for CRA eg use density as a 'currency converter' to do risk assessment
h) Acceptance that there will be more use of risk assessment tools

Afternoon discussions

11. **Refining 'Key Features' documents**

(NOTE: Comments on the design of the key features documents are not

recorded here as they have been included in the revised versions presented in the main text of the report**)**

a) Some species will be difficult to assess cumulatively
b) Oil and gas were requested to do AA for auks but impossible to identify source SPA ie difficult to do CIA or AA unless there's a clear linkage between species and SPA
c) Gannets will be a problem.
d) General agreement on principles of pre-scoping, scoping and communication as key to the process
e) Key features documents/tables very useful
f) Re-issue with modifications

12.Refining 'Methods' recommendations

a) Group to produce a shortlist of species vulnerable to cumulative impacts and biogeographic range over which impacts should be considered
b) Projects to involve ; stick to 'building block approach'
c) Monitoring is critical to confirm impacts
d) Developers and consultants should come forward with information
e) 8 key issues
f) 1 and 2 were discussed earlier

Species: Which should be included?

a. all SPA species need to be considered – 30+ species
b. those from SEA aerial surveys
c. species of all designated sites
d. Annex 1 internationally important seabird species
e. Review of data
f. EIA data from other sites
g. Phone around
h. Use 'Expert Judgement'

b) All of the above should screen via vulnerability/ sensitivity / likelihood of occurrence
c) What about CIA required for some species and not for others. There is confusion between what is needed for EIA compared to CIA.
d) Species screened out should be listed with reasons. Include an Appendix to ES listing what is possibly there and what is not there – Audit Trail.
e) **Action:** A list of target species for CIA along with indicative impacts should be produced.

Scale of Area

a. What area should be looked at?
b. all North Sea wind farms
c. areas with demonstrated connectivity
d. evidence based approach
e. How define which SPA a bird comes from?
f. Consider the impact on regional area ie network of SPAs
g. Use Expert Advice

b) The area is species specific
c) Concerns on linkage between SPAs - need strong evidence to show the link whereas for EIA it doesn't matter where the bird comes from.
d) How do you draw the line at what you can ask developers to do? Cost, too much effort etc.

Developments

a) Which developments should be included at in CIA?

    a. time
    b. scale
    c. fishing – is this part of baseline?
    d. shipping – is this part of baseline?
    e. every activity within geographic range
    f. other wind farm developments
    g. are existing sites part of the baseline?
    h. some effects may have kicked in a lot later on ie after 5 years
    i. expert opinion to define baseline (if different offshore wind farms and different expert opinions then they will not match up so no good!)
    j. zone by zone guidance on baseline

b) It doesn't matter which way do assessment as long as all do it the same way across all sites.
c) Subtle changes over time by constructed wind farms will not be picked up ie in 10 years time how can you prove it is the wind farm that is having the effect?
d) Chair: New baseline after wind farm is considered OK because the project has been granted permission. If this is acceptable then why is it not OK to consider constructed projects as part of the baseline?
e) If the baseline is realigned each time then you would never see effect of wind farms so should there be a benchmark/threshold for each species? Have to have a harvest rate ie it is going to happen over time not a one-off big kill session. Use biogeographic population and give % eg. 10 % is the threshold.
f) In summary:
    a. Step by step approach has no use
    b. Establish what favourable conservation status is for each species that is not in SPA for each zone
    c. Establish level harvesting
    d. Understand legal position but also understand other effects
    e. Make progress to defining FCS
    f. Recognise deficiencies – text to be circulated by SK

Collision Risk

a) Q. If it is known what species and what sites are being considered is it simple to add up all the sites? Answer - No
b) need PCM
c) error and uncertainty is increased
d) there is a general overestimation of collision risks
e) For an estimation it is ok to add them all but if a precautionary approach is taken then this is precaution at each level.
f) Q. Is cumulative impact a sum or not a sum?
    i. Yes unless proven otherwise.
g) It was suggested that until there is guidance on how we calculate collision rates then we can't discuss.
h) In Scotland use one model so SNH can re-do the calculation.
i) In England it is done in a different way.
j) It is actually usually a variation of the same method
k) Onshore – VP survey so can see all of site.
l) Offshore – moving platform through site so a moving density
m) **Action:** Guidance to be prepared on CRA like what is already present in Scotland prepared by SNH.
n) The aim is to get everyone doing this in a consistent way. Possibly produce a spreadsheet where you just fill in numbers and at end get comparable results.

o) Guidance is also required on the input ie the calculation of flight activity – density of passage rate. Different rates for different birds, not all birds assessed at same rate.
p) Importance of PCM to inform CIA – targeted monitoring.

13. Useful summary of issues

a) Group will produce list of species and key vulnerabilities with potential for cumulative impacts and an indicator of the geographic scale at which they should be considered. Circulation of text on FCS of species not in SPA.
b) Other developments – operational definition required but needs to be expanded upon but cant be decided yet. Zone by zone guidance to be looked at.
c) Screening of species with potential for cumulative impacts
d) No firm conclusions were made on area to consider
e) Population baseline on which to measure change – no firm conclusion (define baseline zone by zone?
f) Data sharing – may consider standardised format of summary data from EIA as per SNH
g) Guidance needed on CRM eg summarise info on avoidance rates and how to calculate occupation so get consistent output. A note on avoidance rates would be very useful and table of all those known already – circulate for discussion.
h) Plea for data for monitoring, need to show how it is needed for CIA. Collision risk for consented wind farms and not just a re-assessment of the baseline.
i) Round 2 monitoring on FEPA licence states collision risk needs to be looked at, a great change from Round 1.
j) Favourable conservation status needs to be defined and levels of harvesting which can be tolerated plus thresholds for change (this is extra to project)

Appendix 2

Position Paper 1 (Original) – CIA and the Regulatory Context

Andrew Prior, PMSS

COWRIE cumulative impacts workshop

Cumulative impact assessment and the regulatory context

1. Introduction

This paper has been commissioned by COWRIE to consider some of the key regulatory issues associated with the assessment of potential cumulative / in-combination effects on bird populations arising from offshore wind farm development within United Kingdom waters. The paper draws on the author's experience of the consenting process associated with Round 2 wind farms and on the views expressed by some of those involved closely with that process.

It should be noted that while consultation has taken place in respect of this paper, and its contents have been guided by a steering group, the views expressed herein are solely those of the author. Statements within this document should not be attributed to any particular organisation, including for the avoidance of doubt, either COWRIE or the Crown Estate. The contents of this document are intended to form a basis for discussion by a small group of experts at a workshop on October 2nd and should be read in that context.

A second paper, on technical approaches to cumulative impact assessment, has also being commissioned from the British Trust for Ornithology (BTO).

1.1. General approach adopted in this paper

The steering group has concluded that, rather than attempting to prescribe a methodology, there is benefit to be gained by adopting a process-led approach to delivering ornithological cumulative / in-combination impact assessment. A variety of challenges suggest that the benefits of prescribing a technical methodology are likely to be limited. These challenges include:

- Lack of understanding of key variables (avoidance rates, population size, population viability)
- Variation of likely approach between species and sites
- Possibility that the scientific community will focus on gaps in knowledge resulting in calls for further research and stalling the application of any methodology
- Risk of pre-empting the Appropriate Assessment process

The emphasis of this paper on a process-led approach does not seek to undermine the importance of robust and sound science in informing decision making. However those consulted have generally expressed a preference to separate consideration of the regulatory process (the subject of this paper) from the scientific processes informing that process (the subject of the BTO paper).

1.2. Role of Strategic Environmental Assessment

It is thought that earlier calls for potential cumulative impact to be rigorously assessed at the strategic level, for example through Strategic Environmental Assessment (SEA) are unlikely to be satisfied in the United Kingdom in the near future.

The Steering Group, the author of this paper, and many of those consulted during drafting, believe that the strategic level may be the most appropriate to consider cumulative impacts (of all types, not just those involving birds). However given the likelihood that developers of Round 3 and other offshore developments will have to deliver their own cumulative impact assessments it has been agreed that the approach for this second workshop should be firmly rooted at the project level.

However, it should be noted that the zone based approach adopted by the Crown Estate for Round 3 deployment may be better suited to delivering effective cumulative impact assessment than the site based approach of previous rounds. This is because there will be more scope for a single developer (or partnership of developers) to procure, control and analyse the information required to carry out these assessments over a wider area than has occurred during Round 2, where developments controlled by different developers are in close geographical proximity.

1.3. Focus of paper on the project level

The focus of this paper is therefore on cumulative / in-combination impact assessment (referred to as "CIA" hereafter) in relation to Environmental Impact Assessment and, in particular, the collection and provision of information necessary to inform the Competent Authority during the Appropriate Assessment process.

2. Outline of paper and summary of key issues

The steering group believes that there are three areas of the regulatory process associated with the assessment of potential cumulative / in-combination effects on birds which could usefully be improved. These are

- Scoping – the need for early data acquisition and the provision of a 'key features' paper are discussed
- Pre- and post- application communication – ways to improve the approach of both developers and statutory consultees are proposed
- Policy and guidance, - the need for clarity particularly in respect of conflicts between the Habitats Directive and the Renewable Energy Directive and the application of the precautionary principle is outlined

Throughout these three areas one can encounter two main themes, communication and certainty of process.

Many of these issues relate to improving communication flows between various parties and building consensus on key issues. In the context of this requirement for improved communication this paper introduces the concept of a "key features" document, drawn up at the scoping stage of the environmental impact assessment process and subject to regular review throughout the consenting timetable. A sample draft "key features" document is provided at Appendix 1.

In respect of certainty of process, while it may not be possible to obtain agreement on detailed methodologies, it is hoped that the high-level approval of a common process (irrespective of potential outcomes) would assist greatly with CIA. The importance of clearly formed policies and guidance containing sufficient detail to provide certainty is central to this approach and is discussed further below. In particular the author believes that consideration of the Precautionary Principle in context of CIA for renewable energy projects would be timely. The understanding of the Precautionary Principle in the context of biodiversity protection and renewable energy appears to lag behind that of other sectors, for example in respect of pharmaceuticals, pesticides or genetically modified crops.

3. **Key issues**

The steering group has identified a number of areas in the current UK offshore wind farm cumulative / in-combination assessment process where practice and procedures could be improved. It is important to stress at this point that this is not a criticism of organisations or individuals involved in this process. As with other issues associated with offshore wind, developers, regulators, statutory advisors and stakeholders have all had to deal with adapting to a new industry with the potential to give rise to novel impacts and new challenges. It is also important to note that the legislative framework associated with consenting offshore wind farms is extremely challenging, particularly when decision makers are attempting to balance environmental gains (reducing greenhouse gas emissions) and the delivery of legally binding renewable energy targets against potential impacts on species and habitats protected under European law.

3.1. Scoping

Although many offshore wind farm project developers have sought scoping information the provision of comprehensive information to inform cumulative impact assessment at an early stage in the process has not been commonplace. While of course many factors will only emerge during the EIA process it should be possible to identify and focus on a number of key issues at an earlier stage in the EIA timeline, rather than concentrating on cumulative impact towards the end of the process. Such issues could include

- Agreement on key species likely to be at risk
- Identification of key sites (SPAs) which may be affected
- Definition of relevant population
- Agreement and guidance on key methodologies used to assess impacts
- Guidance on data collection and analysis, particularly in respect of treatment of risk and the precautionary principle (see below).

To assist with a standardised approach to scoping (which would provide consistency across and between projects) parameters for early discussion could be easily defined. It is suggested that a “key features” document could accompany a scoping request and form the basis for subsequent discussions. A sample “key features” document is attached at Appendix 1 for consideration and amendment by the workshop participants.

Such an approach may give rise to the following issues:

- Requirement for early data acquisition and provision of detailed information to inform scoping request

  Generally scoping requests have only included limited ornithological information. Developers may need to consider providing more detailed information or even

commissioning small scale surveys or risk assessments to inform scoping. This would entail additional front end costs (but may deliver a premium in terms of reducing time to consent). Early consultation with key stakeholders (most notably the RSPB) could also assist in this process.

- Fuller engagement in the scoping process

  The delivery of more detailed information by developers at the scoping stage would give rise to an expectation of full engagement from the regulators (currently BERR and MFA) and statutory advisors (Natural England, Countryside Council for Wales, JNCC). Although informal scoping does take place, the focus is currently on the statutory process by which BERR collate scoping responses from various consultees. Historically such responses in respect of bird issues have been relatively concise statements on key features and policies. The provision of detailed information could facilitate more useful scoping responses, capable of resolving problematic issues, such as CIA, more easily.

- Resourcing

  An increased focus on early and fully informed scoping is likely to require additional resources. Developers may need to acquire additional data ahead of their main EIA programme, ecology and other specialist consultancy input may be required to produce outputs similar to the "key features" document and the emphasis on more detailed scoping responses will inevitably lead to an increased level of casework within public sector bodies. In particular significant resources may be needed to propose, validate and agree the application of innovative approaches early in the process rather than relying on standard methodologies and template documents.

  While it is acknowledged that environmental impact assessment is firmly the responsibility of the developer, technical expert feedback from statutory bodies on cumulative impact has in many cases not been easy to access, even though many of the ornithology experts in the country reside within those organisations.

3.2. Communication

Generally it is felt that open communication between regulators, statutory advisors, stakeholders, developers and consultants about cumulative impact assessment could be improved. Round 2 has seen only limited information flowing between developers and statutory bodies during the early stages of the consenting process and the history of collaborative working between developers (essential for assessing cumulative impacts) is limited. It is not the purpose of this paper to discuss the reasons for this situation however it is notable that, generally speaking, the failure of **all** parties to fully address cumulative impacts at an early stage in the process has tended to result in entrenched positions with the potential for conflict rather than promoting a collaborative approach. Generally speaking cumulative impacts have tended to be addressed towards the end of the consenting process once data collection has occurred, rather than in a strategic manner at the start of the process.

It should be noted that often the industry has not assisted in the process, with reluctance among some developers to share data capable of assisting in the assessment of cumulative impacts across strategic areas. There is little evidence to suggest that sharing bird data is likely to prejudice a development and, indeed, in cases where collaborative approaches to

cumulative impact have taken place (for example in respect of marine mammal projects in the Thames strategic area or as part of the BERR aerial survey programme) consenting times have generally been decreased. It would be prudent for the industry as a whole to secure more collaboration between developers (perhaps by means of a requirement within Crown leases to share data) in respect of cumulative impacts.

A number of parties, including a key NGO and a statutory advisor, have highlighted an example of good communication which could be utilised as a case study for future work. The London Array project was one of the first Round 2 wind farms to be consented and the regulatory process assessing potential cumulative impacts there and in the wider Thames strategic area (in this case on Red-Throated Diver) was generally perceived to have been robust with all the main parties on the London Array project engaging each other in a positive and effective manner.

Key features of the approach adopted in respect of the London Array project include:

- Regular and frequent meetings with all parties
- Transparent and open exchange of information
- Proactive and positive approach of statutory advisor (Natural England) and key stakeholder (RSPB) to wind development at the site
- Willingness of developer to resolve potential conflict through binding agreements with key stakeholders
- Adoption of adaptive management process to allow consenting of the scheme with sufficient safeguards to address concerns about uncertainty

In addition to the emphasis on early and informed scoping discussed above the "key features" document (at Appendix 1) builds upon the London Array case study by adopting an iterative process providing a schedule for regular and frequent meetings to provide updates on data acquisition and analysis and discussion of significant challenges.

4. Need for policy and guidance to provide context and certainty

Developers and consultants have to some extent been working in an uncertain regulatory environment where the approach to cumulative impact assessment has tended to be *ad hoc* and on a case-by-case basis. Clear guidance on EIA from the agencies (which the author understands is currently being commissioned by BERR and MFA) would assist in providing greater certainty as to the approach taken by the agencies when balancing the environmental impacts of offshore wind (including cumulative impacts) against the climate change and biodiversity benefits of renewable energy.

A number of those consulted informally as part of the process of writing this paper felt that internally within the statutory nature conservation agencies (and particularly within Natural England) there was a lack of understanding at the junior level of the policy drivers promoting both emissions reductions and the deployment of renewables. Failure on the part of Natural England to commit to a renewables target[1] (in contrast, for example to the RSPB's clear signal made in "80% Challenge: Delivering a low-carbon UK"[2]) has further strengthened this perception, leading some to allege (perhaps unfairly in the author's view) that there is an "anti-wind" sentiment behind some of the advice received in respect of cumulative impacts. Clear and

[1] For example at the recent Natural England policy workshop in Reading on July 29th, 2008
[2] http://www.ippr.org/publicationsandreports/publication.asp?id=573

unambiguous policy statements from key players in the CIA process would assist by delivering much needed certainty.

In particular there is an urgent need to place the precautionary principle into a firmer context. It is clear from both guidance and case-law that the philosophy behind the precautionary approach is not one of risk elimination but rather one of risk minimisation taking into account both the likelihood and magnitude of potential risks. In the context of cumulative impact assessment this is particularly relevant because a series of extremely conservative scenarios (for example in respect of collision risks with consecutive wind farms along a flyway) can rapidly act as multipliers of risk, giving rise to an extremely negative assessment.

The author of this paper suggests that in at least one case the precautionary principle has been interpreted as requiring a zero risk approach to consenting, something which is probably not tenable.

It is thought that agreed guidance on the application of the precautionary principle would be of benefit to all parties involved in the EIA and CIA process and it is recommended that as a first step the proposed environmental impact assessment guidance referred to above considers the recent IUCN guidelines[3] on applying the precautionary principle to biodiversity conservation which recommend, *inter alia*, that:

- All relevant stakeholders are included in a transparent process of assessment, decision-making and implementation
- That in adopting the precautionary principle measures are adopted which are proportionate to the potential threat
- That social and economic benefits be considered when applying the precautionary principle
- That adaptive management approaches, including monitoring and evaluation, be adopted when a high level of certainty is not available.

It is also important to note that Central Government, mandated as it is to decide between competing interests of biodiversity protection and renewable energy targets, cannot deliver those targets by seeking to "consent by consensus". BERR and MFA may need to acknowledge that in order to meet challenging renewable energy targets it will not always be possible to consent projects without incurring some significant risk of challenge. The author of this paper observes that the regulator's appetite for risk in respect of consenting is as equally conservative in respect of the management of objections as that of some stakeholder groups in respect of potential impacts on environmental receptors. It is hoped that recent judicial review decisions (for example in respect of Teesside) will provide government with some comfort that reasonable decisions which seek to balance conflicting demands are a normal part of government and should not be avoided where sound science supports that decision.

5. Summary and next steps

This paper proposes three areas of focus to improve cumulative impact assessment for birds in respect of offshore wind farm development. These areas are scoping, communication and guidance/policy.

[3] www.pprinciple.net

It is intended that this paper forms a basis for discussion at the workshop scheduled for October 2nd. In particular comments from those reviewing this paper are sought in respect of the following:

- Is the emphasis on scoping and communication in this paper appropriate? Are problems with cumulative impact more institutional (e.g. differing interests of developers, advisers, regulators and NGOs) and therefore beyond the scope of this workshop ?

- This paper identifies a number of challenges associated with an "early scoping" approach including, most notably, resourcing. Are there additional challenges not noted here?

- Is the "key features" document a useful approach? Does it require more or less detail? Is it overly onerous at such an early stage in a project life? Are there key features missing from the document?

- Is the focus of the second section of the paper on improving communication overly simplistic? Is it possible to import best practice in respect of consultation to all projects, regardless of the personalities involved?

- Is it possible to provide greater certainty through policy and guidance documents? Has the precautionary principle been mis-applied in respect of Round 2 CIA development? Will guidance on the precautionary principle assist with CIA for future projects?

The use of a facilitated session at the workshop is intended to seek a constructive approach to future regulatory solutions to the problems arising from cumulative impact assessment and it is hoped that this paper can assist in that process

6. Acknowledgements

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Appendix 1

Proposed "key features" template to inform ornithological scoping request

COWRIE

PMSS

Key ornithological issues associated with proposed wind farm development at [ ]

Table 1

Species summary

Bird species known to frequent area of development	Information sources used[1]	Vulnerability to wind farm development ? – high, medium, low, unknown			Feature of SPA with potential for interaction with site? (if yes then see table 2 below)	Migratory species? (if yes then see table 3 below)	Potential for cumulative impact? (if yes then see table 4 below)
		Displacement[2]	Collision	Barrier effect			

[1] E.g. Seabirds at Sea database, SEA data, preliminary surveys commissioned by developer, NBN gateway etc
[2] Including direct habitat loss

Table 2

Special Protection Area – summary of potential affected sites

Species[3]	Site name(s)	Site number(s)	Qualifying feature?[4]	Population of SPA[5]	Additional notes[6]

[3] From table 1 above
[4] Some species fall within definition of aggregations rather than being listed by species
[5] From SPA data form unless more recent data available
[6] Please note here, if relevant, any relationship between the sites – e.g. shared population, key ecological linkage etc – or other relevant information

Table 3

Species not associated with Special Protection Areas

Species[7]	Use of area[8]	Relevant population[9]	Potential for SPA designation?	Additional notes

[7] From table 1 above
[8] e.g. passage bird/migrant passing through area, over-wintering aggregation etc
[9] For purposes of environmental impact assessment – provide further details if necessary to justify selection of this quantum, minimum and maximum size should be stated

Table 4

Projects and activities to be considered as part of cumulative impact assessment

Project / activity	Cumulative factor in respect of? (y/n)			For which species?	Potential cumulative / in-combination impact on SPA? If so please identify site
	Displacement[10]	Collision	Barrier effect		
Wind farm projects					
Aggregates projects					
Oil and gas activities					
Other regulated activities					

Please list below other relevant projects / activities not included above, e.g. those at an early design stage:

[10] Including direct habitat loss

Table 5

Proposed survey and analysis methodologies

Bird species[11]	Survey technique[12]	Frequency and duration of surveys	Proposed review dates / milestones[13]	Summary of proposed methodology to assess potential impact			Validation / discussion with regulator and / or statutory advisor required?
				Displacement[14]	Collision	Barrier effect	

[11] As identified in table 1
[12] e.g. boat based survey, aerial with observer, aerial with high definition camera, radar, thermal imaging, shore based observation, tagging
[13] E.g six monthly
[14] Including direct habitat loss

Table 6

Record of scoping response, communication and review

Date	Action[15]	Comments / observations						
		Developer	Consultant	BERR	MFA	Natural England / CCW / JNCC	RPSB	Other stakeholder
	Preliminary scoping meeting							
	Issue of scoping request							
	Scoping meeting							
	Issue of scoping opinion							
	First review meeting							
	Second review meeting							
	Third review meeting							

Proposed date for review of this document:

[insert date, suggest 3-6 months from first review, align with survey milestones, see table 5 above]

[15] Suggested only, actions will be site and project dependent

Appendix 3

Key Features Document
Andrew Prior, PMSS

Cumulative ornithological impacts – background information to support scoping request

Key ornithological issues associated with proposed wind farm development at [ ]

Table 1

Species summary

Bird species known to frequent area of development	Vulnerability to wind farm development? (high, medium, low, unknown)				Feature of SPA with potential for interaction with site? (if yes then see table 2 below)	Use of site (breeding, wintering, passage, combination)	Potential for cumulative impact? (if yes then see table 4 below)	Information sources used (see notes)[1]
	Displacement [2]	Collision	Barrier effect	Indirect effects e.g. prey species				

Notes: This table is intended to outline core information about bird sensitivities to inform early stakeholder liaison and support a formal scoping request.

[1] Information source column to include details of evidence base for information set out in previous column including vulnerability, SPA designation, cumulative impact etc. Sources may include Seabirds at Sea database, SEA data, preliminary surveys, historical EIA data, NBN gateway, etc

[2] "Displacement" includes direct habitat loss

Table 2

Special Protection Area – summary of potential affected sites

Species[3]	Site name(s)	Site number(s)	Minimum distance of development from site	Qualifying feature?[4]	Population of SPA[5] and status (current, at designation or from SPA review)	Sensitivity[6]	Additional notes[7]

Notes:

This table is intended to provide further details of SPA features identified in table 1 as being likely to be affected by offshore wind farm development

[3] From table 1 above
[4] Some species fall within definition of aggregations rather than being listed by species
[5] From SPA data form unless more recent data available
[6] From 2nd column of table 1
[7] Please note here, if relevant, any relationship between the sites – e.g. shared population, key ecological linkage etc – or other relevant information

Table 3

Species not associated with Special Protection Areas

Species[8]	Use of area[9]	Distance from site	Relevant population[10]	Is species part of another designated feature or class? (SSSI, Ramsar, BAP etc) If so state which.	Potential for SPA designation?	Sensitivity	Additional notes

Notes:
This table is intended to summarise information relating to bird species using the development site but not linked to an SPA

[8] From Table 1 above
[9] From Table 1
[10] For purposes of environmental impact assessment – provide further details/evidence to justify selection of this quantum, minimum and maximum size should be stated

Table 4

Projects and activities to be considered as part of cumulative impact assessment

Project / activity	Cumulative factor in respect of? (y/n)[11]				For which species?	Potential cumulative / in-combination impact on SPA? If so please identify site
	Displacement	Collision	Barrier effect	Indirect effects e.g. prey species		
Wind farm projects						
Aggregates projects						
Oil and gas activities						
Other regulated activities						

Notes:
This table is intended to record other activities and projects along with which the development under EIA will be considered. The guidance note which accompanies this document provides more details on which projects should be considered within the scope of a CIA.

[11] Insert information from table 1

Table 5

Summary of potential cumulative impacts of wind farm projects on a species by species basis

	Sensitive receptors identified at table 4?	**Sensitive receptors identified at table 4 in respect of other wind farms in planning or construction?**		
Sensitive receptors	**Proposed wind farm**	**Wind farm 1**	**Wind farm 2**	**Wind farm 3**
Species 1				
Species 2				
Species 3				
Species 4				
Species 5				

Notes:
This table is intended to summarise sensitive receptors (identified in table 4) on a species-by-species basis (rather than according to project). The wind farms included within this table will be those whose effects will not yet be visible in the baseline i.e. those in planning, consented or under construction. The box is ticked if the species is present as sensitive receptor. Species sensitive at more than one site are then easily identified as being potentially cumulatively impacted.

Table 6

Proposed survey and analysis methodologies

Bird species[12]	Survey or analysis technique[13]	Frequency and duration of surveys[14]	Proposed review dates/ milestones	Summary of proposed methodology to assess potential impact				Validation/ discussion with regulator and /or statutory advisor required?
				Displacement	Collision	Barrier effect	Indirect effects e.g. prey species	

Notes:
This table is intended to record details of the survey and analysis techniques intended to be used to address EIA and CIA issues

[12] As identified in table 1
[13] e.g. boat based survey, aerial with observer, aerial with high definition camera, radar, thermal imaging, shore based observation, tagging
[14] e.g monthly

Table 7

Record of scoping response, communication and review

Date	Action[15]	Comments / observations						
		Developer	Consultant	BERR	MFA	Natural England / CCW / JNCC / SNH	RSPB	Other stakeholder
	Preliminary scoping meeting							
	Issue of scoping request							
	Scoping meeting							
	Issue of scoping opinion							
	First review meeting							
	Second review meeting							
	Third review meeting							
Proposed date for review of this document: *[insert date, suggest 3-6 months from first review, align with survey milestones, see table 6 above]*								

Notes:
This table is intended to reflect the intention that CIA scoping is likely to be an ongoing iterative process and that challenges are most likely to be most successfully overcome if addressed early in the consenting process

[15] Project specific

Appendix 4

Position Paper 2 (Original) – Developing Guidelines for Ornithological CIA: Methods and Techniques

Ilya Maclean and Mark Rehfisch, BTO

BTO Research Report No. 513

Developing Guidelines for Ornithological Cumulative Impact Assessment: Draft Discussion Document

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EXECUTIVE SUMMARY

- Industrial nations agreed in the 1997 Kyoto Protocol to reduce their greenhouse gas emissions by an average of 5% (compared to 1990) by 2012. In response to this agreement, the Crown Estate launched its "Round 3" leasing programme for the delivery of up to 25 GW (gigawatts) of new offshore windfarm sites by 2020. This programme is expected to greatly increase the number of UK offshore windfarms projects.

- Cumulative Impact Assessments (CIAs) are an important component of the Environmental Statements (ESs) prepared by developers to assess the likely effect of these wind farms on the environment. However, there is considerable inconsistency in the manner in which such assessments have been conducted. The aim of this report is to provide a review of the current methodologies for birds used in CIA and draft guidelines based on best practice. To seek consensus for the guidelines and to ensure a high-level of quality assurance, the recommendations will be reviewed by an expert group comprising scientists and ornithologists, regulatory and statutory bodies, developers and consultants. Final guidance and recommendations will be incorporated into a COWRIE report following the workshop on 2nd October.

- Windfarms may impact birds in a number of different ways, including collision with wind turbines, displacement due to disturbance and habitat loss and barrier effects. Collision at windfarms with rotors, towers, nacelles and associated structures such as guy cables, power lines and meteorological masts can cause mortality or sub-lethal injury. Birds may be displaced from windfarms and surrounding areas due to direct loss of habitat (though this is usually minimal) or visual intrusion and disturbance, which effectively amounts to habitat loss. Barrier effects occur because birds are often forced to fly around wind farms and thus expend more energy. The significance of these impacts is generally assessed using a matrix approach in which the magnitude of effects is cross-tabulated with the sensitivity of species to these impacts. Cumulative effects derive from the additional impact of an individual development to the impacts of other developments.

- Environmental Impact Assessments (EIAs) generally have five stages: (1) screening / scoping, (2) data gathering, (3) analysis, (4) test of significance and (5) reporting. It has been proposed that Cumulative Impact Assessment (CIA) be integrated with all of these processes. In general however, it is more usual to give CIA post-hoc treatment in the reporting phase, although in some instances some analyses are undertaken. We present six case studies, which illustrate the ways in which cumulative impact have been assessed to date. The approaches used differ considerably.

- We identify three aspects to CIA for which guidelines are needed:

  Firstly, what plans, projects and developments should be incorporated into the cumulative impact assessment process? This aspect is covered in more detail in the second position paper provided for this workshop.

  Secondly, over what time-scale should impacts be considered?

  Thirdly, over what area should impacts be considered?

We also identify the need for specific guidelines for data gathering, analysis and data reporting. By considering and discussing the regulatory and ecological implications of various approaches and assumptions, we provide appropriate guidelines.

- With regards to data gathering, we suggest that most requirements for CIA are the same as for EIA, but that additional data should be collected if (a) a specific project, plan or development has inadequate data associated with it to inform the CIA process and is likely to significantly add to the overall cumulative effects, (b) disturbance or barrier-effects are likely to be significant or (c) cumulative effects on designated features of protected areas are likely to be significant and cannot be assessed due to lack of knowledge about use of a wider area.

- With regards to which effects should be considered, we recommend that all sources of potential impact from developments, not just those from other windfarms should be considered. However, broader factors associated with environmental change such as fishing pressure and climate change should generally not be considered.

- With regards to time-scale we recommend that all ongoing and proposed projects should be considered, the exception being the consideration of impacts on designated features of proposed protected areas prior to the assessment of the conservation value of that area. Mortality should be presented as a rate per unit time rather than an overall number over a defined time-period.

- With regards to the area over which cumulative impacts should be assessed, we propose that areas be defined on a site-by-site basis following the same principals as are used to designate SPAs. Where an assessment of the boundaries of the CIA area cannot be made, we propose that the Round 2 Strategic Windfarm Areas or Round 3 Development Zones be used.

- We recommend that for collision and displacement, the significance of cumulative impacts is assessed by summing the impacts from each component development. Disturbance and barrier-effects impacts accrue sigmoidally. We propose that cumulative impacts of disturbance and barrier-effects are first considered in a qualitative manner making best-use of available information. If the cumulative impacts of disturbance and barrier effects are thought to be significant, then a more detailed quantitative study should be carried-out. We recommend that the significance of cumulative impacts be made using the same matrix approach that is routinely used for EIA.

- In order to facilitate the calculation of cumulative impacts, there is a need to ensure that the outputs of EIA are compatible. There is an urgent need for guidelines that specify more precisely, the outputs of EIA. More rigorous guidelines for CIAs could then be formulated.

1. INTRODUCTION

1.1. Background information

Within the framework of the United Nations Climate Convention, industrial nations agreed in the 1997 Kyoto Protocol to reduce their greenhouse gas emissions by an average of 5% (compared to 1990) by 2012. In response to this agreement, the UK government has committed to obtaining 10% of the UK's electricity from renewable sources by 2010 and to meet the EU target of 20% of energy from renewables by 2020. In June 2008, the Crown Estate launched its "Round 3" leasing programme for the delivery of up to 25 GW (gigawatts) of new offshore windfarm sites by 2020. This programme is expected to greatly increase the number of UK offshore windfarms projects.

Although windfarms could be viewed as beneficial to wildlife because they contribute to reducing climate change, they are also of potential detriment as they may displace wildlife from favoured areas or directly cause mortality to wildlife through collisions. The taxonomic group most likely to be affected in this way is birds (Exo *et al.* 2003; Garthe and Hüppop 2004; JNCC 2004; Desholm and Kahlert 2005) as aggregations of large numbers of seabirds may be found in UK offshore waters throughout the year (Skov *et al.* 1995; JNCC 2004). In the UK, all wild birds have a level of protection under the 1981 Wildlife and Countryside Act. Additionally, European inshore coastal and offshore marine waters support globally significant numbers of seabirds (Carter *et al.* 1993; Skov *et al.* 1995) and European Union Member States are obliged to protect populations of these species, under the EU Directive on the Conservation of Wild Birds (79/409/EEC, the Birds Directive) and the Ramsar Convention on Wetlands (Ramsar Convention Bureau 1988). These international agreements, together with the United Nations Law of the Seas (United Nations 1982) and the EU Directive on the Assessment of the Effects of Certain Plans and Programmes on the Environment (2001/42/EC, the SEA Directive) requires that States accept responsibility for assessing the effects of major offshore development on the environment.

Cumulative Impact Assessments (CIAs) are an important component of the Environmental Statements (ESs) prepared by developers to assess the likely effect of any major plan or project on the environment. However there remains uncertainty as to the way these should be implemented. In May 2007, COWRIE held a workshop on the cumulative impacts of offshore windfarms on birds to gauge opinion and provide recommendations for improving the delivery of CIA. The results of this workshop were published in November 2007 (Norman *et al.* 2007). This document, reflecting the consensus of the workshop, provides a very useful platform for consideration of CIA guidelines. However, in general, the document highlights the further actions required before specific guidelines can be provided. A clear series of simple-to-use and specific recommendations and guidelines, which could be used when undertaking CIA or when preparing the ESs, are now required.

1.2. Aims of this report

Building on the platform provided by Norman *et al.* (2007), the aim of this report is to provide methodological guidelines in relation to CIA for offshore windfarms. This is to be achieved through (a) a review of existing methods, with commentary on the implications of different approaches and examples of good practice flagged-up, (b) detailed discussion of the assumptions and complexities associated with CIA in both a legislative and ecological context and (c) the provision of set of specific guidelines relating to how to carry out CIA, justified by discussion in previous sections of the report.

To gain widespread recognition for these guidelines and to ensure a high-level of quality assurance, the recommendations will be reviewed by an expert group comprising scientists and ornithologists, regulatory and statutory bodies, developers and consultants. Final guidance and recommendations will be summarised in a COWRIE report following the one-day workshop on 2nd October 2008.

To distil the information presented in this report and thus expedite its interpretation, salient points from each section are presented in blue-coloured boxes at the end of relevant sections.

2. ASSESSING ORNITHOLOGICAL IMPACTS

2.1. Collision with wind turbines

As birds pass through an area during migration or during the course of their daily activities, direct mortality or lethal injury of birds can result from collisions with rotors (Drewitt and Langston 2006). Additionally, mortality or injury can result from collision with towers, nacelles and associated structures such as guy cables, power lines and meteorological masts. There is also evidence of birds being forced into the sea as a result of being drawn into the vortex created by moving rotors (Winkelman 1992b).

The majority of studies of collisions caused by offshore wind turbines have recorded relatively low levels of mortality (e.g. Winkelman 1992a, 1992b, Painter *et al.* 1999, Erickson *et al.* 2001). This is perhaps largely a reflection of the fact that many of the studied windfarms are located away from large concentrations of birds. It is also important to note that many (onshore) records are based only on finding corpses, with no correction for corpses that are overlooked or removed by scavengers (Langston and Pullan 2003). Nevertheless, most Environmental Impact Assessments (EIAs) assume that a very high proportion of birds passing through a windfarm site avoid mortality and injury.

In general quantifying collision risk involves incorporating a high degree of uncertainty. Collision risk depends on a range of factors related to bird species, numbers and behaviour, weather conditions and topography and the nature of the windfarm itself, including the use of lighting (Brown *et al.* 1992; Drewitt and Langston 2006). Many recent assessments have employed a collision risk model (e.g. Band *et al.* 2005) to predict the rate of bird collisions following the construction of a windfarm. Such models are potentially useful but, in order to be effective, require sufficient data on bird movements (numbers, intensity, flight height and angle of approach) under various environmental and temporal conditions to parameterise them. Unfortunately, very few studies of existing developments allow the calculation of reliable avoidance rates and, at present, these only exist for a limited range of species under a restricted range of circumstances. This has led to some EIAs utilizing available estimates of collision risk, even though they may have been derived for different species in different habitats, and without the necessary testing of their relevance (Drewitt and Langston 2006). Moreover, given that the model is very sensitive to the avoidance rate used, even a very small variation in the estimated rate of avoidance can lead to very large variations in estimates of mortality (Chamberlain *et al.* 2006).

The net result of the limitations inherent in collision-risk assessment is that there is a very high degree of uncertainty. Typically this uncertainty is incorporated by using a precautionary approach. Assessment of cumulative impacts, irrespective of the precise approach used, entails some form of assessment of impacts from various developments. Since the accuracy of such assessment will always be constrained by the accuracy of assessing the impacts of individual developments, cumulative assessment of collision-risk will inevitably be fraught with similarly high degrees of uncertainty, compounding precautionary assumptions made for each individual wind farm.

2.2. Displacement due to disturbance and habitat loss

Birds may be displaced from windfarms and surrounding areas due to the direct loss of habitat (though this is usually minimal) or due to visual intrusion and disturbance, which can amount effectively to habitat loss. Displacement often occurs during both the construction and

operational phases of windfarms. The scale and degree of disturbance will vary according to site- and species-specific factors and is usually assessed on a site-by-site basis (Drewitt and Langston 2006). Studies at Horns Rev found that divers, Gannets, Common Scoters and auks occurred in lower numbers than expected in the windfarm area up to 4 km from the windfarm itself (Petersen *et al.* 2004). However, there are several studies that have examined displacement from windfarm areas, and these studies show that the scale of disturbance caused by windfarms varies greatly. This variation is likely to depend on a wide range of factors including seasonal and diurnal patterns of use by birds, location with respect to important habitats, availability of alternative habitats and perhaps also turbine and windfarm specifications (Drewitt and Langston 2006).

Few studies of displacement due to disturbance are conclusive, primarily because ESs must be prepared prior to construction and thus direct assessment of displacement effects is not possible. Assessment of disturbance effects generally entails assuming that all birds are displaced within the immediate vicinity of turbines, that some of the birds (usually 50%) are displaced within a buffer zone surrounding this footprint area, but that the influence of the windfarm does not extent beyond the boundaries of this buffer zone. The size of this buffer zone varies, but is intended to be indicative of the distance over which windfarms cause displacement. Typically buffer zones extend for 1 km from the perimeter of the footprint area. It is also worth noting that few impact assessments assume that birds become habituated to disturbance, thus taking a precautionary approach (npower 2002, 2005; PMSS 2005; RPS 2005; RES 2007).

The construction of turbines and associated infrastructure also causes direct habitat loss. The scale of this direct habitat loss depends on the size of the windfarm project but, generally speaking, is likely to be small relative to the area from which birds are displaced. Typically, actual habitat loss amounts to less than 5% of the total development area (Drewitt and Langston 2006; Fox *et al.* 2006), though effects could be more widespread where developments interfere with geomorphological processes resulting in changes including increased erosion (Drewitt and Langston 2006). Although each turbine is likely to result in minimal direct habitat loss, the scale of offshore developments, especially in the context of relatively limited areas of shallow sandbanks supporting large aggregations of feeding seabirds, is such that their cumulative effects may be significant.

2.3. Barrier effects

Windfarms may also impose an effect on birds by altering their migration flyways or local flight paths to avoid them. This effect is of concern because of the possibility of increased energy expenditure when birds have to fly further and potential disruption of linkages between distant feeding, roosting, moulting and breeding areas otherwise unaffected by the windfarm (Drewitt and Langston 2006). As with other impacts, these barrier effects are dependent on a whole range of factors including the species, the type of bird movement, flight height, the layout of turbines and wind force and direction.

Studies of bird movements in response to offshore developments have recorded wildfowl taking avoiding action between 100 and 3000 m from turbines (Winkelman 1992c, Christensen *et al.* 2004, Kahlert *et al.* 2004b) and that such avoidance occurs even at night (Winkelman 1992a, Dirksen *et al.* 1998, 2000). However, depending on the distance between turbines some birds will fly between turbine rows, for example in the case of Common Eider at Nysted in Denmark, where the turbines are 480 m apart (Christensen *et al.* 2004, Kahlert *et al.* 2004a).

Bird movements around a windfarm are generally assessed using radar but, due to cost and limited range, the number of offshore sites where this technology has been deployed is limited. However, irrespective of costs, barrier effects can only assessed directly after a windfarm has been built and thus only quantitative measures using radar can feed into EIAs and ESs. Nevertheless, a review of the literature suggests that none of the barrier effects identified so far have significant impacts on populations (Drewitt and Langston 2006). However, several windfarms could act cumulatively to create an extensive barrier, which could lead to diversions of many tens of kilometres, thereby incurring increased energy costs.

2.4. Assessing the significance of impacts

Although approaches vary, typically assessment of the likely significance of the impact on each species is assessed using a cross-tabulation of two criteria: the magnitude of the expected effect and the sensitivity of the species in question (following Percival *et al.* 1999). The sensitivity of species has been assessed in different ways and in some instances is impact specific (e.g. different sensitivities are assumed for collision and displacement). One common way, in which the sensitivity of species is assessed, is to consider their conservation importance (e.g. Percival 2001; SNH 2005). For example, cited species interest features of Special Protection Areas (SPAs), Special Areas of Conservation (SACs) and Sites of Special Scientific Interest (SSSIs) are considered very-highly sensitive, other species that contribute to the integrity of an SPA or SSSI or which occur in numbers in excess of 1% of the national population are considered highly sensitive. Those occurring in regionally important numbers or which are of conservation concern (e.g. listed on Annex 1 of the EU Birds, Schedule 1, UKBAP) are considered of medium sensitivity and all others are considered of low sensitivity i.e. not sensitive to any effects. Other assessments of sensitivity also take into account the ecology of the species. For example, long-lived species with low productivity and slow maturation rates are considered more sensitive than shorter-lived species (Drewitt and Langston 2006). Other methods consider other species' attributes, such as flight characteristics and sensitivity towards disturbance, which have been combined into a single sensitivity index by Garthe and Hüppop 2004).

The magnitude of the expected effect is determined through the EIA. Total loss or expected declines in excess of 80% are typically considered very high. Major declines in the order of 20-80% are considered high, declines in the order of 5-20% medium, 1-5% low and less than 1% negligible. The cross-tabulation process varies across studies, but typically is as shown in Table 2.4.1.

Table 2.4.1 Matrix of magnitude of effect and sensitivity used to test the significance of effects. The significance category of each combination is shown in each cell (see Percival *et al.* 1999).

Magnitude of impact	**Sensitivity**			
	Very High	**High**	**Medium**	**Low**
Very High	Very High	Very High	High	Medium
High	Very High	Very High	Medium	Low
Medium	Very High	High	Low	Very low
Low	Medium	Low	Very low	Very low
Negligible	Low	Very low	Very low	Very low

However, particularly in the assessment of impacts on populations of European importance, the threshold for significance is less formulaic. This is because Appropriate Assessment requires consideration of whether there is an impact on the "integrity" of the population that forms the interest feature of the European site that may be affected (IEEM 2006). In practice, determining what constitutes an impact on "integrity" is rather subjective and a default threshold of 1% change is often used in the first instance.

3. A REVIEW OF EXISTING METHODS FOR CUMULATIVE IMPACT ASSESSMENT

3.1. General methodology

EIAs generally have five stages: (1) screening / scoping, (2) data gathering, (3) analysis, (4) test of significance and (5) reporting. It has been proposed that CIA be integrated with all of these processes (Norman *et al.* 2007). In general however, it is more usual to give cumulative assessment post-hoc treatment in the reporting phase, although in some instances some analyses are undertaken. It is sometimes considered in the scoping phase, but only in the most general terms and the need for CIA only rarely results in additional data collection. In this section, the nature of the way in which cumulative impact assessment has been carried-out to date is described. We also describe the range of ways in which CIA has been undertaken by referring to specific examples, in which different approaches were used.

3.1.1. Screening and scoping

Typically, scoping tends to focus on project specific matters and although CIA is usually recognised as a requirement, it is usually dealt with in general terms (Norman *et al.* 2007). However, the process of scoping provides an opportunity to identify, at an early stage, the nature of potential cumulative impacts, leading to clearer identification of information requirements. This stage is discussed in more detail in the accompanying paper by Andrew Prior.

3.1.2. Data gathering

In most instances, little, if any additional data gathering occurs specifically for CIAs, although on the whole, data, particularly from aerial surveys, are collected over an area that extends well beyond the windfarm footprint and buffer areas for other reasons (e.g. Cranswick *et al.* 2007). The availability of data from entire regions make it possible to gain insight into effects on populations that forage over large areas (e.g. Common Scoter and divers) and to assess the likely impacts of other developments occurring within the same region. Likewise, the use of radio-tracking to assess the relative importance for foraging of areas occupied by windfarms (e.g. Perrow *et al.* 2006) could be used to determine the range over which specific features of SPAs forage and thus, the likelihood of them being affected by any offshore development identified as contributing cumulative effects.

3.1.3. Data analyses

A wide variety of approaches has been used to assess cumulative impacts. Some ESs do not give any quantitative details of cumulative effects, relying instead on qualitative interpretation, whereas others provide quantitative assessment. In some instances, all other relevant developments are considered (PMSS 2005; RPS 2005), but in other instances (RPS 2007), only the cumulative effects of other windfarms are considered. Issues of scale and the area over which cumulative assessments are carried out differ. Some consider cumulative effects of developments occurring within Round 2 strategic areas (PMSS 2005), whereas others examine cumulative impacts within functional ecological units such Liverpool Bay (Npower 2002). In some instances there are limitations that constrain the effectiveness of the

CIA process and the highly varied approaches mean that objective comparisons of cumulative impacts across developments are difficult to make.

3.1.4. Test of significance

There are a number of different ways in which cumulative impacts have been assessed to determine their significance. Most follow the basic approach adopted when conducting EIA, whereby likely significant impacts on different species are determined by considering both the magnitude of the impact and sensitivity of the species. Indeed, for the most part, the significance of cumulative impacts has been considered in a manner similar to the significance of environmental impacts generally.

Despite these generalities, the concept of "significance" has been interpreted in remarkably diverse ways. In some instances, such as with cumulative impacts reported in the Environmental Statement in relation to the London Array windfarm, cumulative impacts were considered to be insignificant because the additional effects of the *other* windfarms were low in comparison to that of the London Array (although subsequent assessments examined cumulative impacts by summing effects). In other instances, for example when considering cumulative impacts in relation to the Greater Gabbard, cumulative impacts were considered to be unimportant because the impact of the windfarm *itself* was low in comparison to that of other impacts. This somewhat paradoxical approach of considering the additional impact of the windfarm with a lesser effect, will inevitably lead to a biased interpretation in which cumulative impacts are considered of low importance. A third approach, which has been used and is not subject to such bias, has been to identify all developments contributing cumulative impacts and simply to sum their effect.

3.1.5. Reporting

The environmental statement is the main method of reporting on outcomes of impact assessments, including CIAs. In some instances, discussion papers on cumulative impacts over a broader area have also been produced (PMSS 2004). Most studies only consider cumulative impacts during the operational stage, or at least do not specifically differentiate between construction cumulative impacts and those occurring at other times. However, the limited plant available to build offshore windfarms, means that projects are likely to be built sequentially and not overlap temporally. Nonetheless, there is scope for concurrent construction in terms of piling to install turbine bases at one site whilst nacelles and blades are installed at another. Moreover, there is a need to consider the construction and operational phases separately as the cumulative impacts of two windfarms during the operational phase may not be the same as for one windfarm during the construction phase combined with another during the operational phase.

3.2. Specific examples

3.2.1. London Array

The CIA approach used for the proposed London Array (RPS 2004) was to discuss with English Nature (now Natural England) and identify five key categories of existing or planned activity within the Thames estuary area that could potentially contribute significantly to impacts on birds in combination with the construction and / or operation of the London Array Windfarm. These categories were:

(1) Other windfarms
(2) Marine aggregates extraction

(3) Capital dredging
(4) Shipping
(5) Submarine cable installation.

The potential cumulative impacts were assessed for the one species (Red-throated Diver), which was expected to experience a greater than negligible adverse effect due to the presence of the London Array. In so doing, there is an inherent assumption that negligible effects cannot accumulate to become non-negligible. For most of the categories, the assessment was qualitative, being quantitative only when the cumulative impacts of other windfarms were considered. The quantitative method used was as the "interaction with proportional distribution method", in which the distribution (and/or relative abundance) of species is mapped and the proportion of the population encompassed by the windfarm footprint and buffer area is assessed.

Issues	Method adopted
Developments considered:	Proposed windfarm and other developments.
Area considered:	Thames estuary.
Key cumulative impacts investigated:	Red-throated Diver displacement.
Key techniques employed:	Quantitative: interaction with proportional distribution.
Assessment of significance	Other developments relative to London Array in ES; summing in subsequent assessments.

3.2.2. Greater Gabbard

The CIA approach for the proposed Greater Gabbard windfarm mainly considered those cumulative impacts arising through the construction of additional windfarms rather than other categories of activity (PMSS 2005). However, the Environmental Statement does note other developments, i.e. shipping (e.g. port expansions at Harwich Haven and London Gateway), marine aggregate extraction and capital dredging. Cumulative impacts were discussed both when the significance of the likely impacts from the proposed Greater Gabbard Offshore Windfarm alone was at least moderate and when there is was realistic possibility of cumulative impacts being capable of raising the assessed level of significance. No quantitative assessments of cumulative impacts were made, except in so far as noting that since effects of indirect loss of habitat through disturbance / disruption of flight-lines and collision risk were considered of Very Low to Low significance and as such, the additional impacts of the Greater Gabbard were likely to be low in comparison to that of the London Array. This was largely because the information necessary for quantitative CIA was lacking.

Issues	Method adopted
Developments considered:	Proposed and existing windfarms.
Area considered:	Thames strategic area aerial survey blocks.
Key cumulative impacts investigated:	Displacement & collision of all species; emphasis on those occurring in nationally important numbers.
Key techniques employed:	Qualitative.
Assessment of significance	Greater Gabbard relative to other developments.

3.2.3. Anonymous site (Commercially Sensitive – ES in preparation)

The CIA approach for this site was to consider those cumulative impacts arising through the construction of additional windfarms rather than other categories of activity. In many respects, it is one of the most robust and rigorous assessment of cumulative impacts of the examples given here. All windfarms within the strategic area within the planning process as well as those that have been consented were considered in the assessment of cumulative impacts. Cumulative impacts were considered both during the construction and operational phases. In so doing, a realistic assumption was made that on the whole, simultaneous construction of windfarms is unlikely due to limited plant, but a worst case-scenario of increased boat traffic during construction of three sites simultaneously as sufficient plant exists to install turbine bases at one site while simultaneously installing nacelles and blades at others.

Using the matrix approach typical of Ornithological Impact Assessments (Percival 2001; SNH 2005), a matrix of impacts was constructed for all possible impacts and potentially sensitive species. Any species identified as sensitive in any of the Environmental Statements for each development was selected for inclusion and impacts were assessed in an additive manner where possible. Since cumulative impacts can occur only if a sensitive species occurs at more than one site, those species which occurred only at one site were excluded. Cumulative disturbance impacts were assessed by combining the sensitivity of the species with the magnitude of the effect derived from a scale provided in Garthe and Hüppop (2004). This was used to produce a significance of impact, to which a score was assigned for each site separately, the final score being the sum of all sites. Cumulative displacement impacts during operation were assessed by determining the abundance of birds within each windfarm and buffer zone based on populations calculated using aerial survey data. These populations were combined for all sites and compared to the overall maximum population within aerial survey region (Cranswick *et al.* 2007). Impact significance was assigned according to the proportion of birds potentially displaced.

In a manner similar to the interaction with the proportional distribution method, regional aerial survey data were used to map the relative abundance of species and an assessment of the extent to which the species showed preferential use of each windfarm area and all windfarm areas combined was made using Jacob's Selectivity Index (Jacobs 1974). Predicted cumulative collision mortality for each species at each site where this was available was combined by summing to give an overall annual mortality rate. The significance of both the additive mortality (proportion of birds colliding compared to the total population) and the percentage increase above background mortality was assessed using the same method as for the EIA.

Issues	Method adopted
Developments considered:	Proposed and existing windfarms.
Area considered:	Round 2 strategic area.
Key cumulative impacts investigated:	Displacement, collision & disturbance of any species considered as potentially sensitive at any site provided it occurred at more than one site.
Key techniques employed:	Quantitative: Disturbance - Garthe and Hüppop scores, Displacement - Jacobs Selectivity Index, Collision – sum of annual rates.
Assessment of significance	The site relative to other developments.

3.2.4. North Hoyle

The CIA approach for the proposed North Hoyle windfarm was to consider existing developments around the coast and waters of Liverpool Bay as part of the existing environment, even if they do not affect bird populations, and to suggest that they form the existing environment against which any predicted change should be measured. It was thus considered impossible to assess cumulative effects against the bird populations that might exist in the absence of all these activities and possible only to assign a level of risk to the Liverpool Bay seabird populations from one or any combination of the proposed projects.

One of the arguments for the above, was that for SPAs the "favourable status" that should be maintained relates to the habitats that support the population level for which a SPA is classified and not that which supports a hypothetical population that could exist in the absence of existing activities. This is indeed true if the developments have been ongoing since prior to SPA designation, or as is the case for Liverpool Bay, the area is a potential, rather than existing SPA. However, there are other regulations that specify the need for CIA. Although these other regulations do not specifically state that ongoing developments should be considered as contributing impacts, rather than being part of the baseline, there is an inherent assumption that they should be considered. For example, the guidelines for managing Natura 2000 make specific reference to the need to take account of progressive loss of site integrity. The use of the term "progressive" logically implies that the impacts of each proposed development should be considered in relation to previous developments as, in this context, it is clearly taken to refer to changes occurring through time. Moreover, the concerns associated with developments that underpin the regulatory needs for cumulative impact assessment is that the impacts of any given development in its own right may not be significant, but in combination with others, both existing and proposed, the overall impacts are significant.

In relation to seabird populations, cumulative effects were thus considered in relation to proposed windfarms for development in Liverpool Bay, although it was highlighted that little useful baseline information existed from which the cumulative effects of other offshore activities could be assessed. Thus, to assess the risk of those potential impacts on bird populations, a semi-quantitative assessment was undertaken. Cumulative effects were assessed by summing the known or estimated proportion of populations occurring in European or nationally important numbers within the area over which there was considered to be a risk of impact. Regarding both cumulative collision risk and cumulative habitat loss, it was argued that, since the observed bird movement through the North Hoyle site was so small and there was little habitat or feeding potential for important seabird populations in the site or in the area surrounding it, it could be concluded that the proposed North Hoyle Offshore Windfarm would not of itself contribute to the risk of cumulative impact. It should be noted, that using this line of argument, cumulative impacts would only be perceived as of risk, if the environmental impacts of a particular project were perceived as of risk. This approach does not guard against the possibility that cumulative effects, while not being significant in their own right, may act in combination to result in a significant effect.

To assess the cumulative impacts of disturbance, the proportion of seabird populations at risk due to North Hoyle and nearby Rhyl Flats, was summed and then assessed against sensitivity in the same way as for the EIA to determine the overall significance of the impact. The cumulative effects due to other windfarms were assessed in a qualitative way due to lack of data. Analyses focused on populations of European and national importance.

Issues	Method adopted
Developments considered:	Proposed windfarms.
Area considered:	Liverpool Bay.
Key cumulative impacts investigated:	Displacement of populations occurring in European or nationally important numbers within areas considered at risk of impact.
Key techniques employed:	Semi-quantitative by summing populations where possible
Assessment of significance	North Hoyle relative to other developments

3.2.5. Gunfleet Sands II (GS2)

The CIA approach for the proposed Gunfleet Sands II windfarm was to consider cumulative impacts arising from other offshore wind developments in the Thames Estuary only. However, other developments were not included. Cumulative impacts associated with habitat loss were not quantified but were argued to be negligible on the basis that the area of seabed directly affected by windfarm construction and operation would be very small. Cumulative impacts arising due to displacement effects were assessed, giving consideration to the extent to which construction of different windfarms would occur concurrently. On the basis that cumulative effects had been assessed for the London Array and were found to be negligible and because of the relatively small magnitude of the predicted displacement effect arising from Gunfleet Sands, cumulative impacts arising from displacement effects were considered to have no effect on any species. It is worth noting that the CIA for London Array recorded that there was no significant cumulative effect because the impact of Gunfleet Sands (and Kentish Flats) was low in relation to the London Array, but did not consider the impacts arising by summing impacts from each development and in particular, did not consider the contributing component of the London Array itself in the CIA process. For this reason, the CIA that is presented in the ES for Gunfleet Sands II (based only on the impact of Gunfleet Sands and the CIA for London Array) does not actually consider cumulative impacts arising due to the London Array. Moreover, it is difficult to see how a conclusion of "no effect" can be derived by considering component impacts, which all have an effect, albeit negligible or relatively low. It should be noted however, that a subsequent assessment of cumulative impacts within the Thames Estuary area was made.

Similarly, cumulative impacts arising as a result of collision and barrier effects were considered to have no impact because no significant impact from any of the component windfarms feeding into the CIA were significant. Again, it is difficult to see how a conclusion of "no effect" can be derived by considering component impacts, which all have an effect. Importantly also, the fact that no attempt was made to sum the effects in a quantitative manner and as such, a significant effect would only result if one of the component developments had a significant effect, rather undermines the reason for carrying-out a CIA in the first place.

Issues	Method adopted
Developments considered:	Windfarms only
Area considered:	Thames estuary
Key cumulative impacts investigated:	All cumulative impacts considered to be negligible
Key techniques employed:	qualitative
Assessment of significance	Gunfleet Sands II relative to London Array

3.2.6. Lincs

The CIA approach for the proposed Lincs offshore windfarm was to consider cumulative impacts arising from other offshore wind developments only. Consented Round 1 sites as well as proposed Round 2 sites for which data existed were incorporated into the assessment. The broad approach was to assume that any identified impacts could potentially occur on a cumulative level and as such, the standard matrix analyses used for the EIA was performed for the CIA incorporating other windfarm developments in an additive manner wherever this was possible. Those sites for which no data existed were excluded from the assessment, thus making the assumption that they have no effect.

The analysis was not limited to species identified as sensitive at Lincs, but also included an analysis of how Lincs might impact cumulatively on species identified as sensitive at other sites. Where species were listed in ESs as groups, e.g. 'geese', and 'divers', these were assumed to be Pink-footed Geese and Red-throated Divers, which were the most sensitive species at Lincs, in order that the worst-case scenario could be assessed.

The general aim of the analyses was to produce a measure of the cumulative impacts of four Greater Wash windfarm developments, consented or in planning, on the regional populations of potentially sensitive species in the context of the national and international importance of the regional populations of these species. The sensitivity of each species was thus classified in the same manner as in the analysis of impacts of the Lincs development alone. Where sensitivity was determined on the basis of the numbers present (as a result of 1 per cent of the national population) in the EIA process, this sensitivity was also applied during the CIA process as numbers at all sites would inevitably be in excess of the 1% threshold. However, when numbers did not exceed 1% thresholds at any given site, no quantitative assessment was made of whether 1% thresholds were exceeded when numbers from all sites were added, although this issue was partially addressed qualitatively.

Cumulative impacts during construction and decommissioning were assumed to be negligible, if negligible at all sites, thus assuming that negligible impacts do not accrue to become non-negligible. This is partially justified as being necessary due to data constraints. During the operational phase, numbers from the aerial surveys from each of the sites were added to assess impacts.

Issues	Method adopted
Developments considered:	Other windfarms
Area considered:	Round 2 strategic area.
Key cumulative impacts investigated:	All species identified as sensitive at Lincs or any of the other sites
Key techniques employed:	Aerial surveys data used to calculate peaks for the area
Assessment of significance	Summing

3.2.6. Other Assessments

In additional to CIAs carried out for ESs, there have been a number of broader and/or more detailed assessments that have been undertaken for key species, as additional information is often requested by statutory agencies or to inform the Appropriate Assessment. Several of these assessments are briefly described here.

Individual-based models

This technique was applied to assess Common Scoter mortality in Liverpool Bay. Liverpool Bay is by far the most important site in the UK for Common Scoter, regularly hosting in excess of 60,000 birds (Austin *et al.* 2008). To assess the cumulative impacts of displacement from potential feeding habitats through the avoidance of windfarms in Liverpool Bay, COWRIE commissioned a study that used field observations and surveys combined with an individuals-based modelling approach (Kaiser *et al.* 2002). Model simulations were run to predict the cumulative impacts of various existing and consenting wind farms.

The computer code developed for this model is generic and could be applied to a very wide range of consumer-resource systems including assessments of disturbance and barrier effects. The model is based on fundamental ecological principles such as fitness maximisation by individual animals that will apply under any change to environmental circumstances. However, in order to tailor the model to specific circumstances, it is necessary to collect detailed information so that accurate values can be ascribed to the model parameters. The model did not produce an absolutely perfect fit to the distribution of common scoter across the bay, suggesting that some of its predictions may be unreliable. However, overall, there was good quantitative agreement between model outputs and a variety of independent empirical data. It was found that the presence of a windfarm on Shell Flat which, in combination with the others, leads to significantly increased common scoter mortality.

Radio-tracking

This technique was applied to Little Terns of the east Norfolk coast. Scroby Sands offshore windfarm encroaches to within 2 km of the most important breeding site for Little Terns in the UK: the Great Yarmouth North Denes Special Protection Area (SPA). In order to assess the relative importance of the area occupied by this windfarm ratio-telemetry was used (Perrow *et al.* 2006). The same principal could be applied to determine the relative importance of more than one area (although at present, there are technical limits to what distance terns can be tracked over). Many seabirds travel widely to exploit variably distributed prey resources, utilizing even profitable patches only briefly as prey become available. Assessing the relative importance of areas occupied by windfarms relies on sufficient survey effort to increase the probability of detection and later assessment to an acceptable level. Conventional techniques suffer from high sampling costs and infrequent sampling of patches within larger areas, but remote techniques, which continuously sample habitat, may offer a solution.

Although there were technical difficulties associated with tagging and subsequently following this small seabird, resulting in limited data collection, comparative data from 2 years (2003 and 2004), revealed striking differences in activity and foraging patterns, which changed the perception of the scope of the birds. Actively breeding birds occupied a much smaller range than failed breeders, suggesting that the impact of windfarms may differ substantially in years with good food availability than in years with poor food availability. The potential value of radio (and satellite) telemetry in illustrating habitat use within a wide area, is that it provides a more detailed means of risk mapping – i.e. identification of whether windfarm areas are located in important foraging areas. It could also be used set precautionary distance limits for wind farms from important breeding sites.

Mapping species abundance

Mapping the abundance of species over a wider area is a highly informative way of assessing the proportion of the population with which developments are likely to interact and thus can be used to assess the significance of cumulative impacts. They could also be used to identify

high-risk areas, thus informing various windfarm options. At its simplest, this method entails plotting mean or peak numbers (as recorded by boat or aerial survey) within 2 km x 2km grid cells (e.g. PMSS 2005). Other more sophisticated techniques have been developed for doing this, which involve spatial kriging algorithms and/or the incorporation of habitat variables (e.g. RPS 2004; Newson & Noble 2003). In many instances the production of such maps forms part of the baseline assessment and it is thus a straightforward task to apply these maps in a CIA context. One method, which offers considerable scope would be to use dynamic oceanographic variables (i.e. ones which vary through time) to map species abundances. The use of such variables is essential if windfarm induced changes to bird populations are to be detected with high certainty (Maclean *et al.* 2006; 2007). However in the context of impact assessment it would be highly advantageous in identifying where concentrations of seabirds may occur at times other than the snap-shot period in which surveys are carried-out.

Population Viability Analyses

Population viability analysis (PVA) is a species-specific process used to identifying the process that determines the probability that a population will go extinct within a given number of years (Shaffer, 1983; 1987; Boyce 1992) and is thus used to identify the most important threats facing a particular species population. It differs from conventional population modelling in that it takes into account stochastic events, i.e. random changes in demographic rates such as survival or productivity. As such, it is the variability in demographic parameters that is as important as mean values and the greater the variability, the more prone a population is to extinction all other things being equal. PVAs are often used to reveal the sensitivity of populations to particular demographic parameters so that the most important impacts on extinction probabilities can be determined. Extrinsic forces, such as habitat loss, over-harvesting, and competition or predation by introduced species, often lead to population decline. Although the traditional methods of wildlife ecology can reveal such deterministic trends, random fluctuations that increase as populations become smaller can lead to extinction even of populations that have, on average, positive population growth when below carrying capacity and mechanisms that incorporate intrinsic factors are needed if extinction risks are to be determined (Lacy 1993).

PVAs can be used to address several questions, and often the nature of these questions changes during the course of a PVA analysis as the process is refined. Typically, initial questions are very general, such as "Is this species threatened, and if so, why?" PVAs often then concentrate on the identification of factors (including natural factors and human impacts) that are important in dynamics of the specific populations and meta-populations under study, as well as conservation and management options. The methods to be used for this depend on the specific case at hand. They might include statistical analysis of historical data, comparison of populations that are declining with those that are stable, and correlating recent changes in the environment (climatic or habitat changes, introduced species, changing harvest patterns, etc.) with changes in the species. In the context of cumulative impact assessment, the broad question is “do several offshore windfarms acting in combination have a deleterious effect on bird populations?” Specific questions are likely to be “what is the maximum level of windfarm-induced mortality that can be absorbed by bird populations of species X, so that the overall population does not decline by an amount greater than Y within Z years” or “given that windfarms cause X number of bird species Y to die, by how much will the population decline within Z number of years?”

However, there are some limitations with regards to what population viability analysis can achieve. Mortality resulting from windfarms may reduce competition for resources, thus reducing the rate of natural mortality. The extent of the latter cannot be determined solely through conventional population viability analysis, but also requires detailed understanding of the extent to which demographic parameters are density-dependent. Reasonable data on

density-dependence are only available for three species: cormorant, shag and kittiwake (Maclean *et al.* 2007).

Tool	Use	Limitations
Individual-based modelling	To provide actual estimates of mortality resulting from displacement. Could also be used to obtain mortality estimates from disturbance and barrier-effects.	Difficult to parameterise models. Requires intensive data collection
Radio-tracking	To provide a detailed assessment of habitat-use in areas in which windfarms are located	Technological constraints on how big an area can be covered and on how much data can be collected. Labour intensive.
Distribution mapping	To assess proportion of population with which developments interact; identify high-risk areas (i.e. those with high bird densities)	Best method of mapping likely to be species and location dependent.
Population Viability Analysis	To assess effects of windfarm-induced mortality on population size and likelihood of persistence	Limited data availability and very costly to collect more data. Requires measures of density-dependent demographic parameters, which is currently only available for three species.

4. CUMULATIVE IMPACT ASSESSMENT

4.1. The need for Cumulative Impact Assessment

4.1.1. Regulatory needs

Windfarm projects are proposed for various consents through a variety of regimes. However, the lead consent is likely to be Section 36 of the Electricity Act, the EIA of which is carried out under the Electricity Works (Environmental Impact Assessment) (England and Wales) Regulation 2000. Schedule 3 to these Regulations requires that in addition to the individual potential environmental effects of a proposed development, the potential for cumulative effects should be considered and, where appropriate, assessed. In Scotland, Schedule 4 of the EIA(S) Regulations 1999 specifies matters to be included in an Environmental Statement, and includes under item 4 " a description of the likely significant effects of the development on the environment, which should cover the direct effects and any indirect, secondary, cumulative, short, medium and long-term, permanent and temporary, positive and negative effects of the development….". Additionally, the EC Habitats Directive 92/43/EEC, in Article 6(3), states "any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or *in combination* with other projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives". Similarly, the EU guidance document for managing Natura 2000 sites indicates that "..it is important that some account is still taken of such plans and projects in the assessment, if they have continuing effects on the site and point to a pattern of progressive loss of site integrity". For most purposes, cumulative, progressive and in combination effects are considered to be the same.

4.1.2. Definitions of Cumulative Impact Assessment

There are numerous definitions of cumulative effects and cumulative EIA and agreeing a definition of cumulative impact has proved contentious (Norman *et al.* 2007). In a COWRIE workshop designed to address issues associated with cumulative impact assessment, it was recognised that there are two classes of factor to be addressed – timescale and source of impact – and that both these need to be explicitly reported upon (Norman *et al.* 2007). With regard to timescale there are four components – past (historic) impacts, current impacts, impacts not yet manifest but that will occur due to factors already operating and future predicted impacts. With regard to source of impact there are four components - the proposed windfarm, other windfarms, other projects that have been given consent or are reasonably foreseeable and activities such as fishing and boat traffic that are not consented on a project basis. We propose three additional that should be considered: (1) which species should be included in CIA, (2) how to ensure a compatibility of outputs from each EIA, so that CIA can be undertaken and (3) what area should be used to delineate the boundaries of the reference population and that in which assessments should be considered. The lack of formal definitions, particularly with regard to the intended reason for and desired output of conducting a CIA, has constrained the delivery and effectiveness of CIAs.

4.1.3. Selecting species for inclusion in CIA

At present there are no clear guidelines as to what features should be included in CIA. As a consequence, a variety of approaches have been used. One of the most common to only select those species for which a significant effect is expected in one or more of the contributing developments. However, this approach does not account for the possibility that several non-

significant impacts may accumulate to become significant. An alternative approach is to consider all species. This has its merits, but is likely to be highly time-consuming if done rigorously for all possible impacts and in many instances, even the cumulative impacts are likely to trivial. A reasonable compromise might be to introduce a screening procedure for identifying which species should be included in the cumulative impact assessment, including those that are non-significantly, but almost significantly impacted by individual developments, but excluding those for which the impacts of individual developments are truly trivial. Problems arise as it is difficult to provide guidance for this screening procedure, particularly as broad guidance may be inappropriate, and screening necessary on a windfarm by windfarm basis. This inevitably introduces a high-degree of subjectivity into the process and is likely to lead to approaches of varying rigour being used.

Species for inclusion	Issues
Option A: consider only those species for which there is a significant impact is expected in one or more of the contributing developments	Does not guard against non-significant impacts accumulating to become significant.
Option B: Consider all species	Potentially costly and time-consuming if done rigorously for all impacts
Option C: Implement a screening procedure to select species for inclusion in CIA	Subjective interpretation of screening procedure could result in approaches of varying rigour being used.

4.1.4. Ensuring compatibility of EIA outputs so that CIA can be conducted

One of the major stumbling blocks to carrying-out quantitative CIAs is that at present, different EIAs use different approaches and the outputs of each are not necessarily compatible or useful the sense that can be summed for example. The best and easiest way to address this issue would be to provide very explicit guidelines with respect to what outputs should be produced from EIAs and to make these a requirement of the EIA process. All that would be needed to perform CIA would be to obtain these outputs and combine them using simple algebra, such as summing. We urge strongly that such guidelines should be set in place in time for the Round 3 assessments. The alternatives would be (1) to make all data publicly available so that compatible outputs can be calculated from first principals or (2) to continue the status quo of qualitative assessments where quantitative CIAs cannot be carried-out. In many instances, particularly those in which assessments have been performed by different consultants or where wind farms are operated by different companies within a windfarm strategic area, the necessary data are likely to be commercially sensitive. The present method of performing qualitative assessments in many instances, is highly subjective and has led to assessments that differ substantially in quality and rigour.

Ensuring compatible outputs	Issues
Option A: ensure compatible outputs from individual EIAs by providing further EIA guidance	Production of such guidelines may not be ready in time for Round 3.
Option B: ensure greater data sharing so that compatible outputs can be calculated	Data may be commercially sensitive
Option C: maintain status quo and carry-out qualitative assessments where quantities assessments are not possible	Highly subjective and likely to lead to assessments that differ substantially in quality and rigour

4.1.5. Cumulative impacts and time-scale

None of the regulations that refer to the need for cumulative impact make specific reference to the time-scale over which cumulative impacts should be assessed, or which of past, present and proposed developments should be included. Thus, the time-frame over which cumulative impacts have been assessed has varied from windfarm to windfarm. Some, such as North Hoyle, have considered only proposed developments, arguing that others form part of the baseline environment. Most others consider all ongoing developments. We argue that it is more relevant to include all ongoing developments. Regulatory needs for CIA stem from concerns that as more developments occur, the environment is degraded through time in a manner that would go unnoticed if each development were considered in isolation. To illustrate the logical inconsistency of considering ongoing developments as part of the baseline environment, we consider what would happen if developments were proposed sequentially such that each were assessed prior to further developments being announced. Under such circumstances, cumulative impacts over and above the impacts of each development in isolation would always be zero and any cumulative effects arising from the combined effects of all developments would go undocumented even if 100% of the natural environment were destroyed.

There is some argument to be made that this may not be relevant with regards to designated features of SPAs being maintained in "favourable status", since the features that should be maintained relate to population levels for which an SPA is classified and not the hypothetical population that could exist in the absence of existing activities. We propose that the most consistent and logical way in which this should be interpreted should be to consider all ongoing activities if the site is already designated. However, where a site is a proposed SPA, the cumulative impacts of developments should be considered on species assigned as highly sensitive because they are candidate SPA designated features, if that development is expected to have resulted in increased impacts since the baseline survey for site designation. Nevertheless, the cumulative impacts of all ongoing developments should also be assessed on these species, but by assigning them to whichever sensitivity category they would be assigned to if they were not designated features of the proposed SPA. The overall significance of the impact should be assessed using both methods, and which ever is highest taken as the actual significance of the impact. However, in the context of Round 3 development zones, as few lie adjacent to current SPAs, there would rarely be a need to do both. The future designation of entirely marine SPAs may change this situation.

There is also an issue of time-scale with respect to mortality from collision, as the overall estimate of mortality will increase if longer assessment periods are used. This issue is not specific to CIA, and should ideally be addressed by adhering to EIA guidelines. However, since no such guidelines have been produced we recommend that collision mortality be reported as a rate, and the significance of this mortality be assessed by taking into account life-history characteristics of the species in question, such that longer-lived and slow-reproducing species such as Fulmar are considered more sensitive to any given mortality rate than shorter lived, faster breeding species such as Wigeon. The biological justification for this approach is that mortality from any source (including collision) will be at least partially compensated for by recruitment into the population. Particularly so if there is competition for resources and lower mortality of other individuals associated with the local population occurs due to the reduced competition for resources that would result from such mortality (Perrins *et al.*1993). However, there is generally a time-delay and it is widely recognised that long-lived species, which reproduce slowly, are far less able to compensate for such mortality, and the overall impact on populations of these species would thus be higher (Maclean *et al.* 2007).

Time-scale	Issues
Option A: consider all ongoing developments	Not method most frequently adopted/ may not be legally required.
Option B: Consider only proposed and consented developments:	Does not guard against baseline degradation (i.e. gradual degradation of environment through time)
Timescale and collision risk	**Issues**
Option A: Report collision mortality as rate:	Easier to assess against life-history parameters (e.g. longevity of species)
Option B: Report collision mortality as absolute amount over defined time-period	Gives overall mortality figure to compare to population thresholds but selection of time period arbitrary?

4.1.6 Cumulative impacts and source of impact

None of the regulations that refer to the need for cumulative impact make specific reference to what type of developments cumulative impacts should be assessed for. To date, several types of development have been considered. Some, such as the assessment of North Hoyle considered only those accruing from other windfarm projects. Others, such as that for the London Array and Greater Gabbard considered other types of development such as shipping and aggregates extraction. None to our knowledge consider cumulative effects of windfarms with climate change and fishing pressure, two of the major causes of seabird declines, (Frederiksen *et al.* 2004; Harris *et al.* 2005, Wanless 2005), although generally this is not required and, if part of the baseline then arguably not necessary.

The Electricity Works (Environmental Impact Assessment) (England and Wales) Regulation 2000 states that regulatory needs for CIA refer only to any application under Section 36 of the Electricity Act 1989 for consent to construct, extend or operate a generating station. While it is clear that CIA only needs to be carried-out only for such generating stations under these regulations, nowhere are "developments" (as referred to in the regulations in relation to CIA" clearly defined. However, with the exception the EU guidance document for managing Natura 2000 sites, all regulations refer either to "projects" or developments". The Natura 2000 guidance refers to both "plans" and projects".

We interpret the relevant regulations, statutory clauses and guidance documents as referring to all developments and projects, not just windfarm projects. However, we interpret that the term "project" or "development" does not refer to longer-term and wide-scale issues such as climate change and fishing pressure.

Source of impact	Issues
Option A: consider all projects / developments	Not method most frequently reported in Environmental Statements
Option B: Consider windfarms only	Existing regulations and guidelines seem to imply that this is required

4.1.7 Cumulative impacts and area / reference population

None of the regulations that refer to the need for cumulative impact make specific reference to the area in which cumulative impacts should be assessed, nor what constitutes the population against which impacts should be assessed. However, where the need for CIA stems from the EU Habitats Directive and Natura 2000 guidance, one can infer that the area is

that which is used by designated features of these sites and the reference population is that hosted by the site. As a result of lack of clear guidance, windfarm assessments have been quite varied in their approach. The most common is to consider only those additional developments and populations occurring within Round 2 strategic windfarm areas. Others, such as the assessment for North Hoyle consider a "discrete biogeographical area" such as Liverpool Bay the most appropriate in which to consider cumulative impacts.

In general terms, the larger the area that is considered, the more developments that are likely to be encompassed and thus the greater the cumulative impact. However, if the standard matrix approach is used (Table 2.4.1), then the reference population against which the magnitude of the effect is assessed also increases with area. Thus, although the use of a larger area will result in a higher cumulative impact, the impact per unit area being equal, the significance of the impact will be the same (provided the same sensitivity criteria are used). Problems associated with using a larger area, stem not from the magnitude of the cumulative impact itself, but from the availability of data and difficulties of assessment within this wider area. If a larger area is used, it may be more costly to carry out the assessment, but benefits are likely to arise because a more strategic approach is taken.

Much of the regulatory need for CIA stems from legislation and guidelines associated with the EU Habitats and Birds Directives and from Natura 2000 guidance and it may not be relevant to consider too large an area, because the protected features may utilise only part of it. However, in the context of Round 3, most of the proposed sites are far offshore and not adjacent to currently designated SPAs and determining use by SPA features may be problematic in any case.

Thus in summary, there is an absence of clear guidance as to what area should be used for CIA, and while the adoption of a large area may be strategically beneficial there would be practical constraints in so doing. For these reasons, we propose that the Round 2 Strategic Windfarm Areas (Thames, Greater Wash and North-west) or the strategic areas identified in Round 3, be used. However, where such areas demonstrably do not constitute a discrete functional unit, because regulatory needs for CIA stem in part from the EU Habitats and Birds Directives and due to ongoing efforts to designate marine SPAs, we propose that in some instances, the same principals as are used to designate SPAs in which functional units are defined, be used to identify appropriate areas for CIA. A detailed discussion of these principals is provided in Stroud *et al.* (2001), but in essence the process entails identifying an area that is distinct in habitat and/or ornithological importance from surrounding areas. In the context of marine environments this may be hard to assess, but bathymetry may offer a useful clue as it is of high importance in determining both habitat and species. Furthermore the mapping of species distributions as part of baseline assessments would allow discrete populations to be identified.

However, although terrestrial and coastal sites generally have obvious hydrological or physical boundaries, such boundaries are less obvious at sea. One method which offers considerable scope in the identification of such areas is to use Marine Classification Criterion based on relative species densities (Skov *et al.* 2006). Using real data collected from the North Sea and Baltic, they were able to demonstrate that the application criterion could be used to identify and delineate concentrations of seabirds. This method offers some scope for delineating the boundaries of concentrations of seabirds, but is likely to be costly to implement. We thus suggest that strategic wind farm areas are used as a default, but if demonstrably unsuitable, then identification of cumulative impact areas / reference populations should assessed on a case-by-case basis following SPA principals.

Area / reference population	Issues
Option A: define discrete functional unit using SPA principals	Ecologically sensible, but rather subjective
Option B: use Round 2/3 Strategic Areas	Easy to define, but may not be most appropriate ecologically

4.2. Cumulative impacts due to collision

Cumulative impacts due to collision arise primarily because of the development of more than one windfarm within an area. However, they could also arise if other types of development involve the erection of structures into which birds could fly, although in practise such developments are rare and estimates of collision difficult. The mathematically correct way in which to calculate cumulative impacts due to collision is as follows:

$$C_T = C_1 + C_2\left(\frac{P - C_1}{P}\right) + C_3\left(\frac{P - (C_1 + C_2)}{P}\right) ..... + C_n\left(\frac{P - \sum_{n-1}^{0} C_{n-1}}{P}\right)$$

where C_T is the total cumulative mortality due to collision, P is the population size of the bird in question, C_1, C_2 etc are the cumulative mortalities due to developments 1, 2 etc and n is the total number of developments. Technically, the cumulative effects arising from each development cannot simply be summed, as once removed from a population due to collision with one development, the bird cannot collide again. It should also be noted that the presence of one development could elicit a behavioural response from a bird that makes it more or less likely to collide with others. For example, a bird displaced or having deflected its flight from one windfarm, could be more likely to collide with other structures. Conversely, a near-miss from a turbine could make a bird more wary, thus making it less likely to collide with other structures. However, in practical terms, unless major behavioural responses occur or a high proportion of the population is removed through collisions, summing the effect from each development individually is likely to lead to an insignificantly small error in relation to other sources of error such unknown collision rates.

An alternative approach might be to generalise collision risks for key species likely to be susceptible to cumulative impact, based for example on: bird density, flight height and the number of turbines present within an area. This approach has advantages in that it would lead to rapid assessment, but would take no account of differing numbers of birds flying through different areas. A compromise, yet entirely reasonable approach might be to assume constant avoidance rates and flight heights throughout the area, although in practise the method of calculation in so doing differs very little from just summing the effects.

Cumulative collision impacts	Issues
Option A: account for behavioural changes that may arise through multiple developments	Ecologically valid, but highly complex and time-consuming and likely to result in only minimal improvements in accuracy
Option B: sum collision effects	Fairly rapid and straightforward to assess, provided collision rates are reported for each development
Option C: develop generic approach based on e.g. bird densities, flight characteristics, number of turbines	Very rapid and straightforward to assess, but does not take account of likely scenario of very different numbers of birds flying through different developments

4.3. Cumulative impacts due to displacement / habitat loss

The extent to which effects associated with habitat loss and/or displacement accumulate is complex. It depends largely on the extent to which the area around a windfarm development is at carrying capacity, i.e. to what extent numbers are limited by the availability of resources. If birds are displaced from a windfarm area then it is likely that they would settle at the highest quality area in the vicinity, quality being determined by the availability of resources and level of competition (Fretwell and Lucas 1970). If numbers are indeed limited by the availability of resources, then this displacement would result in increased competition and hence higher mortality in the remaining habitat (Burton *et al.* 2006). The cumulative impacts habitat loss / displacement would be calculated by summing the effects from each of the contributing developments. If numbers were not constrained by resource availability, then cumulative displacement effects would be negligible.

The extent to which areas around windfarms are at carrying capacity is likely to vary from location to location as well as through time. An assessment of the extent to which areas are at carrying-capacity is time-consuming and difficult, requiring survival estimates to be calculated before and after displacement (e.g. Burton *et al.* 2006) or the development of individual-based models (e.g. Kaiser *et al.* 2002). Nevertheless, there is ample evidence, from many locations and over long time-periods, that seabird numbers are hugely affected by food availability (Wooller *et al.* 1992; Frederiksen *et al.* 2004; Harris *et al.* 2005, Wanless 2005). This would suggest that many, if not most areas are at or close to carrying capacity and as such, cumulative impacts associated with habitat loss or displacement from developments can be calculated by summing the impacts of each of the contributing developments.

Cumulative displacement impacts	Issues
Option A: assume all areas are at carrying-capacity and calculate cumulative effects by summing components	Would lead to inflated estimates of mortality (thus precautionary, perhaps overly so), but simple and straightforward to calculate
Option B: assess extent to which areas are at carrying-capacity and estimate mortality accordingly	Highly complex and time consuming, but results in more realistic survival estimates

4.3. Cumulative impacts due to disturbance

The extent to which disturbance effects accumulate are likely to be non-linear for two reasons. Firstly because a single disturbance event can influence the behaviour of the bird subsequently and secondly because the relationship between energy expenditure and foregone energy intake and mortality risk is likely to be sigmoidal. After a bird has been disturbed it can become more panicky increasing the response to subsequent disturbances (Beale and Monaghan 2004). However, after repeated disturbances, birds can become accustom to the nature of the disturbance and thus become less likely to respond (Nisbet 2000).The relationship between energy expenditure (and forgone energy intake) and mortality-risk is sigmoidal as small amounts of energy-expenditure are likely to have a minimal impact (Figure 4.3.1). However, with increasing expenditure of energy or loss of time for feeding, a critical threshold may be crossed where a bird cannot meet its energy-requirements and mortality is likely to occur (Stevens and Krebs 1986). This threshold level will vary, being dependent on the condition of the bird, temperature food-availability and other factors.

An informative assessment of the cumulative impacts of disturbance may require detailed study of energy-budgets of birds within the area (which would in any case be required for an

informative assessment of disturbance effect in isolation). If the cumulative impacts of disturbance are likely to be significant, then we recommend that such an assessment should be made. However, if resources are unavailable for such an assessment, or disturbance impacts are minimal, we recommend subjective treatment of the issue. We do not provide strict instructions for how cumulative effects of disturbance should be calculated. However, we recommend that those undertaking assessments of disturbance impacts should be alert to the fact that cumulative effects are likely to be greater than the sum of individual effects.

Cumulative disturbance impacts	Issues
Option A: carry-out detailed energy-budget study	Time-consuming, but only way in which disturbance impacts can be calculated
Option B: assess disturbance subjectively / desk-based scoping	Realistic within prescribed time-frame, but cannot provide quantitative measure of impact
Option C: sum disturbance impacts	Not precautionary and unlikely to lead result in a realistic assessment, but doable within prescribed time-frame

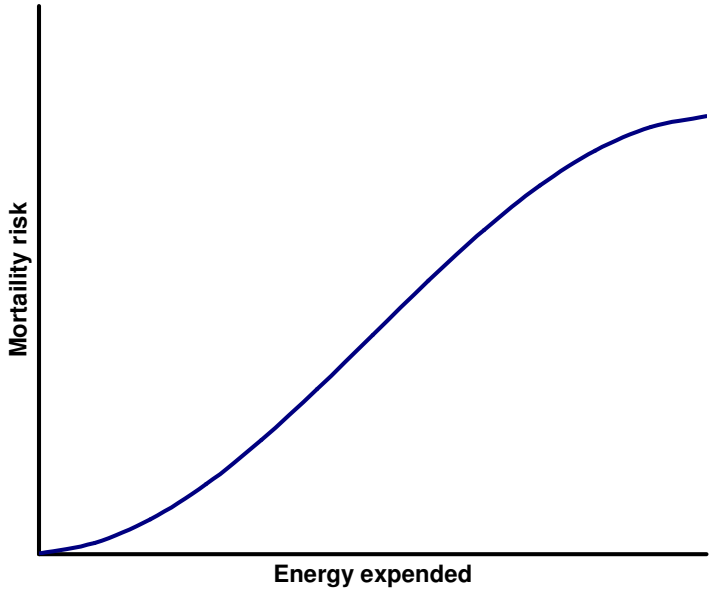

Figure 4.3.1 Theoretical relationship between energy-expenditure / foregone energy intake and mortality risk. Adapted from: Stevens and Krebs (1986).

4.5. Cumulative impacts due to barrier effects

The manner in which the impacts of barrier effects accumulate, will be dependent on the geometry of developments within an area and the way in which birds fly through / around the site. To illustrate this, consider two developments located adjacent to one another, with one due north of the other. If birds approach the northern development from the east or west, it is likely they would skirt around the northern edge of the development and the additional cumulative impact of the other development would be negligible. If birds approach the northern development from the north, then they would be forced to circumvent both developments. Since the relationship between energy expenditure / foregone energy-intake

and mortality risk is non-linear (see discussion in previous section), the cumulative impact of both developments will greater than the sum of each.

If cumulative barrier effects are likely to be significant, we recommend that a detailed assessment of flight-directions, energetics and the source and destination of birds be assessed, informed for example, through the use of radar. However, if the cumulative barrier effects are likely to be negligible, then we recommend that summing the individual impacts is a reasonable alternative. In some instances, the cumulative impacts will be less than summing the individual impacts, but in others it will be more than this. On average, summing impacts may thus not give an inaccurate result.

Cumulative barrier effects impacts	Issues
Option A: carry-out detailed energy-budget study	Time-consuming, but only way in which disturbance impacts can be calculated
Option B: assess disturbance subjectively / desk-based scoping	Realistic within prescribed time-frame, but cannot provide quantitative measure of impact
Option C: sum disturbance impacts	Not precautionary and unlikely to lead result in a realistic assessment, but do-able within prescribed time-frame

5. GUIDELINES AND RECOMMENDATIONS

5.1. Summary guidelines

Data gathering requirements	Issues
Option C: Use data already gathered for EIA. Collect additional data where existing data are inadequate for CIA	Additional data collection likely to be costly and time-consuming. Need for additional data likely to be subjectively interpreted.
Species for inclusion	**Issues**
Option C: Implement a screening procedure to select species for inclusion in CIA	Subjective interpretation of screening procedure could result in approaches of varying rigour being used.
Ensuring compatible outputs	**Issues**
Option A: ensure compatible outputs from individual EIAs by providing further EIA guidance	Production of such guidelines may not be ready in time for Round 3.
Timescale	**Issues**
Option A: consider all ongoing developments	Not method most frequently adopted and may not be legally required, but guards against baseline degradation.
Timescale and collision risk	**Issues**
Option A: Report collision mortality as rate	Easier to assess against life-history parameters (e.g. longevity of species), but does not give absolute mortality value for assessment against population thresholds
Source of impact	**Issues**
Option A: consider all projects / developments	Not method most frequently reported in Environmental Statements, but appears to be legal requirement
Area / reference population	**Issues**
Option B: use Round 2/3 Strategic Areas unless demonstrably not a discrete functional unit	Easy to define, but may not be most appropriate ecologically
Option B: define discrete functional unit using SPA principals where unit does not coincide with Strategic Areas	Ecologically sensible, but rather subjective
Cumulative collision impacts	**Issues**
Option B: sum collision effects	Fairly rapid and straightforward to assess, provided collision rates are reported for each development
Cumulative displacement impacts	**Issues**
Option A: assume all areas are at carrying-capacity and calculate cumulative effects by summing components	Would lead to inflated estimates of mortality (thus precautionary, perhaps overly so), but simple and straightforward to calculate

Cumulative disturbance impacts	Issues
Option A: carry-out detailed energy-budget study if cumulative impact of disturbance unlikely to be significant	Time-consuming, but only way in which disturbance impacts can be calculated. Requires method for determining whether impacts are likely to be significant
Option B: assess disturbance subjectively / desk-based scoping study if cumulative impact of disturbance unlikely to be significant	Realistic within prescribed time-frame, but cannot provide quantitative measure of impact. Requires method for determining whether impacts are likely to be significant
Cumulative barrier effects impacts	**Issues**
Option A: carry-out detailed energy-budget study if cumulative impact of barriers unlikely to be significant	Time-consuming, but only way in which barrier impacts can be calculated. Requires method for determining whether impacts are likely to be significant
Option C: sum disturbance impacts	Realistic within prescribed time-frame and likely to lead to fairly accurate results
Testing the significance out outputs	**Issues**
Sum impacts from individual components	Component information for summing may not be compatible. For some effects, impacts may not accrue linearly.

5.2. Clarification of regularity requirements

Hitherto, there have been no clear guidelines for carrying-out CIAs at offshore windfarms and it is the aim of this report to provide such guidelines. Nevertheless, it should be noted that the primary reason for the lack of guidelines to date, and one of the major hurdles in presenting the guidelines here, is that regulatory obligations pertaining to CIA are vague. Consequently both here and previously (see for example Norman *et al.* 2007), they have needed to be interpreted subjectively.

This subjectivity has lead to the wide variety of approaches used and the variable rigour with which CIA has been conducted. It is important that the obligatory requirements of cumulative impact assessment are more clearly specified.

5.3. Recommendations based on existing EIA

5.3.1. Data gathering

We recommend that in general, there is little need to gather additional data for CIA, so the data gathering requirements for CIA are the same as for EIA, although highlight that the data requirements for EIAs are not always clearly defined. The exceptions to this are as follows:

(1) *If a project, plan or development to be considered in the CIA has inadequate data associated with it to inform the cumulative assessment process, yet it is likely to significantly add to the overall cumulative effects*: We recommend that additional data gathering requirements should be assessed in the scoping / screening process and additional data collection implemented if necessary.

(2) *If disturbance effects are likely to be significant*: Since the impacts of disturbance cannot be assessed by summing the contributions from individual project, plans and developments, a more detailed assessment may need to be made. This would require a more detailed study

focusing on disturbance and energetics or by parameterising of individual behaviour-based-models (Kaiser *et al.* 2002, 2006; Stillman *et al.* 2007).

(3) *If barrier-effects are likely to be significant:* Since barrier effects cannot be assessed by summing the contributions from individual project, plans and developments, a more detailed assessment may need to be made. This would require a more detailed study focusing on flight directions through the sites and the energetic costs of having to fly around sites and the need to do so.

(4) *If cumulative effects on the designated features of protected areas are likely to be significant and cannot be assessed due to lack of knowledge about use of a wider area*: In the assessment of cumulative impacts within a wider area, it may not be clear to what extent individual developments are affecting designated features, because it may be impossible to establish the origin of individual birds. In some instances, only a proportion may originate from the SPA, whereas others may come from elsewhere. To inform this assessment and to avoid specifying unduly high impacts on designated features, it may be necessary to quantify the proportion of birds within different parts of the cumulative impact area that actually originate from the SPA. This could be informed through radio-tracking (see Perrow *et al.* 2006) or colour-marking and resighting individual birds.

5.3.3. Data analysis

Many CIAs are hampered by the different approaches used to carry out EIAs. Thus it is worth flagging in this report, that there is a need to standardise the methods for carrying out EIAs so that components that feed into the CIA are compatible. Additionally, we recommend the following:

Selection of species for inclusion: introduce a screening procedure for identifying which species should be included in the cumulative impact assessment, including those that are non-significantly, but almost significantly impacted by individual developments, but excluding those for which the impacts of individual developments are truly trivial.

Source of impact: all sources of impact, not just those from other windfarms should be considered.

Ensuring compatible outputs: provide very explicit guidelines with respect to what outputs should be produced from EIAs

Time-scale: we suggest that all ongoing and proposed projects should be considered, the exception being the consideration of impacts on designated features of proposed protected areas prior to the assessment of the conservation value of that area. Mortality should be presented as a rate rather than an overall number over a defined time-period.

Area /reference population: we suggest that the reference population and area in which CIAs should be considered follow the boundaries of the Round 2 Strategic Windfarm Areas (Thames, Greater Wash and North-west) or any such areas identified in Round 3. Where these areas demonstrably do not constitute a discrete functional unit, then the identification of the relevant area / reference population should follow the same principles as are used to designate SPAs. The process entails identifying an area that is distinct in habitat and/or ornithological importance from surrounding areas. In the context of marine environments the baseline mapping of species distribution may help to identify discrete areas. This process could be further enhanced by undertaking habitat-association modelling incorporating environmental or physical factors such as bathymetry.

5.3.4. Test of significance and reporting

We recommend that for most impacts, the significance of cumulative impacts is assessed by summing the impacts from each component development. The exception to summing, should be in assessing cumulative impacts of disturbance and barrier-effects, where the impacts accrue in a non-linear manner. We propose that cumulative impacts of disturbance and barrier-effects are first considered in a qualitative manner making best-use of available information. If the cumulative impacts of disturbance and barrier effects are thought to be significant, then a more detailed quantitative study should be carried-out.

We recommend that the significance of mortality be assessed using mortality-rates rather than actual mortality over a finite period. The assignment of species to a sensitivity category should take account of life-history parameters, with long-lived species with low reproductive rates considered more sensitive. Population viability analyses could inform this assessment.

We also recommend that the significance of cumulative impacts be made using the same matrix approach that is routinely used for EIA. Assessment should not be based on only those species for which there is a significant impact at any one of the component developments, but should encompass all species. It is entirely plausible that the accumulation of negligible impacts could result in a non-negligible impact.

6. CONCLUDING REMARKS

It is our intention to provide specific guidelines so that CIAs can be standardised and the quality and rigour improved. However, one of the major constraints in presenting such guidelines is that guidelines for EIAs do not specify precisely what outputs should be provided for ornithological impact assessment with regards to offshore developments. As such, there is often a lack of a common currency that allows cumulative impacts to be assessed. There is an urgent need for these guidelines to be in place and for legal obligations to be clarified. More rigorous guidelines for CIAs could then be formulated.

7. WORKSHOP QUESTIONS

(1) How can we ensure greater compatibility of data that feeds into CIA?

In many instances we propose the summing of effects from individual developments to carry out CIA. This is not possible if the component information for summing is not compatible. One means of ensuring greater compatibility would be to provide firmer EIA guidance. However, the production of such guidelines may not be ready in time for Round 3.

(2) How should data gathering requirements for CIA be assessed?

In many instances data for carrying out CIA are collected as part of the baseline for environmental impact assessments. However, in some instances it may be necessary to collect additional data. Additional data collection is likely to be costly and time-consuming. The need for additional data is likely to be subjectively interpreted.

(3) What species should be included in CIA?

A common method to date has been to include only those species that are significantly impacted by one of the individual developments that contribute to CIA. This approach does not guard against non-significant impacts that could accrue to become significant. An alternative approach would be to include all species, but this is likely to be time-consuming if all potential impacts are to be considered in a rigorous manner. A possible compromise would be to implement some screening procedure for identifying the species that should be included. However the methods or guidance for such screening have yet to be developed

(4) Should all ongoing developments be considered, or only proposed developments?

Direct interpretation of legislation does not clarify this issue, but the matter may have been considered in a legal context elsewhere. Most CIA to date has only considered proposed developments rather than ongoing and proposed developments. There is some argument to say that ongoing developments form part of a baseline. However, not considering ongoing developments means that there is no way of guarding against a degrading baseline. Theoretically 100% of the natural environment could be destroyed incrementally if developments occurred sequentially.

(5) Should cumulative collision mortality be reported as a rate or a fixed amount over a defined time-period?

Reporting collision mortality as a rate makes it easier to assess against life-history parameters, but does not give absolute mortality value for assessment against population thresholds. Arguably it is more logical to assess sensitivity as a rate, as loss of 10% in one year of a population of a long-lived, slow-reproducing species is much worse than the equivalent loss of a short-lived, rapidly reproducing species.

(6) Should all projects / developments be considered, or only windfarms?

Regulations seem to imply that cumulative assessment of all developments are needed, but the norm to date has been to consider windfarms only.

(7) Should the Round 2/3 Strategic Areas/Zones be used as the areas in which to consider cumulative impacts and to define reference populations?

This is clear-cut and easy to implement. However in some instances, such areas may not form discrete functional units (a subjective term in any case!).

(8) Should collision effects be summed or should flight responses to developments be accounted for?

Summing effects is straightforward provided suitable data are available. However it does not consider whether a bird deflecting from one development, may be more/less likely to collide with others.

(9) Should we assume that all areas are at carrying-capacity and thus calculate cumulative displacement effects by summing component effects.

In reality areas are likely to be close to carrying-capacity, but this may vary spatially and temporally. Summing effects is precautionary, perhaps overly so? Alternative methods of assessment, such as individual-based modelling, are complex, and fairly costly and time-consuming.

(10) Should detailed energy-budget studies be carried-out to assess the cumulative impacts of disturbance?

This is likely to be costly and time-consuming, but the only way in which cumulative disturbance impacts can be quantified. One option would be to only do so, if significant cumulative disturbance impacts are expected. A further question then arises: how can we determine whether cumulative disturbance impacts are likely to be significant?

(11) Should detailed energy-budget studies be carried-out to assess the cumulative impacts of barrier effects?

This is likely to be costly and time-consuming, but the only way in which cumulative barrier impacts can be quantified precisely. However, unlike with disturbance, summing barrier-effects may not lead to hugely erroneous results. In a similar manner to disturbance, one option would be to only do so, if significant cumulative barrier effects impacts are expected. A further question then arises: how can we determine whether cumulative disturbance impacts are likely to be significant?

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Appendix 5

Key legislation relating to cumulative impact assessment

<table>
<tr><th>European Legislation</th><th>National Legislation</th></tr>
<tr><td>SEA Directive</td><td></td></tr>
<tr><td rowspan="2">The assessment of the effects of certain plans and programmes on the environment
Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001

Article 3 (1) describes projects requiring environmental assessment in accordance with Articles 4 to 9.

Article 5 describes the environmental report required for environmental assessment and states that ‘likely significant effects’ must be identified

Annex 1 describes the effects to be included:

ie ‘secondary, cumulative, synergistic, short, medium and long-term permanent and temporary, positive and negative..’

Annex II describes the criteria for determining the significance of effects with part 2 specifically referring to:</td><td>The Environmental Assessment of Plans and Programmes Regulations 2004
Statutory Instrument 2004 No. 1633

<u>Schedule 1</u> Criteria for determining the likely significance of effects on the environment 2b states that the characteristics considered must include ‘the cumulative nature of the effects’

<u>Schedule 2</u>: Information for environmental reports states in part 6 that

‘The likely significant effects on the environment, including short, medium and long-term effects, permanent and temporary effects, positive and negative effects, and secondary, cumulative and synergistic effects, …’should be included</td></tr>
<tr><td>Environmental Assessment (Scotland) Act 2005 asp 15

<u>Schedule 2</u> Criteria for determining the likely significance of effects on the environment 2b states that the characteristics considered must include ‘the cumulative nature of the effects’

<u>Schedule 3</u>: Information for environmental reports states in part 6 (e) that

‘secondary, cumulative and synergistic effects’ on the environment must be considered</td></tr>
</table>

'- *the **cumulative** nature of the effects'*	**The Environmental Assessment of Plans and Programmes Regulations (Northern Ireland) 2004** Statutory Rule 2004 No. 280 Schedule 1: Criteria for determining the likely significance of effects on the environment 2b states that the characteristics considered must include '*the **cumulative** nature of the effects*' Schedule 2 Information for environmental reports part 6 states that '*The likely significant effects on the environment, including short, medium and long-term effects, permanent and temporary effects, positive and negative effects, and secondary, cumulative and synergistic effects*',
EIA Directive	
The assessment of the effects of certain public and private projects on the environment Council Directive **97/11/EC** of 3 March 1997 amending Directive **85/337/EEC** Article 3 defines the general content of the environmental impact assessment with further details in Articles 4 to 11 Article 4 defines projects which must be considered with reference to Annex II which states in part 3 (1) '*Installations for the harnessing of wind power for energy production (wind farms)*'.	**The Electricity Works (Environmental Impact Assessment) (England and Wales) Regulations 2000** (as amended) Statutory Instrument 2000 No. 1927 Schedule 4 *Content of an Environmental Statement* Part I (3) requires: *'A description of the likely significant effects of the development on the environment, which should cover the direct effects and any indirect, secondary, **cumulative**, short, medium and long-term, permanent and temporary, positive and negative effects …'* **The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2000** Scottish Statutory Instrument 2000 No. 320 Schedule 4 *Content of an Environmental Statement* Part I (3) requires: *'A description of the likely significant effects of the development on the environment, which should cover the direct effects and any indirect, secondary, **cumulative**, short, medium and long-term, permanent and temporary, positive and negative effects …'*

Article 4 (3): requires the use of 'criteria' for assessment of defined projects and Annex III defines these criteria including the significance of their effect in '***cumulation***' with other projects Article 5 (1) gives details of the information required in the environmental impact assessment which are expanded in Annex IV and include the: '*description of the likely significant effects*' described in footnote (1) as '*direct effects and any indirect, secondary, **cumulative**, short, medium and long-term, permanent and temporary, positive and negative effects of the project*'	**The Offshore Electricity Development (Environmental Impact Assessment) Regulations (Northern Ireland) 2008** Schedule 4 *Matters for Inclusion in Environmental Statement* Part I (4) requires: *'A description of the likely significant effects of the development on the environment, which should cover the direct effects and any indirect, secondary**, cumulative**, short, medium and long-term, permanent and temporary, positive and negative effects…'* **Marine Works (Environmental Impact Assessment) Regulations 2007** Statutory Instrument 2007 No. 1518 Schedule 3 *INFORMATION TO BE INCLUDED IN AN ENVIRONMENTAL STATEMENT* Part 3 (1) requires '*A description, complying with sub-paragraph (2), of the likely significant effects of the project and the regulated activity on the environment resulting from—* *(a) the nature of the activities to be carried out and the manner in which they are to be carried out;….'* Part 3 (2) '*The description should cover each of the following categories of effect— (c) cumulative effects….'* **Town & Country Planning (Environmental Impact Assessment) Regulations 1999** Statutory Instrument 1999 No. 293 Schedule 4 Information for inclusion in environmental statements Part I (4) requires a consideration of significant effects including: '*direct effects and any indirect, secondary, **cumulative**, short, medium and long-term, permanent and temporary, positive and negative effects*'

	Environmental Impact Assessment (Scotland) Regulations 1999 Schedule 4 *Information for inclusion in environmental statements* Part I (4) requires a consideration of significant effects including: '*direct effects and any indirect, secondary, **cumulative**, short, medium and long-term, permanent and temporary, positive and negative effects*..' **Transport and Works (Assessment of Environmental Effects) Regulations 1995** amends section 14 of the Transport and Works Act 1992 to require the production of an Environmental Statement whose contents are described in the **Transport and Works (Applications and Objections Procedure) 1992** (as amended) Statutory Instrument 1992 No. 2902. *Schedule 1 Environmental Statements* Part 2 (e) requires the consideration of the 'likely significant direct and indirect effects on the environment…' with 'effects' defined to include '*secondary, **cumulative,** short-, medium- and long-term, permanent, temporary, positive and negative effects*'

Habitats Directive	**Habitats Regulations**
The conservation of natural habitats and of wild fauna and flora Council Directive **92/43/EEC** of 21 May 1992 Article 6 (3) states '*Any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or* ***in combination*** *with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives*' Article 7 extends the above requirements to SPAs by incorporating the requirements of Article 4 (4) of the Birds Directive 79/409/EC A useful document interpreting the above	**The Conservation (Natural Habitats, &c.) Regulations 1994** (as amended) Statutory Instrument 1994 No. 2716 Part IV: 48 *'Assessment of implications for European site'* states: *(1) A competent authority, before deciding to undertake, or give any consent, permission or other authorisation for, a plan or project which -* *(a) is likely to have a significant effect on a European site in Great Britain (either alone or* ***in combination*** *with other plans or projects), and* *(b) is not directly connected with or necessary to the management of the site,* *shall make an appropriate assessment of the implications for the site in view of that site's conservation objectives'* Interpretation of the term 'in-combination' and how it is applied and implemented can be found in English Nature (2001) Habitats regulations guidance note (HRGN) 4: Alone or in-combination

requirements is published by the European Commission (2000) Managing NATURA 2000 sites: The provisions of Article 6 of the 'Habitats' Directive 92/43/EEC.	**The Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007** Statutory Instruments 2007 No.1842 Wildlife **Part 2: Conservation of Natural Habitats and habitats of species: Protection of European offshore marine sites and European sites** **25.**—(1) Before deciding to undertake, or give any consent, permission or other authorisation for, a plan or project which....(b) is likely to have a significant effect on a European offshore marine site or a European site (either alone or **in combination** with other plans or projects), and (c) is not directly connected with or necessary to the management of the site, a competent authority must make an appropriate assessment of the implications for the site in view of that site's conservation objectives.
	The Conservation (Nature Habitats, etc.) Regulations (Northern Ireland) 1995 Statutory Rule 1995 No. 380: Part IV: 43 *'Assessment of implications for European site'* states *(1) A competent authority, before deciding to undertake, or give any consent, permission or other authorisation for, a plan or project which -* *(a) is likely to have a significant effect on a European site in Northern Ireland (either alone or in combination with other plans or projects), and* *(b) is not directly connected with or necessary to the management of the site,* *shall make an appropriate assessment of the implications for the site in view of that site's conservation objectives.*

Appendix 6

A selection of available guidance relating to terms, definitions and methods of CIA

Guidance documents: Habitats Regulations
Managing Natura 2000 sites: the provisions of Article 6 of the Habitats Directive 92/43/EC (2000) European Communities 73pp Useful reference for definitions and terms Available from: http://ec.europa.eu/environment/nature/natura2000/management/docs/art6/provision_of_art6_en.pdf
Habitats Regulations Guidance Note 4: Alone or in-combination (2001) English Nature Short, useful summary. Not specific to offshore projects Available from: http://www.mceu.gov.uk/MCEU_LOCAL/Ref-Docs/EN-HabsRegs-InComb.pdf
Guidance documents: EIA Regulations
Nature Conservancy Agency Guidance on Offshore Windfarm Development: a guidance note for developers undertaking offshore windfarm developments. Version 5 (2004) Countryside Council for Wales, English Nature, Joint Nature Conservation Committee Status: currently being updated. Section on bird survey but CIA only mentioned as a requirement.
Nature Conservation Guidance on Offshore Windfarm Development. (2005) Defra Status: currently being updated. Section on bird survey but CIA only mentioned as a requirement (text same as previous document in this section).
Offshore Wind Farms Guidance note for Environmental Impact Assessment In respect of FEPA and CPA requirements. Version 2 – June 2004 (2004) CEFAS on behalf of MCEU Status: current but no detailed comments on CIA Available from: http://www.cefas.co.uk/publications/files/windfarm-guidance.pdf
Guidance on the cumulative effects of windfarms (2005) Scottish Natural Heritage Status: current. Discusses birds specifically but relates to onshore Available from: http://www.snh.org.uk/pdfs/strategy/Cumulativeeffectsonwindfarms.pdf
Department of Energy and Climate Change Guidance on the Assessment of Cumulative Impacts of Onshore Windfarms Phase 2 report. Entec UK Ltd. (In press). Entec on behalf of DECC Status: shortly to be published on the DECC website. Gives guidance on all aspects of cumulative impact assessment, including ornithology, for onshore wind farms.

The Assessment of Cumulative Effects: a discussion paper to the Offshore Renewable Energy Environment Forum (OREEF) (2007) Hartley Anderson Ltd for the Research Advisory Group Literature review and discussion of international initiatives particularly in the context of offshore SEA.
Wind farm development and nature conservation: A guidance document for nature conservation organisations and developers when consulting over wind farm proposals in England (2001) English Nature RSPB WWF-UK Outdated in relation to offshore projects. Limited guidance on CIA Available from: http://www.bwea.com/pdf/wfd.pdf
COWRIE workshop on the cumulative impact of offshore windfarms on birds (2007) RPS Useful discussion document. Contains good guidance points on CIA but not specifically summarised. Available from: http://www.offshorewindfarms.co.uk/Pages/Publications/Archive/Birds/COWRIE_workshop_on_the_cumulative_impact_of_offshore_windfarms_on_birds/
Cumulative effects of wind turbines: Volume 3: Report on the results of consultation on Cumulative effects of wind turbines on birds. ETSU W/14/00538/REP/3 (2000) Landscape Design Associates Summary of discussions on cumulative issues to this report held in relation to onshore wind farms. Includes some definitions and recommendations for good practice. Available from: http://www.berr.gov.uk/files/file17849.pdf
Guidance on Environmental Considerations for Offshore Wind Farm Development (2008) OSPAR Limited mention of CIA Available from: http://www.ospar.org/
Guidelines for Ecological Impact Assessment in Britain and Ireland – Marine and Coastal (2008) Institute for Ecology and Environmental Management Status and comments: Current. Draft out for public consultation. CIA mentioned in some detail but not specific to birds Available from: http://www.ieem.net/ecia.asp
A Review of Assessment Methodologies for Offshore Windfarms (2009) McLean *et al* COWRIE METH-08-08 Useful new review of methodologies used in EIA including recommendations on reporting Available from: http://offshorewindfarms.co.uk
Guidance documents: Other
Guidance note: Offshore wind farms consent process (2004) DTI and MCEU Status and comments: Current. CIA mentioned as a requirement and projects to be considered described Available from: http://www.berr.gov.uk/files/file22990.pdf

Considering Cumulative Effects under the National Environmental Policy Act (1997) Council on Environmental Quality Relates to onshore projects in US but contains a good general review of tools and techniques. Good background reading. Available from: http://www.nepa.gov/nepa/ccenepa/exec.pdf
Review of Guidance on the Assessment of Cumulative Impacts of Onshore Windfarms: Phase 1 Report (2008) Entec Thorough review produced for BERR on all aspects of CIA for onshore with good reference list. Available from the BERR website or http://www.entecuk.com/berrwindfarmreport/
Other
Effects of offshore wind farms on the energy demands of sea birds (In press) Speakman, J., Gray, H. and Furness L Bioenergetics paper Available from DECC on request. Shortly to be made available on the DECC website

Appendix 7[1,2]

Species (excluding passerines) likely to be susceptible to cumulative impacts within the Round 3 Development Zones

Table A7.1 List of species likely to be susceptible to cumulative impacts within each of the Round 3 development zones

Species	Susceptible 1=possible 2 = likely 3 = high	Development Zones 1	2	3	4	5	6	7	8	9	Justification
Bewick's Swan	1					x	x	x		x	Designated feature of adjacent SPAs, may migrate through the area and be at risk of collision or barrier effects
Whooper Swan	1					x				x	Designated feature of adjacent SPAs, may migrate through the area and be at risk of collision or barrier effects
Bean Goose	1					x					Designated feature of adjacent SPAs, may migrate through the area and be at risk of collision or barrier effects
Pink-footed Goose	3		x			x				x	Very likely to migrate through area in large numbers and be at risk of collision
Eurasian White-fronted Goose	2					x					Designated feature of adjacent SPAs and probably migrates through area in significant numbers
Icelandic Greylag Goose	3	x									A high proportion of the biogeographic population is likely to migrate through the area and there may be a high risk of collision or barrier effects
Dark-bellied Brent Goose	1		x			x					Designated feature of adjacent SPAs, may migrate through the area and be at risk of collision or barrier effects
Shelduck	1							x	x		Designated feature of adjacent SPAs, may migrate through the area and be at risk of collision or barrier effects

[1] Zones as defined at http://copyright.thecrownestate.co.uk/CECopyright/Default.aspx?DocID=round3_map-3.pdf. Last accessed 10th June 2009. Zones may be subject to redefinition pending the final report of the UK Offshore Energy SEA.

[2] This Appendix was compiled based on information available in 2008. It will require expert review and updating as more information becomes available.

Species	Susceptible 1=possible 2 = likely 3 = high	Development Zones 1	2	3	4	5	6	7	8	9	Justification
Wigeon	2	x				x		x			Designated feature of adjacent SPAs and probably migrates through area in significant numbers
Pintail	1								x	x	Designated feature of adjacent SPAs, may migrate through the area and be at risk of collision or barrier effects
Teal	1								x		Designated feature of adjacent SPAs, may migrate through the area and be at risk of collision or barrier effects
Shoveler	1					x					Designated feature of adjacent SPAs, may migrate through the area and be at risk of collision or barrier effects
Scaup	2	x									Designated feature of adjacent SPAs with moderate numbers occurring offshore, mostly within 5 km of the shore offshore
Eider	3	x	x							x	Designated feature of adjacent SPAs and forages offshore in large numbers mostly within 10 km of the shore
Long-tailed Duck	3	x	x								Designated feature of adjacent SPAs and forages offshore in large numbers, mostly within 10 km of the shore
Common Scoter	3	x	x	x	x	x			x	x	Designated feature of adjacent SPAs and forages offshore in large numbers, mostly within 10 km of the shore
Velvet Scoter	3	x	x								Designated feature of adjacent SPAs and forages offshore in large numbers, mostly within 10 km of the shore
Goldeneye	1	x	x								Designated feature of adjacent SPAs and small numbers occur offshore, mostly within 5 km of the shore
Red-breasted Merganser	2	x	x	x				x			Designated feature of adjacent SPAs with moderate numbers occurring offshore, mostly within 10km of the shore
Red-throated Diver	2		x						x	x	Designated feature of adjacent SPAs with moderate numbers occurring up to 30 km offshoree
Black-throated Diver	1	x	x							x	Possibly occurs in significant numbers occurring up to 30 km offshore
Great Crested Grebe	1					x				x	Moderate numbers known to occur offshore, mostly within 5 km of the shore
Slavonian Grebe	1	x									Moderate numbers known to occur offshore, mostly within 5 km of the shore
Fulmar	3	x	x							x	Designated feature of adjacent SPAs and forages offshore in large numbers. Pelagic
Great Shearwater	1								x		Small, but increasing numbers occur offshore in UK waters. Pelagic

Species	Susceptible 1=possible 2 = likely 3 = high	Development Zones									Justification
		1	2	3	4	5	6	7	8	9	
Sooty Shearwater	1	x	x		x				x	x	Mainly pelagic and known to migrate through area in moderate numbers. Pelagic
Manx Shearwater	3								x	x	Designated feature of adjacent SPAs and forages offshore in large numbers. Pelagic
Balearic Shearwater	1					x	x	x	x		Small, but increasing numbers occur offshore in UK waters. Pelagic
Storm Petrel	2								x		Designated feature of adjacent SPAs with moderate numbers occurring offshore. Pelagic
Leach's Petrel	1									x	Small numbers occur offshore. Pelagic
Gannet	3		x		x				x	x	Designated feature of adjacent SPAs and forages offshore in large numbers. Pelagic
Cormorant	2		x			x				x	Designated feature of adjacent SPAs with moderate numbers occurring up to 30 km offshore
Shag	3	x	x							x	Designated feature of adjacent SPAs and forages up to 30 km offshore in large numbers
Oystercatcher	1	x	x		x	x			x	x	Designated feature of adjacent SPAs, may migrate through the area and be at risk of collision or barrier effects
Ringed Plover	1					x		x	x	x	Designated feature of adjacent SPAs, may migrate through the area and be at risk of collision or barrier effects
Golden Plover	1				x	x				x	Designated feature of adjacent SPAs, may migrate through the area and be at risk of collision or barrier effects
Grey Plover	1				x	x		x	x	x	Designated feature of adjacent SPAs, may migrate through the area and be at risk of collision or barrier effects
Lapwing	1		x		x	x		x		x	Designated feature of adjacent SPAs, may migrate through the area and be at risk of collision or barrier effects
Knot	1				x	x			x	x	Designated feature of adjacent SPAs, may migrate through the area and be at risk of collision or barrier effects
Sanderling	1				x					x	Designated feature of adjacent SPAs, may migrate through the area and be at risk of collision or barrier effects
Dunlin	1				x	x		x	x	x	Designated feature of adjacent SPAs, may migrate through the area and be at risk of collision or barrier effects
Black-tailed Godwit	1				x	x		x	x	x	Designated feature of adjacent SPAs, may migrate through the area and be at risk of collision or barrier effects

Species	Susceptible 1=possible 2 = likely 3 = high	Development Zones 1	2	3	4	5	6	7	8	9	Justification
Bar-tailed Godwit	1	x	x		x	x				x	Designated feature of adjacent SPAs, may migrate through the area and be at risk of collision or barrier effects
Curlew	1				x	x		x	x	x	Designated feature of adjacent SPAs, may migrate through the area and be at risk of collision or barrier effects
Redshank	1	x	x		x	x		x	x	x	Designated feature of adjacent SPAs, may migrate through the area and be at risk of collision or barrier effects
Grey Phalarope	1									x	Predominantly pelagic species, which may sometimes occur in development zones in large numbers. Pelagic
Pomarine Skua	3	x	x	x	x	x	x	x			Predominantly pelagic. Large numbers likely to pass through development zones. Pelagic..
Arctic Skua	3	x	x		x	x			x	x	Predominantly pelagic. Large numbers likely to pass through development zones. Pelagic.
Great Skua	3	x	x	x	x	x			x		Predominantly pelagic. Large numbers likely to pass through development zones. Pelagic.
Little Gull	3		x	x	x	x			x	x	Predominantly pelagic. Large numbers likely to pass through development zones. Pelagic.
Black-headed Gull	2	x	x		x	x					Designated feature of adjacent SPAs with moderate numbers occurring offshore, mostly within 5 km of the shore.
Common Gull	3	x	x		x	x				x	Designated feature of adjacent SPAs and occurs in high numbers offshore, mostly within 10 km of the shore
Lesser Black-backed Gull	2	x	x						x	x	Designated feature of adjacent SPAs with moderate numbers occurring up to 30 km offshore
Herring Gull	3	x	x		x				x	x	Designated feature of adjacent SPAs and occurs in high numbers up to 30 km offshore
Iceland Gull	1	x									Small numbers, but high proportion of UK population present up to 30 km offshore in this area
Glaucous Gull	1	x									Small numbers, but high proportion of UK population present up to 30 km offshore in this area
Great Black-backed Gull	2	x	x		x					x	Designated feature of adjacent SPAs with moderate numbers occurring up to 30 km offshore
Kittiwake	3	x	x	x	x	x			x	x	Designated feature of adjacent SPAs and occurs in high numbers offshore. Pelagic
Sandwich Tern	3		x			x		x		x	Designated feature of adjacent SPAs and occurs in high numbers up to 30 km offshore
Roseate Tern	2		x	x				x		x	Designated feature of adjacent SPAs, small numbers, but significant proportion of UK population likely to feed offshore, mostly within 10 km of the shore
Common Tern	2	x	x			x		x	x	x	Designated feature of adjacent SPAs with reasonable numbers foraging offshore, mostly within 10 km of the

Species	Susceptible 1=possible 2 = likely 3 = high	Development Zones 1	2	3	4	5	6	7	8	9	Justification
											shore
Arctic Tern	3	x	x							x	Designated feature of adjacent SPAs and occurs in high numbers offshore, mostly within 10 km of the shore
Little tern	2		x			x	x	x		x	Designated feature of adjacent SPAs with reasonable numbers foraging offshore, mostly within 10 km of the shore
Guillemot	3	x	x	x	x	x			x	x	Designated feature of adjacent SPAs and occurs in high numbers offshore. Pelagic
Razorbill	3	x	x		x	x			x	x	Designated feature of adjacent SPAs and occurs in high numbers offshore. Pelagic
Black Guillemot	3	x								x	Designated feature of adjacent SPAs and occurs in high numbers offshore. Pelagic
Little Auk	3	x	x	x	x						Predominantly pelagic. Large numbers likely to pass through development zones. Pelagic
Puffin	3	x	x	x					x	x	Designated feature of adjacent SPAs and occurs in high numbers offshore. Pelagic
Chough	1								x		Designated feature of adjacent SPAs and may be at risk of collision

Table A7.2 Sensitivity scores for each of the species listed in Table A5.1

Species	**Flight manoeuvrability** Species scored subjectively from a very high flight manoeuvrability (score 1) to low flight manoeuvrability (score 5)	**Flight altitude** 1 = median height 0-5m; 2 = median height 5-10m; 3 = median height 10-20m & 90% < 50m; 4 = median height 10-20m & 90% < 100m; 5 = median height 10-20m & >10% > 100m.	**Percentage of time flying** 1 = 0–20% of time at sea flying; 2 = 21–40% of time at sea flying; 3 = 41–60% of time at sea flying; 4 = 61–80% of time at sea flying; 5 = 81–100% of time at sea flying.	**Nocturnal flight activity** Species scored subjectively from a hardly any flight at night (score 1) to much flight activity at night (score 5)	**Disturbance by ship and helicopter traffic** Species scored subjectively from 1 (very flexible in habitat use) to 5 (reliant on specific habitat characteristics); 0 = not dependent on offshore habitats	**Flexibility in habitat use** Species scored subjectively from 1 (very flexible in habitat use) to 5 (reliant on specific habitat characteristics); 0 = not dependent on offshore habitats	**Biogeographical population size** 1 = >3 million individuals; 2 = >1 million - 3 million individuals; 3 = >500,000 - 1 million individuals; 4 = >100,000 - 500,000 individuals; 5 = <500,000 individuals	**Adult survival rate** 1 = <0.75; 2 = >0.75 - 0.80; 3 = >0.80 - 0.85; 4 = >0.85 - 0.90; 5 = >0.90.	**European Threat & Conservation status** 1 = 'secure' and no SPEC status given; 2 = 'secure' & SPEC status of 4; 3 = "localized"; 4 = 'declining'; 5 = 'vulnerable'.	**Total sensitivity score** see Garthe & Hüppop (2004) for details of the way in which this is calculated
Red-throated Diver	5[1]	2[1]	3[1]	1[1]	4[1]	4[1]	4[1]	3[1]	5[1]	44.0
Black-throated Diver	5[1]	2[1]	2[1]	1[1]	4[1]	4[1]	5[1]	3[1]	5[1]	43.3
Velvet Scoter	3[1]	1[1]	2[1]	3[1]	5[1]	4[1]	3[1]	2[1]	3[1]	27.0
Shag	4[5]	1[5]	3[5]	1[5]	4[5]	3[5]	4[2]	4[4]	4[3]	26.3
Sandwich Tern	1[1]	3[1]	5[1]	1[1]	2[1]	3[1]	4[1]	4[1]	4[1]	25.0
Little Tern	1[5]	2[5]	5[5]	1[5]	2[5]	3[5]	5[2]	4[5]	4[3]	24.4
Slavonian Grebe	3[5]	2[5]	1[5]	1[5]	3[5]	5[5]	5[2]	1[5]	4[3]	23.3
Cormorant	4[1]	1[1]	4[1]	1[1]	4[1]	3[1]	4[1]	3[1]	1[1]	23.3
Black Guillemot	4[5]	1[5]	1[5]	2[5]	3[5]	3[5]	4[3]	4[5]	3[3]	22.0
Bewick's Swan	5[5]	5[5]	5[5]	5[5]	2[5]	0[5]	5[2]	3[4]	5[3]	21.7
Dark-bellied Brent Goose	5[5]	5[5]	5[5]	5[5]	2[5]	0[5]	4[2]	4[4]	5[3]	21.7

Species	**Flight manoeuvrability** Species scored subjectively from a very high flight manoeuvrability (score 1) to low flight manoeuvrability (score 5)	**Flight altitude** 1 = median height 0-5m; 2 = median height 5-10m; 3 = median height 10-20m & 90% < 50m; 4 = median height 10-20m & 90% < 100m; 5 = median height 10-20m & >10% > 100m.	**Percentage of time flying** 1 = 0–20% of time at sea flying; 2 = 21–40% of time at sea flying; 3 = 41–60% of time at sea flying; 4 = 61–80% of time at sea flying; 5 = 81–100% of time at sea flying.	**Nocturnal flight activity** Species scored subjectively from a hardly any flight at night (score 1) to much flight activity at night (score 5)	**Disturbance by ship and helicopter traffic** Species scored subjectively from 1 (very flexible in habitat use) to 5 (reliant on specific habitat characteristics); 0 = not dependent on offshore habitats	**Flexibility in habitat use** Species scored subjectively from 1 (very flexible in habitat use) to 5 (reliant on specific habitat characteristics); 0 = not dependent on offshore habitats	**Biogeographical population size** 1 = >3 million individuals; 2 = >1 million - 3 million individuals; 3 = >500,000 - 1 million individuals; 4 = >100,000 - 500,000 individuals; 5 = <500,000 individuals	**Adult survival rate** 1 = <0.75; 2 = >0.75 - 0.80; 3 = >0.80 - 0.85; 4 = >0.85 - 0.90; 5 = >0.90.	**European Threat & Conservation status** 1 = 'secure' and no SPEC status given; 2 = 'secure' & SPEC status of 4; 3 = ''localized'; 4 = 'declining'; 5 = 'vulnerable'.	**Total sensitivity score** see Garthe & Hüppop (2004) for details of the way in which this is calculated
Red-breasted Merganser	3[5]	1[5]	2[5]	3[5]	3[5]	4[5]	4[2]	3[5]	1[3]	21.0
Roseate Tern	1[5]	2[5]	5[5]	1[5]	2[5]	3[5]	5[2]	3[5]	3[3]	20.6
Eider	4[1]	1[1]	2[1]	3[1]	3[1]	4[1]	2[1]	4[1]	1[1]	20.4
Great Crested Grebe	4[1]	2[1]	3[1]	2[1]	3[1]	4[1]	4[1]	1[1]	1[1]	19.3
Great Black-backed Gull	2[1]	3[1]	2[1]	3[1]	2[1]	2[1]	4[1]	5[1]	2[1]	18.3
Common Scoter	3[1]	1[1]	2[1]	3[1]	5[1]	4[1]	2[1]	2[1]	1[1]	16.9
Whooper Swan	5[5]	5[5]	5[5]	5[5]	2[5]	0[5]	5[2]	3[4]	2[3]	16.7
Glaucous Gull	2[5]	3[5]	2[5]	3[5]	2[5]	2[5]	4[2]	5[5]	1[3]	16.7
Gannet	3[1]	3[1]	3[1]	2[1]	2[1]	1[1]	4[1]	5[1]	3[1]	16.5
Goldeneye	3[5]	1[5]	2[5]	3[5]	3[5]	4[5]	2[2]	3[4]	1[3]	15.8
Razorbill	4[1]	1[1]	1[1]	1[1]	3[1]	3[1]	2[1]	5[1]	2[1]	15.8
Pink-footed Goose	5[5]	5[5]	5[5]	5[5]	2[5]	0[5]	4[2]	3[4]	2[3]	15.0
Icelandic Greylag Goose	5[5]	5[5]	5[5]	5[5]	2[5]	0[5]	5[2]	3[4]	1[3]	15.0
Scaup	3[5]	2[5]	2[5]	3[5]	3[5]	0[5]	4[2]	3[5]	5[3]	15.0

Species	**Flight manoeuvrability** Species scored subjectively from a very high flight manoeuvrability (score 1) to low flight manoeuvrability (score 5)	**Flight altitude** 1 = median height 0-5m; 2 = median height 5-10m; 3 = median height 10-20m & 90% < 50m; 4 = median height 10-20m & 90% < 100m; 5 = median height 10-20m & >10% > 100m.	**Percentage of time flying** 1 = 0–20% of time at sea flying; 2 = 21–40% of time at sea flying; 3 = 41–60% of time at sea flying; 4 = 61–80% of time at sea flying; 5 = 81–100% of time at sea flying.	**Nocturnal flight activity** Species scored subjectively from a hardly any flight at night (score 1) to much flight activity at night (score 5)	**Disturbance by ship and helicopter traffic** Species scored subjectively from 1 (very flexible in habitat use) to 5 (reliant on specific habitat characteristics); 0 = not dependent on offshore habitats	**Flexibility in habitat use** Species scored subjectively from 1 (very flexible in habitat use) to 5 (reliant on specific habitat characteristics); 0 = not dependent on offshore habitats	**Biogeographical population size** 1 = >3 million individuals; 2 = >1 million - 3 million individuals; 3 = >500,000 - 1 million individuals; 4 = >100,000 - 500,000 individuals; 5 = <500,000 individuals	**Adult survival rate** 1 = <0.75; 2 = >0.75 - 0.80; 3 = >0.80 - 0.85; 4 = >0.85 - 0.90; 5 = >0.90.	**European Threat & Conservation status** 1 = 'secure' and no SPEC status given; 2 = 'secure' & SPEC status of 4; 3 = ''localized'; 4 = 'declining'; 5 = 'vulnerable'.	**Total sensitivity score** see Garthe & Hüppop (2004) for details of the way in which this is calculated
Iceland Gull	1[5]	3[5]	2[5]	3[5]	2[5]	2[5]	4[2]	5[5]	1[3]	15.0
Common Tern	1[1]	2[1]	5[1]	1[1]	2[1]	3[1]	3[1]	4[1]	1[1]	15.0
Puffin	3[1]	1[1]	1[1]	1[1]	2[1]	3[1]	2[1]	5[1]	5[1]	15.0
Lesser Black-backed Gull	1[1]	4[1]	2[1]	3[1]	2[1]	1[1]	4[1]	5[1]	2[1]	13.8
Bean Goose	5[5]	5[5]	5[5]	5[5]	2[5]	0[5]	5[2]	2[4]	1[3]	13.3
Arctic Tern	1[1]	1[1]	5[1]	1[1]	2[1]	3[1]	3[1]	4[1]	1[1]	13.3
Long-tailed Duck	3[5]	1[5]	2[5]	3[5]	3[5]	4[5]	1[2]	3[5]	1[3]	13.1
Little Gull	1[1]	1[1]	3[1]	2[1]	1[1]	3[1]	5[1]	2[1]	4[1]	12.8
Balearic Shearwater	2[5]	1[5]	3[5]	4[5]	1[5]	1[5]	5[3]	5[5]	5[5]	12.5
Great Skua	1[1]	3[1]	4[1]	1[1]	1[1]	2[1]	5[1]	4[1]	2[1]	12.4
Common Gull	1[1]	3[1]	2[1]	3[1]	2[1]	2[1]	2[1]	2[1]	4[1]	12.0
Guillemot	4[1]	1[1]	1[1]	2[1]	3[1]	3[1]	1[1]	4[1]	1	12.0
Great Shearwater	3[5]	1[5]	3[5]	4[5]	1[5]	1[5]	4[3]	5[5]	4[5]	11.9
Herring Gull	2[1]	4[1]	2[1]	3[1]	2[1]	1[1]	2[1]	5[1]	1[1]	11.0

Species	**Flight manoeuvrability** Species scored subjectively from a very high flight manoeuvrability (score 1) to low flight manoeuvrability (score 5)	**Flight altitude** 1 = median height 0-5m; 2 = median height 5-10m; 3 = median height 10-20m & 90% < 50m; 4 = median height 10-20m & 90% < 100m; 5 = median height 10-20m & >10% > 100m.	**Percentage of time flying** 1 = 0–20% of time at sea flying; 2 = 21–40% of time at sea flying; 3 = 41–60% of time at sea flying; 4 = 61–80% of time at sea flying; 5 = 81–100% of time at sea flying.	**Nocturnal flight activity** Species scored subjectively from a hardly any flight at night (score 1) to much flight activity at night (score 5)	**Disturbance by ship and helicopter traffic** Species scored subjectively from 1 (very flexible in habitat use) to 5 (reliant on specific habitat characteristics); 0 = not dependent on offshore habitats	**Flexibility in habitat use** Species scored subjectively from 1 (very flexible in habitat use) to 5 (reliant on specific habitat characteristics); 0 = not dependent on offshore habitats	**Biogeographical population size** 1 = >3 million individuals; 2 = >1 million - 3 million individuals; 3 = >500,000 - 1 million individuals; 4 = >100,000 - 500,000 individuals; 5 = <500,000 individuals	**Adult survival rate** 1 = <0.75; 2 = >0.75 - 0.80; 3 = >0.80 - 0.85; 4 = >0.85 - 0.90; 5 = >0.90.	**European Threat & Conservation status** 1 = 'secure' and no SPEC status given; 2 = 'secure' & SPEC status of 4; 3 = ''localized'; 4 = 'declining'; 5 = 'vulnerable'.	**Total sensitivity score** see Garthe & Hüppop (2004) for details of the way in which this is calculated
Manx Shearwater	2[5]	1[5]	3[5]	5[5]	1[5]	1[5]	3[3]	5[4]	3[2]	10.1
Pomarine Skua	1[5]	3[5]	5[5]	1[5]	1[5]	2[5]	3[3]	4[5]	1[3]	10.0
Arctic Skua	1[1]	3[1]	5[1]	1[1]	1[1]	2[1]	4[1]	3[1]	1[1]	10.0
Black-tailed Godwit	2[5]	5[5]	5[5]	5[5]	1[5]	0[5]	5[2]	4[4]	5[3]	9.9
Leach's Petrel	1[5]	1[5]	5[5]	5[5]	1[5]	1[5]	4[3]	2[4]	3[3]	9.0
Eurasian White-fronted Goose	5[5]	5[5]	5[5]	5[5]	2[5]	0[5]	3[2]	1[4]	1[3]	8.3
Sooty Shearwater	2[5]	1[5]	3[5]	4[5]	1[5]	1[5]	1[5]	5[5]	4[5]	8.3
Black-headed Gull	1[1]	5[1]	1[1]	2[1]	2[1]	2[1]	1[1]	3[1]	1[1]	7.5
Kittiwake	1[1]	2[1]	3[1]	3[1]	2[1]	2[1]	1[1]	3[1]	1[1]	7.5
Knot	1[5]	5[5]	5[5]	5[5]	1[5]	0[5]	4[2]	3[4]	4[3]	7.3
Grey Phalarope	1[5]	2[5]	2[5]	2[5]	2[5]	2[5]	3[2]	2[5]	1[3]	7.0
Little Auk	3[5]	1[5]	2[5]	1[5]	3[5]	3[5]	1[3]	2[5]	1[3]	7.0
Shoveler	3[5]	3[5]	5[5]	5[5]	1[5]	0[5]	5[2]	1[5]	4[3]	6.7
Redshank	1[5]	5[5]	5[5]	5[5]	1[5]	0[5]	4[2]	2[4]	4[3]	6.7

Species	**Flight manoeuvrability** Species scored subjectively from a very high flight manoeuvrability (score 1) to low flight manoeuvrability (score 5)	**Flight altitude** 1 = median height 0-5m; 2 = median height 5-10m; 3 = median height 10-20m & 90% < 50m; 4 = median height 10-20m & 90% < 100m; 5 = median height 10-20m & >10% > 100m.	**Percentage of time flying** 1 = 0–20% of time at sea flying; 2 = 21–40% of time at sea flying; 3 = 41–60% of time at sea flying; 4 = 61–80% of time at sea flying; 5 = 81–100% of time at sea flying.	**Nocturnal flight activity** Species scored subjectively from a hardly any flight at night (score 1) to much flight activity at night (score 5)	**Disturbance by ship and helicopter traffic** Species scored subjectively from 1 (very flexible in habitat use) to 5 (reliant on specific habitat characteristics); 0 = not dependent on offshore habitats	**Flexibility in habitat use** Species scored subjectively from 1 (very flexible in habitat use) to 5 (reliant on specific habitat characteristics); 0 = not dependent on offshore habitats	**Biogeographical population size** 1 = >3 million individuals; 2 = >1 million - 3 million individuals; 3 = >500,000 - 1 million individuals; 4 = >100,000 - 500,000 individuals; 5 = <500,000 individuals	**Adult survival rate** 1 = <0.75; 2 = >0.75 - 0.80; 3 = >0.80 - 0.85; 4 = >0.85 - 0.90; 5 = >0.90.	**European Threat & Conservation status** 1 = 'secure' and no SPEC status given; 2 = 'secure' & SPEC status of 4; 3 = ''localized'; 4 = 'declining'; 5 = 'vulnerable'.	**Total sensitivity score** see Garthe & Hüppop (2004) for details of the way in which this is calculated
Pintail	4[5]	3[5]	3[5]	5[5]	1[5]	0[5]	5[2]	1[5]	4[3]	6.3
Storm Petrel	1[5]	1[5]	5	5[5]	1[5]	1[5]	3[3]	2[5]	1[3]	6.0
Fulmar	3[1]	1[1]	2[1]	4[1]	1[1]	1[1]	1[1]	5[1]	1[1]	5.8
Bar-tailed Godwit	2[5]	5[5]	5[5]	5[5]	1[5]	0[5]	4[2]	3[5]	1[3]	5.7
Curlew	2[5]	5[5]	5[5]	5[5]	1[5]	0[5]	3[2]	1[4]	4[3]	5.7
Ringed Plover	1[5]	5[5]	5[5]	5[5]	1[5]	0[5]	5[2]	2[4]	1[3]	5.3
Lapwing	1[5]	5[5]	5[5]	5[5]	1[5]	0[5]	1[2]	2[4]	5[3]	5.3
Sanderling	1[5]	5[5]	5[5]	5[5]	1[5]	0[5]	4[2]	3[4]	1[3]	5.3
Shelduck	4[5]	4[5]	5[5]	5[5]	1[5]	0[5]	4[2]	2[4]	1[3]	5.3
Oystercatcher	2[5]	5[5]	5[5]	5[5]	1[5]	0[5]	2[2]	4[4]	1[3]	5.0
Grey Plover	1[5]	5[5]	5[5]	5[5]	1[5]	0[5]	4[2]	2[5]	1[3]	4.7
Chough	1[5]	5[5]	5[5]	1[5]	1[5]	0[5]	4[3]	1[5]	4[3]	4.5
Golden Plover	1[5]	5[5]	5[5]	5[5]	1[5]	0[5]	3[2]	1[4]	2[3]	4.0
Teal	2[5]	3[5]	5[5]	5[5]	1[5]	0[5]	4[2]	1[4]	1[3]	3.8

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Dunlin	1[5]	5[5]	5[5]	5[5]	1[5]	0[5]	2[2]	1[4]	2[3]	3.3
Wigeon	3[5]	4[5]	4[5]	5[5]	1[5]	0[5]	2[2]	1[4]	1[3]	2.7

[1] Derived from Garthe & Hüppop (2004), [2] Derived from Wetlands International (2006), [3] Derived from BirdLIfe International (2004), [4] Robinson (2005),[5] Expert opinion (IMDM)