Natural England Commissioned Report NECR147

Development of a generic framework for informing Cumulative Impact Assessments (CIA) related to Marine Protected Areas through evaluation of best practice

First published 14 April 2014

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Foreword

Natural England commission a range of reports from external contractors to provide evidence and advice to assist us in delivering our duties. The views in this report are those of the authors and do not necessarily represent those of Natural England.

Background

The increasing development of the marine environment and the rising number, type and size of designated sites means that there is a greater overlap between both direct and indirect pressures associated with human activity and conservation features for which MPAs are designated. Consequently, significantly more emphasis will need to be placed on how environmental assessments consider and evaluate the combined effects of human activity on the marine environment in the future.

This is highlighted in environmental legislation which requires that Environmental Impact Assessments, Strategic Environmental Assessments and Habitats Regulations Assessments fully consider and manage the potential interactions between plans, projects and activities which affect the environment.

This study was commissioned to provide a detailed review and evaluation of methods for conducting cumulative impact assessments (CIA) both within and beyond the marine environment.

Using the outputs of this review the study develops a generic framework for undertaking CIA and provides clear guidance on the processes and steps which could be adopted when undertaking robust and comprehensive CIA for all types of project affecting MPAs. The work has focussed on the scoping and planning of the CIA and provides the foundation for further work on other phases of CIA (including assessment and mitigation).

The findings in this report will be used support Natural England advisors involved in guiding cumulative impact assessments (CIA) of human activities in marine protected areas (MPAs).

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Keywords - climate change impacts, cumulative effects, development (planning), marine, marine aggregates, research

Further information
This report can be downloaded from the Natural England website: **www.naturalengland.org.uk**. For information on Natural England publications contact the Natural England Enquiry Service on 0845 600 3078 or e-mail **enquiries@naturalengland.org.uk**.

ISBN 978-1-78354-102-7

Executive Summary

ABP Marine Environmental Research Ltd (ABPmer) supported by Wildfowl & Wetlands Trust Consulting was commissioned by Natural England to develop a generic framework to support Natural England advisors involved in guiding cumulative impact assessments (CIA) of human activities in marine protected areas (MPAs).

The aim of this study has been to provide a detailed review and evaluation of methods for conducting CIA both within and beyond the marine environment. The review has identified strong case studies and clear outline methodologies from the literature, evaluating where CIA methodologies have worked and their strengths and weaknesses. Building on this review, the study has developed a generic CIA framework, providing clear guidance on the process which could be adopted for robust and comprehensive CIA for all projects affecting MPAs. The study has then applied the idealised CIA framework in a hypothetical case study to test and demonstrate its use and value. The study has focussed on the scoping and planning of the CIA and provides the foundation for further work on other phases of CIA (including assessment and mitigation).

The increasing development of the marine environment and the rising number, type and size of designated sites means that there is a greater overlap between both direct and indirect pressures[1] associated with human activity and conservation features for which MPAs are designated. Consequently, significantly more emphasis will need to be placed on how environmental assessments consider and evaluate the combined effects of human activity on the marine environment in the future. This is highlighted in environmental legislation which requires that Environmental Impact Assessments (EIA), Strategic Environmental Assessments (SEA) and Habitats Regulations Assessments (HRA) fully consider and manage the potential interactions between plans, projects and activities which affect the environment.

For the purposes of this study, the recent guiding principles work that was undertaken by RUK/NERC (2013) is considered to have the most comprehensive and appropriate definition of cumulative impacts: "*those that result from additive effects caused by other past, present or reasonably foreseeable actions together with the plan, programme or project itself and synergistic effects (in-combination) which arise from the reaction between effects of a development plan, programme or project on different aspects of the environment*".

Literature Review

Case Studies

A review has been carried out of several CIAs that have been undertaken recently as part of EIAs. Strong case studies that provide clear CIA methodologies and enable their strengths and weaknesses to be evaluated have been selected. These span a range of sectors and cover key ecological receptors of relevance to MPAs, namely habitats, marine mammals, birds and/or fish. The case studies include projects of varying scale, although necessarily focusing more on larger developments which tend to undertake more robust and comprehensive CIA. Although this study selected a contrasting range of strong case studies that had undertaken CIA, there were still significant weaknesses in a number of the assessments and none of the case studies included all the elements that might be expected in an idealised CIA.

[1] Environmental changes brought about by activities (e.g. generation of noise by piling or increase in suspended sediments).

Methodologies

A targeted literature search was undertaken to identify academic papers and/or guidance documents on the overall CIA process. The literature search focussed on systematic and quantitative methods to support the development of the generic framework and identifying any variation in CIA across different industries.

A number of key guidance and research papers were identified. These included CEQ (1997) and Hyder (1999) which provide relatively early and sound guidance on CIA in the United States and Europe respectively. More recently, a number of initiatives have been taken forward in the UK, mainly driven by the requirements to adequately assess the cumulative impacts of offshore wind development. These include work to develop methodologies for CIA for seabirds (King et al., 2009), a general review of CIA for offshore wind farm development (MMO, 2013 in draft) and work to develop guiding principles for offshore wind CIA (RUK/NERC, 2013).

Assessment Tools

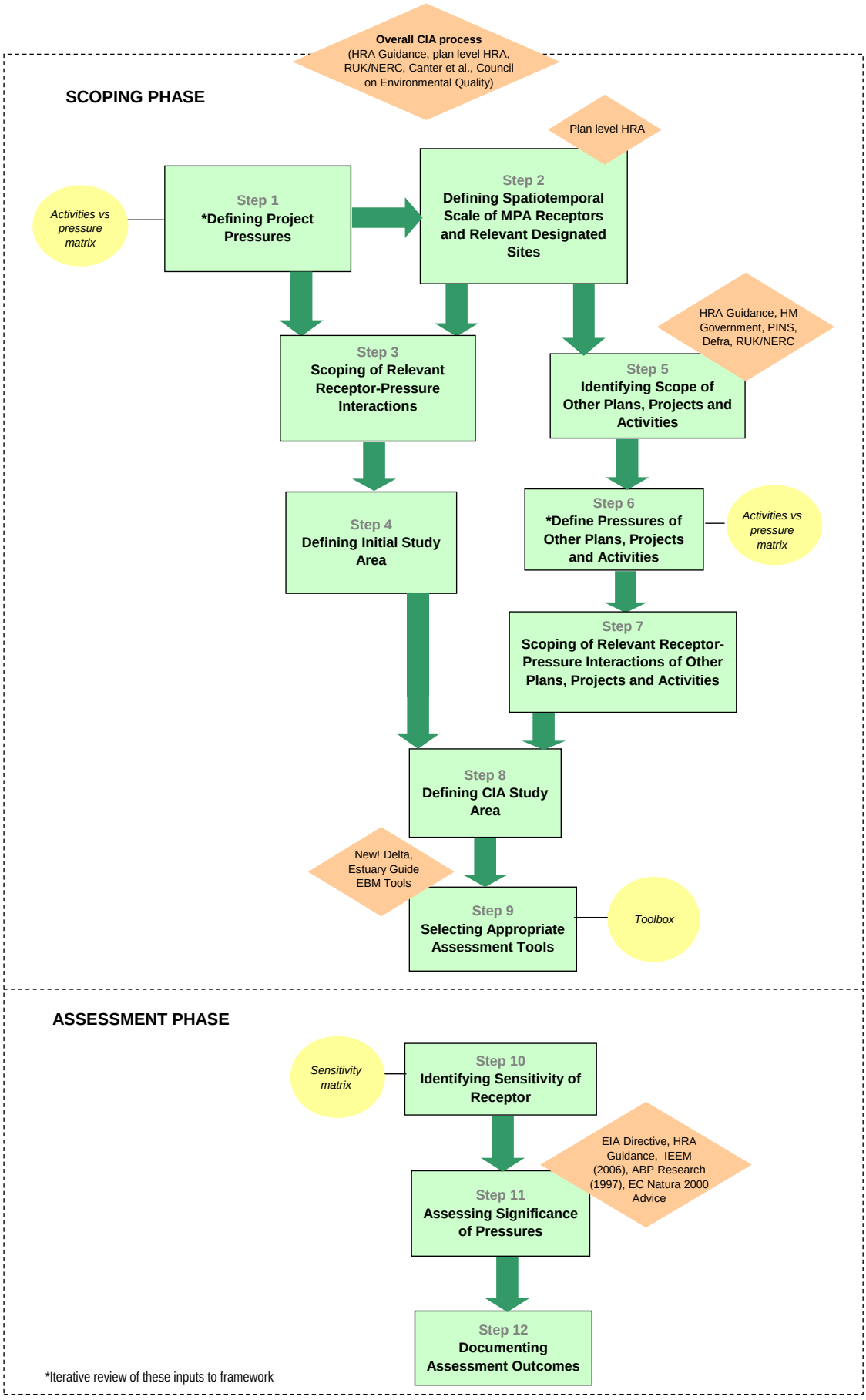
As part of the review, the range of assessment tools that can be used for assessing major cause and effect pathways within environmental assessments and CIAs have been identified and reviewed. These assessment tools range from simple desk-based assessments through to complex modelling tools.

In selecting suitable tools and methods for CIA, it is important to seek to ensure that they are fit for purpose, for example, appropriate to use with the available data, the errors surrounding impact estimates are understood, and that the level of resolution of assessment tools and methods are appropriate to the issues being assessed.

Development of a Generic Framework for CIA

The main aim of this study has been to produce a comprehensive yet standardised framework that is practical, logical and usable by Natural England case officers advising on CIA of human activities affecting MPA features. The framework that has been developed is applicable across all sectors and will allow case officers to advise on projects of varying scales from an individual jetty construction to offshore wind farm development. It has been based on what is considered to be best practice in project-level EIA and incorporates the key criteria and considerations for CIA, drawing on guidance in the literature. Without being overly prescriptive, the framework has been designed to ensure that a clear audit trail of the evidence and assumptions underlying the CIA is followed, and promotes a quantitative, systematic and predictive approach to CIA.

The generic framework that has been developed is shown below. The key process steps involved in the CIA are outlined in the green boxes, a variety of supporting tools in the form of matrices are identified in the yellow circles and relevant guidance and/or information sources are highlighted in orange diamonds. The main focus within this study is on scoping to ensure that this process is as robust as possible as this will greatly facilitate the preparation of meaningful CIAs.


Overall CIA process
(HRA Guidance, plan level HRA, RUK/NERC, Canter et al., Council on Environmental Quality)
SCOPING PHASE
Plan level HRA
Activities vs pressure matrix
Step 1
*Defining Project Pressures
Step 2
Defining Spatiotemporal Scale of MPA Receptors and Relevant Designated Sites
HRA Guidance, HM Government, PINS, Defra, RUK/NERC
Step 3
Scoping of Relevant Receptor-Pressure Interactions
Step 5
Identifying Scope of Other Plans, Projects and Activities
Step 4
Defining Initial Study Area
Step 6
*Define Pressures of Other Plans, Projects and Activities
Activities vs pressure matrix
Step 7
Scoping of Relevant Receptor-Pressure Interactions of Other Plans, Projects and Activities
Step 8
Defining CIA Study Area
New! Delta, Estuary Guide EBM Tools
Step 9
Selecting Appropriate Assessment Tools
Toolbox
ASSESSMENT PHASE
Sensitivity matrix
Step 10
Identifying Sensitivity of Receptor
EIA Directive, HRA Guidance, IEEM (2006), ABP Research (1997), EC Natura 2000 Advice
Step 11
Assessing Significance of Pressures
Step 12
Documenting Assessment Outcomes
*Iterative review of these inputs to framework

The main report provides a series of underlying review questions within each of the steps in the CIA framework that Natural England case officers should consider as part of their review of CIA methodologies within scoping documents and/or assessments within EIAs or HRAs. These are likely to comprise the essential building blocks for their advice to developers (e.g. scoping response).

The generic framework for CIA has been applied to a hypothetical offshore wind farm case study to test its practicability and determine any methodological limitations. This demonstrated that the CIA framework could be used to determine complex issues associated with CIA for large-scale developments.

Discussion

There are a number of challenges in applying and reviewing CIA, particularly given the complex nature of the marine environment. These difficulties are often passed on to regulators and their advisors, and can lead to unnecessary delays or lack of rigour in the decision making process. The key challenges and some suggested methods of overcoming them are discussed in more detail in the main report and outlined as follows:

- Lack of clear and consistent guidance;
- Difficulties in defining spatiotemporal scales and CIA study areas;
- Uncertainties in characterising the magnitude of pressures;
- Uncertainties in cause and effect relationships;
- Challenges in assessing significance of impacts;
- Piecemeal nature of CIAs undertaken within EIAs;
- Proportionate CIA; and
- Managing uncertainty in assessment outcomes.

Recommendations

While it is not feasible to resolve all of the challenges of undertaking CIA in the short-term, it is possible to make significant progress in a number of areas which will greatly assist with the preparation of more meaningful CIAs. Based on the findings of this study, the following recommendations are proposed:

- Develop guidance to enable the CIA framework to be trialled on a range of development projects;
- Develop guidance for developers on the general process that developers are expected to follow in undertaking CIA, based on the framework developed in this study;
- Develop guidance on how CIA information should be presented in EIAs and HRAs to enhance consistency and audit trails;
- Develop and promote resources to support CIA such as:
    - Information on the functional use of the marine environment by mobile species;
    - Information on pressures that can be associated with different development activities;
    - Information on impact pathways associated with particular development activities;
    - Information on the sensitivity of MPA features to human pressures;

- Databases of extant and future projects and relevant activities in areas subject to multiple developments; and
- Development of validated receptor-specific CIA models.

- Undertake further research on how to assess cumulative impact significance i.e. determining unacceptable thresholds of change and tipping points that trigger synergistic impacts.

Abbreviations

AA	Appropriate Assessment
ABP	Associated British Ports
ABPmer	ABP Marine Environmental Research Ltd
AC	Alternating current
AIS	Automatic Identification System
BMAPA	British Marine Aggregates Producers Association
BTO	British Trust for Ornithology
CEA	Cumulative Environmental Assessment
CEQ	Council on Environmental Quality
CIA	Cumulative Impact Assessment
COWRIE	Collaborative Offshore Wind Research Into The Environment
Defra	Department of Environment, Food and Rural Affairs
DETR	Department of the Environment, Transport and the Regions
DP	Descriptive predictions
DPSIR	Driver, Pressure, State, Impact, Response
DSOWF	Docking Shoal Offshore Wind Farm
EB	Effects based
EC	European Commission
EEC	European Economic Community
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
ENVID	Environmental Issues Identification
ES	Environmental Statement
ESAS	European Seabirds at Sea
EU	European Union
FAME	The Future of the Atlantic Marine Environment
FPSO	Floating Production Storage and Offloading
GES	Good Environmental Status
GIS	Geographic Information Systems
GWF	Galloper Wind Farm
HM	Her Majesty's
HRA	Habitats Regulations Assessment
HRGN	Habitats Regulations Guidance Note
HVDC	High Voltage Direct Current
ICZM	Integrated Coastal Zone Management
IECS	Institute of Estuarine and Coastal Studies
IEEM	Institute of Ecology and Environmental Management
IEMA	Institute of Environmental Management and Assessment
IFC	International Finance Corporation
JNCC	Joint Nature Conservation Committee
Km	Kilometre
MAREA	Marine Aggregate Regional Environmental Assessments
MarLIN	Marine Life Information Network
MCZ	Marine Conservation Zone
MMO	Marine Management Organisation
MPA	Marine Protected Area
MSFD	Marine Strategy Framework Directive
MW	Megawatt
NERC	Natural Environment Research Council
N-RIP	National Renewables Infrastructure Plan
OSP	Offshore Substation Platform

OSPAR	Oslo/Paris convention (for the Protection of the Marine Environment of the North-East Atlantic)
OWF	Offshore Wind Farm
PAM	Passive acoustic monitoring
PCAD	Population Consequences of Acoustic Disturbance
PINS	Planning Inspectorate
PVA	Population Viability Analysis
QP	Quantitative Predictions
R-SEA	Regional Strategic Environmental Assessment
RBMP	River Basin Management Plans
RFFA	Reasonably Foreseeable Future Activities
RFFP	Reasonably Foreseeable Future Projects
RSPB	Royal Society for the Protection of Birds
RUK	Renewables UK
SAC	Special Area of Conservation
SB	Stressor-indicator based
SCANS	Small Cetacean Abundance in the European Atlantic and North Sea
SCOS	Special Committee on Seals
SEA	Strategic Environmental Assessment
SI	Scoping and Identification
SNCB	Statutory Nature Conservation Body
SNH	Scottish Natural Heritage
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
UK	United Kingdom
US	United States
USA	United States of America
WeBS	Wetland Bird Survey
WFD	Water Framework Directive

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1. Introduction

ABP Marine Environmental Research Ltd (ABPmer) supported by Wildfowl & Wetlands Trust Consulting was commissioned by Natural England to develop a generic framework to support Natural England advisors involved in guiding cumulative impact assessments (CIA) of human activities in marine protected areas (MPAs).

As development in the marine environment has intensified and expanded, and the number, size and type of designated areas have also increased, the level of spatial overlap between human induced environmental effects and conservation features has magnified. Consequently significantly more emphasis now needs to be placed on the consideration and evaluation of cumulative impacts on the marine environment. As a statutory conservation body working closely with industry and regulatory authorities, Natural England has prioritised the development of skills, understanding and tools to support the CIA process, in order to provide well–informed advice on the potential for cumulative impacts on England's suite of protected sites.

1.1 Mission Statement

The aim of this study has been to provide a detailed review and evaluation of methods for conducting CIA both within and beyond the marine environment. The review has identified strong case studies and clear outline methodologies from the literature, evaluating where CIA methodologies have worked and their strengths and weaknesses. Building on this review, the study has developed a generic CIA framework, providing clear guidance on the process which could be adopted for robust and comprehensive CIA for all projects affecting MPAs. In particular, matrices and other assessment tools have been identified to support the CIA framework. The study has then applied the idealised CIA framework in a hypothetical case study to test its use and value.

This report is the first stage of what is an ongoing programme of research and development on CIA. The framework has focussed on the scoping and planning of the CIA. The development of CIA advice needs to be iterative and further research will be required to develop guidance for other phases of CIA, including the assessment phase and evaluation of impact significance (e.g. determination of thresholds, tipping points, population changes), and mitigation measures. This work, however, provides the foundation upon which such further work could be based.

1.2 Report Structure

This report has been structured as follows:

Section 2 **Literature Review –** a detailed literature review of case studies and CIA methodologies has been undertaken using material gathered from industry and academia both nationally and internationally;

Section 3 **Development of Generic Framework –** the lessons learnt from the literature review have been pulled together to inform and refine a workable CIA framework for human activities in MPAs;

Section 5 **Discussion –** a discussion of the difficulties in implementing marine CIA and potential pit falls and uncertainties; and

Section 6 **Recommendations –** a summary of the key recommendations of the study.

2. Literature Review

2.1 Overview of Cumulative Impact Assessment

2.1.1 Background

The increase in development in the marine environment and the number and size of designated sites means that there is a greater overlap between both direct and indirect pressures[2] associated with human activity and conservation features for which MPAs are designated. Consequently, significantly more emphasis will need to be placed on how environmental assessments consider and evaluate the combined effects of human activity on the marine environment. This emphasis is highlighted in environmental legislation which requires that Environmental Impact Assessments (EIA), Strategic Environmental Assessments (SEA) and Habitats Regulations Assessments (HRA) fully consider and manage the potential interactions between plans, projects and activities which affect the environment (see Section 2.1.1). While the focus of this study is centred on CIA for MPAs, more general principles for CIA are relevant, as well as the particular requirements under the EC Habitats and Wild Birds Directives together with any specific approaches developed for Marine Conservation Zones (MCZs) designated under the Marine and Coastal Access Act 2009.

CIAs prepared as part of environmental assessments for projects in England have been described as inadequate and unsatisfactory across all industry sectors (IEMA, 2011). Bad practice is not restricted to England, but widespread across Europe and North America (Duinker and Greig; 2006; Masden et al., 2009). There are many reasons for this including availability of information to undertake a meaningful assessment, the costs of undertaking detailed CIA, the lack of detailed guidance provided by regulators (Cooper and Sheate, 2002) and review by regulators of assessments lacking in rigour (Duinker and Greig, 2006).

Although CEQ (1997), Hegmann et al. (1999) and Hyder (1999) provided relatively early and sound guidance on CIA, due to some of the reasons outlined above, its uptake and implementation has been slow. US and Canadian guidance on the assessment of cumulative impacts (CEQ, 1997; Hegmann et al., 1999), although helpful, was designed to fit the respective countries' EIA procedures, which vary from the EIA implementing procedures in England. The EC Guidance on CIA (Hyder, 1999), however, does not provide an explicit framework for CIA (Cooper and Sheate, 2002). In recent years, a number of initiatives have been taken forward in the UK, particularly driven by the requirements to adequately assess the cumulative impacts of offshore wind development. These include work to develop methodologies for CIA for seabirds (King et al., 2009), a general review of CIA for offshore wind farm development (MMO, 2013 in draft) and work to develop guiding principles for offshore wind CIA (RUK/NERC, 2013).

While CIA is conceptually straightforward, it is difficult to implement in practice. In particular, sufficient information on the pressures associated with other plans, projects and activities is often lacking, making it difficult to undertake a meaningful assessment. Issues often arise in seeking to define an appropriate spatial scale for

[2] Environmental changes brought about by activities (e.g. generation of noise by piling or increase in suspended sediments, see Section 2.1.3.1).

the assessment of relevant receptor[3] groups in order to keep the assessment manageable and proportionate to the environmental risks posed by the proposed development that triggers the requirement for CIA. There are also particular challenges in seeking to quantify the effects of multiple pressures of different types on a receptor (for example, how to evaluate the combined effects of habitat loss, disturbance, increased turbidity and underwater noise on the spawning success of herring).

In addition, certain sectors have attempted to simplify the CIA process by splitting the scope of the cumulative assessment into cumulative assessment (e.g. all aggregate activities) and 'in-combination' assessment (e.g. aggregate activities with other sector activities). The Marine Aggregate Regional Environmental Assessments (MAREAs) are a non-statutory and voluntary initiative introduced by the UK marine aggregate dredging industry in 2003 to assess cumulative effects of marine aggregate extraction across regions. They did not assess cumulative impacts with other sectors; this was left for the individual EIAs to take account of.

CIAs also often wrongly seek to restrict the range of human activities considered, for example, by focusing on the effects stemming from other plans and projects and tend to ignore effects associated with existing activities. From an ecosystem perspective, CIA can be helpful in identifying and evaluating the influence of the totality of current and reasonably foreseeable future human pressures on the marine environment and the extent to which this might cause changes from current environmental state. In going forward, it is therefore desirable to adopt an ecosystem approach to ensure that CIAs are meaningful.

2.1.2 Legislative Drivers

All proposals for projects that are subject to the EC Environmental Impact Assessment (EIA) Directive (85/337/EEC, as amended by the Directives 97/11/EC, 2003/35/EC, 2009/31/EC, and replaced by 2011/92/EU), must be accompanied by an Environmental Statement (ES) describing the aspects of the environment likely to be significantly affected by the project. The Directive requires that the "*potential significant effects of projects must be considered in relation to… the cumulation of impacts with the impacts of other projects (in particular existing and/or approved) by the same or different developers*". In late 2012, the European Commission issued proposals for possible revisions to the EIA Directive (EC, 2012) although none of these proposed revisions have particular implications for CIA.

Separately, the EC Habitats Directive (92/43/EEC) requires that "*any plan or project not directly connected with or necessary to the management of the site[4] 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"*. In accordance with the Directive, in-combination effects need to be considered for relevant Natura 2000 site features (habitats and species) (see Section 2.1.2.1). The overall process of screening for likely significant effects and, where appropriate, the undertaking of an Appropriate Assessment (AA) is known as a Habitats Regulations Assessment (HRA). The Habitats Directive is implemented in England and Wales through The Conservation

[3] Any ecological or other defined feature (e.g. marine mammals) that is sensitive to or has the potential to be affected by an impact (IEEM, 2010).

[4] Natura 2000 sites include Special Areas of Conservation (SAC) designated under the Habitats Directive and Special Protection Areas (SPA) classified under the EC Wild Birds Directive (2009/147/EC codified version).

of Habitats and Species Regulations 2010 (as amended), which consolidate all the various amendments made to the Conservation (Natural Habitats &c.) Regulations 1994 in respect of England and Wales, and The Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007.

Cumulative impacts are also referred to in the Strategic Environmental Assessment (SEA) Directive (2001/42/EC) on the assessment of certain plans and programmes on the environment. The Directive requires information to be provided on "*the likely significant impacts including cumulative and synergistic impacts… on the environment*."

Despite these legal requirements for CIA, no appropriate definition of cumulative effects, or standard guidance on scope or methods of assessment is available, creating an uncertain regulatory environment for industry and practitioners (Masden et al., 2009).

2.1.2.1 In-combination assessment

There has been a considerable amount of confusion about the scope of CIA, in part brought about by differing terminology used in the EIA Directive ('cumulative effects') and the Habitats Directive ('in-combination assessment'). In the case of an EIA, the baseline is usually established by describing conditions as they are at the present time and also defining a future baseline. The HRA, on the other hand, considers the integrity of Natura 2000 sites at the time they were designated.

The integrity of a Natura 2000 site relates to the site's conservation objectives and has previously been defined as "*the integrity of a site is the coherence of its ecological structure and function, across its whole area, that enables it to sustain the habitat, complex of habitats and/or the levels of populations for which it was classified*"[5]. In this way, a site can be described as having a high degree of integrity where the inherent potential for meeting site conservation objectives is realised, the capacity for self-repair and self-renewal under dynamic conditions is maintained, and a minimum of external management support is required (EC, 2000). The opinion of the advocate general in the recent Sweetman case provides further guidance on the notion of site integrity which "*must be understood as referring to the continued wholeness and soundness of the constitutive characteristics of the site concerned*"…"*The integrity that is to be preserved must be that 'of the site'. In the context of a natural habitat site, that means a site which has been designated having regard to the need to maintain the habitat in question at (or to restore it to) a favourable conservation status*"[6].

In terms of the HRA, the baseline may change as further understanding of the site develops. This may have implications for the baseline which is used for the purposes of a CIA. For example, it may be necessary to take account of effects from development already built and operational (i.e. past projects), as these may have or represent an ongoing effect on the integrity of the Natura site since its designation.

2.1.3 Terminology

2.1.3.1 Impacts and effects

Literature and practice display a high level of inconsistency in the use of terminology with 'impact' and 'effect' used interchangeably. The position is not helped by the

5 Paragraph 20 page 9 ODPM Circular 06/2005.

6 Sweetman, Minister for the Environment, Heritage and Local Government (Ireland) V Galway County Council, Galway City Council.

legislation, with the EIA Directive referring to the assessment of 'significant effects' and the SEA Directive referring to 'significant impacts'.

Various attempts have been made to rationalise the terminology but with limited success. For example, some practitioners consider that an 'effect' can be likened to an environmental change, which depending on the sensitivity of the receptor being assessed, may or may not result in an 'impact'. In contrast, RUK/NERC (2013) considered an impact to be an environmental change that may not necessary give rise to an effect!

For the purposes of this study, we support the approach adopted by MMO (2013 in draft) which is based on the framework adopted by the European Environment Agency for describing the interaction of effects between development and the environment: the Driver, Pressure, State, Impact, Response (DPSIR) model. The DPSIR approach requires a sound understanding of DRIVERS of change, such as offshore wind energy or navigational dredging. These drivers create a series of distinct PRESSURES, for example the generation of noise by piling or increase in suspended sediments. The STATE refers to the characteristics of the existing environment or ecological receptors. A PRESSURE, when exerted, may result in a change in STATE that can be considered to be an effect. This might include a change in the population of a particular fish, bird or mammal species; a modification of the habitat; a change to the local hydrodynamics; or the introduction of a contaminant. This STATE change is considered to represent an IMPACT if certain effects thresholds are exceeded (e.g. x% of a population of harbour porpoise is disturbed by construction activity; y km^2 of modified habitat is created). In other words, pressures can have an effect on the state of an environmental receptor, which can result in an impact if certain limits are exceeded.

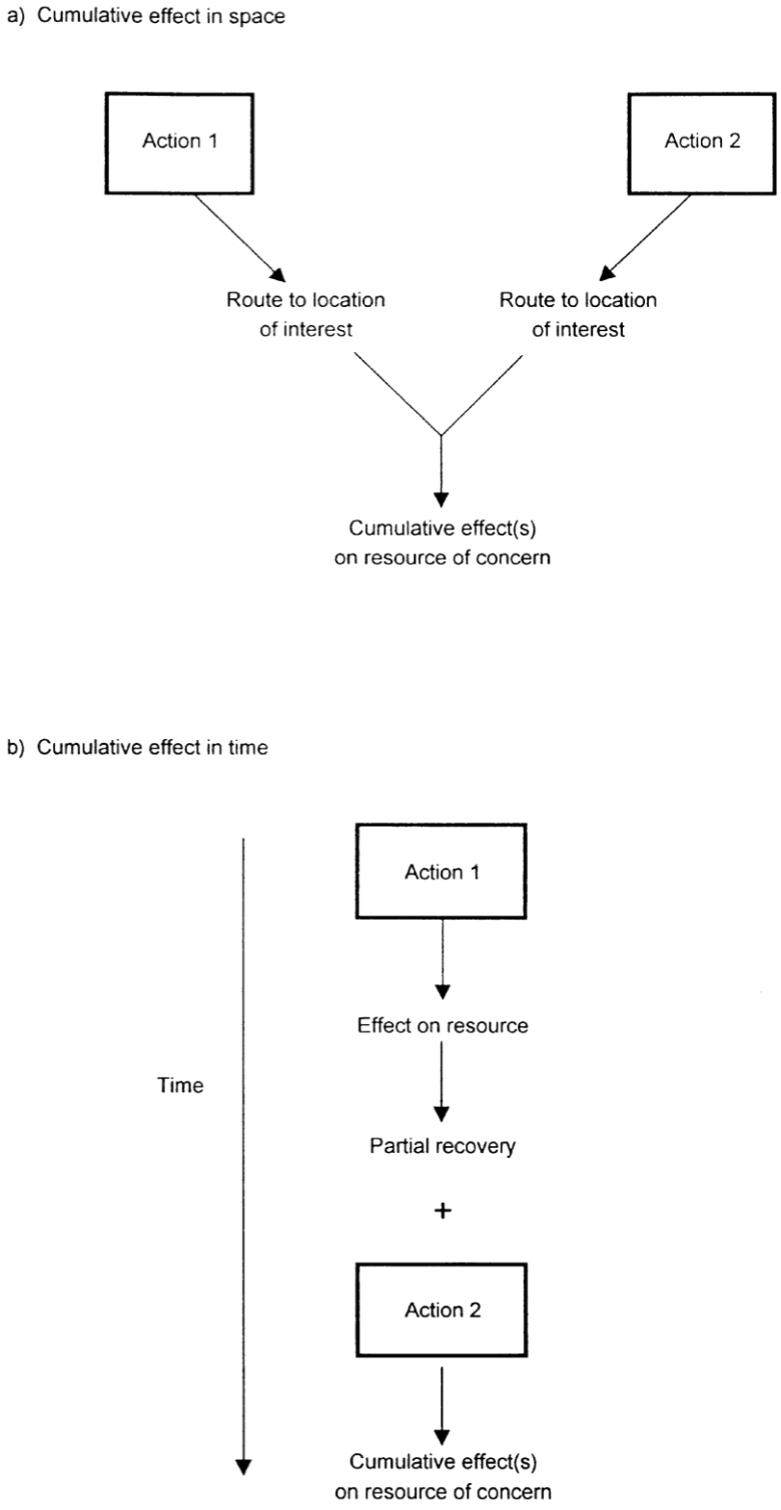
2.1.3.2 Cumulative impacts

Cumulative impacts result from the combined impacts of human pressures. They can be positive or negative, as well as either direct (e.g. loss of habitat) or indirect (e.g. changes in suspended sediments). They can result from effects arising from a single development (i.e. intra-project effects) as well as effects arising from multiple developments (i.e. inter-project effects). These could include multiple impacts of the same type acting on a single receptor or environmental resource. In addition, the environmental effects on a single receptor may not be regarded as significant when considered in isolation. However, when individual effects can interact, they should be considered in combination, which may result in the cumulative effect being significant. For example, marine mammals may be affected by adverse effects in terms of noise, water quality and visual impact combined. Furthermore, cumulative effects can occur both spatially across geographic areas (e.g. from multiple activities at different locations) and temporally over time (e.g. by sequential activities if the initial effect persists and interacts with subsequent activities). The spatiotemporal element to cumulative effects is depicted in Figure 1.

There are many definitions of cumulative impacts to categorise or explain different types of impact and also depending on the context in which the term is applied. This could be helpful in some cases but in reality it might lead to confusion as many of these terms actually refer to the same thing. In addition, many of the definitions and explanations of the concept of cumulative effects often appear complicated and thus not easily understandable to the layperson.

The choice of definition used for cumulative effects in EIAs is, however, important (Warnback, 2007). Some studies point out that there is a relationship between the

definition used in EIAs and the scope of the cumulative assessment. An assessment using a narrow definition like "*combined effects of different components of a project/development*" was typically found to focus on the impacts of a certain type of activity, whereas the use of a broader definition tended to include a wider range of unrelated activities in the consideration of potential cumulative effects (Cooper and Sheate, 2002).



(Source: MacDonald, 2000)

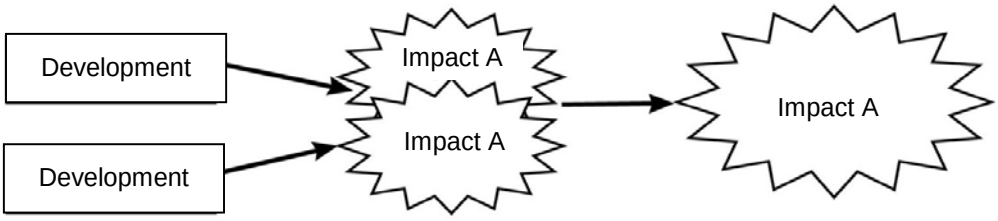
Figure 1. Cumulative effects resulting from a combination of activities in (a) space or (b) time

Following the introduction of the requirement to assess cumulative effects, a number of countries developed guidance in response to concerns that the legal requirements had exceeded the ability of the science to deliver (Connelly, 2011). Key examples include:

- Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions, EU (Hyder, 1999);
- Considering Cumulative Effects, Under the National Environmental Policy Act, United States (CEQ, 1997); and
- Effects Assessment, Practitioners Guide, Canada (Hegmann et al., 1999).

Definitions of cumulative impacts and other related impacts in the European guidelines (Hyder, 1999) are as follows.

Cumulative Impacts: Impacts that result from incremental changes caused by other past, present or reasonably foreseeable actions together with the project.

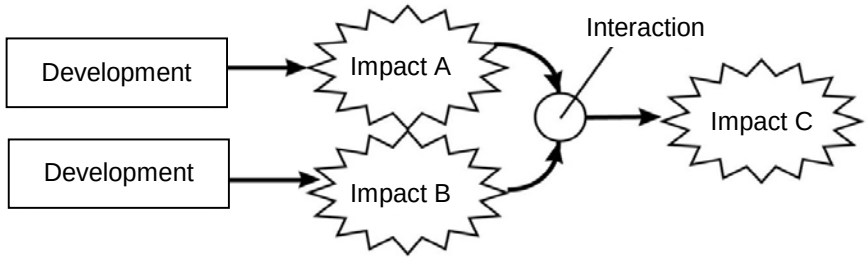


Cumulative Impact

Indirect Impacts: Impacts on the environment, which are not a direct result of the project, often produced away from or as a result of a complex pathway. Sometimes referred to as second or third level impacts, or secondary impacts.

Indirect Impact

Impact Interactions: The reactions between impacts, whether between the impacts of just one project, or between the impacts of other projects in the areas. These interactions can be manifested as additive, antagonistic/synergistic, or a combination of these.



Impact Interaction

Guidelines from the US (CEQ, 1997), define cumulative impacts as "*the impact on the environment which results from the incremental effects of an action when considered together with other past, present and reasonably foreseeable future actions regardless of who undertakes such other actions*".

A cumulative effect is defined in the Canadian practitioners guide (Hegmann et al., 1999) as an "*effect on the environment that results from the incremental, accumulating and interacting impacts of an action when added to other past, present and reasonably foreseeable future actions*".

For the purposes of this study, the recent guiding principles work that was undertaken by RUK/NERC (2013) is considered to have the most comprehensive and appropriate definition of cumulative impacts (see box below). This definition includes the current state of the environment, rather than just impacts of various actions.

Cumulative impacts are those that result from additive effects caused by other past, present or reasonably foreseeable actions together with the plan, programme or project itself and synergistic effects (in-combination) which arise from the reaction between effects of a development plan, programme or project on different aspects of the environment (RUK/NERC, 2013).

2.1.3.3 Cumulative impact assessment

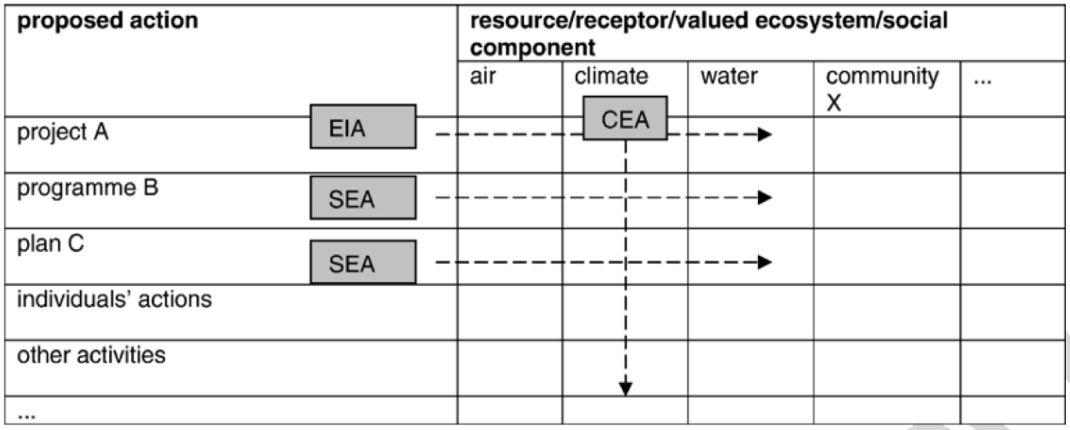
The phrase cumulative effect assessment (CEA) is used interchangeably in industry and literature with CIA. Only one term should be used in any single document in order to avoid confusion (Natural England, 2007). Although the original specification for this study used the term CEA, this report now refers to the term CIA to bring into line with the recent CIA guiding principles study (RUK/NERC, 2013). Although this differs to MMO (2013 in draft), which refers to CEA, CIA is considered more appropriate given that the ultimate goal of the process is to assess the impact of cumulative pressures and effects (see Section 2.1.3.1).

CIA is a systematic procedure for identifying and evaluating the significance of the cumulative impacts from multiple pressures and/or activities and the analysis of the causes, pathways and consequences of these effects within the framework of the impact assessment process (MMO, 2013 in draft). CIA involves analysing the potential impacts and risk on the chosen receptors over time, and also proposing concrete measures to avoid, reduce, or mitigate such cumulative impacts and risk to the extent possible (Essa Technologies Ltd. and IFC, 2013).

The objectives for CIA as outlined by Essa Technologies Ltd. and IFC (2013) are to:

- Ensure that the proposed development's cumulative social and environmental impacts and risks will not exceed a threshold that could compromise the sustainability of receptors;
- Ensure that the proposed development's value and feasibility are not limited by cumulative social and environmental impacts and risks; and
- Support development of regional governance structures for decision making and managing cumulative impacts.

Whereas an EIA focuses on assessing the effects of a project and SEA does the same but for strategic plans or programmes, a CIA focuses on the receiving environment and considers all the effects on a given receptor (Therivel and Ross, 2007; Essa Technologies Ltd. and IFC, 2013). This is illustrated in Figure 2 below.

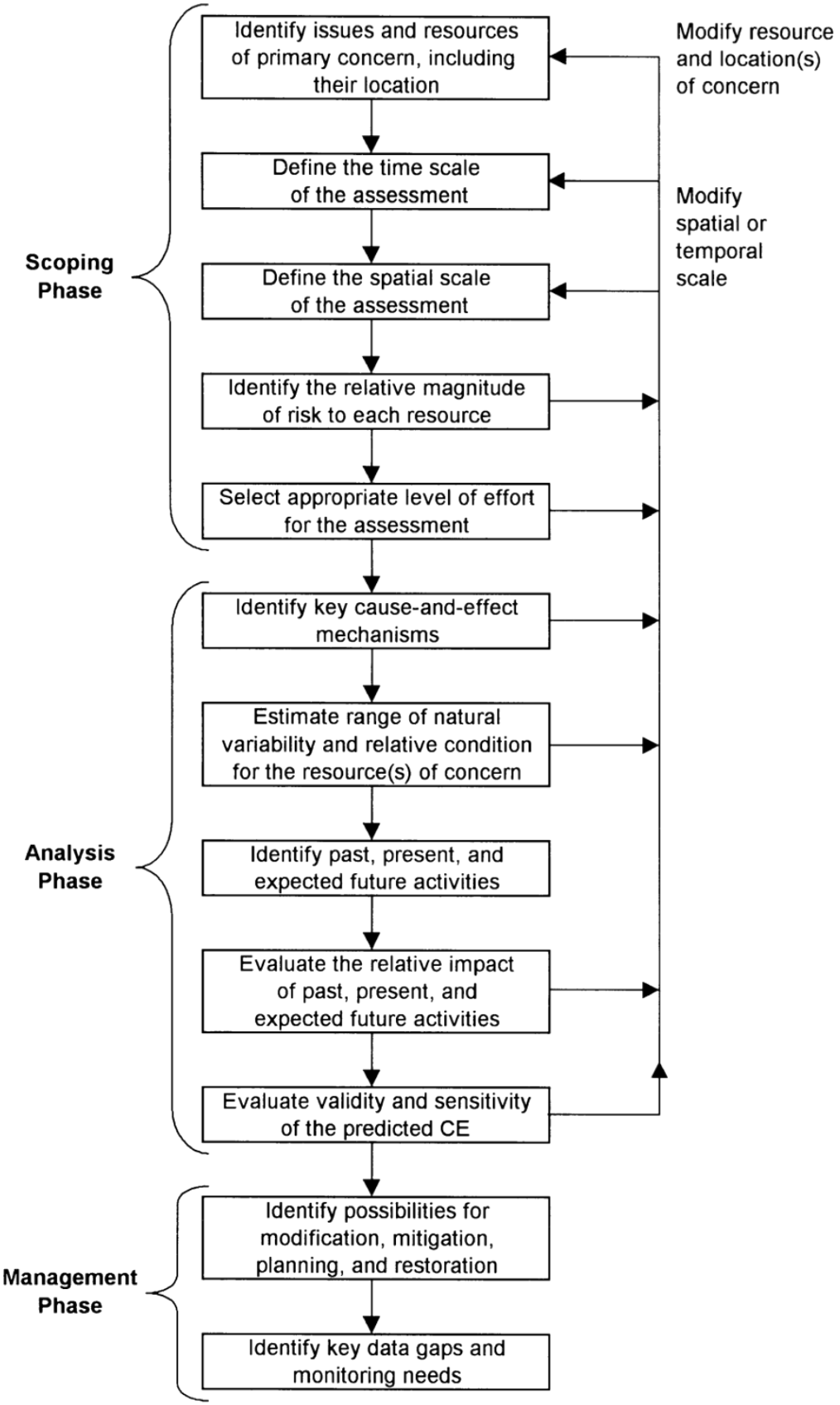


(Source: Therivel and Ross, 2007)

Figure 2. Schematic of CIA/ CEA versus EIA and SEA process

2.1.4 Cumulative Impact Assessment Approach

The majority of guidance documents that have been reviewed are fairly consistent in advising how to undertake a CIA (Hyder 1999; CEQ, 1997; Hegmann et al., 1999; Therivel and Ross, 2007; Essa Technologies Ltd. and IFC, 2013 etc.). MacDonald (2000) provides a comprehensive conceptual process for assessing cumulative effects, based on an extensive literature review, practical experience and case law. The CIA process itself is divided into three main phases: the scoping phase, analysis phase, and implementation and management phase (Figure 3). Each of the phases is further divided into interrelated steps. Although the process that is illustrated in Figure 3 is linear, in practice the assessment is almost always an iterative process and not necessarily in sequence. Each of the steps in the process, however, is considered critical to the overall assessment, and the omission of a step will typically lead to an incomplete or flawed analysis.



(Source: MacDonald, 2000)

Figure 3. Conceptual process for assessing cumulative effects

2.1.5 Principles of Cumulative Impact Assessment

Although no universally accepted framework for CIA exists, general principles as outlined in CEQ (1997) and summarised here in Table 1 have gained acceptance. Each of these principles illustrates a property of CIA that differentiates it from traditional EIA. The principles can be used to facilitate the CIA process planning, implementation and evaluation.

Table 1. Eight principles of CIA (Source: CEQ, 1997)

Steps	CIA Principles
1	Cumulative effects are caused by the aggregate of past, present and reasonably foreseeable future actions.
2	Cumulative effects are the total effect, including both direct and indirect effects, on a given resource, ecosystem and human community of all actions taken.
3	Cumulative effects need to be analysed in terms of the specific resource, ecosystem, and human community being affected.
4	It is not practical to analyse the cumulative effects of an action on the universe; the list of environmental effects must focus on those that are truly meaningful.
5	Cumulative effects on a given resource, ecosystem and human community are rarely aligned with political or administrative boundaries.
6	Cumulative effects may result from the accumulation of similar effects or the synergistic interaction of different effects.
7	Cumulative effects may last for many years beyond the life of the action that caused the effects.
8	Each affected resource, ecosystem and human community must be analysed in terms of its capacity to accommodate additional effects, based on its own time and space parameters.

Guiding principles for CIA have been developed further most recently by RUK/NERC (2013) specifically for the offshore wind farm industry but the key messages are more widely applicable. The main recommendation from this study, which concurred with CEQ (1997), was that the focus should be on producing meaningful assessments, which strike the right balance between pragmatism and precaution and provide a meaningful analysis of the environmental effects of any developments while allowing development to proceed in a timely fashion. Furthermore, RUK/NERC (2013) suggested that the emphasis should be on the assessment of potentially significant effects rather than on comprehensive cataloguing of every conceivable effect that might occur. In summary, a meaningful assessment should be based on:

- Establishing and assessing risks;
- Collaboration;
- A transparent uncertainty management process;
- Clearly acknowledging the role of “expert opinion” in the assessment of significance;
- Sufficient data of an appropriate agreed quality;
- Transparency of the CIA process in developers’ assessment reports;
- Clear and transparent guidance from both regulators and advisors;
- An agreed appropriate spatial and temporal resolution;
- A process involving periodic review and re-assessment;
- Methods that permit joint analysis of data and effects from current, past and future projects, necessitating timely sharing of data and outputs;
- Assessing the total/cumulative effects on the environment/sensitive receptors plus underlying trends;

- Identifying all Reasonably Foreseeable Future Projects (RFFP) for which sufficient information is available;
- Identifying limits of what is tolerable (i.e. ecological thresholds or headroom) and comparing the total/cumulative effects against the limits of tolerability, using the precautionary principle; and
- Using the resulting information as a sound basis for decision-making within acceptable timeframes.

The guiding principles that were developed by the RUK/NERC study are outlined in Table 2 and described in more detail in Appendix A:

Table 2. Eleven principles of CIA (Source: RUK/NERC, 2013)

Steps	CIA Principles
1	CIA is a project level assessment, carried out as part of a response to the requirements of the European EIA, Habitats and Wild Bird Directives, designed to identify potentially significant impacts of developments and possible mitigation and monitoring measures.
2	Developers, regulators and stakeholders will collaborate on CIA.
3	Clear and transparent requirements for CIA to be provided by regulators and their advisors.
4	CIAs will include early, iterative and proportionate scoping.
5	Boundaries for spatial and temporal interactions for CIA work should be set in consultation with regulators, advisors and other key stakeholders, in line with best available data.
6	Developers will utilise a realistic Project Design Envelope.
7	Developers will consider projects, plans and activities which have sufficient information available in order to undertake the assessment.
8	The sharing and common analysis of compatible data will enhance the CIA process.
9	CIA should be proportionate to the environmental risk of the project and focused on key impacts and sensitive receptors.
10	Uncertainty should be addressed and where practicable quantified.
11	Mitigation and monitoring plans should be informed by the results of the CIA.

2.2 Cumulative Impact Assessment Case Studies

A review has been carried out of several CIAs that have been undertaken recently as part of EIAs. Strong case studies that provide clear CIA methodologies and enable their strengths and weaknesses to be evaluated have been selected. These span a range of sectors and cover key ecological receptors of relevance to MPAs, namely habitats, marine mammals, birds and/or fish. The case studies include projects of varying scale, although necessarily focusing more on larger developments which tend to undertake more robust and comprehensive CIA. The literature review has mainly focused on UK marine examples, but also included an appraisal of a few international CIAs (US, Canadian and Danish) and one UK terrestrial example. The case studies that have been included and the receptor assessments that have been reviewed are summarised in Table 3.

The varying approaches to CIA that were applied by each project have been reviewed and their effectiveness has been evaluated against the main components of a draft idealised generic CIA framework that was developed at the project plan phase. This in turn has further informed the development of the generic framework which is presented in detail in Section 3.

Table 3. Summary of CIA case studies reviewed

Project	Year	Location	Sector	Receptor(s) Reviewed
Cape Wind Offshore Wind Farm (OWF)	2004	USA (Massachusetts)	Energy	Fish
Docking Shoal OWF	2008	UK (Wash and North Norfolk Coast)	Energy	Birds
Anholt OWF	2009	Denmark	Energy	Marine mammals
Quad 204 Oil Field Redevelopment Project	2010	UK (Shetlands)	Oil and Gas	Marine mammals
M1 Junction 19 Improvements	2010	UK (Midlands)	Infrastructure	Habitats
Chukchi Oil and Gas Leasing	2011	USA (Alaska)	Oil and Gas	Marine mammals
Galloper OWF	2011	UK (Outer Thames Estuary)	Energy	Birds and Fish
Associated British Ports (ABP) Southampton Berth 201/202 Works	2011	UK (Hampshire and Isle of Wight Coast)	Ports	Habitats
Licence Renewal for Areas 212,328 B and C and 240	2013	UK (Anglian Coast)	Marine Aggregates	Habitats

2.2.1 Review of Projects

The tables in Appendix B evaluate each of the case studies outlined in Table 2 against the key components of an idealised and generic CIA framework (see Section 3).

Although this study selected a contrasting range of strong case studies that had undertaken CIA, there were still significant weaknesses in a number of the assessments and none of the case studies included all the elements that might be expected in an idealised CIA (see Section 2.1.3.3). Those considered particularly comprehensive included the Anholt OWF, Galloper OWF and Licence Renewal (aggregate) case studies. These followed a systematic process to identifying project pressures, as well as pressures associated with other plans, projects and activities. Initial project study areas were clearly defined in view of the spatial extent of significant project specific pressures. Galloper and Anholt OWFs went a step further and also defined CIA study areas in the light of the spatial extent of significant cumulative pressures.

All of the case studies applied a range of quantitative and qualitative assessment tools or methods, in particular impact matrices, numerical modelling, expert judgement and consultation. The potential application of these tools to CIA is discussed in more detail in Section 2.4.

2.3 Cumulative Impact Assessment Methodologies

A targeted literature search has been undertaken to identify academic papers and/or guidance documents on the overall CIA process. The literature search has focussed on systematic and quantitative methods (particularly matrix approaches) to support the development of the generic framework and identifying any variation in CIA across different industries.

A range of relevant database search tools including Web of Science and Science Direct, as well as internet search tools such as Google Scholar have been used to collate relevant reports. A database providing a high level summary review and reference tool of the literature sources that have been collated and recorded is included in Appendix C. The review of available literature has identified a number of useful sources describing the overall CIA process or key components to it. These have been summarised in Table 4.

Table 4. Summary of key theoretical and/or guidance reports reviewed

Author	Year	Report Title
Council on Environmental Quality (CEQ)	1997	Considering Cumulative Effects Under the National Environmental Policy Act. http://energy.gov/nepa/downloads/considering-cumulative-effects-under-national-environmental-policy-act
Hyder	1999	Guidelines for the assessment of indirect and cumulative impacts as well as impact interactions. Brussels: EC DGX1 Environment, Nuclear Safety and Civil Protection. http://ec.europa.eu/environment/eia/eia-studies-and-reports/guidel.pdf
English Nature	2001	HRA guidance documents including Habitats Regulations Guidance Note (HRGN) No. 4. Alone or in combination.
English Nature[7]	2006	A practical toolkit for assessing cumulative effects of spatial plans and development projects on biodiversity in England. http://publications.naturalengland.org.uk/publication/64008
Canter	2008	Conceptual models, matrices, networks and adaptive management- emerging methods for CIA. http://www.iaia.org/iaia08calgary/documents/Conceptual%20Models%20Paper%2012-08.pdf?AspxAutoDetectCookieSupport=1
King et al.	2009	Developing guidance on ornithological cumulative impact assessment for offshore wind farm developers. COWRIE. Crown Estate
Canter	2012	Guidance on Cumulative Effects Analysis in Environmental Assessments and Environmental Impact Statements http://www.nero.noaa.gov/nepa/docs/nmfsneronepaguidancecumulativeimpacts.pdf
Scottish Natural Heritage (SNH)	2012	Assessing the cumulative impact of onshore wind energy developments http://www.snh.gov.uk/docs/A675503.pdf
Marine Management Organisation (MMO)	2013 (in draft)	Evaluation of the current state of knowledge on potential cumulative effects from offshore wind farms to inform marine planning and licensing. MMO project:1009 http://www.marinemanagement.org.uk/evidence/documents/1009.pdf
Renewables UK/ Natural Environment Research Council (RUK/NERC)	2013	Guiding Principles for Cumulative Impact Assessments in Offshore Wind Farms https://ke.services.nerc.ac.uk/Marine/Members/Documents/Guidance%20documents/Cumulative%20Impact%20Assessment%20Guidelines.pdf
Essa Technologies Ltd. and International Finance Corporation (IFC)	2013	Good Practice Note - Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets http://www.socialimpactassessment.com/documents/CIA_PNG_ExternalReview.pdf

[7] Report was updated by Natural England in 2007. Both reports have been reviewed as part of this study.

2.3.1 Evaluation of Different Approaches

Tables 5 to 15 evaluate and compare the CIA methodologies presented in the key theoretical and guidance reports included in Table 14. This review has helped to inform and further develop the idealised and generic CIA framework (see Section 3).

Table 5. Methodology review of CEQ (1997)

	Case study	**Considering Cumulative Effects under the National Environmental Policy Act (CEQ, 1997)**		
	Sector	General		
Systematic Process for Identifying Impacts Associated with Other Plans, Projects and Activities:	**Scope of other plans, projects and activities**	Past, present and reasonably foreseeable future plans, projects and activities. General guidelines are provided as to when a RFFP can be excluded from the CIA. These are if: the activity is outside the geographic boundaries or timeframe established for the CIA; the activity will not affect resources that are subject of the CIA; or including the activity would be arbitrary.		
	Systematic Process for defining pressures associated with other plans, projects and activities	Spatial: Create a project impact zone. One way is to consider the distance a defined pressure can travel. The spatial boundary of the CIA can also be receptor dependant i.e. if considering water quality, then the spatial boundary could consider a particular river basin that the proposed project is located within. However, proximity to the project does not necessarily mean that it should be included within the CIA, there may be no potential for the activities from different projects to create cumulative effects. These activities must have some influence on the receptors affected. For example, when considering fish the possible spatial area that would be used for the CIA would be a stream, river basin, estuary, or parts thereof, e.g. spawning area and migration route.	Temporal: The timescale in which to consider the cumulative effects should draw from the individual project's specific timescales i.e. if the effects are predicted to last 5 years, then this timescale would be seen as appropriate.	Intensity: Paper provides examples of quantitative/qualitative/narrative methods that can be used to determine the magnitude/scale of cumulative effects e.g. matrices, networks, modelling and GIS overlay mapping.
	Significance of pressures defined with regard to sensitivity of features to pressures	As this is a theoretical example, there are no defined impact pathways. Also, the sensitivity of receptor does not appear to be overtly mentioned as an important element of the assessment. The paper does, however, provide guidelines for identifying cause and effect relationships between the pressure and the receptor, with the use of conceptual models and networks and system diagrams considered the preferred method of conceptualising impacts. It also notes that the cumulative effects on a specific receptor may not necessarily be the sum of the effects of all the activities i.e. effects are not always additive.		
	CIA Study area defined in light of spatial extent of significant cumulative pressures	The CIA study area is formed from the establishment of the geographic scope of the receptor and the project impact zone. This could be different for each potential receptor. The spatial area for mobile species is defined using factors such as breeding grounds, migratory routes, wintering areas or total range of affected population units. The process for defining the CIA study area involves determining the area that will be affected by the individual project (i.e. the distance an effect can travel); listing the receptors within that area; determining the spatial area occupied by the receptor; and defining the affected institutional jurisdictions. The CIA study area is likely to differ between projects and different receptors.		
	Clear justification for choice of assessment tools and methods	Networks and systems diagrams are used to conceptualise cause and effect relationships. The tools assessed in the paper are: questionnaires, interviews and panels; checklists; matrices; networks and system diagrams; modelling; trends and analysis; overlay mapping and GIS; carrying capacity analysis; ecosystem analysis; economic impact analysis; and social impact analysis. The report describes the strengths and weaknesses of each of these tools, taking into account whether it can: assess effects that are the same and different in nature; spatiotemporal changes; environmental interactions; quantify and synthesize these effects; and whether its validated, flexible, reliable and repeatable.		

Table 6. Methodology review of Hyder (1999)

	Case study	Guidelines for the Assessment of indirect and Cumulative impacts as well as impact interactions (Hyder, 1999)		
	Sector	General		
Systematic Process for Identifying Impacts Associated with Other Plans, Projects and Activities:	**Scope of other plans, projects and activities**	Past present and future activities should be included in the cumulative assessment. How far back in time information needs to be considered will depend on the project and the historical use of the area.		
	Systematic Process for defining pressures associated with other plans, projects and activities	Spatial: It has been identified that boundaries cannot be prescriptive and must be drawn on a project by project basis. Spatial boundaries will depend upon: Nature of the project; nature of the impacts; sensitivity of the receiving environment; availability of data; and natural boundaries. Additional data may need to be gathered to ensure that any additional cumulative impacts and interaction networks are considered. Spatial pressures included may be modified according to the baseline/scoping conditions.	Temporal: Consideration should be given to activities in the past, present and future. Temporal boundaries will depend on historical uses of the area; information available; local or national planning horizons for future development; and the lifespan of the project from construction to decommissioning. It is suggested that there is too much uncertainty associated with looking into the future beyond 5 years. Temporal pressures included may be modified according the baseline/scoping conditions.	Intensity: The cumulative impact should be quantified if possible and practical to do so. If this is not possible then a qualitative assessment can be done with the magnitude of the impact ranked, e.g. High, Medium or Low. The significance of pressures defined can be assessed using modelling, matrices, assessments of carrying capacity and threshold analysis. When assessing the intensity, factors to consider are: what changes would occur in the environment if the project did not go ahead?; and how have past actions contributed to the current baseline condition:
	Significance of pressures defined with regard to sensitivity of features to pressures	The appropriate boundary for the assessment is dependant upon the nature of the impact and receptor being affected. An important component of the assessment is to establish how environmental receptors will respond to impacts (i.e. sensitivity) and therefore to establish their ability to tolerate change. The cumulative impact should be quantified if possible and practical to do so. If this is not possible then a qualitative assessment can be done with the magnitude of the impact ranked, e.g. High, Medium or Low. The paper suggests assessing the significance using a variety of tools as appropriate: modelling, matrices, assessments of carrying capacity and threshold analysis.		
	CIA Study area defined in light of spatial extent of significant cumulative pressures	The CIA study area is defined based on the significant spatial and temporal impact identified at the scoping stage, which can be iterative and modified in the light of new information.		
	Clear justification for choice of assessment tools and methods	There are no suggested tools for the systematic process for defining spatial and temporal boundaries. However, the paper suggests a number of methods/ tools for the actual assessment of cumulative impacts which fall into two groups: (1) scoping and impact identification; and (2) evaluation. The tools are as follows: expert opinion, consultations and questionnaires, checklists, spatial analysis, network and systems analysis, matrices, carrying capacity and modelling. These tools are reviewed and compared against each other. A variety of approaches can be adapted and used by the assessor to suit the particular project.		

Table 7. Methodology review of English Nature (2001)

	Case study	**Habitats Regulations Guidance Note (HRGN4) (English Nature, 2001)**
	Sector	General
Systematic Process for Identifying Impacts Associated with Other Plans, Projects and Activities:	**Scope of other plans, projects and activities**	Guidance suggests including plans and projects that are approved but as yet uncompleted; permitted ongoing activities; where an application has been made and is currently under consideration but not yet approved; activities where no consent was given or required and natural processes. In some circumstances it may be appropriate to include plans and projects not yet submitted to the competent authority for consideration, but for which there is sufficient detail on which to make judgements on their impact.
	Systematic Process for defining pressures associated with other plans, projects and activities	Plans or projects which may be considered so trivial or inconsequential as not to be significant either alone or in combination with other plans or projects, should not be brought into the assessment. Where there is not sufficient detail on an activity as to make a judgement on likely significant effect, the precautionary approach should be taken that where there is uncertainty, the conclusion should determine a likely significant effect, unless available information clearly indicates otherwise.
	Significance of pressures defined with regard to sensitivity of features to pressures	The cumulative effect on the site should be assessed relative to the conservation objectives for the site and the favourable condition table for that given site. Where a feature for which the site has been selected as being of European Importance is already in unfavourable condition or critical thresholds are being exceeded, any additional plans or projects which either alone or in combination adds to these levels is likely to have a significant effect on the European Site.
	CIA Study area defined in light of spatial extent of significant cumulative pressures	The CIA study area is not specifically defined in the paper.
	Clear justification for choice of assessment tools and methods	When considering a number of large and complex sites where many authorities are involved, a strategic and pro-active approach is required to provide focus and a framework from which activities that have the potential to cause effect can be identified. Any judgements on the impact of plans or projects should be based on information which reasonably indicates cause and effect.

Table 8. Methodology review of English Nature (2006) and updated by Natural England (2007)

	Case study	**A practical toolkit for assessing cumulative effects of spatial plans and development projects on biodiversity in England (English Nature, 2006). This report was updated by Natural England in 2007.**		
	Sector	General		
Systematic Process for Identifying Impacts Associated with Other Plans, Projects and Activities:	**Scope of other plans, projects and activities**	All other relevant policies, plans, programmes and development projects that may affect the same ecological features. The boundaries of the mapped study area (see below) can provide an area of search: Other policies, plans, programmes and development projects or ecological features that fall within this catchment can be considered in the assessment of cumulative effects.		
	Systematic Process for defining pressures associated with other plans, projects and activities	Spatial: The geographical extent of the area likely to be affected by the plan or project and the important ecological features within this area which are likely to be affected needs to be defined. The geographical extent of the effects will vary depending on the type of effect, the pathways connecting the source of the effects to the ecological feature, and the sensitivity of the feature. There may, therefore, be a need to establish different geographic boundaries for different effects and these should be based on ecological catchments (e.g. river basins, natural areas) and on the spatial extent of the potential significant cumulative effects. It may be necessary to set appropriate spatial boundaries for some ecological features to reflect their distribution and patterns of movement e.g. migratory bird populations.	Temporal: The temporal scale of cumulative effects need to be described but no systematic method is provided as to how this process is carried out. It may be necessary to set appropriate temporal boundaries for some ecological features to reflect their distribution and patterns of movement e.g. migratory bird populations.	Intensity: The toolkit does not mention how the scale or magnitude of impact should be determined.
	Significance of pressures defined with regard to sensitivity of features to pressures	The current condition (i.e. baseline) of the ecological features likely to be affected by the plan or project should be characterised and an evidence base for identification of environmental issues provided. There is also a need to define the evolution of the ecological features likely to be affected by the plan or project, without implementation of the plan or project (i.e. future baseline). Assessment of the significance of cumulative effects should be based upon the characteristics of the effects and the sensitivity of the ecological feature. The techniques for weighting and balancing the relative magnitude of effects and the sensitivity of the ecological features on significance will vary from effect to effect. The significance of cumulative effects must also be considered within the context of the likely effects of other policies, plans, programmes and projects.		

Table 8 continued…

CIA Study area defined in light of spatial extent of significant cumulative pressures	An example approach to establishing geographic extent of a CIA and ecological features to be considered is provided based in the Canadian guidelines (Hegmann et al, 1999). This involves the following steps:1. Establish a local study area in which the obvious, easily understood and often mitigatable effects will occur;2. Establish a (sub-) regional study area that includes the areas where there could be possible interactions with other actions;3. Consider the use of several boundaries, one for each ecological feature; ensure boundaries are ecologically defensible wherever possible;4. Expand boundaries to address the cause-effect relationships between actions and the ecological features;5. Ensure boundaries take into account the abundance and distribution of the ecological features at a local, regional and larger scale if necessary;6. Determine if geographic constraints may limit cumulative effects within a relatively confined area;7. Characterise the nature of pathways that describe the cause and effect relationships to establish a line of enquiry;8. Set boundaries at a point where cumulative effects become insignificant; and9. Be prepared to adjust the boundaries during the assessment process if new information suggests this is warranted, and defend any such changes.
Clear justification for choice of assessment tools and methods	Judgements made in relation to the likely significance of the cumulative effects need to be sound and based on the most up-to-date research and baseline information. The links (i.e. impact pathways) between the plan or project proposed and its potential effects on the various ecological features can be illustrated using methods that show their cause-effect relationship (e.g. network analysis, tables and diagrams). Geographic Information Systems (GIS) provide a useful way of mapping both geographic and temporal boundaries and Planning Authorities should be encouraged to use them. A table of methods for identifying cumulative effects is provided and this has been adapted from CEQ (1997) and includes matrices, networks, modelling and expert opinion. Any uncertainties or limitations in the information underlying both qualitative and quantitative predictions should be provided.

Table 9. Methodology review of Canter (2008)

	Case study	**Conceptual Models, Matrices, Networks and Adaptive Management - Emerging methods for CIA (Canter, 2008)**		
	Sector	General		
Systematic Process for Identifying Impacts Associated with Other Plans, Projects and Activities:	**Scope of other plans, projects and activities**	Boundaries of the CIA are sought but there is no evidence of a systematic process suggested to identify extant plans, projects and activities. In the examples provided the following were scoped into the CIA: public and private entities that have direct or indirect impact on receptors in the study area; reasonably foreseeable future activities (RFFA) and activities that maybe forecasted by trends, probable occurrences, policies, regulations or other credible data that may have a bearing on the receptors.		
	Systematic Process for defining pressures associated with other plans, projects and activities	Spatial: The spatial boundaries are to be described but there is no systematic method of how this process is carried out. The paper suggests questions to consider when defining the spatial boundary of the project, e.g. what are the requirements in the spatial extent of the system? Should this include all nearby activities contributing to cumulative effects on receptors? Or should the extent address key environmental transport and fate pathways?	Temporal: The temporal boundaries are to be described but there is no systematic method of how this process is carried out. All other plans, projects and activities are grouped together according to temporal phase such as construction, operation and post-operation. The paper suggests questions to consider when deciding the temporal boundary of the project for example, does the model address a single existing or hypothetical point in time or is the model to be used for evaluating past and future conditions?	Intensity: Drivers, stressors, essential ecosystem characteristics and end points are defined. The paper does not, however, mention how the scale or magnitude of impact can be determined.
	Significance of pressures defined with regard to sensitivity of features to pressures	Potential drivers and stressors are defined, whereby drivers are the natural and anthropogenic processes that cause the change in environmental conditions. Stressors are the physical, chemical and biological changes that result from natural and human-caused forces and effect other changes in ecosystem structure and or function. Stressors may affect a single receptor or components or act on multiple components. The paper does not, however, consider the sensitivity of receptors to stressors.		
	CIA Study area defined in light of spatial extent of significant cumulative pressures	The linkage between the initial CIA study area and the significance of other plans, projects and activities is not clear from the paper.		
	Clear justification for choice of assessment tools and methods	The paper reviews a number of assessment tools: Conceptual models provide a simplified depiction of reality and are not comprehensive, taking account of only a selection of 'important' elements. Interaction matrices can be useful for delineating the impacts of the first and second or multiple phases of a two-phase or multiple phase project and creative codes can be used in the matrix to delineate this. Networks are a useful way of identifying anticipated direct, indirect and cumulative effects associated with potential projects. Adaptive management can be used post EIA to provide mitigation for some of the uncertainty associated with CIA.		

Table 10. Methodology review of King et al. (2009)

	Case study	**Developing Guidance on Ornithological Cumulative Impact Assessment for Offshore Wind Farm Developers. COWRIE. (King et al., 2009)**		
	Sector	Offshore Wind		
Systematic Process for Identifying Impacts Associated with Other Plans, Projects and Activities:	**Scope of other plans, projects and activities**	The report recommends including projects which have been consented but not constructed, projects for which applications have been made, foreseeable projects, relevant non wind farm projects subject to EIA, and existing projects which have yet to exert a predicted effect.		
	Systematic Process for defining pressures associated with other plans, projects and activities	Spatial: The report recommends that spatial scale of disturbance needs to be assessed at a site by site basis. Regarding SPA species, the spatial scale of reference populations should be the area which is used by the receptor bird species. Reference populations are those supported by SPA sites.	Temporal: The report states that indirect effects may be significant when pressures continue at a number of projects over several years. Time of year the site is in use (i.e. breeding, wintering, passage or a combination) should be taken into account.	Intensity: The report covers use of collision risk modelling for quantifying cumulative collision mortality and recommends summing the collisions from component projects. It also recommends further population modelling if collision mortality is likely to be significant.
	Significance of pressures defined with regard to sensitivity of features to pressures	Vulnerability on a three point scale of bird species to pressures associated to wind farm development was included as a field in a key features template to inform ornithological scoping. Sensitivity of receptor species is included as a field on a template to summarise SPA and non SPA affected sites.		
	CIA Study area defined in light of spatial extent of significant cumulative pressures	The CIA study area should cover the spatial scale of reference populations. Assessments of cumulative impacts at a range of spatial scales may be appropriate where different populations use the area at different times of year.		
	Clear justification for choice of assessment tools and methods	The report refers to the use of collision risk modelling for quantifying cumulative collision mortality and recommends further population modelling if collision mortality is likely to be significant.		

Table 11. Methodology review of Canter (2012)

	Case study	**Guidance on Cumulative Effect Analysis in Environmental Assessment and Environmental Impact Statements (Canter, 2012)**		
	Sector	Fisheries		
Systematic Process for Identifying Impacts Associated with Other Plans, Projects and Activities:	**Scope of other plans, projects and activities**	Past, present and reasonably future fishing and non fishing activities which would be expected to have been, are now, or will be contributing their impacts on the selected receptor.		
	Systematic Process for defining pressures associated with other plans, projects and activities	Spatial: The spatial boundaries are identified based on a review of the direct and indirect impacts. Direct effects are defined as being caused by the activity and occur at the same time and place. Indirect effects are defined as being caused by the activity and are later in time or further removed in distance but are still reasonably foreseeable. For example they may include effects related to induced changes in the pattern of land use.	Temporal: There is not a clear process to define the temporal scale of pressures associated with other plans, projects and activities.	Intensity: The intensity or impact is qualitatively defined using impact matrices.
	Significance of pressures defined with regard to sensitivity of features to pressures	The potential cumulative impacts from different plans, projects and activities are assessed for each receptor on an individual basis. In tabular form, the impacts associated with these activities (i.e. pressures) are evaluated and assessed through consideration of the receptor's sensitivity. Note is also taken if the pressure has a positive impact on the receptor. When defining pressures associated with the other plans, projects and activities, additional non-fishery related pressures are included in the assessment.		
	CIA Study area defined in light of spatial extent of significant cumulative pressures	The CIA study area should evolve from steps 1-8 in CEQ (1997) which involves evaluating the existing and historical conditions, and status and trends for the receptors. It is not clear from the guidance whether the entire spatial extent of the CIA study area is taken through to the final cumulative assessment or just the impacts that were found to be significant at the scoping stage of the process.		
	Clear justification for choice of assessment tools and methods	Uses of matrices (tables) and blocks are suggested to provide a transparent and auditable process for the CIA.		

Table 12. Methodology review of Kershaw (2012)

	Case study	**Evaluation of the current state of knowledge on potential cumulative effects from offshore wind farms (OWF) to inform marine planning and licensing. MMO 1009 (Kershaw et al., 2012)**		
	Sector	Offshore Wind		
Systematic Process for Identifying Impacts Associated with Other Plans, Projects and Activities:	**Scope of other plans, projects and activities**	The paper recommends including wind farm projects which are at application stage, consented and foreseeable as well as relevant non wind farm projects subject to EIA. Existing projects which have yet to exert a predicted effect should also be included.		
	Systematic Process for defining pressures associated with other plans, projects and activities	The paper suggests that this could be done generically e.g. using sector-activity and pressure linkage tables that are being developed by the Options for Delivering Ecosystem-Based Marine Management (ODEMM) project (Koss et al., 2011), rather than a case by case basis. This would introduce standardisation and consistency in the approach.		
		Spatial: The paper recommends a 'long list' of receptor species to undergo CIA, to be screened using expert judgement. For SPA species, the reference population used is that cited in SPA documents. For others, expert judgement should be used to define area and regional population. In a cumulative modelling geospatial framework, footprints of activities are used to map pressures. Pressures are identified generically but not defined specifically with reference to their spatial scale.	Temporal: With regard to birds, collision risk should be calculated on month by month basis where there is seasonal variation in bird populations.	Intensity: Collision risk modelling is highlighted as a useful tool to quantify impacts on birds, but can be limited by lack of accurate species specific data. Cumulative collision impact should be shown as the sum of collisions from component projects.
	Significance of pressures defined with regard to sensitivity of features to pressures	No specific impact pathways are defined in the report, but they suggest that it is important to consider if and/or how pressures from different sectors may be grouped together i.e. abrasion, sea bed disturbance. The significance of impacts has been considered with regard to the sensitivity of the receptor, examples given include barrier effects on terns (sensitive) and shearwaters (less sensitive). The report also mentions using threshold levels to ensure the cumulative effect of a development does no exceed this threshold.		
	CIA Study area defined in light of spatial extent of significant cumulative pressures	Paper recommends that the default boundary should be the relevant strategic area, Round 3 zone or equivalent, unless there is reliable evidence to support the definition of an alternative discrete biogeographic region e.g. area incorporating onshore breeding colony; Regional Sea, etc.		
	Clear justification for choice of assessment tools and methods	Proposes the Drivers, Pressures, State, Impact and Response (DPSIR) approach as the underlying principle for CIA. This procedure should allow users to refine and target the issues for inclusion in the CIA. The paper recommends early stakeholder liaison and frequent dialogue between developers, regulators, SNCB's and stakeholders.		

Table 13. Methodology review of SNH (2012)

	Case study	**Assessing the cumulative impact of onshore energy developments. (SNH, 2012)**		
	Sector	Offshore Wind		
Systematic Process for Identifying Impacts Associated with Other Plans, Projects and Activities:	**Scope of other plans, projects and activities**	The paper recommends that CIAs should not be restricted to other wind farm developments and should include all plans and projects in the area and any associated development of these plans. Operational developments should be considered first, with projects at application stage considered later.		
	Systematic Process for defining pressures associated with other plans, projects and activities	Spatial: The CIA can assess pressures at a number of scales ranging from very local (within the footprint) to regional and national. The spatial scale of barrier effects and habitat loss are mentioned.	Temporal: The guidance focuses on longer term cumulative impacts. Short term temporary impacts should be assessed separately. The paper acknowledges the temporal difference between pressures such as displacement and disturbance.	Intensity: Collision risk modelling and population viability analysis can provide a measure of intensity for collision mortality. Comparisons must be made on annual collision rates. Sums of collision mortality may overestimate cumulative effects. Disturbance can be measured as numbers of territories lost. Displacement can be measured in terms of hectares of habitat lost.
	Significance of pressures defined with regard to sensitivity of features to pressures	Project impacts should be assessed for all sensitive bird species, with sensitivity based on conservation and legal status. Use of matrices is mentioned.		
	CIA Study area defined in light of spatial extent of significant cumulative pressures	The aim is to assess impacts upon a species population size, trend and natural range within Scotland. Cumulative impacts are best assessed quantitively for each eligible species.		
	Clear justification for choice of assessment tools and methods	Consultation with SNH is recommended at an early stage. Assessment tools mentioned are collision risk modelling, population viability analysis and matrices.		

Table 14. Methodology review of RUK/NERC (2013)

	Case study	Guiding principles for cumulative impact assessments (CIA) in offshore wind farms (OWF) (RUK/NERC, 2013)		
	Sector	Offshore Wind		
Systematic Process for Identifying Impacts Associated with Other Plans, Projects and Activities:	**Scope of other plans, projects and activities**	Developers to liaise with regulators/advisors at the early stages of scoping to create a comprehensive list of national and international plans, projects and regulated activities which include past, present or reasonably foreseeable actions.		
	Systematic Process for defining pressures associated with other plans, projects and activities	Spatial: Should consider relevant spatial boundaries for individual receptors and the spatial extent of environmental changes introduced by developers.	Temporal: Temporal boundaries should take account of the project life cycle and recovery times of potentially affected receptors and reference populations. Should end at the lifetime of the applicant's project and include any RFFP and activities within that timeframe.	Intensity: CIA should be kept reasonable and in proportion to the nature and scale of the development. There needs to be an upfront agreement of suitable acceptable threshold/targets which should be underpinned by sound science but may be generated from an agreed 'policy' basis.
	Significance of pressures defined with regard to sensitivity of features to pressures	Scoping should establish a source-pathway-receptor rationale, building upon plan level strategic assessments. Using this approach allows the developer to undertake a CIA in a transparent and auditable way, screening out plans, projects and activities on a parameter by parameter basis. There is, however, no mention of how the sensitivity of receptors should be considered as part of the assessment.		
	CIA Study area defined in light of spatial extent of significant cumulative pressures	Developers will use a realistic project design envelope and the study area will be set on a receptor specific basis as discussed with relevant agencies. Spatial boundaries should take account both of the relevant spatial scales for individual receptors (foraging distances, migratory routes) and the spatial extent of environmental changes introduced by developments so that all potential impact pathways can be identified in line with the source-pathway-receptor model. Temporal boundaries should take account of the project life cycle (and duration of environmental changes introduced by the project at different phases of the life cycle) and the life cycles and recovery times of potentially affected receptors and reference populations.		
	Clear justification for choice of assessment tools and methods	Iterative reviews of CIA and its approach should be undertaken when required on the basis of new information, changes to the project envelope or when improved approaches to the assessment becomes available. Much like a design freeze, there should be a final cut off date after which no further reviews will be carried out at the scoping phase. This allows the developer to undertake an assessment, write the ES and consult on it. In addition the guidelines state that for an assessment to be meaningful it has to be based on evidence. For projects where there is insufficient baseline data or data about the environmental effect of a project are incomplete a 'precautionary but pragmatic' approach based upon the best available scientific evidence should be used. There is no mention in the paper on the choice of assessment tools that can be used as part of the CIA.		

Table 15. Methodology review of Essa Technologies Ltd. and IFC (2013)

	Case study	**Good practice note: Cumulative Impact Assessment and Management. Guidance for the Private Sector in Emerging Markets (Essa Technologies Ltd. and IFC, 2013)**		
	Sector	General		
Systematic Process for Identifying Impacts Associated with Other Plans, Projects and Activities:	**Scope of other plans, projects and activities**	Other existing, planned and/or reasonably predictable future projects and developments. When considering which RFFP to include in the assessment, its is known that projects of the same type as the one being assessed cause further associated development to occur, then such developments are reasonably predictable. Since such developments are not identified based on specific development plans, scenario analysis may be an appropriate approach for examining the potential cumulative impacts that could be associated with induced development.		
	Systematic Process for defining pressures associated with other plans, projects and activities	Spatial: Suggested guidelines of how to set spatial boundaries are to include the area that will be directly affected; list the important receptors within the area which is directly impacted; define if these receptors occupy a wider range beyond the direct zone; and consider the distance an effect can travel.	Temporal: Suggested guidelines to determine the temporal boundaries are to define the expected timeframe of the potential effect of the proposed activity, balance between overestimate/underestimate and exclude futures actions if a) outside geographical boundary b) does not affect receptor and c) its inclusion seem arbitrary.	Intensity: The paper suggests that in CIA, impacts are not measured in terms of the intensity, rather in terms of the receptor response and its condition. The methods used for analysis will be specific to the characteristics of the receptor.
	Significance of pressures defined with regard to sensitivity of features to pressures	Preference should be given to receptors that are likely to be at greatest risk from a project's contribution to cumulative impacts. It is important to adopt an appropriate strategy for identification of stresses that result from activities other than the proposed project. With this in mind it may be helpful to classify different developments according to common characteristics of their impacts.		
	CIA Study area defined in light of spatial extent of significant cumulative pressures	The CIA study area is not specifically defined in the paper.		
	Clear justification for choice of assessment tools and methods	The paper suggests that CIA is future oriented. The significance of cumulative impacts is not evaluated in terms of the amount of change, but the potential resulting impacts to the vulnerability and/or risk to the sustainability of the receptors assessed. The importance of continued participation and meaningful engagement with government/ nature conservation bodies, third party and affected communities over the lifespan of the project is highlighted.		

2.4 Assessment Tools

As part of the review, the range of assessment tools that can be used for assessing major cause and effect pathways within environmental assessments and CIAs have been identified and reviewed. There are two main reasons for using such tools or methods as described by Canter (2008):

(1) To facilitate the scoping and identification of cumulative impacts – identification methods can be useful in scoping for receptors and anticipated impact pathways[8]; establishing spatial and temporal boundaries for the assessment; selecting receptor-related indicators or thresholds of cumulative effects; determining what features to address in preparing a description of past to current baseline conditions; and in communicating study results relative to cumulative effects; and

(2) For the qualitative or quantitative prediction of such impacts - prediction methods are fundamental to delineating actual cumulative effects and to determining their magnitude and significance in relation to thresholds and carrying capacities.

These assessment tools range from simple desk-based assessments through to complex modelling tools, including spatial-based numerical models to assess changes in physical processes, water quality and habitat impacts, and single and multispecies ecological models for features such as fish, birds and marine mammals, together with ecosystem models that consider wider energy flows or processes.

A range of potentially appropriate tools have been identified as part of the literature review. Helpful sources of information have included The Estuary Guide website[9] and outputs from the EU funded New Delta! Project (ABPmer, 2007). In addition, the Ecosystem Based Management Tools Network website[10] provides some high level information on tools that can help improve coastal-marine spatial planning and management decision making.

Table 16 presents a compilation of some of the main assessment tools that have been identified to be particularly relevant to ecological receptors associated with MPAs. Key sources are provided in the table should further background information be required. In particular, CEQ (1997) and Hyder (1999) provide comprehensive accounts and examples of most of the assessment tools in Table 16, including their main strengths and weaknesses.

In selecting suitable tools and methods, it is important to seek to ensure that they are fit for purpose, for example, appropriate to use with the available data, the errors surrounding impact estimates are understood, and that the level of resolution of assessment tools and methods are appropriate to the issues being assessed.

8 An impact pathway is the mechanism by which a pressure could affect a receptor i.e. a receptor-pressure interaction (e.g. elevated underwater noise levels resulting in a barrier to migratory fish, see Section 2.1.3.1).

9 http://www.estuary-guide.net/guide/analysis_and_modelling/index.asp

10 http://ebmtoolsdatabase.org/node

Table 16. Summary of key assessment tools for CIA

Method	Description	Key Sources
Expert judgement	A means of both identifying and assessing cumulative impacts. Expert Panels can be formed to facilitate exchange of information of different aspects of the impacts of a project. This approach can be used for Scoping and Identification (SI) and for descriptively i.e. qualitatively predicting (DP) cumulative effects.	Smit and Spaling (1995); CEQ (1997); Hyder (1999); MacDonald (2000)
Consultation, interviews and questionnaires	Useful for gathering the wide range of information on multiple actions and receptors need to address cumulative effects. Brainstorming sessions and group consensus building activities can help identify the important cumulative effects issues in the study area or region. These methodologies can be used in internal and external scoping and in the identification of cumulative effects (SI).	CEQ (1997); Hyder (1999)
Checklists and questionnaire checklists	Useful for identifying potential cumulative effects by providing a list of common or likely effects and juxtaposing multiple actions and receptors. Checklists can be dangerous for the practitioner that uses them as a shortcut to thorough scoping and conceptualisation of cumulative effects issues. These methodologies can be used for SI and for descriptively i.e. qualitatively predicting (DP) cumulative effects.	Canter and Kamath (1995); Canter (2000); CEQ (1997); Hyder (1999); MacDonald (2000)
Network and pathway/ systems analysis/ causal chain analysis	Useful for delineating the cause and effect relationships resulting in cumulative effects. Can be used to analyse the multiple, subsidiary effects of various activities or pressures, and trace indirect effects to receptors that accumulate from direct impacts on other receptors. These methodologies can be useful for SI, DP, and quantitative predictions (QP).	Smit and Spaling (1995); CEQ (1997); Hyder (1999); Canter (2000; 2008); MacDonald (2000)
GIS and spatial analysis techniques	These methods incorporate geographical information into cumulative effects analysis and help set the boundaries of the analysis and identify areas where effects will be the greatest. Map overlays can be based on either the accumulation of stresses in certain areas or on the suitability of each land unit for development. These methodologies can be useful for SI, DP, and QP.	Smit and Spaling (1995); Canter and Kamath (1995); CEQ (1997); Hyder (1999); Canter (2000); MacDonald (2000); Dube (2003); MMO (2013 in draft)

Method	Description	Key Sources
Impact or interaction matrices	Use a tabular format to organise and quantify the interactions between human activities and resources of concern. Matrices can also be used to combine the values in individual cells in the matrix to evaluate the cumulative effects of multiple activities or pressures on individual receptors. These methodologies can be used for SI and DP.	Smit and Spaling (1995); Canter and Kamath (1995); CEQ (1997); Hyder (1999); Hegmann et al. (1999); Canter (2000; 2008; 2012); Oakwood Environmental (2002); MacDonald (2000)
Carrying capacity analysis	Carrying capacity analysis identifies thresholds (as constraints on development) and provides mechanisms to monitor the incremental use of unused capacity. Carrying capacity in the ecological context is defined as the threshold of stress below which populations and ecosystem functions can be sustained. In the social context, the carrying capacity of a region is measured by the level of services (including ecological services) desired by the population. These methodologies can be useful for DP and QP, as well as the determination of the significance of cumulative effects.	CEQ (1997); Hyder (1999)
Mathematical modelling (e.g. hydrodynamic, sediment, ecological, advection/diffusion modelling, population viability analysis (PVA))	A potential powerful technique for quantifying the cause and effect relationships leading to cumulative effects. Modelling can take the form of mathematical equations describing cumulative processes such as soil erosion, the use of receptor-specific software, or an expert system that computes the effect of various project scenarios based on a program of logical decisions. There are numerous available mathematical models that can be useful for QP.	Smit and Spaling (1995); Cooper and Canter (1997); CEQ (1997); Hyder (1999); Jeffrey and Duinker (2000); MacDonald (2000); Maclean et al. (2007); Masden (2009); Canter (2008); King et al. (2009); Keskinen and Kummu (2010); Canter and Atkinson (2011); MMO (2013 in draft)
Conceptual modelling (e.g. sediment budget analysis)	Conceptual models are simple abstractions of reality created to express a general understanding of a more complex process or system. Accordingly, they represent a summary of known scientific and policy information about the components of an environmental or social system (ecosystem), the characteristics and interactions of the components, and the effects of societal actions on such characteristics and interactions. Although they are primarily used for DP, in certain circumstances they can also be used for QP.	Canter (2008)

Method	Description	Key Sources
Trend analysis	This methodology can be used to assess the status of receptors over time and to develop graphical projections of past or future conditions. Changes in the occurrence or intensity of stressors (contributing effects from other activities or pressures) over the same time period can also be determined. Trends can help the practitioner identify cumulative effects problems, establish appropriate environmental baselines, and project future cumulative effects. This category of methodologies can be used for both DP and QP.	CEQ (1997)
Ecosystem analysis	Ecosystem analysis explicitly addresses biodiversity and ecosystem sustainability. The ecosystem approach uses natural boundaries (such as watersheds and ecoregions) and applies ecological indicators (such as indices of biotic integrity and landscape pattern). Ecosystem analysis entails the broad regional perspective and holistic thinking that are required for successful cumulative effects assessment. These special methodologies can be useful for DP and QP.	CEQ (1997)
Indicators/ thresholds and environmental indices	An indicator, comprising a single datum (a variable) or an output value from a set of data (aggregation of variables), can be used to describe a system or process such that it has significance beyond the face value of its components. An environmental index can be seen as referring to a numerical or descriptive categorisation of a large quantity of environmental data or information involving multiple metrics, with the primary purpose being to summarise and simplify such data and information so as to make it useful to decision makers and various stakeholders. This assessment tool can be useful for DP.	Dube (2003); Therivel and Ross (2007); Canter and Atkinson (2011)
Spatial risk assessment	Spatial risk assessment in GIS is an approach that enables the rapid assessment of risks to marine habitats at broad scales. Spatial risk assessments incorporate spatial models of species distribution with qualitative and quantitative information on the relative impact and distribution of multiple anthropogenic activities. This approach can be useful for DP.	Grech et al. (2011)

Method	Description	Key Sources
Adaptive management	Adaptive management is an emerging method which has usefulness in reducing numerous uncertainties associated with CIA, and in informing decision makers regarding the effectiveness of both local mitigation of cumulative effects and regional management of such effects resulting from multiple actions within defined spatial and temporal boundaries. Adaptive management can be viewed as an emerging post-EIA method which can be used to inform current and future studies focused on CIA.	Canter (2008); MacDonald (2000); CEQ (1997)

3. Development of Generic Framework for CIA

The main aim of this study has been to produce a comprehensive yet standardised framework that is practical, logical and usable by Natural England case officers advising on CIA of human activities affecting MPA features. The framework that has been developed is applicable across all sectors and will allow case officers to advise on projects of varying scales from an individual jetty construction to offshore wind farm development. It has been based on what is considered to be best practice in project-level EIA and incorporates the key criteria and considerations for CIA, drawing on guidance in the literature. Without being overly prescriptive, the framework has been designed to ensure that a clear audit trail of the evidence and assumptions underlying the CIA is followed, and promotes a quantitative, systematic and predictive approach to CIA.

Developers may also find this framework useful in ensuring that the likely cumulative effects of their development projects are considered from the very earliest stages of scheme design. It also gives developers insight into Natural England's expectations with respect to the identification, examination and reporting of likely cumulative effects of human activities.

The generic framework that has been developed is shown in Figure 4. The key process steps involved in the CIA are outlined in the green boxes, a variety of supporting tools in the form of matrices are identified in the yellow circles and relevant guidance and/or information sources are highlighted in orange diamonds. Each of the steps identified in Figure 4 is described in more detail in Sections 3.1 to 3.12. The framework covers both the scoping and assessment phases of CIA. The main focus within this study is on scoping to ensure that this process is as robust as possible as this will greatly facilitate the preparation of meaningful CIAs. The development of CIA advice needs to be iterative and further research will be required to develop guidance for other phases of CIA, including assessment and mitigation. This work, however, provides the foundation upon which any further work could be based.

It is also important to recognise that a good process for assessing the impacts on a receptor is an essential pre-requisite for undertaking good CIA. The first four steps in the framework effectively reflect the processes involved in EIA for scoping the issues and identifying relevant receptors for the project alone. In particular, the source-pathway-receptor model[11] is central to effective assessment in providing a systematic process for identifying and evaluating the impacts on receptors as a result of a project.

It is important that users of the generic framework for CIA take account of the following:

- That the agreed scope for a CIA is proportionate to the environmental risks of the project for which the assessment is required, taking account of the limitation of data availability. The process that is represented by the generic framework will therefore require a significant degree of judgement to be applied in determining what should be included or excluded in the assessment phase for each individual CIA; and

[11] The purpose of the 'source- pathway-receptor' model is to identify the pathways between the source of an effect (e.g. pile-driving generating underwater noise pressure) and potentially sensitive receptors (e.g. harbour porpoise).

- That the CIA is viewed as an iterative process, particularly for large projects, for which there may be a degree of uncertainty surrounding project design and the potential environmental effects. The framework should, therefore, be viewed as an iterative process that follows through into the assessment phase of the CIA.

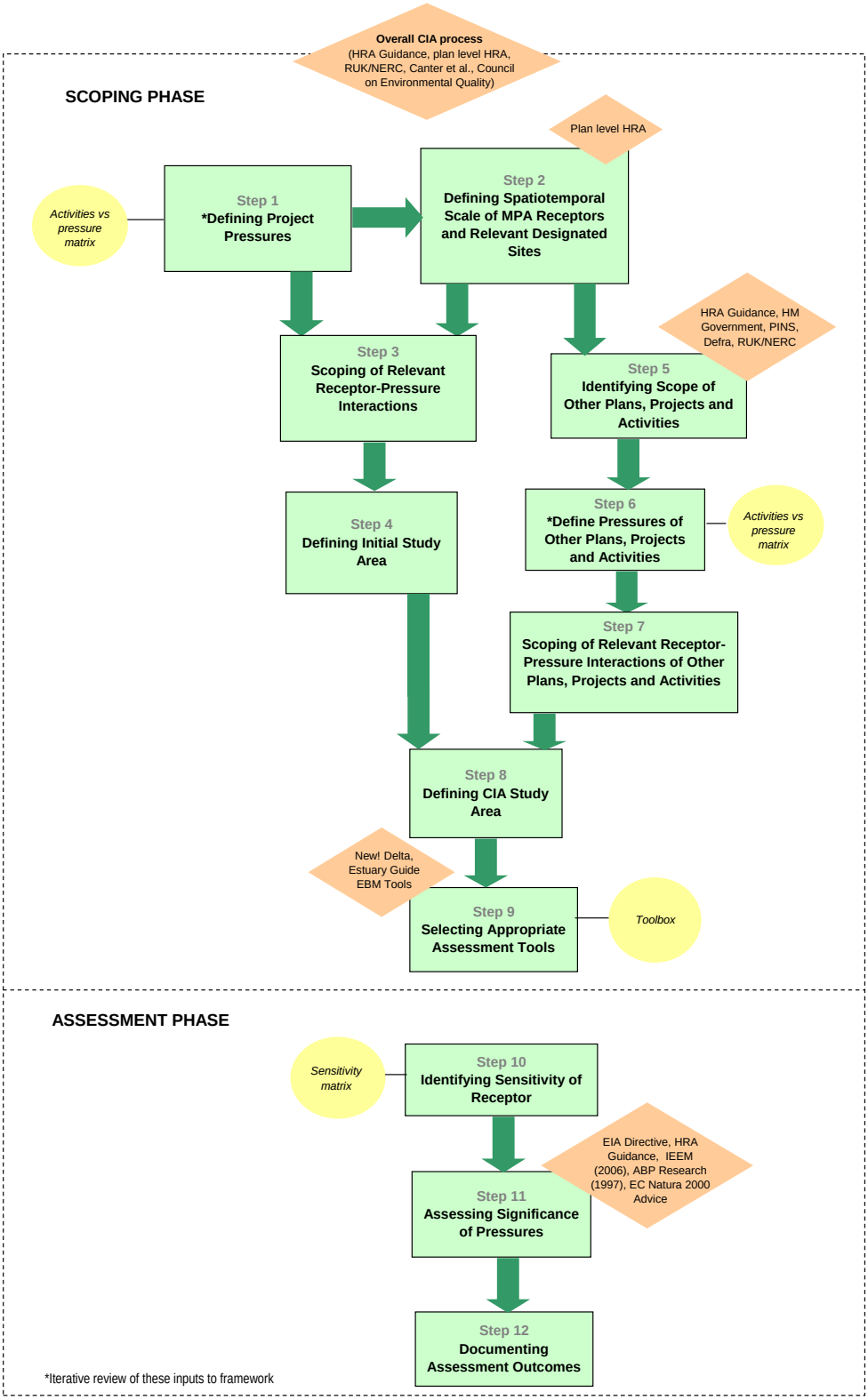


Figure 4. Generic framework for CIA

The key steps comprising the generic framework are described in more detail in the following sections. The boxes within each of these sections provide a series of underlying review questions that Natural England case officers should consider as part of their review of CIA methodologies within scoping documents and/or assessments within EIAs or HRAs. These are likely to comprise the essential building blocks for their advice to developers (e.g. scoping response).

- Step 1: Defining Project Pressures (Section 3.1);
- Step 2: Defining Spatiotemporal Scale of MPA Receptors and Relevant Designated Sites (Section 3.2);
- Step 3: Scoping of Relevant Receptor-Pressure Interactions (Section 3.3);
- Step 4: Defining Initial Study Area (Section 3.4);
- Step 5: Identifying Scope of Other Plans, Projects and Activities (Section 3.5);
- Step 6: Defining Pressures of Other Plans, Projects and Activities (Section 3.6);
- Step 7: Scoping of Relevant Receptor-Pressure Interactions of Other Plans, Projects and Activities (Section 3.7);
- Step 8: Defining CIA Study Area (Section 3.8);
- Step 9: Selecting Appropriate Assessment Tools (Section 3.9);
- Step 10: Identifying Sensitivity of Receptor (Section 3.10);
- Step 11: Assessing Significance of Pressures (Section 3.11); and
- Step 12: Documenting Assessment Outcomes (Section 3.12).

The generic framework for CIA has been applied to a hypothetical case study to test its practicability and determine any methodological limitations. This is included in Appendix D. An offshore wind farm was chosen as the case study project to demonstrate the more complex issues associated with CIA for large scale developments and how the CIA framework can still be applied. This case study has been taken forward to completion of the scoping phase (i.e. identifying the impact pathways that are likely to be relevant at a high level and recommended assessment methods) which has involved undertaking Steps 1 to 9 of the CIA framework but not the detailed assessment phase steps.

3.1 Step 1: Defining Project Pressures

The main objective of Step 1 is to define, as far as is practicable, the pressures that might be brought about by activities associated with the project alone. This will involve identifying the spatiotemporal boundaries of pressures and characterising their intensity or magnitude.

This component of the CIA framework first involves defining the details of the project (i.e. scheme plan, construction methodology, proposed programme etc.). Adequately defining a project's characteristics is a vital step. If project elements are missed, then potential impact pathways will also be missed. Where there is uncertainty in project design, these can be addressed by documenting a realistic Project Design Envelope, which is also referred to as the Rochdale Envelope (PINS, 2012), to encompass necessary uncertainty. Drawing on a sound project description, the potential environmental changes (pressures) that are likely to arise from activities associated with a specific project can then be scoped. A generic 'activities versus pressures' matrix could be used as a checklist at this stage to help to identify the types of environmental changes (or pressures) arising from different human activities. There are also a range of good examples of sector specific descriptions of activities and pressures, for example, in relation to marine aggregates (Tillin et al., 2011) and offshore renewables (Marine Scotland, 2012).

The spatiotemporal boundaries of the identified project pressures and their intensity or magnitude should then be characterised as far as is practicable at the particular phase in the EIA. Spatial boundaries should take account of the geographic extent of environmental changes and temporal boundaries should take account of the duration of environmental changes at different phases of the project life cycle. The developer may only be able to do this at a high level and qualitatively at the scoping phase but once more project design information is available, the characteristics of the pressures are more likely to be quantifiable. In other words, this input to the CIA should be iteratively reviewed in the light of new project information as denoted by an asterisk (*) in the framework diagram (see Figure 4). Any uncertainties associated with defining pressures (e.g. confidence in model calibration and validation) should also be clearly presented and taken into account as part of the assessment.

Natural England Review Questions

- *Has the project been adequately defined (all potential project elements, activities and components, Project Design Envelope)?*
- *Have all the potential pressures associated with project activities been identified?*
- *Have the pressures been clearly defined as far as is practicable both spatially and temporally?*
- *Have any uncertainties associated with the pressures been identified and defined?*

3.2 Step 2: Defining Spatiotemporal Scale of MPA Receptors and Relevant Designated Sites

The main objective of Step 2 is to define the spatiotemporal boundaries of MPA receptors[12] that overlap with the boundaries of pressures associated with the project alone identified in Step 1. These should be defined on a case-by-case basis, taking account of the varying scale of projects.

This step assists in the identification of designated sites and associated features that need to be included within the CIA. Spatial boundaries should take account of the relevant geographic extent of individual receptors and temporal boundaries should take account of specific life cycles (e.g. breeding seasons, migration periods). The following spatiotemporal scales are considered suitably precautionary starting points for the main categories of MPA receptors:

- Habitats – a full tidal excursion or tidal ellipse[13];
- Birds – bird disturbance distances, foraging pathways/distances and breeding/non-breeding seasons for seabirds, and migratory pathways/distances for waterbirds;
- Marine mammals – functional use of territory; and
- Fish – functional use of territory and migratory routes.

[12] This should include interest features of potential MPAs (e.g. candidate SACs (cSACs), potential SPAs (pSPAs) etc.).

[13] Defines the size and extent of tidal circulations. The nature of coastal and offshore tidal movements are such that they can be described as an almost closed ellipse i.e. a package of water moving over one tidal cycle, typically along a dominant axis, returning to almost the same position.

While this approach is highly precautionary, it is considered appropriate at scoping stage, particularly in the light of the requirements of the EC Habitats and Wild Birds Directives. It is helpful at this stage to develop a matrix of designated sites and the relevant features that need to be considered within each site.

Additional Considerations

Non-Breeding SPA Seabird Features
It is important to note that breeding populations of qualifying seabird features of SPAs are afforded protection throughout the year and therefore 'off-site' impacts to these populations during the non-breeding season should be taken account of in CIAs, in addition to any impacts that are spatially remote from the breeding site. The Joint Nature Conservation Committee (JNCC) and Natural England have recently produced interim advice on HRA screening for SPA seabird species outside of the breeding season (e.g. in their post breeding dispersal and over wintering phases). The advice includes guidance on identifying SPAs of relevance and determining the likely presence of qualifying seabird features in the non-breeding period based on best available evidence (JNCC and Natural England, 2013).

Cetaceans
In terms of marine mammals, there are no cetaceans that are qualifying features of MPAs in England, however, given their level of protection at an international level, they will need to be taken account of in CIAs as part of EIAs and SEAs. Therefore although the generic framework for CIA was initially intended to be used specifically for MPA features it can still be applied to other ecologically important receptors, including European Protected Species. Furthermore, there is a need to consider the potential for transnational cumulative effects to occur on mobile features. The hypothetical case study included in Appendix D, for example, demonstrates how the generic framework has taken account of harbour porpoise. Although this species is not currently a qualifying feature for any designated UK site, it was included in the scope of the hypothetical CIA given that it forages/migrates over very large distances and therefore there is a need to take account of the potential cumulative effect on Natura 2000 sites of other Member States where this species is a qualifying feature.

Where projects take place within or in close proximity to MPAs, there tends to be a more direct or immediate overlap between receptors and project pressures. For these projects, where impact pathways are more direct and localised, more detailed criteria should be considered when identifying potential interactions relevant to the CIA. These criteria should primarily be based on the measures and targets provided in Natural England advice packages under Regulation 35(3) of The Conservation of Habitats and Species (Amendment) Regulations 2012, Sites of Special Scientific Interest (SSSI) citations and any Water Framework Directive (WFD) protected area objectives within relevant River Basin Management Plans (RBMPs). These will also be relevant at the assessment phase (Step 11) of the CIA framework (Section 3.11) for projects of all sizes.

There are a range of potential data sources that could be used for projects of varying scale to inform the characterisation of the baseline environment at the scoping phase. A summary of the key sources for each of the main categories of MPA receptors is provided in Table 17. As discussed earlier, although there are no cetaceans that are qualifying features of MPAs in England, given that they are European Protected Species and there is the potential for transnational cumulative effects, this table has included potential data sources on cetaceans within the marine mammal category.

Table 17. Potential sources of information to inform baseline description and scoping of MPA features

MPA Feature	Potential Data Sources
Habitats	▪ UKSeaMap 2010 website[14] - predictive mapping of seabed habitats; and ▪ Marine Life Information Network (MarLIN) MarLIN website[15]
Birds	▪ Wetland Bird Survey (WeBS) data; ▪ JNCC Seabird Monitoring Programme Online Database; ▪ European Seabirds at Sea (ESAS) database; ▪ Future of the Atlantic Marine Environment (FAME) project website[16]; ▪ Birdlife International seabird database (BirdLife International, 2010); and ▪ Information on bird disturbance distances and displacement behaviour (e.g. Dwyer (2010); IECS (2009a,b); Ruddock and Whitfield (2007)); and ▪ Information on the foraging ranges of UK seabirds prepared jointly by BTO, RSPB and Birdlife International (Thaxter et al., 2012).
Marine Mammals	▪ Small Cetacean Abundance in the European Atlantic and North Sea programmes (SCANS and SCANS-II); ▪ Atlas of Cetacean Distribution in North West European Waters (Reid et al., 2003); ▪ Towards Marine Protected Areas for Cetaceans in Scotland, England and Wales (Clark et al., 2010); ▪ Special Committee on Seals (SCOS) Annual Report (e.g. SCOS, 2011); ▪ Joint Cetacean Protocol Reports (Thomas, 2009; Paxton and Thomas, 2010; Paxton et al., 2011); and ▪ The Natural England Marine Mammals Working Group is currently writing guidance documents which include the recommended data sources that should be included in an assessment.
Fish	▪ Environment Agency data; ▪ Life in UK Rivers project (Hendry and Cragg-Hine, 2003); and ▪ OSPAR reviews for Atlantic salmon, allis shad and the sea lamprey (OSPAR, 2008; OSPAR, 2009).

The quality of the baseline data available and the need for further survey should be ascertained at this stage. Any uncertainties relating to the distribution of receptors that are poorly studied or, in some cases, difficult to study, should be identified and taken into account as part of the scoping process.

Natural England Review Questions

- *Has the spatiotemporal scale of MPA receptors been defined in relation to project pressures?*
- *Has the level of uncertainty associated with the spatiotemporal distribution of receptors been identified?*
- *Has a suitably precautionary approach been adopted to identifying sites and features for inclusion within the assessment?*
- *Is any further survey work required to define the baseline environmental character of the area for the purposes of the CIA?*

14 http://jncc.defra.gov.uk/page-2117
15 http://www.marlin.ac.uk/
16 http://www.fameproject.eu/en

3.3 Step 3: Scoping of Relevant Receptor-Pressure Interactions

The main objective of Step 3 is to review the relevance of receptor-pressure interactions (i.e. impact pathways) in terms of the project pressures identified in Step 1 and MPA receptors identified in Step 2.

This step involves defining the impact pathways of the project alone using the source-pathway-receptor model as described earlier. Following a precautionary approach, **only receptors that clearly do not overlap with project pressures** should be excluded from this part of the assessment.

Natural England Review Questions

- *Is there a clear audit trail of the impact pathways that have been scoped in and out of the assessment?*

3.4 Step 4: Defining Initial Study Area

The main objective of Step 4 is to define the initial study area i.e. the overlap between the project pressures that have been scoped into the assessment in Step 3 and the boundaries of MPA receptors identified in Step 2.

This component of the CIA framework is likely to be different for each specific receptor. Furthermore, and particularly at the scoping stage, this initial study area should include both significant and insignificant pressures. **Even if a proposed project alone results in an insignificant effect on a receptor, there is the possibility that in-combination with other plans, projects or activities, this same pressure may become significant.**

It would be helpful for the applicant to depict the spatial extent of each receptor study area on a figure as far as is practicable at that particular phase in the EIA. However, there may be insufficient information to do this at the scoping phase. Figure 5 shows a simple schematic of a CIA study area.

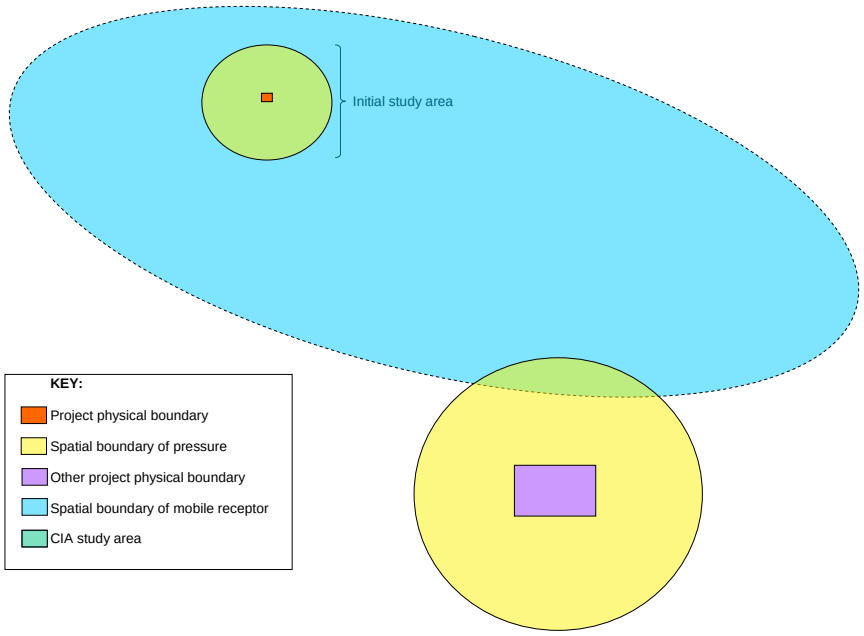


Figure 5. A simple schematic of a CIA study area

In effect, the initial study area in this figure comprises the project physical boundary and the spatial boundary of the pressure for the project alone. An example project could be a small-scale jetty development and the pressure could be the extent of behavioural response in migratory Atlantic salmon due to underwater noise generated by piling. The temporal boundary of the pressure should also be described at this stage e.g. the degree of overlap between the proposed programme for piling for the jetty and the main periods for salmon migration. In this way, each individual receptor will have a different study area to take account of the differing impact pathways that are relevant and receptor sensitivities.

A key output at this stage will be a list of MPA sites versus interest features of potential concern which can be used as a checklist to ensure all the relevant features and sites for that area have been considered as part of the assessment. The case study in Appendix D provides an example of the information that might be presented as part of this step.

Natural England Review Questions

- *Has the initial study area taken account of both significant and insignificant pressures associated with the proposed project alone?*
- *Can the spatial boundaries of the initial study area be shown on a figure?*
- *Have the temporal boundaries of the initial study area been defined?*
- *Have the MPA sites and associated interest features within the defined initial study area been scoped into the CIA?*

3.5 Step 5: Identifying Scope of Other Plans, Projects and Activities

The main objective of Step 5 is to identify other relevant plans, projects and activities that should be scoped into the CIA, in consultation with regulators and their advisors. In order to undertake a meaningful assessment, it is important that sufficient information is available for other plans, projects and activities. Where the level of available information regarding a particular project is considered to be insufficient to warrant its inclusion within the CIA, the reasoning and justification behind this decision needs to be clearly documented.

The scope of other plans, projects and activities in England is most clearly defined in the regulatory guidance documents outlined in Table 18. The existing guidance is not consistent either in terms of the extent to which future projects should be taken into account or in the requirement to include ongoing activities. Consultation with regulators and their advisors will be important in agreeing requirements for individual projects. In general, we suggest that the approach to be followed should include ongoing activities and should include future projects where there is meaningful information (either to inform a qualitative or quantitative assessment). In areas of intensive development activity, it may be helpful to develop and maintain registers of projects, plans and activities for inclusion in CIA.

Information availability may change over the course of the assessment and new plans, projects or activities may be identified. It is, therefore, important that a cut-off date, after which no further scoping reviews will be carried out, should be mutually agreed between the developer and regulator (and advisors). This allows the applicant sufficient time to undertake the assessment, write the ES, consult on it, revise it and then apply. Additional significant changes may need to be considered

through the use of addenda to the ES but these should be used as little as possible. Once issues have been scoped out and agreed there must be a strong justification for scoping them back in again.

In line with the recent study undertaken by RUK/NERC (2013), for an assessment to be meaningful it has to be based on evidence. Where there is insufficient evidence this will necessarily preclude a meaningful quantitative assessment, as it is not appropriate for developers to make assumptions about the detail of future projects in such circumstances. However, applicants should make some attempt to address cumulative impacts (even if only qualitatively) even when information and data may be missing or sparse, or when it is difficult to analyse the impacts on receptors brought about by future actions. When information is missing, sparse, or unavailable, it is important to ensure that the situation and rationale for assessment conclusions are adequately documented. However, the focus of the assessment will, therefore, be on those project or activities where sufficient relevant information exists.

Table 18. Key sources of guidance on scope of other plans, projects and activities

Author	Year	Report Title	Scope
English Nature	2001	HRA guidance documents including HRGN No. 4. Alone or in combination	▪ Plans and projects that are approved but as yet uncompleted; ▪ Permitted ongoing activities; ▪ Where an application has been made and is currently under consideration but not yet approved; and ▪ In some circumstances it may be appropriate to include plans and projects not yet submitted to the competent authority for consideration, but for which there is sufficient detail on which to make judgements on their impact.
HM Government	2012	Report of the Habitats and Wild Birds Directives Implementation Review	▪ Only include plans or projects which have happened or are likely to happen in the future (rather than any possible future plans or projects). https://www.gov.uk/government/publications/report-of-the-habitats-and-wild-birds-directives-implementation-review
Planning Inspectorate (PINS)	2012	Advice Note Nine: Rochdale Envelope	▪ Other major developments that are under construction; ▪ Permitted application(s), but not yet implemented; ▪ Submitted application(s) not yet determined; ▪ Projects on the Planning Inspectorate's Programme of Projects; ▪ Identified in the relevant Development Plan (and emerging Development Plans - with appropriate weight being given as they move closer to adoption) recognising that much information on any relevant proposals will be limited; and ▪ Identified in other plans and programmes (as appropriate) which set the framework for future development consents/approvals, where such development is reasonably likely to come forward. http://infrastructure.independent.gov.uk/wp-content/uploads/2011/02/Advice-note-9.-Rochdale-envelope-web.pdf

Author	Year	Report Title	Scope
Department of Food and Rural Affairs (Defra)	2012	The Habitats and Wild Birds Directives in England and its seas: Draft core guidance for developers, regulators & land/marine managers	▪ All current and proposed plans or projects. This would include proposals where planning permission (or a similar regulatory consent) has been applied for or granted. ▪ It is not necessary to take account of plans or projects for which there have been no formal applications under an approvals process. ▪ The authority should take account of the effects of past plans or projects if they are having an ongoing effect on the conservation objectives of the site. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/82706/habitats-simplify-guide-draft-20121211.pdf
RUK/NERC	2013	Guiding principles for cumulative effects assessment (CIA) in offshore wind farms (OWF)	▪ All Reasonably Foreseeable Future Projects (RFFP), in line with regulatory requirements provided by PINS (2012) (see above). Broadly, RFFP are considered to be projects which are currently known to the planning system or already within the consenting process. https://ke.services.nerc.ac.uk/Marine/Members/Documents/Guidance%20documents/Cumulative%20Impact%20Assessment%20Guidelines.pdf

Natural England Review Questions

- *Have other relevant plans, projects and activities been identified consistent with the advice provided by existing regulatory guidance documents?*
- *Has a cut-off date for the scoping review been agreed between the developer and regulator?*

3.6 Step 6: Defining Pressures of Other Plans, Projects and Activities

The main objective of Step 6 is to define, as far as is practicable, the pressures that might be brought about by activities associated with other plans, projects and activities that have been scoped into the CIA at Step 5. This will involve identifying the spatiotemporal boundaries of pressures and characterising their intensity or magnitude.

Determining pathways associated with other plans, projects and activities is a critical step in assessing cumulative impacts because it provides a means to understand the nature and extent of impacts that are likely to occur. It also provides a systematic way to screen-out pressures and/or receptors and ensuring the assessment process is more efficient and targeted (MMO, 2013 in draft).

This component of the CIA will need to be iteratively reviewed and updated in light of new and available information regarding other plans, projects and activities. This is denoted by an asterix (*) in the framework diagram (see Figure 4). Any data gaps and/or uncertainties associated with defining pressures should be clearly presented and taken into account as part of the assessment.

The process should adequately characterise the environmental pressures associated with other plans, projects and activities as far as possible to permit a meaningful

assessment. In particular, it is important not just to identify where various pressures from plans, project and activities may overlap spatially with those from the proposed development (thus giving rise to possible additive effects which can be easily summed and also synergistic effects), but CIA also needs to take account of the effect of spatially discrete pressures acting on the same receptor. For example, in relation to the former, CIA might need to take account of the interaction between sediment plumes generated from dredge material disposal and marine aggregate dredging which, when spatially overlapping might increase the intensity and duration of changes in suspended sediment concentration experienced by a benthic habitat. In relation to the latter, CIA might need to take account of losses of or disturbance to a certain seabed habitat within a MPA caused by various forms of development or activity (e.g. losses of subtidal mixed sediments to an individual jetty, marine aggregate dredging, fishing etc). In terms of the latter, it is important that the spatiotemporal boundaries of mobile receptors are clearly defined, recognising the limitations of the available information (e.g. lack of monitoring and survey data), to ensure that potential cumulative effects across their full range are taken into account as part of the CIA (see Section 3.2). This is depicted as a simple schematic in Figure 5, whereby a specific pressure associated with the proposed project is spatially discrete from pressures brought about by another project but both overlap with the spatial range of a particular mobile receptor.

Natural England Review Questions

- *Have all the pressures associated with other plans, projects and activities been identified?*
- *Have the pressures been clearly defined both spatially and temporally?*
- *Have any data gaps and/or uncertainties associated with the pressures been identified and defined?*

3.7 Step 7: Scoping of Relevant Receptor-Pressure Interactions of Other Plans, Projects and Activities

The main objective of Step 7 is to review the relevance of cumulative pressures identified in Step 6 to MPA receptors identified in Step 2.

This component of the CIA framework involves identifying the cause and effect pathways (pressures) that are likely to be brought about by other plans, projects and activities that overlap with the defined spatiotemporal scale of MPA receptors (see Section 3.2). Following a precautionary approach, only receptors that clearly do not overlap with cumulative pressures should be excluded from this part of the assessment.

This component of the framework would ideally be integrated with the scoping evaluation of project specific pressures (Section 3.3) to provide a more streamlined approach to CIA. However, in practice, project specific pressures are initially evaluated separately to cumulative pressures and, therefore, these components have been kept separate in the framework for clarity. In the longer-term, integration of these into a single process will be beneficial for effective CIA.

Natural England Review Questions

- *Is there a clear audit trail of the impact pathways that have been scoped in and out of the assessment?*

3.8 Step 8: Defining CIA Study Area

The main objective of Step 8 is to define the CIA study area i.e. the area where the spatiotemporal extent of the pressures associated with the project alone and other relevant plans, projects and activities overlaps with the spatiotemporal range of a specific receptor. In this way, each individual receptor will have a different study area to take account of the differing impact pathways that are relevant and different receptor sensitivities.

This component of the CIA framework should follow the same approach as for defining the initial study area outlined in Section 3.4, taking account of the spatiotemporal extent of cumulative pressures associated with both the proposed project and other relevant plans, projects and activities.

It would be helpful for the applicant to depict the spatial extent of each receptor CIA study area on a figure as far as is practicable at that particular phase in the EIA. Figure 5 shows a simple schematic of a CIA study area. As described in Section 3.4, an example project could be a small-scale jetty development and the pressure could be the behavioural response in Atlantic salmon as a result of underwater noise generated by piling. The other project could, for example, be a large-scale offshore wind farm development and the pressure is the behavioural response in Atlantic salmon as a result of piling noise (although it could also be a different pressure acting on the same receptor). The temporal boundary of the pressure should also be described at this stage (e.g. the degree of overlap between the proposed programme for piling for the jetty and other project and the main migratory periods for salmon). A visual representation of how spatial boundaries may change with time would be useful.

A key output at this stage will be a revised list of MPA sites versus features of potential concern which can be used as a checklist to ensure all the relevant features and sites for that area have been considered as part of the assessment.

Natural England Review Questions

- *Has the CIA study area taken account of both significant and insignificant pressures associated with other plans, projects and activities?*
- *Can the spatial boundaries of the CIA study area be shown on a figure?*
- *Have the temporal boundaries of the CIA initial study area been defined?*
- *Has the full suite of MPA sites and associated interest features within the defined CIA study area been scoped into the CIA? Use MPA sites versus features of potential concern matrix as a checklist*

3.9 Step 9: Selecting Appropriate Assessment Tools and Methods

The main objective of Step 9 is to identify the assessment tools and methods that could be used as part of the CIA for analysis of effect and which are fit for purpose and proportionate to the scale of environmental risk. Documentation of the rationale for the selected methods, as well as their assumptions and key features, can facilitate the application of best practice approaches. It is important that where quantitative predictions are made, the uncertainties surrounding these estimates are documented and understood.

A range of assessment tools that can be used for assessing impact pathways within CIAs has been reviewed in Section 2.4.

During the EIA process it may be that a combination of techniques are used, or that approaches are adopted at different stages of the project (Hyder, 1999). Ultimately, the CIA should seek to apply assessment tools that are practical and proportionate to the scale of the project and the environmental risk. There are, however, a number of factors that influence the approach adopted for the assessment of cumulative impacts for a particular project. These include the data/information available and the timeframe for the evaluation (MacDonald, 2000). The amount of effort required by an assessment can be influenced by the level of public concern and the amount of resources available. However, it is essential that all assessments are pragmatic and proportionate to the scale of any potential impacts and the confidence that is required. For example in some situations a simple qualitative assessment may be considered adequate, but in others a detailed quantitative modelling project needing major resource inputs may be required (RUK/NERC, 2013).

There are various approaches to the selection of suitable assessment tools and methods: professional judgement only, systematic but qualitative comparisons of different methods for usage for different purposes, and detailed quantitative comparisons of different methods arrayed against a series of weighted decision criteria (Canter, 2008). Where professional judgement is used alone, the developer should still provide a clear rationale for this (e.g. absence of any quantitative evidence). In actual fact, professional judgment is likely to be involved in all three approaches. In this regard, specific decision criteria for comparing methods may not be delineated, with choices probably being related to the familiarity and possible previous usage of methods by individuals. Finally, it is important to note that professional judgement can relate to both substantive issues addressed by individual methods as well as their comparative ease of usage in terms of required data, time considerations, and budgetary limitations. In order to facilitate the comparison of CIAs across projects, it is suggested that regulators and their advisors should provide applicants with guidance on preferred assessment tools for particular applications. Consultation with regulators and their advisors is recommended in seeking to agree suitable tools and methods.

Natural England Review Questions

- *What is the rationale for the selection of particular assessment tools for the CIA?*
- *Are the assessment tools fit for purpose and proportionate to the scale of environmental risk?*

3.10 Step 10: Identifying Sensitivity of Receptor

The main objective of Step 10 is to take account of the sensitivity of receptors (resilience, adaptability and recoverability) to the particular cumulative pressures that have been defined i.e. scale of effect. Any uncertainties associated with defining the sensitivity of a receptor to pressures (e.g. lack of data on recovery rates, collision damage and behavioural responses to noise etc.) should be clearly presented and taken into account as part of the assessment.

A sensitivity matrix could be used at this stage to help to determine which receptors are sensitive to the defined project pressures and, thus, need to be scoped into the assessment. Tillin et al. (2010) developed a sensitivity matrix specifically for MPA

benthic habitats and associated species. The MarLIN website[17] also provides a useful source of sensitivity information for a number of marine invertebrate species and habitats. An initial search of the available literature has not identified any sensitivity matrices for other MPA receptors i.e. birds, marine mammals and fish. It is considered that such matrices could be a useful supporting tool to be used in conjunction with the framework so there is value in developing these in future. Recent plan-level HRAs for Scottish offshore renewables and the East Marine Plan include some detailed sensitivity information on MPA features that could initially be drawn on for these purposes (ABPmer, 2011; ABPmer, 2013). Where such approaches are used, it is important to understand that sensitivity assessments relate to a benchmark pressure. Consideration therefore needs to be given to the specific pressures associated with the development being assessed and whether they might be higher or lower than the benchmark pressure used to inform the sensitivity assessment. Issues of scale also need to be taken into account, for example, is the pressure very localised or pervasive, as this will influence judgements on the significance of any impact.

It is important to note that evaluating the vulnerability of receptors to pressures (which is based on a combination of sensitivity of receptors and exposure to change) is receptor specific even where different receptors occur in the same area. For example, a benthic habitat located within an area that is exposed to change as a result of a project activity is unable to avoid effects and is exposed for the duration of the activity, whereas wide-ranging, highly mobile species such as fish and marine mammals may be vulnerable only in a small proportion of their range and may be able to avoid the pressure.

In practice, the focus of the CIA will need to be on receptors that are likely to be at greatest risk from a project's contribution to cumulative impacts. It may therefore be possible to screen out some plans, projects and activities on this basis. For example, the simple schematic in Figure 5 shows that the pressure associated with the other project only overlaps marginally with the full range of the mobile receptor and, therefore, it may be appropriate to screen this project out of the assessment given its limited contribution. However, this will need to be considered on a receptor-by-receptor and project-by-project basis.

Natural England Review Questions

- *Has the sensitivity of MPA receptors in relation to cumulative pressures been taken into account?*
- *Has the level of uncertainty associated with the sensitivity of receptors been identified?*

3.11 Step 11: Assessing Significance of Pressures

The main objective of Step 11 is to assess the significance of cumulative pressures. The determination of significance will involve taking account of any impact margins or thresholds which might be exceeded. The baseline conditions should also be taken into account as part of the assessment, including consideration of natural variability and any future trends.

The conceptual basis for undertaking impact assessment is well established, through guidance from legislation, regulators, professional bodies and consultants, for example:

[17] http://www.marlin.ac.uk/

- The criteria listed in Annex III of the EC Environmental Impact Assessment Directive (85/337 EEC as amended by 97/11/EC); http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:026:0001:0021:EN:PDF
- The assessment processes developed by statutory conservation agencies to provide advice on operations within European Marine Sites e.g. Natural England's advice given under Regulation 35(3) Habitats Regulations' (3); http://www.naturalengland.gov.uk/ourwork/marine/mpa/ems/default.aspx
- An Environmental Risk Assessment approach developed by ABP Research (ABP Research, 1997);
- Institute of Ecology and Environmental Management's (IEEM) Guidelines for Ecological Impact Assessment in the UK (IEEM, 2006) and Guidelines for Ecological Impact Assessment in Marine and Coastal Environments (IEEM, 2010); http://www.cieem.net/data/files/Resource_Library/Technical_Guidance_Series/EcIA_Guidelines/Final_EcIA_Marine_01_Dec_2010.pdf
- Managing Natura 2000 sites. The provisions of Article 6 of the 'Habitats' Directive 92/43/EEC European Commission, 2000. http://ec.europa.eu/environment/nature/natura2000/management/docs/art6/provision_of_art6_en.pdf

In summary, the significance of an impact is defined by evaluating the vulnerability of a receptor to an effect, taking account of its 'importance'. MPA receptors are considered to have a high importance given that they are internationally or nationally designated and protected. Margins and thresholds that are considered of particular relevance to MPA features are the conservation objectives and favourable condition targets provided in Natural England advice packages under Regulation 35(3) of The Conservation of Habitats and Species (Amendment) Regulations 2012. In addition, any WFD protected area objectives that are outlined within relevant RBMPs should be taken account of as part of the assessment. The baseline conditions that are characterised within the assessment will differ between HRAs, which should consider the condition of receptors at the time of designation, and EIAs, which focus on the present day situation (see Section 2.1.1).

Any cumulative impacts that are found to be adverse and of an unacceptable level will require mitigation and management measures to reduce residual impacts, as far as possible, to environmentally acceptable levels. Identifying what those acceptable limits are will a require site specific evaluation of what the current status of the feature is in relation to its conservation objectives and the preservation of site integrity (see Section 2.1.2.1). Within the assessment procedure the use of mitigation and management measures will alter the risk of exposure and hence will require significance to be re-assessed and thus the residual impact identified.

The use of matrices to provide clear audit trails documenting how assessments of significance have been derived may be helpful, although these are not currently required under existing guidance. Regulators and their advisors should consider whether such approaches might facilitate auditing assessments.

Natural England Review Questions

- *Have appropriate impact margins or thresholds been taken into account as part of the assessment?*
- *Has the significance of cumulative impacts been clearly documented?*

3.12 Step 12: Documenting Assessment Outcomes

The objective of the final step in the CIA framework to document the assessment outcomes against the specific conservation objectives for the features for which relevant sites have been designated. Judgements on the significance of impacts should take account of relevant guidance and case law.

The outcomes of the CIA should be clearly documented within an ES (or Appropriate Assessment Information Report for stand-alone HRAs). This could either comprise a separate chapter or as a CIA section within each of the receptor-specific EIA chapters.

4. Discussion

Although the basic steps involved in undertaking a CIA are similar to those for assessing an individual project, there are a number of challenges in applying and reviewing CIA, particularly given the complex nature of the marine environment. These difficulties are often passed on to regulators and their advisors, and can lead to unnecessary delays or lack of rigour in the decision making process. The key challenges and some suggested methods of overcoming them are discussed in the sections below.

4.1 Lack of Clear and Consistent Guidance

There is a lack of certainty over the process for undertaking a CIA, with inconclusive guidance and inconsistent definitions (e.g. the scope of other plans, projects and activities). Although, some sound guidance on CIA has existed since the late 1990s (e.g. CEQ, 1997; Hyder, 1999) and has been taken forward in recent years in the UK (e.g. King et al., 2009; MMO, 2013 in draft; RUK/NERC, 2013), no explicit framework for undertaking CIA has been proposed. This study contributes to filling this gap by providing a generic framework that outlines the methods and processes through which a robust CIA can be based. However, it is desirable that regulators and their advisors collaborate on the development of detailed guidance for developers.

4.2 Difficulties in Defining Spatiotemporal Scales and CIA Study Areas

Assumptions that have been made to define study areas are often not transparent in project CIAs, which is probably due to a lack of clarity and guidance on how CIA study areas should be defined. There is difficulty in defining the geographic (spatial) and time (temporal) boundaries that underpin CIA study areas. The selection of an appropriate scale is very subjective and depends on many factors such as the type and size of project, plan or activity, the ecological processes being studied, and how heterogeneous or homogeneous the spatial setting is. Furthermore, the choice of scales can have important repercussions for the reliability of any CIA. If the boundaries are defined too broadly, the analysis becomes unmanageable. However, if they are defined too narrowly, significant issues may be overlooked, and decision makers will be incompletely informed about the consequences of activities.

In addition, although receptors should be a key aspect of CIA, they often seem to be an afterthought, with CIAs often focusing only on the spatiotemporal extent of overlapping pressures. In order to keep the assessment manageable and proportionate to the environmental risks posed by the proposed development, it is proposed that a receptor-led approach be applied to CIA and that the appropriate scale for the assessment be determined and agreed early on at the scoping phase. The generic CIA framework that has been developed as part of this study in Section 3 and tested on a hypothetical project in Section 4, embraces this principle. However, it is still necessary to apply a significant level of judgement in developing the scope of a CIA to ensure it is proportionate.

4.3 Uncertainties in Characterising the Magnitude of Pressures

Information on the scale of pressures associated with other plans, projects and activities is often lacking, making it difficult to undertake a meaningful assessment. There is also a large level of uncertainty in characterising the magnitude of pressures given that cumulative effects may occur at considerable distances from the source (e.g. noise propagation); they may be transnational boundary in character; they may be difficult to quantify due to a lack of robust science (e.g. collision risk and displacement); and there may be insufficient underlying data. This uncertainty is compounded by seeking to quantify multiple pressures of different types on a receptor (e.g. how to evaluate the combined effects of habitat loss, disturbance, increased turbidity and underwater noise on the spawning success of herring). Dealing with uncertainties at greater spatial and temporal scales will require an integrated and evidence-based approach. The nature, level and location of uncertainty, thus, need to be clearly defined within CIAs so that they can be appropriately considered by decision-makers. Furthermore, it should be recognised that CIA needs to be an iterative process, particularly for large projects where there may be project design uncertainties. The framework has, therefore, been designed to allow iterative review as new information becomes available.

4.4 Uncertainties in Cause and Effect Relationships

Pressures will interact in different ways (additive, synergistic, antagonistic, independent etc.) to lead to direct or indirect cumulative effects. A key challenge to CIA in marine environments is the lack of scientific knowledge about cause and effect relationships and, therefore, the difficulty in predicting cumulative effects. There is a lot of uncertainty about whether cumulative effects will respond in a linear fashion to the increase in pressures, or whether there may be non-linear responses indicative of a threshold being reached. This leads to uncertainty in predicting the response of receptors.

The lack of well-developed and validated receptor-specific CIA models represents a critical gap in the scientific literature. The models would need to be able to incorporate variations in the spatial and temporal scale of cumulative pressures. The availability and resolution of robust data underpinning these models would also be a critical consideration.

Adaptive management approaches, including monitoring of the cumulative effects of projects, will make a potentially significant contribution to the state of understanding and knowledge of how the cumulative weight of development may affect biodiversity (English Nature, 2006). In particular, monitoring will provide a useful test of the accuracy of predictions made in the assessment process and should reduce the level of uncertainty in future assessments. Monitoring may also provide the evidence needed to establish the capacity of ecosystems to accommodate development and the thresholds beyond which irreversible damage to biodiversity will result, ultimately allowing environmental limits to be more clearly defined.

4.5 Challenges in Assessing Significance of Impacts

Although impact assessments should be underpinned by a combination of best available evidence and proportionate assessment tools (e.g. GIS mapping, numerical modelling and expert judgment), few definitive significance criteria and acceptable threshold levels for receptors currently exist under which the cumulative effects of projects can be managed. Differences in how projects assign and describe

environmental risk can make apparently similar statements like “moderate adverse impact” mean very different things. It is, therefore, considered that matrices could be used to provide a clear audit trail of the reasoned argument that has been undertaken to arrive at the final impact significance level. In this way, the generic CIA framework that has been developed for this study incorporates a number of supporting tools that take the form of matrices (e.g. sensitivity matrix).

4.6 Piecemeal Nature of CIAs Undertaken within EIAs

Relevant CIA information is not always overt within Environmental Statements and generally involves reviewing a number of different sections, including methodology chapters, baseline and impact assessment sections for relevant receptors and any specific cumulative impact sections. Furthermore, CIA information is sometimes included as a brief statement within chapter sections, a summary at the end of chapters or a collated summary in a separate section or chapter. The generic framework that has been developed as part of this study will enable Natural England case officers to advise regulators and developers on the scope of CIA and should help to enable a more consistent approach and format to be applied at the assessment phase of the EIA. This will in turn allow regulators and their advisors to more easily work on and manage multiple projects, make comparisons between them, and identify potential errors or problems in a timely manner.

4.7 Proportionate Cumulative Impact Assessment

The agreed scope for a CIA should be proportionate to the scale of project issues. Although the generic CIA framework has been developed to be applicable for projects of varying scales, the process will still require a certain amount of professional judgement to determine the scope of issues for consideration at the assessment phase. In this way, the focus should be on producing meaningful CIA, which strike a balance between pragmatism and precaution and, therefore, provide a meaningful analysis of the cumulative effects of developments while allowing development to proceed in a timely fashion. It is important to emphasise the need to keep the assessment clearly focused and not unmanageably large. This can only be done as part of close collaboration between developers, regulators and their advisors, who should work together from the early stages of project inception to identity and manage significant issues.

4.8 Managing Uncertainty in Assessment Outcomes

The inherent uncertainties associated with CIA outcomes present significant challenges to decision makers and their advisors in seeking to reach conclusions about the implications for protected sites. This is particularly the case for European Marine Sites where policy and case law afford very high levels of protection to designated features. While outside the scope of this study, further policy development in this area may be helpful to establish how uncertainty relating to CIA outcomes should be reflected in project level decision making. This might also usefully consider the role of strategic mitigation as a means for dealing with uncertainty across a number of projects potentially giving rise to a significant cumulative effect, similar to the approach adopted on land for Thames Basin Heaths (Thames Basin Heaths Joint Strategic Partnership Board, 2009).

5. Recommendations

Undertaking meaningful CIA is currently very challenging. This reflects the complexity of CIA, the relative paucity of data to inform assessments, scientific uncertainty relating to effects thresholds and combined impacts from different pressures as well as the lack of certainty relating to CIA requirements. However, while it is not feasible to resolve all of these issues in the short-term, it is possible to make significant progress in a number of areas which will greatly assist with the preparation of more meaningful CIAs. In particular, there is scope for regulators and their advisors to provide more detailed guidance on their expectations for CIA, the process that they expect developers to follow and resources to support CIA. Based on the findings of this study, the following recommendations are proposed:

- Develop guidance to enable the CIA framework to be trialled on a range of development projects;
- Develop guidance for developers on the general process that developers are expected to follow in undertaking CIA, based on the framework developed in this study. This might particularly promote consideration of potential CIA issues at scoping stage and integrating CIA issues within the overall EIA;
- Develop guidance on how CIA information should be presented in EIAs and HRAs to enhance consistency and auditability. For example, this might encourage the use of matrix approaches to document the basis for statements on impact significance;
- Develop and promote resources to support CIA such as:
    - Information on the functional use of the marine environment by mobile species, for example, foraging ranges of seabirds, migration routes of fish and use of territories by marine mammals;
    - Information on pressures that can be associated with different development activities;
    - Information on impact pathways associated with particular development activities;
    - Information on the condition of MPA features;
    - Information on the sensitivity of MPA features to human pressures;
    - Databases of extant and future projects and relevant activities in areas subject to multiple developments ; and
    - Development of validated receptor-specific CIA models.
- Undertake further research on how to assess cumulative impact significance i.e. determining unacceptable thresholds of change and tipping points that trigger synergistic impacts; and
- Develop guidance on mitigation and management of cumulative impacts.

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Appendices

Appendix A

RUK/NERC (2013)
Guiding Principles

Appendix A. RUK/NERC (2013) Guiding Principles

The following sections provide some further detail on the guiding principles that were developed by the RUK/NERC study.

Project Level Assessment

One of the guiding principles presented by the RUK/NERC study was that CIA should be a project-level assessment. The CIA should cover the effects that result from additive and synergistic impacts, caused by other past (including consented/constructed developments), present or reasonably foreseeable human use activities together with the project in question in order to assist regulators and their advisors to ensure that environmental capacity will not be exceeded, in respect of the EIA and to inform the in-combination assessment for AA (where required). Strategic level assessments, such as SEAs can help to scope project level CIA, identify strategic research needs that are required to inform the CIA of project level EIA and information requirements for the competent authority to carry out the AA (where required), as well as provide a clear steer on mitigation and monitoring requirements.

Collaboration

It is to the mutual benefit of all to collaborate in identifying cumulative effects of OWF developments. Collaboration on data collection, modelling, agreeing strategic level mitigation measures and monitoring can be more cost effective and provide greater certainty in CIA. Developers, consultees and regulators should proactively work together to identify and manage issues, and aim to resolve as many issues as early as possible. Where areas of disagreement occur, they should seek to define the disagreement as clearly as possible to facilitate mutual efforts to arrive at solutions. Seek early agreement of baseline data sets, assessment processes, and pragmatic evidence based thresholds. Evidence Plans can help to achieve this.

Clarity and Transparency

Regulators and statutory consultees should ensure that their CIA requirements from developers are explicit, transparent and based on best available evidence. In turn, developers need to ensure that CIAs include clear audit trails so that the basis for judgements on impacts is transparent. Iterative engagement with Statutory Nature Conservation Bodies (SNCBs) and regulators on the development process and timelines can help ensure regulator input and resources are effectively deployed.

Scoping

Scoping should be undertaken as early in the process as possible, in order to gather decisions on information requirements and their sources. Early scoping helps to focus on key impacts and makes the CIA process more efficient and proportionate. However, there may not be enough information in the early stages to scope issues effectively and subsequent iterative reviews may need to be undertaken where appropriate.

Developers in liaison with regulators/advisors should generate a comprehensive list of national and international plans, projects and regulated activities that have the potential to contribute to cumulative effects of the Project. Adopting this approach allows developers to undertake an auditable process of screening out plans, projects and activities on a parameter by parameter basis (based on expert judgment and a source-pathway-receptor

rationale) and minimises the risk of missing something that may later be raised in consultation or during the examination phase. Projects should then be scoped out where sufficient justification exists. Justification for scoping out projects should be clear and transparent. Projects where there is not sufficient information to undertake the assessment should be scoped out. Reviews should be undertaken, where required on the basis of new information, on the basis of changes to the project envelope or when improved approaches to assessment become available.

The frequency and timing of scoping reviews, and any final cut-off dates after which no further reviews will be carried out, will be set by mutual agreement during the initial scoping phase. A final cut-off date is an important step, as it allows the applicant sufficient time to undertake the assessment, write the ES, consult on it, revise it and then apply. Additional significant changes may need to be considered through the use of addenda to the ES but these should be used as little as possible. Once issues have been scoped out and agreed there must be a strong justification for scoping them back in again.

Boundaries

Spatial boundaries should take account both of the relevant spatial scales for individual receptors (foraging distances, migratory routes) and the spatial extent of environmental changes introduced by developments so that all potential impact pathways can be identified in line with the source-pathway-receptor model. Temporal boundaries should take account of the environmental changes introduced by the project at different phases of the life cycle (construction, operation and decommissioning) and recovery times of potentially affected receptors and reference populations. The temporal scale of the CIA assessment should end at the lifetime of the applicants project and consider the cumulative or in combination impact of constructing, operating and decommissioning any reasonably foreseeable projects and activities within that timeframe.

Project Design Envelope

Although Project Design Envelopes are essential consenting tools, they should be realistic in scale. Wide Project Design Envelopes can make the CIA assessment process more difficult, through a multiplicity of “worst case” estimates giving rise to unrealistic project level CIA. Developers should bear in mind that the worst case may not provide the basis for a meaningful CIA, as the consenting envelope may be very different from the built development. Although there is a genuine need for flexibility, developers should accept that the larger the envelope the more challenging it is for other CIA assessments and the greater the potential cumulative effects with wide envelopes using up vital environmental carrying capacities.

Projects, Plans and Activities

Developers should consider projects, plans and activities which have sufficient information available in order to undertake the assessment. In scoping CIA work, developers and Statutory Consultees should include in the CIA process all Reasonably Foreseeable Future Projects (RFFP), in line with regulatory requirements. Broadly, RFFP are projects which are currently known to the planning system or already within the consenting process. However, the detail of which projects and human use activities should be included in a CIA will need to be discussed and agreed with regulators and their statutory advisors.

Data

The sharing and common analysis of compatible data by developers enhances the CIA process. CIA is made more difficult by the limited information that is available for the marine environment. The gathering and use of common data sets and common methodologies will enhance the CIA process by:

- Reducing the potential for conflict between different user groups;
- Potentially shorten timescales for assessment;
- Helping to ensure that effects upon sensitive receptors are identified;
- Facilitating decisions on future locations;
- Assisting regulators in comparing proposals, and
- Facilitating mitigation and monitoring.

Baseline

The baseline should assess the historical state and the likely future state without the development. The future baseline is an important reference point against which cumulative effects should be assessed, particularly in the marine environment, where the baseline may change significantly over time. The acknowledgement of shifting baselines is important in understanding of the state of the marine environment. However, in the context of CIA this needs to be done in terms of the characterisation of the environment as part of the EIA. For HRA it should also be related to the conservation objectives and the condition of the features for which the site has been designated. As part of the characterisation, it is important to consider the residual effects of consented'/constructed projects to inform the CIA if they have not been totally removed through mitigation.

Assessment

CIA should be proportionate to the environmental risk of the project and focused on key effects and sensitive receptors. A key challenge in CIA is to keep the assessment reasonable and in proportion to the nature and scale of the development. Common sense and risk assessment has an important part to play in reaching agreement about the scope of the assessment. All stakeholders have to exercise their judgment about what is appropriate and proportionate and be able to justify the approach taken. Carefully thinking through the significant cumulative effects that are likely to be generated by the development should allow a sensible decision to be reached at the scoping stage. CIA should be proportionate, focusing on key effects and sensitive receptors, to ensure a holistic assessment of the environmental risks and effects. Where uncertainty exists there is merit in looking at these issues in more detail.

Uncertainty

Uncertainty should be addressed and where practicable quantified. Uncertainty (due to the absence of data or uncertainty due to natural variation) can make it difficult to be definitive about a potential effect and it is crucial to define any uncertainty and seek to understand, minimise and communicate it. A "precautionary but pragmatic" approach, based around the best available scientific evidence, should be used where baseline data or data about the environmental effect of a project are incomplete.

Scoping of CIA is likely to take the form of qualitative assessments to identify potentially significant effects, taking care to identify the entire spectrum of possible local and wider effects. However, the potentially significant effects identified during scoping need to be

properly evaluated using a quantitative assessment tool where it is proportionate to environmental risk.

Mitigation

Mitigation should be informed by the results of the CIA. Regulators have the power to impose mitigation measures as conditions within the consent for the project. These may also be documented in separate legal agreements between interested parties. CIA presents particular problems for the implementation of mitigation proposals in terms of spatial scale and the need for collaboration. The regional spatial nature of any mitigation proposals is an important consideration in implementing mitigation plans. Collaboration is therefore essential.

Monitoring

Regulators have the power to impose monitoring obligations on developers as conditions within the consent for the project. These may also be documented in separate legal agreements between interested parties. CIA presents particular problems for the implementation of monitoring proposals in terms of spatial scale and the need for collaboration. The regional spatial nature of any monitoring proposals is an important consideration in implementing monitoring plans. Collaboration is therefore essential.

Developers also have a responsibility to monitor impacts of their developments; however, any wider monitoring proposals need to be considered in collaboration with regulators/stakeholders.
It is widely recognised that an effective assessment will involve some form of monitoring to assess the actual environmental outcomes that result from a development, and to provide a check on the quality of the predictions made within such assessments.

Clear objectives for the monitoring programme are essential to ensure that appropriate monitoring is implemented. They should be appropriate and proportionate to the magnitude of observed effects.

Appendix B

Review of Case Studies

Appendix B. Review of Case Studies

Table B1. Review of Cape Wind OWF case study: Fish

	Case study	**Cape Wind OWF Environmental Impact Statement**		
	Brief Project Description	The Environmental Impact Statement (EIS) for the proposed Cape Wind Associates, LLC Cape Wind Energy Project has been prepared by the United States Army Corps of Engineers. The purpose and need for the project is to provide a utility-scale renewable energy facility providing power to the New England grid. Renewable sources of energy are need to provide additional power to meet demand and to reduce dependency on non-local, non-renewable energy sources. The Applicant proposes to meet the demonstrated need for new regionally-significant renewable energy production by installing and operating a wind-powered electric generating facility comprising 130 offshore wind turbine generators, a centrally located Electrical Service Platform and associated transmission cables and equipment. This offshore wind park will be capable of producing an average annual output of approximately 170 megawatts (MW) with a maximum deliverable capacity of approximately 454 MW.		
	Sector	Offshore wind		
	Receptor	Fish		
	Location	USA (Massachusetts)		
Systematic Approach to Identifying Project Impacts:	**Systematic process for defining pressures (environmental changes introduced by development)**	Spatial: There is no clear systematic process as to how pressures have been scoped into assessment and spatially defined. It appears that only environmental changes occurring in the Project Area (i.e. within footprint of wind farm and associated cables) and those identified during consultation have been considered in the assessment.	Temporal: The assessment has considered potential direct and indirect impacts occurring at different phases of the project life cycle (construction, operation and decommission).	Intensity: A review of scientific literature and expert opinion has informed the assessment of effects and defined the magnitude of changes brought about by the project.
	Receptors defined with regard to spatial and temporal scales of project pressures	Spatial: The assessment has identified key fish species occurring in the Project Area.	Temporal: The seasonal distribution of fish receptors in the Project Area has been described in relation to the different stages of the project life cycle.	
	Significance of pressures defined with regard to sensitivity of features to pressures	This has been undertaken based on published scientific information and expert judgement.		
	Initial study area defined in light of spatial extent of significant pressures	No clear initial study area for the CIA has been described.		

Table B1 continued…

Systematic Process for Identifying Impacts Associated with Other Plans, Projects and Activities:	**Scope of other plans, projects and activities**	Other projects and activities in the past, present or future which may occur in and outside Massachusetts waters, within the location and timeframe of the proposed project and could contribute to cumulative impacts have been included.		
	Systematic Process for defining pressures associated with other plans, projects and activities	Spatial: The assessment provides some description of the relative distance of pressures associated with other projects and activities to the proposed development.	Temporal: A description of the likely timescale of pressures associated with other projects and activities in relation to the pressures associated with the proposed development has been included.	Intensity: The assessment does not fully quantify the magnitude of effects associated with other projects or activities.
	Significance of pressures defined with regard to sensitivity of features to pressures	The method used to assess whether any other projects or activities are likely to have a cumulative effect is based on a review of the spatial and temporal distribution of pressures. The CIA contains no information on the sensitivity of receptors.		
	CIA Study area defined in light of spatial extent of significant cumulative pressures	The CIA study area has not been clearly defined. In addition, there is no overall assessment of the potential cumulative effects of all the other projects and activities that have been scoped into the CIA, rather they have been assessed on an individual basis in relation to the proposed development.		
	Clear justification for choice of assessment tools and methods	The assessment has been based on a review of scientific literature, consultation and expert judgement. There is no clearly defined EIA or CIA methodology and no clear justification for the approach that was used.		
	Consideration of mitigation and/or monitoring requirements	Project construction methodologies have been selected to minimise cumulative environmental impacts so there is no overall significant impact on fish.		

Table B2. Review of Docking Shoal OWF case study: Birds

	Case study	**Docking Shoal OWF (DSOWF) Project**		
	Brief Project Description	In 2008, Centrica proposed the development of the Docking Shoal Offshore Wind Farm (DSOWF), located approximately 14 km off the north Norfolk coast. The wind farm was proposed to have an installed capacity of approximately 500 MW. The development follows an invitation from The Crown Estate in July 2003 to bid for wind farm sites within three strategic offshore areas. In the Greater Wash strategic area, Centrica owns two consented wind farms, Lynn and Inner Dowsing on which construction is now well advanced. Centrica has also sought consent to build the Lincs Offshore Wind Farm. The proposed DSOWF would extend over an area of approximately 75 km^2. The wind turbines, inter-turbine cable network and offshore substations would be located within the Greater Wash strategic area.		
	Sector	Offshore wind		
	Receptor	Birds		
	Country	England		
Systematic Approach to Identifying Project Impacts:	**Systematic process for defining pressures (environmental changes introduced by development)**	Spatial: The assessment has identified the main effects for birds during the construction, operation and decommissioning of the DSOWF such as habitat loss, disturbance, displacement, collision mortality and impacts on flight lines (barrier effects). Sections of the project in different locations, such as turbines and export cabling have been included. Spatial extent of the pressures have been addressed by quantifying distances over which birds are affected by boat traffic and estimating distances which construction noise can be heard for receptors and prey (indirect effects).	Temporal: The assessment uses techniques such as collision risk modelling to determine losses of individuals from populations of sensitive species over a year. The assessment identifies different pressures to receptors during different stages of development, such as construction of wind farm, cable laying, and decommissioning, as well as indirect effects. The assessment has also considered temporal scales of pressures from these different stages.	Intensity: Intensity of impacts such as population change due to collision mortality for the ornithological receptors have been assessed using collision risk modelling. Modelling and results of recent research have been used to determine changes to populations during development.
	Receptors defined with regard to spatial and temporal sections of project pressures	Spatial: In accounts of receptor species, information is presented on distribution of the species in the region, and occurrence within the study areas. Receptor species have been considered in the context of both wind farm and export cable developments.	Temporal: Temporal distribution of each receptor has been characterised in the assessment.	
	Significance of pressures defined with regard to sensitivity of features to pressures	Using published scientific information, receptors have been scored on a four point scale with regard to their sensitivity to different pressures, and the impact these pressures may have on receptor populations. Impact matrices have been used to determine significance of pressures.		
	Initial study area defined in light of spatial extent of significant pressures	The initial study areas were based on the anticipated extent of changes, for example habitat loss or disturbance, and the locations where other pressures, such as collision mortality would occur.		

Table B2 continued…

Systematic Process for Identifying Impacts Associated with Other Plans, Projects and Activities:	**Scope of other plans, projects and activities**	The pressures associated with wind farm developments which are under construction, proposed or consented close by have been considered. Increased shipping traffic was also considered.		
	Systematic Process for defining pressures associated with other plans, projects and activities	Spatial: Other plans and projects considered were offshore wind farm projects within the Greater Wash, which would exert similar pressures on similar spatial scales to the DSOWF.	Temporal: Timescales and stage of development of pressures associated with other wind farm projects in the Greater Wash have been considered.	Intensity: Cumulative impact significance has been ranked using four levels of intensity. The use of numerical modelling such as collision risk modelling and latest research has been used to assess effects and has determined qualitative changes in populations due to development.
	Significance of pressures defined with regard to sensitivity of features to pressures	Significance of pressures have been clearly defined using a four point scale, taking into account the sensitivity of the receptor species. This has been presented for each pressure associated with wind farm development.		
	CIA Study area defined in light of spatial extent of significant cumulative pressures	The CIA study area has taken into account impacts from other nearby wind farm projects and shipping which overlap with foraging ranges of receptors (e.g. Sandwich Terns). Each pressure from each project has been dealt with individually, then assessed as an overall effect.		
	Clear justification for choice of assessment tools and methods	The assessment has taken account of the total effects of pressures from wind farms acting upon twelve receptor species. Consultation with ornithological consultancies and Natural England helped select monitoring methodologies. Modelling studies and results from published scientific literature have been used in assessing pressures. Consideration is given to other activities, projects and plans within the study area which may also create pressures on ornithological receptors. Expert judgement and consultation with regulatory bodies has been included.		
	Consideration of mitigation and/or monitoring requirements	There are no specific mitigation measures proposed in the ES for cumulative impacts. However, this project was rejected by Government because of the potential for cumulative impact on birds, specifically Sandwich Terns, as a result of the number of windfarms in the wider area.		

Table B3. Review of Anholt OWF case study: Marine mammals

	Case study	**Anholt OWF Environmental Impact Report**		
	Brief Project Description	In 1998 the Ministry of Environment and Energy empowered the Danish energy companies to build offshore wind farms of a total capacity of 750 MW, as part of fulfilling the national action plan for energy, Energy 21. In the years 2002-2003 the two first wind farms were established at Horns Rev west of Esbjerg and Rødsand south of Lolland, consisting of 80 and 72 wind turbines, respectively, producing a total of 325,6 MW. In 2004 it was furthermore decided to construct two new wind farms in proximity of the two existing parks at Horns rev and Rødsand. The two new parks, Horns rev 2 and Rødsand 2, are going to produce 215 MW each and are expected to be fully operational by the end 2010. The 400 MW Anholt Offshore Wind Farm constitutes the next step of the fulfilment of aim of the action plan. The wind farm will be constructed in 2012, and the expected production of electricity will cover the yearly consumption of approximately 400.000 households.		
	Sector	Offshore wind		
	Receptor	Marine Mammals		
	Location	Denmark		
Systematic Approach to Identifying Project Impacts:	**Systematic process for defining pressures (environmental changes introduced by development)**	Spatial: The assessment has clearly identified all the relevant impact pathways based on published literature and the spatial scale at which these are relevant. As such, the potential impact area for marine mammals has been extended outside the 144km^2 project area to include the wider marine region (approximately a 100km buffer).	Temporal: The duration of pressures associated with the construction and operational phases of the project has been clearly defined.	Intensity: Magnitude of pressures have been clearly defined based on a review of previous studies, relevant scientific literature, GIS analysis (for calculating areas of habitat affected), simple transmission loss formula for underwater noise effects and sediment modelling for plume effects.
	Receptors defined with regard to spatial and temporal scales of project pressures	Spatial: Spatial modelling of survey and telemetry data and time series analyses of echolocation data has been undertaken to characterise the distribution of marine mammals in the wider area and identify suitability of habitats. Designated Natura 2000 sites with marine mammal features and seal sanctuaries are shown on a figure.	Temporal: The temporal occurrence of marine mammals in the wider area has been described (including mating/breeding seasons).	
	Significance of pressures defined with regard to sensitivity of features to pressures	Impact assessment criteria have been clearly defined. The impact assessment is based on expert judgment and published literature of the sensitivity of marine mammals to various pressures largely following the methods developed and applied by previous OWFs. The source-pathway-receptor model has been applied and is summarised in a tabular form.		
	Initial study area defined in light of spatial extent of significant pressures	Behavioural impact study area is defined as 20km radius from project area and relates to the greatest impact arising from the development (piling noise).		

Table B3 continued…

Systematic Process for Identifying Impacts Associated with Other Plans, Projects and Activities:	**Scope of other plans, projects and activities**	The methodology chapter suggests that other man-made third party structures and projects/activities have been considered in the cumulative assessment but there is no clear list as to what these are. The assessment chapter then only mentions one other OWF in the CIA.		
	Systematic Process for defining pressures associated with other plans, projects and activities	Spatial: There is no figure illustrating the location of the other OWF project, but distance has been described. There is not a transparent justification for the scoping out of other activities and cumulative impact pathways.	Temporal: The timescales where the construction and operational phases of the development overlap with the other OWF project have been described. No information, however, has been provided on the likely timescale of activities associated with the other project.	Intensity: Magnitude of activities associated with the other OWF project has been estimated to be similar to the proposed development. Gaps in information (e.g. operational noise) are highlighted.
	Significance of pressures defined with regard to sensitivity of features to pressures	The impact pathways that have been scoped into the CIA are not clearly defined. There is also limited information on the sensitivity of receptors in the CIA. The judgements made to reach a conclusion on the significance of cumulative impacts has been based on a review of earlier assumptions made in the receptor specific impact assessment which are not made overtly transparent in the CIA chapter..		
	CIA Study area defined in light of spatial extent of significant cumulative pressures	The linkage between the initial CIA study area and the significance of the other OWF project has been described in the assessment. However, it would be useful for this to be presented on a figure.		
	Clear justification for choice of assessment tools and methods	The impacts from Anholt OWF have been primarily assessed on its individual merits and is largely based on expert judgement and a range of assessment tools (e.g. sediment modelling). Cumulative impacts from other human activities in the region have been taken into consideration in the CIA (namely one other OWF project). Although the methodology also mentions cumulative impacts and effects related to the joint impacts from various activities associated with the proposed development itself, it is not clear that this has been included in the CIA.		
	Consideration of mitigation and/or monitoring requirements	Although it is acknowledged that there may be a cumulative effect, no mitigation measures are suggested within the Environmental Impact Report.		

Table B4. Review of Quad 204 case study: Marine mammals

	Case study	**Quad 204 Project. Environmental Statement**		
	Brief Project Description	The proposed Quad204 Project involves the redevelopment of the existing Schiehallion and Loyal fields which are approximately 130km west of Shetland and 35km east of the Faroe-UK median line, in water depths of 350-500m on the slope of the Faroe-Shetland channel. This includes new surface production facilities with the replacement of the existing Schiehallion Floating Production Storage and Offloading (FPSO) vessel, additional new production and water injection wells and additional new subsea infrastructure. The new FPSO will have increased capacity to enable optimum reservoir recovery and extend field life and also allow for any future expansion.		
	Sector	Oil and Gas		
	Receptor	Marine Mammals		
	Location	UK (Shetland)		
Systematic Approach to Identifying Project Impacts:	**Systematic process for defining pressures (environmental changes introduced by development)**	Spatial: Areas of concern regarding the project were identified as part of scoping and consultation. Key environmental issues associated were determined by undertaking environmental issues identification (ENVID) workshops. Noise modelling was undertaken to define spatial scale of noise impacts associated with project activities.	Temporal: The assessment has considered the temporal scales of pressures occurring over the entire life of the project.	Intensity: The magnitude of noise sources relevant to the project have been described based on published literature.
	Receptors defined with regard to spatial and temporal scales of project pressures	Spatial: Baseline section includes summary of the spatial distribution of marine mammals found in the project area based on published survey data. The project area is, however, not clearly defined.	Temporal: Seasonal occurrence of cetaceans in the project area have been defined based on a review of published scientific reports.	
	Significance of pressures defined with regard to sensitivity of features to pressures	This has been undertaken based on published scientific information, Joint Nature Conservation Committee (JNCC) guidelines and expert judgement using impact matrices and the source-pathway-receptor model.		
	Initial study area defined in light of spatial extent of significant pressures	No clear initial study area for the CIA has been described.		

Table B4 continued…

Systematic Process for Identifying Impacts Associated with Other Plans, Projects and Activities:	**Scope of other plans, projects and activities**	Other existing and long-term potential projects occurring in the wider region and ongoing activities that are unrelated to the oil and gas industry have been included. Advice sought from regulator and advisors at scoping stage.		
	Systematic Process for defining pressures associated with other plans, projects and activities	Spatial: The location of other projects and activities has not been clearly defined. The potential pressures associated with other projects or activities that could act in combination with the proposed development are reviewed. Noise modelling that is available from other projects has been considered as part of assessment.	Temporal: The timescales of other projects have been considered in general terms as part of the assessment.	Intensity: The assessment considers the likely magnitude of pressures associated with other projects and activities. However, this is based on a general qualitative description rather than quantitative data.
	Significance of pressures defined with regard to sensitivity of features to pressures	The impact pathways that have been scoped into the CIA are not clearly defined. There is also limited information on the sensitivity of receptors. In addition, the judgements made to reach a conclusion on the significance of impacts is based on earlier assumptions in the receptor specific impact assessment chapters which are not made overtly transparent in the CIA section.		
	CIA Study area defined in light of spatial extent of significant cumulative pressures	The CIA study area has not been clearly defined. In addition, there is no overall assessment of the potential cumulative effects of all the other projects and activities that have been scoped into the CIA, rather they have been assessed on an individual basis in relation to the proposed development.		
	Clear justification for choice of assessment tools and methods	The assessment has been based on a review of scientific literature, noise modelling and expert judgement. Effects were considered cumulative if the footprint of the project pressure overlapped with that of adjacent projects/activities or the effects of multiple sources clearly acted on a single receptor or resource. The cumulative effects from other projects and activities were, however, done on an individual basis and therefore did not consider the totality of cumulative effects (see above).		
	Consideration of mitigation and/or monitoring requirements	Cumulative impacts are not considered to be significant and therefore no mitigation measures are proposed.		

Table B5. Review of M1 Junction 19 Improvements case study: Habitats

	Case study	**M1 Junction 19 Improvements Environmental Statement**		
	Brief Project Description	The proposed M1 Junction 19 Improvement was announced as the 'Preferred Route' for the improvement by the Secretary of State for Transport in February 20091, following public consultation in 2008. M1 Junction 19 forms the intersection between three major parts of the motorway and trunk road network, M1 and M6 and the A14 Trunk Road. The A14 and M6 also form part of the Ireland / UK / Benelux Trans European Network. The scheme is in Leicestershire within the District of Harborough, close to the boundaries of Northamptonshire and Warwickshire. The proposed improvement aims to relieve congestion at the junction, making the roads safer and decreasing journey times, whilst minimising the environmental impacts of the project. Land take of approximately 25 hectares of mainly agricultural land would be required to accommodate the improvement including the local road network and facilities for vulnerable users. This area also includes measures to reduce, or mitigate adverse environmental effects including tree and shrub planting, wildlife habitats and new drainage ponds to reduce flooding and protect water quality.		
	Sector	Infrastructure		
	Receptor	Habitats		
	Location	UK (Midlands)		
Systematic Approach to Identifying Project Impacts:	**Systematic process for defining pressures (environmental changes introduced by development)**	Spatial: No clear systematic process for defining the pressures is apparent.	Temporal: Although the assessment has been spilt into the different stages of the project life cycle, there does not seem to be a clear definition of the impacts on a temporal basis.	Intensity: The magnitude of changes have been quantified (e.g. the areas of direct habitat loss have been calculated).
	Receptors defined with regard to spatial and temporal scales of project pressures	Spatial: Baseline section includes characterisation of habitat receptor within the study area as defined in the text. A figure has been produced to depict the study area boundaries. National designations (e.g. SSSI) and international designations within a range of up to 5 and 10km have been included respectively.	Temporal: Not particularly relevant to terrestrial habitats. While broad scale habitats are largely unchanging, the biotopes and associated species can change over time, although there is rarely good information on such changes.	
	Significance of pressures defined with regard to sensitivity of features to pressures	This has been undertaken based on published scientific information and expert judgement using impact matrices and the source-pathway-receptor model. Environmental value (or sensitivity) of habitats have been defined as part of the assessment.		
	Initial study area defined in light of spatial extent of significant pressures	No clear initial study area for the CIA has been described.		

Table B5 continued…

Systematic Process for Identifying Impacts Associated with Other Plans, Projects and Activities:	**Scope of other plans, projects and activities**	Reasonably foreseeable plans or projects that have been committed (i.e. have valid planning permission or have gone through the statutory processes) have been included in scope of CIA. Projects that are in the planning domain but do not have planning consent have not been included in the CIA.		
	Systematic Process for defining pressures associated with other plans, projects and activities	Spatial: There is a figure showing the location of some of the local projects. Although the activities associated with these have been described in general terms, the pressures associated with the activities have not always been defined.	Temporal: The temporal scale of the pressures have not been clearly defined.	Intensity: The magnitude/scale of pressures have been quantified for some other projects but not all.
	Significance of pressures defined with regard to sensitivity of features to pressures	There is limited information on the sensitivity of receptors and there is not always clear justification for the scoping out of certain cumulative impact pathways. Impact matrices describing the impact of the individual project relative to the other plans or projects have been included for some projects but not all.		
	CIA Study area defined in light of spatial extent of significant cumulative pressures	The CIA study area has not been clearly defined. In addition, there is no overall assessment of the potential cumulative effects of all the other plans and projects that have been scoped into the CIA, rather they have been assessed on an individual basis in relation to the proposed development.		
	Clear justification for choice of assessment tools and methods	The CIA methodology applied is based on the Design Manual for Roads and Bridges Volume 2 Environmental Assessment guidance. The CIA firstly assessed where different pressures from the same project can combine and potentially increase effects on a single receptor, and secondly the cumulative effects from other plans and projects in combination with the project being assessed. The latter, however, was done on an individual basis and therefore did not consider the totality of cumulative effects (see above). Impact matrices were used to illustrate potential interactions between receptors.		
	Consideration of mitigation and/or monitoring requirements	No mitigation or monitoring measures are proposed for cumulative impacts.		

Table B6. Review of Chukchi Sea Planning Area case study: Marine mammals

	Case study	**Chukchi Sea Planning Area Environmental Impact Statement**		
	Brief Project Description	The project is for proposed oil and gas leasing in the Chukchi Sea and an exploration seismic survey. The EIS addresses the potential impacts under the various alternatives and the potential mitigation measures associated with the project activities for leasing and associated exploration seismic-survey activity. The project for the lease sale examined in the EIS is to offer for lease approximately 6,156 whole and partial blocks (about 34 million acres) identified as the program area in the 2002-2007 5-Year Program. The scenario assumed for environmental analysis involves the discovery, development, and production of the first offshore oil field in the Chukchi Sea. The Proposed Action for seismic surveying is to permit both prelease and postlease exploration seismic surveys within the entire proposed area.		
	Sector	Oil and Gas		
	Receptor	Marine Mammals		
	Location	USA (Alaska)		
Systematic Approach to Identifying Project Impacts:	**Systematic process for defining pressures (environmental changes introduced by development)**	Spatial: The assessment has identified the type of potential impacts associated with project activities. However there is no clearly defined study or impact area.	Temporal: Pressures are defined during different stages of the project.	Intensity: The magnitude of changes brought about by the project has been defined either qualitatively or quantitatively where sufficient existing scientific information is available.
	Receptors defined with regard to spatial and temporal scales of project pressures	Spatial: Baseline section has included a qualitative description of the spatial distribution of marine mammal receptors based on a review of scientific literature. Where available, marine mammal location data has been presented in figures in relation to the project area.	Temporal: Baseline description includes information on seasonal migrations and distribution patterns based on a review of scientific literature.	
	Significance of pressures defined with regard to sensitivity of features to pressures	This has been undertaken based on published scientific information and expert judgement. The assessment has taken account of the degree of the potential effects during various times of the year depending on species migrations, hunting areas and hibernations. The totality of effects associated with the proposed development alone over its lifetime have also been assessed.		
	Initial study area defined in light of spatial extent of significant pressures	The initial study area for the CIA has not been defined.		

Table B6 continued…

Systematic Process for Identifying Impacts Associated with Other Plans, Projects and Activities:	**Scope of other plans, projects and activities**	Past development/production onshore and offshore projects, present development/production projects, reasonably foreseeable activities and potential speculative activities associated with oil and gas and other sectors have been included in the CIA. Activities other than oil and gas development include sport and subsistence hunting and fishing, scientific surveys and marine transportation. Climate change has also been considered. Future military activities that might affect the region have not been included.		
	Systematic Process for defining pressures associated with other plans, projects and activities	Spatial: The potential pressures associated with other activities has been defined. Spatial extent of impacts have been quantified where possible.	Temporal: CIA has attempted to quantify how long the impacts would last.	Intensity: The magnitude of impacts has been quantified where information is available.
	Significance of pressures defined with regard to sensitivity of features to pressures	The CIA has weighed more heavily on the activities that were more certain, closer in time, and closer geographically to the proposed project. Although the impact pathways that have been scoped into the assessment are not always immediately obvious, the sensitivity of key species to different pressures has been clearly defined based on scientific evidence. A qualitative assessment of the incremental contribution of all activities in relation to the proposed project has been undertaken for each key marine mammal species identified in the baseline.		
	CIA Study area defined in light of spatial extent of significant cumulative pressures	The CIA study area has not been clearly defined.		
	Clear justification for choice of assessment tools and methods	Expert opinion, previous assessments and existing scientific papers provide the basis for the CIA. No evidence that impact matrices or other assessment tools have been used.		
	Consideration of mitigation and/or monitoring requirements	No mitigation or monitoring measures are in place to address cumulative impacts for this development. Recommendations are, however, provided for future projects regarding effective mitigation measures such as winter construction, an advanced leak detection system etc.		

Table B7. Review of Galloper OWF case study: Birds

	Case study	**Galloper Wind Farm (GWF)**		
	Brief Project Description	Galloper Wind Farm Limited is proposing to construct an offshore wind farm including associated infrastructure to facilitate export of power to the national electricity transmission system. The proposed development is located in the Outer Thames Estuary, approximately 27km (14.6 nautical miles) at its closest point to the Suffolk coast. The wind farm comprises three key areas. Wind turbine generators and associated infrastructure may be developed in all, part or not at all in some of these areas and may vary in density across each one. The site straddles the UK territorial waters limit of 12 nautical miles from shore.		
	Sector	Offshore Wind		
	Receptor	Birds		
	Location	England		
Systematic Approach to Identifying Project Impacts:	**Systematic process for defining pressures (environmental changes introduced by development)**	Spatial: The assessment has identified the pressures for birds during the construction, operation and decommissioning of the GWF such as habitat loss, disturbance, displacement, collision mortality and impacts on flight lines (barrier effects). Spatial scale of disturbance from cable installation has been measured as km^2 of seabed disturbed. Scale of direct habitat loss from base structures has been quantified. Swept area has been quantified for collision mortality pressure. However, disturbance from construction noise has not been quantified.	Temporal: The assessment uses modelling such as collision risk modelling to determine losses of individuals from populations over a year. It also considers impacts from different stages of the project life cycle. The assessment has also considered temporal scales of pressures from all these different stages, for example, for disturbance due to construction noise, pile installation time has been quantified.	Intensity: Intensity of impacts such as population change due to collision mortality for the ornithological receptors have been assessed using collision risk modelling. Modelling and results of recent research have been used to determine changes to populations during development.
	Receptors defined with regard to spatial and temporal scales of project pressures	Spatial: In the accounts of receptor species, information is given on the ranges of species in the region and their occurrence in the GWF survey area, compared to their occurrence in the southern and eastern North Sea.	Temporal: Temporal distribution for each receptor has been characterised in the assessment. The assessment has considered impacts in relation to temporal distribution of receptors.	
	Significance of pressures defined with regard to sensitivity of features to pressures	Using published scientific information and impact matrices, receptors have been assessed with regard to their sensitivity to different pressures.		
	Initial study area defined in light of spatial extent of significant pressures	The initial study area (outermost site boundaries plus 4km buffer) was based on the anticipated extent of changes, for example habitat loss or disturbance, and the location where other pressures, such as collision mortality, would occur.		

Table B7 continued…

Systematic Process for Identifying Impacts Associated with Other Plans, Projects and Activities:	**Scope of other plans, projects and activities**	Wind farm developments within the foraging ranges of receptors have been considered, along with other activities including shipping, fisheries, oil and gas exploration and production.		
	Systematic Process for defining pressures associated with other plans, projects and activities	Spatial: The CIA has defined the spatial scale of pressures using foraging range of bird species and other offshore wind developments and other activities occurring within this range.	Temporal: Some activities which may cause pressures for receptors may be ongoing, such as shipping or fisheries. Stage of development and predicted construction periods of other wind farm projects have been determined.	Intensity: Cumulative impact significance has been ranked using five levels of intensity. The use of numerical modelling and latest research has been used to assess effects and has determined qualitative changes in populations due to development.
	Significance of pressures defined with regard to sensitivity of features to pressures	Sensitivity of receptors has been defined primarily to pressures associated with wind farms. Although many impacts may be the same, receptors could be exposed to different pressures from other projects or activities, such as fisheries, which have not specifically been addressed.		
	CIA Study area defined in light of spatial extent of significant cumulative pressures	The assessment has taken into account cumulative impacts from other wind farm projects which receptors could encounter and has dealt with pressures from different wind farms individually.		
	Clear justification for choice of assessment tools and methods	The assessment has taken account of the total effects of pressures from wind farms acting upon twelve species of receptor. Modelling studies and results from published scientific literature have been used in assessing pressures. Consideration has been given to other activities, projects and plans within the study area which may also create pressures on ornithological receptors. Expert judgement and consultation with regulatory bodies has been included at all stages.		
	Consideration of mitigation and/or monitoring requirements	The findings from the cumulative impact assessment aniticipate the impacts to be tolerable and/or not significant therefore there is no mitigation proposed as part of the assessment.		

Table B8. Review of Galloper OWF case study: Birds

	Case study	**Galloper Wind Farm (GWF)**		
	Brief Project Description	Galloper Wind Farm Limited is proposing to construct an offshore wind farm including associated infrastructure to facilitate export of power to the national electricity transmission system. The proposed development is located in the Outer Thames Estuary, approximately 27km (14.6 nautical miles) at its closest point to the Suffolk coast. The wind farm comprises three key areas. Wind turbine generators and associated infrastructure may be developed in all, part or not at all in some of these areas and may vary in density across each one. The site straddles the UK territorial waters limit of 12 nautical miles from shore.		
	Sector	Offshore wind		
	Receptor	Fish		
	Location	England		
Systematic Approach to Identifying Project Impacts:	**Systematic process for defining pressures (environmental changes introduced by development)**	Spatial: The assessment has clearly identified all the relevant impact pathways based on published literature, modelling and the spatial scale at which these are relevant.	Temporal: The assessment has considered potential direct and indirect impacts occurring at different phases of the project life cycle (construction, operation and decommission).	Intensity: Magnitude of pressures have been clearly defined based on a review of previous studies, relevant scientific literature, GIS analysis (for demonstrating spawning/nursery grounds and calculating sound boundaries), underwater noise modelling, herring spawning data investigations.
	Receptors defined with regard to spatial and temporal scales of project pressures	Spatial: Spatial modelling of survey data has been undertaken to characterise the distribution of fish species in the wider area and identify suitability of habitats and are shown in multiple figures. Physical and biological factors have been considered.	Temporal: The temporal occurrence of fish in the wider area has been described and shown in figure format (including migrations and spawning seasons).	
	Significance of pressures defined with regard to sensitivity of features to pressures	Impact assessment criteria have been clearly defined. The impact assessment is based on expert judgment, model outputs and published literature of the sensitivity of fish species to various pressures. The source-pathway-receptor model has been applied and assessment is summarised in a tabular form.		
	Initial study area defined in light of spatial extent of significant pressures	Impact boundaries arising from piling noise from different sized piles models are defined and presented in a figure format. In addition, there is also a cumulative impact summary table which assesses disturbance to fish from other human activities.		

Table B8 continued…

Systematic Process for Identifying Impacts Associated with Other Plans, Projects and Activities:	**Scope of other plans, projects and activities**	Interactions between different aspects of the project with other wind farms and interactions with other activities occurring in the region (onshore and offshore). It is noted that the only other significant human activity in the area is aggregates dredging.		
	Systematic Process for defining pressures associated with other plans, projects and activities	Spatial: Distance between project, other wind farms and other activities in the region have been described and shown in a figure. The distances relate to boundary limits rather than specific features or structures within each site. The pressures are shown on the figures and described in the text of the document.	Temporal: The timescales where the construction and operational phases of the development overlap with the timescales of other OWF project have been described.	Intensity: Magnitude of activities associated with the other OWF project has been estimated to be similar to the proposed development. Gaps in information (e.g. operational noise) are highlighted. Significance of cumulative impacts from other OWF and other activities have been assessed and summarised.
	Significance of pressures defined with regard to sensitivity of features to pressures	Receptor lead process, where the extent, duration and type of impact has, where possible, been considered against the characteristics of the receptor. The impact pathways that have been found to have 'no impact' when the project is considered in isolation, have not been brought into the CIA through lack of pathway.		
	CIA Study area defined in light of spatial extent of significant cumulative pressures	The linkage between the initial CIA study area and the significance of the other OWF projects has been described in the assessment and presented in figures.		
	Clear justification for choice of assessment tools and methods	A clear methodology for the CIA is provided and the results presented in a tabular format. Each chapter has a cumulative section and then there is a summary chapter drawing together the conclusions made on cumulative impacts within the technical chapters and which provides a holistic overview in a summarised tabular form.		
	Consideration of mitigation and/or monitoring requirements	The assessment concludes that there is no significant risk of likely cumulative effects on fish species and spawning grounds, and therefore no mitigation is proposed.		

Table B9. ABP Southampton Berth 201/202 Works case study: Habitats

	Case study	**ABP Southampton Berth 201/202 Works**		
	Brief Project Description	Associated British Ports (ABP) proposes to deepen the dredged pocket and reconstruct the quay walls for Berths 201 and 202 within the Port of Southampton. These works are essential if the Port is to accommodate the latest generation of large container ships currently being brought into service by the world's major shipping lines. The project comprises the deepening of Berths 201 and 202 to 16m below Chart Datum (CD), which, in turn, will require the construction of a new quay wall immediately in front of the existing quay wall. In order for containers to be handled over the quay, up to six new Ship to Shore Gantry Cranes (SSGC) will be provided along the rebuilt berth 201/202 quay.		
	Sector	Ports		
	Receptor	Habitats		
	Location	UK (Hampshire and Isle of Wight Coast)		
Systematic Approach to Identifying Project Impacts:	**Systematic process for defining pressures (environmental changes introduced by development)**	Spatial: The assessment has identified relevant environmental changes associated with the proposed project activities based on published literature and consultation. The spatial scale at which these are relevant have been defined using GIS spatial techniques, hydrodynamic and sediment modelling, ship wash predictions and expert judgement. For example, for potential sediment plume	Temporal: Hydrodynamic and sediment modelling and expert opinion has informed the assessment of effects and defined the temporal scales over which these pressures occur.	Intensity: Hydrodynamic and sediment modelling, ship wash calculations and expert judgement has informed the assessment of effects and defined the magnitude of changes brought about by project activities.
	Receptors defined with regard to spatial and temporal scales of project pressures	Spatial: Baseline section includes spatial characterisation of coastal and marine habitats within the areas where potential direct and indirect impacts are predicted by the models (i.e. within at least a full tidal excursion from the berths). A broad description of habitats in the wider region is also included.	Temporal: Not particularly relevant to marine and coastal habitats. While broad scale habitats are largely unchanging, the biotopes and associated species can change over time, although there is rarely good information on such changes.	
	Significance of pressures defined with regard to sensitivity of features to pressures	This has been undertaken based on published scientific information and expert judgement using impact matrices and the source-pathway-receptor model.		
	Initial study area defined in light of spatial extent of significant pressures	Initial study area for the CIA is based on the anticipated spatial extent of environmental changes and also the wider area of the Solent.		

Table B9 continued…

Systematic Process for Identifying Impacts Associated with Other Plans, Projects and Activities:	**Scope of other plans, projects and activities**	Other relevant plans or projects that are at various points in the planning and consenting domain. Advice was also sought from regulator and advisors at the scoping stage.		
	Systematic Process for defining pressures associated with other plans, projects and activities	Spatial: The location relative to designated areas has been established, along with the nature and scale of the works. The potential changes that could arise from each of the relevant projects have been defined and compared to the impact of the project alone.	Temporal: Likely timescales for projects in the planning domain have been determined an included in a table.	Intensity: Where the designs for the relevant identified projects are available, these have been included in the numerical model in order to ascertain the detailed morphological effects on the hydrodynamic and sedimentation regimes (and in turn the likely effects on marine and coastal habitat features).
	Significance of pressures defined with regard to sensitivity of features to pressures	For each relevant impact pathway (e.g. changes in water levels, sedimentation), the combined impact of all the relevant projects are compared with the impact of the project alone. Given that the potential impacts of all developments on the hydrodynamic and sediment trasnport regimes were considered to be insignificant, the significance to marine and coastal habitats (including nearby MPAs) were considered to be insignificant. There was therefore no need to consider the sensitivity of habitat receptors to these pathways as part of the assessment.		
	CIA Study area defined in light of spatial extent of significant cumulative pressures	The linkage between the initial CIA study area and the significance of the other projects is not clear from the assessment.		
	Clear justification for choice of assessment tools and methods	The assessment has taken account of the combined effect of other projects for each impact pathway. Numerical modelling has underpinned the CIA. Expert judgement and consultation with regulatory bodies was undertaken at all stages.		
	Consideration of mitigation and/or monitoring requirements	There are no significant cumulative impacts on habitat features and therefore no mitigation measures are proposed.		

Table B10. Review of Licence Renewal for Areas 212, 328 B/C and 240 case study: Habitats

	Case study	**Licence Renewal Environmental Statement for Areas 212, 328 B/C and 240**		
	Brief Project Description	Hanson Aggregates Marine Ltd wishes to apply for permission to continue to dredge aggregates from The Crown Estate Licence Areas 212, 328 B, 328 C and 240, which are situated between 10 and 18km from the Anglian coastline to the east of Lowestoft and Great Yarmouth. A renewal licence is sought for these Areas which have been dredged since the 1970s; this renewal licence is to allow for an average of 2.6 million tonnes to be annually extracted from these Areas for a period of 15 years. These Areas have been grouped together within a single application / Environmental Statement primarily due to their geographic proximity to each other and therefore similarity in terms of environmental issues. Hanson Aggregates Marine Ltd will seek to apply for permissions to continue to dredge aggregates from their other Areas in the Anglian region (namely 328 A, 361, 242, 401/2) under separate applications.		
	Sector	Marine aggregates		
	Receptor	Habitats		
	Location	UK (Anglian Coast)		
Systematic Approach to Identifying Project Impacts:	**Systematic process for defining pressures (environmental changes introduced by development)**	Spatial: The assessment has identified relevant environmental changes associated with the proposed project activities based on published literature. The spatial scale at which these are relevant have been defined. For example, for potential sediment plume effects, the EIA has been underpinned by numerical modelling studies and expert judgement which identifies the degree and type of effect and how it will vary with distance from the extraction site.	Temporal: Numerical modelling and expert opinion has informed the assessment of effects and defined the temporal scales over which these pressures occur.	Intensity: Numerical modelling and expert opinion has informed the assessment of effects and defined the magnitude of changes brought about by project activities.
	Receptors defined with regard to spatial and temporal scales of project pressures	Spatial: Baseline section includes spatial characterisation of habitat receptor within the defined direct and indirect impact zones comprising the study area (i.e. within a tidal excursion from the aggregate licence areas).	Temporal: Not particularly relevant to marine habitats. While broad scale habitats are largely unchanging, the biotopes and associated species can change over time, although there is rarely good information on such changes.	
	Significance of pressures defined with regard to sensitivity of features to pressures	This has been undertaken based on published scientific information and expert judgement using impact matrices and the source-pathway-receptor model.		
	Initial study area defined in light of spatial extent of significant pressures	Initial study area for the CIA is based on the anticipated spatial extent of environmental changes and incorporating wider Regional Environmental Assessment (REA) region.		

Table B10 continued…

Systematic Process for Identifying Impacts Associated with Other Plans, Projects and Activities:	**Scope of other plans, projects and activities**	Extant projects and plans in the planning system, and ongoing projects and activities have been included. Advice has been sought from regulator and advisors at the scoping stage.		
	Systematic Process for defining pressures associated with other plans, projects and activities	Spatial: There is a figure showing the location of other plans, projects and activities. The relevant pressures associated with these have been defined based on an activities versus pressure matrix.	Temporal: A number of the activities identified are ongoing. Likely timescales for projects in the planning domain have been determined.	Intensity: The assessment identifies the magnitude/scale of pressures associated with different plans, projects and activities where information is available. However, the intensity is not always quantified and there is not a transparent justification for the scoping out of certain cumulative impact pathways.
	Significance of pressures defined with regard to sensitivity of features to pressures	The impact pathways that have been scoped into the CIA are not always clear. There is also limited information on the sensitivity of receptors in the CIA. In addition, the judgements made to reach a conclusion on the significance of impacts is based on earlier assumptions in the receptor specific impact assessment chapters which are not made overtly transparent in the CIA chapter.		
	CIA Study area defined in light of spatial extent of significant cumulative pressures	The linkage between the initial CIA study area and the significance of other plans, projects and activities is not clear from the assessment.		
	Clear justification for choice of assessment tools and methods	Due to the lack of industry guided standard for conducting CIA, the assessment has taken account of the total effects of all pressures acting upon all relevant receptors. Consideration is given to assessments within the REA which looked at spatial overlaps of the impacts of all aggregate extraction within the wider study area. Additionally, consideration is given to any other activities and plans or projects, including any impacts that do not directly overlap spatially but may indirectly result in a cumulative/in-combination impact. This is all underpinned by expert judgement and consultation with regulatory bodies.		
	Consideration of mitigation and/or monitoring requirements	There are no significant cumulative impacts on habitat features and therefore no mitigation measures are proposed.		

Appendix C

Database of
Cumulative Literature Sources

Appendix C. Database of Cumulative Literature Sources

Name of Case Study	Authors	Date	Country	Marine or Terrestrial	Type	Summary Review
Methods for cumulative effects assessment	Smit, B and Spaling, H.	1995	Canada	Both	Theoretical	Develops a classification of methods for cumulative effects assessment and evaluates them. The paper considers analytical approaches which include spatial analysis, network analysis, biogeographic analysis, interactive matrices, ecological modelling and expert opinion. Planning approaches are classified into multi-criteria evaluation, programming models, land suitability evaluation, programming models, land suitability evaluation and process guidelines. The paper assesses the methods on the basis of their ability to consider multiple perturbations, additive and interactive pathways of accumulation and different types of cumulative effects.
Considering Cumulative Effects: Under the National Environmental Policy Act.	Council on Environmental Quality (CEQ)	1997	USA	Both	Guidance	Handbook that introduces complex issue of cumulative effects, outlines general principles, presents useful steps, and provides information on methods of CIA and data sources. Suggests that a study specific methodology is needed, but using a conceptual framework.
Cumulative Effects Assessment Practitioners Guide	Hegmann, G., C. Cocklin, R. Creasey, S. Dupuis, A. Kennedy, L. Kingsley, W. Ross, H. Spaling and D. Stalker	1999	Canada	Both	Guidance	A guide aimed at practitioners, regulatory bodies and review panels to help understand the process of CEAs and help to recognise what constitutes acceptable and reasonable practice. It provides an overview of the current (at the time of publication) understanding of CEA, suggestions on practical approaches and best professional practice and provides the reader with case studies.
Guidelines for the Assessment of indirect and cumulative impacts as well as Impact Interactions	Hyder	1999	EU	Both	Guidance	These Guidelines consider the assessment of indirect and cumulative impacts as well as impact interactions within the EIA process. The Guidelines give advice on how to approach these kinds of impacts during the various stages of EIA, how to adapt the approach to a specific project and suggests methods and tools for identifying and assessing indirect and cumulative impacts, as well as impact interactions.
Evaluating and Managing Cumulative Effects: Process and Constraints.	MacDonald, L.H.	2000	USA	Terrestrial	Theoretical	A conceptual process for CIA is presented which includes a scoping phase, an analysis phase, and a planning and management phase, Numerous approaches have been reviewed including checklists and complex, physically based models.
Habitats regulations guidance note (HRGN4)	English Nature	2001	EU	Both	Guidance	Provides guidance on how to assess whether, in light of the Habitats Directive, any project or plan either alone in or combination with other plans or projects will have an significant effect on a European Site.

Name of Case Study	Authors	Date	Country	Marine or Terrestrial	Type	Summary Review
Cumulative effects assessment: A review of UK environmental impact statements	Cooper, L.M., and W.R. Sheate	2002	UK	Both	Review	Reviewed 50 Environmental Impact Statements (EISs) and their cumulative impact assessments (1989-2000). Concluded that there needs top be an effective driving force from the local planning authorities requiring the developers to address during the scoping process to address cumulative effects. More tailored guidance for developers and authorities is needed.
Development of a methodology for the assessment of cumulative effects of marine activities using Liverpool Bay as a case study.	Oakwood Environmental Ltd	2002	UK	Marine	Theoretical	A CEA methodology based on best practises was developed to undertake a CEA using the Liverpool Bay area as a case study. A vulnerability assessment for cumulative effects was undertaken for species and habitats using matrices and GIS.
Cumulative effect assessment in Canada: a regional framework for aquatic ecosystems.	Dube, M.G.	2003	Canada	Aquatic	Theoretical	Suggests that in isolation the use of effects-based (EB) methods and stressor-indicator based (SB) interactions do not address CIA needed for sustainable development. It recommends integrating both into a holistic framework for CIA.
Final Report - Literature Review/ Scoping Study on Cumulative Effects Assessment and the Strategic Environmental Assessment Directive	James, E., Tomlinson, P., McColl, V. and C. Fry	2003	UK	Both	Review and guidance to Environment Agency	This report draws together the results of a literature review / scoping study on CEA and the Strategic Environmental Assessment (SEA) Directive on the assessment of the effects of certain plans and programmes on the environment).
Cumulative environmental impacts and integrated coastal management: the case of Xiamen, China	Xue, X., Hong, H., Charles, A.T.	2004	China	Marine	Theoretical	Considers Integrated Coastal Zone Management (ICZM) in the Harbour of Xiamen which is under increasing pressure from rapid economic growth. Firstly undertakes a CEA using key indicators to examine cumulative effects. Secondly, assess the development of a framework for ICZM and concludes that the framework has considered cumulative impacts within the management and monitoring.
Integrating cumulative effects assessments into UK strategic planning: implications of the European Union SEA Directive	Cooper, L.M., and W.R. Sheate	2004	UK	Both	Theoretical	Proposes a framework which identifies key steps and activities in the SEA process to address cumulative effects. Interviewed people who had expert knowledge on EIA and planning processes.
The impotence of Cumulative Effects Assessment in Canada: Ailments and Ideas for Redeployment	Duinker, P.N. and L.A. Greig	2006	Canada	Both	Review/ Opinion	This article aims to articulate the failure of CIA, to examine it in terms of six major problems with CEA, and to propose solutions.

Name of Case Study	Authors	Date	Country	Marine or Terrestrial	Type	Summary Review
A practical toolkit for assessing cumulative effects of spatial plans and development projects on biodiversity in England.	English Nature	2006	UK	Both (mainly terrestrial)	Guidance	Provides a toolkit that presents practical guidance on how to carry out an assessment of the likely cumulative effects on biodiversity of spatial plans and development projects as a part of an overall environmental assessment influencing the preparation of these plans and projects. The toolkit is designed primarily to assist English Nature staff in responding to consultations from Regional Planning Bodies and Local Planning Authorities. However, Planning Authorities and developers may also find it useful in ensure that the likely cumulative effects of their spatial plans and development projects are considered from the very earliest stages of plan preparation and development design. It also gives Planning Authorities and developers insight into English Nature's expectations with respect to identification, examination and reporting of likely cumulative effects of plans and projects.
Cumulative Effects in Swedish Impact Assessment Practice	Warnback, A.	2007	Sweden	Both	Review	Reviewed how cumulative effects are considered in Sweden. Found there is a lack of legislative and professionally based willingness to include cumulative effects. It was found that the lack of CEA was due to the lack of knowledge from the assessor, and the knowledge as to what to include in a CEA in the EIA/SEA process and knowing how to approach cumulative issues, i.e. methods for evaluation. It was found that there were vague demands in terms of legislation, regulation and guidelines.
Cumulative effects assessment: Does scale matter?	Therivel, R. and B. Ross	2007	Canada/ UK	Both	Theoretical	Reviews how CIAs consider and could consider scale issues, spatial extent, level of detail and temporal issues.
Conceptual models, matrices, networks and adaptive management - emerging methods for CIA (presented at Assessing and Managing CIA)	Canter, L.W.	2008	Canada	Both	Theoretical	Four CEA tools are presented: conceptual models, matrices, networks and adaptive management processes. Each is analysed and it is suggested that each could be used and adapted for the differing needs of projects. It is concluded that as the practice of CEA matures the methods and tools used will change and adapt that will lead to improvements of the assessments made.
Interactive and cumulative effects of multiple human stressors in marine systems	Crain, C.M., Kroeker, K. and B.S. Halpern	2008	Worldwide	Marine	Analytical	Synthesized 171 studies that manipulated two or more stressors in the marine and coastal environment and found that cumulative effects in individual were additive (26%), synergistic (36%) and antagonistic (38%). A third stressor increased the effects significantly.
Incorporating cumulative effects into environmental assessments of mariculture: Limitations and failures of current siting methods.	King, S.C., and R. Pushchak	2008	Canada	Marine	Theoretical	A retrospective review of 23 existing mariculture farms was conducted to determine whether or not cumulative interactions would have lead to the site being approved or not. This was based on current scientific evidence of cumulative effects. Before mitigation 19 of the 23 sites failed, and after considering mitigation 8 sites failed.

Name of Case Study	Authors	Date	Country	Marine or Terrestrial	Type	Summary Review
Assessing cumulative impacts within state environmental review frameworks in the US.	Ma, Z., Becker, D.R., and M.A. Kilgire	2009	USA	Both	Review	Examines state practice and materials used in programmes and frameworks for CIA and explores the opportunity for improvement. Used questionnaires and surveys states practices.
Cumulative impact assessments and bird/wind farm interactions: Developing a conceptual framework	Masden, E.A., Fox, A.D., Furness, R.W., Bullman, R., and D.T. Haydon	2009	UK	Marine	Theoretical	The paper proposed a conceptual framework to promote transparency in CIA through explicit definition of impacts, actions and scale within an assessment. Along with CIA being considered at a strategic level. The paper calls for improved legislative guidance on the actions to be included in CIA and advice on the appropriate baselines against which to assess impacts.
A conceptual basis and methodological framework for regional strategic environmental assessment (R-SEA)	Gunn, J.H., and B.F. Noble	2009	Canada	Both	Theoretical	Canada has proposed Regional Strategic Environmental Assessment (R-SEA) as a means to integrate and improve CEA. The paper comments on this initiative and presents a conceptual basis and methodological framework for its development and application.
Integrating cumulative effects in regional strategic environmental assessment frameworks: Lessons from Practice	Gunn, J.H., and B.F. Noble	2009	Canada	Both	Theoretical	Examines recent attempts at regional and strategic type assessment frameworks that assess CEA. It was found that cumulative effects are most effective when there is a shared vision about the future state of the environment and development at the regional scale. CEA is recognised as being more than a simple task of adding up the environmental effects.
Developing Guidance on Ornithological Cumulative Impact Assessment for Offshore Wind Farm Developers. A report to the Crown Estate, as part of the COWRIE funded research 2009.	King,S. MacLean. Norman. T and A. Prior	2009	UK	Marine	Guidance	This project has developed guidelines on the processes, methods and techniques to be utilised for CIA for birds and offshore wind farms. 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.

Name of Case Study	Authors	Date	Country	Marine or Terrestrial	Type	Summary Review
Impact assessment in the Mekong: Review of SEA and CIA	Keskinen, M. and M. Kummu	2010	China	Aquatic	Theoretical	The research paper first places the SEA and the CIA into the broader context by presenting a summary of the most common assessment approaches used currently in the Mekong Region. After that, the more detailed definitions of the SEA and the CIA are provided, followed by a review of selected SEA and CIA processes already carried out in the region.
Conceptual and methodological challenges to integrating SEA and cumulative effects assessment	Gunn, J.H., and B.F. Noble	2011	Canada	Both	Theoretical	Based on interviews with international experts and practitioners. Several approaches were identified during the surveys. But there is no consensus on the correct approach to undertaking CIA.
Alchemy to reason: Effective use of Cumulative Effects Assessment in resource management	Hegmann, G., and G.A. Yarranton	2011	Canada	Both	Theoretical	This paper explores some opportunities to accelerate improvements in decision making in natural resource management and in the utility of CIA as a tool to assist in making such decisions.
Canadian and international EIA frameworks as they apply to cumulative effects	Connelly, R.	2011	Canada and international	Both	Theoretical	This paper presents a brief history of the development of cumulative effects, the current requirements, challenges at the project level, thoughts on how emerging concepts of strategic environmental assessment and regional assessment may offer means to improve the examination of cumulative effects and offers suggestions for current and future needs in CIA.
Appraising the sustainability of project alternatives: An increasing role for cumulative effects assessment	Senner, R.	2011	USA	Both	Theoretical	This paper describes how CEA can provide a way to appraise the sustainability of project alternatives in terms of their probable contributions to long-term trends affecting the condition of receptors.
Multiple uses of indicators and indices in cumulative effects assessment and management	Canter, L.W., and S.F. Atkinson	2011	USA	Both	Theoretical	Identifies tools that can be and have been used in CIA. Describes how they can be used.
A broad-scale assessment of the risk to coastal seagrasses from cumulative threats.	Grech, A., Coles, R., and H., Marsh	2011	Australia	Marine	Theoretical	This paper identifies sites that are exposed to multiple anthropogenic threats at broad scales using qualitative measures of vulnerability combined with geospatial data to evaluate the risk to coastal seagrass meadows.
Assessing the cumulative impact of onshore wind energy developments	Scottish Natural Heritage	2012	Scotland	Terrestrial	General guidance	Provides guidance to public bodies, developers and consultants involved in onshore wind energy development. The guidance sets out methods that it advices should be used to assess cumulative impacts on landscapes and birds. But acknowledges that it is not possible to provide generic advice on the significance of cumulative effects which should be assessed on a case by case basis.

Name of Case Study	Authors	Date	Country	Marine or Terrestrial	Type	Summary Review
Cumulative effects assessment: Linking Social, Ecological and Governance Dimensions	Weber, M., Krogman, N., and T., Antoniuk	2012	Worldwide	Terrestrial	Theoretical	Case studies that explore how scenario analysis can be used to evaluate various land use options and highlight specific challenges with identifying social and ecological responses determining thresholds and targets for land use while integrating level and traditional knowledge in land use planning. Suggests that good science needs to inform and be informed by culturally appropriate democratic processes calls for well planned and multifaceted approaches both to achieve an informed understanding of both residents and governments of the interactive and additive changes caused by development.
Guidance on cumulative effects analysis in Environmental Assessments and Environmental Impact Statements	Canter, L.W.	2012	USA	Marine	Guidance	Provides guidance of how to plan and conduct CEA. Incorporates Scoping and Baseline, and Impact assessment. Uses Pressure - receptor pathways (cause and effect relationships).
The Habitats and Wild Birds Directives in England and its seas Core guidance for developers, regulators & land/marine managers	Defra	2012	England	Both	Guidance	Gives an overview of the main requirements from the Habitat Directive, when they are likely to apply and the regulatory process. It does not apply to functions devolved to Scotland, Wales or Northern Ireland.
Assessing the risks to marine mammal populations from renewable energy devices - an interim approach.	Lusseau, D., Christiansen, F., Harwood, J., Mendes, S., Thompson, P.M., Smith, K., and G.D. Hastie	2012	UK	Marine	Theoretical	Reports on the progress which has been made by a Working Group on the Population Consequences of Acoustic Disturbance (PCAD). The Group has developed a simplified framework to characterise biologically significant marine mammal behaviour, and has applied this framework to a number of case studies, including bottlenose dolphins. This framework takes account of cumulative impacts also.
Evaluation of the current state of knowledge on potential cumulative effects from offshore wind farms (OWF) to inform marine planning and licensing (MMO project)	MMO	2013	England	Marine	Theoretical	Investigates sources of available evidence on the potential for cumulative environmental effects arising from offshore wind farm development to inform marine planning and licensing. The report initially outlines a clear working definition of cumulative effects and identifies a conceptual framework based on the DPSIR approach. This framework is then used to describe the main steps for assessing cumulative environmental effects within the context of Marine Spatial Planning. Information on existing methods for assessing cumulative effects are presented together with the lessons learnt from other sectors facing similar requirements when undertaking CEAs.

Name of Case Study	Authors	Date	Country	Marine or Terrestrial	Type	Summary Review
Guiding principles for cumulative effects assessment (CIA) in offshore wind farms (OWF).	RUK/NERC	2013	UK	Marine	Guidance	Provides a framework which promotes consistency and standards rather than guidance. It aims to ensure that all stakeholders have the same expectations of the CIA process, reduce uncertainty and promote streamlining of the consenting process. Uses Source-Pathway - Receptor Rationale.
Consequences of a cumulative perspective on marine environmental impacts: Offshore wind farming and seabirds at North Sea scale in context of the EU Marine Strategic Framework Directive (MSFD)	Busch, M., Kannen, A., Garthe, S., and M. Jessopp	2013	North Sea	Marine	Theoretical	Provides a new methodology of how to estimate the cumulative habitat loss due to ongoing and planned offshore wind farm developments. Considers seasonal distribution of bird species and estimates of potential habitat loss and highlights the need for transnational cooperation.
Good Practice Note - Cumulative Impact Assessment and Management: Guidance for the Private Sector in Emerging Markets.	Jointly prepared by ESSA Technologies Ltd., Richmond Hill, ON and the International Finance Corporation - World Bank Group.	2013	USA	Both	Guidance	Gives guidance from the scoping phase onwards in the development of projects. Compares CIAs with EIAs and suggests what needs to be considered throughout the assessment process.

Appendix D

Case Study:
Testing the Generic Framework

Appendix D. Case Study: Testing the Generic Framework

The generic framework for CIA (see Figure 4 in Section 3 of main report) has been applied to a hypothetical case study to test its practicability and determine any methodological limitations. This case study has been taken forward to completion of the scoping phase (i.e. identifying the impact pathways that are likely to be relevant at a high level and recommended assessment methods) but not the detailed assessment phase. It has considered habitat, bird and marine mammal receptors.

The case study comprises a theoretical 500 megawatts (MW) offshore wind farm located approximately 12km off the Caithness coast near Wick, Scotland (Figure E1). The wind farm has been assumed to have a maximum installed capacity of up to 500 MW comprising up to 100 x 5MW three bladed horizontal axis wind turbines. The turbines will be secured to the seabed and a network of electricity cables, known as the intra-array cables, will be required to connect each of the turbines to one of, up to three, Offshore Substation Platforms (OSPs). Export cables will run to shore, close to Wick. The turbines will be designed to operate for a period of 25 years after which the wind farm will be decommissioned.

Figure E1. Map showing the location of the hypothetical offshore wind farm

Step 1: Defining Project Pressures

The following information is provided as an illustrative project description (in a scoping document a much more detailed description of the development would be expected):

- **Offshore wind turbines -** Up to a maximum of 100 x 5MW offshore turbines are likely to be required. Based on current assumptions of the scheme, the total footprint of the array will be 66km^2. The offshore wind turbines will be three bladed horizontal axis turbines. They will be mounted onto a substructure which will connect the turbine to a foundation which will secure the structure to the seabed. At the scoping stage of the assessment process it is not possible to determine the precise dimension and number of turbines that will be installed at the site. The turbines that are likely to be installed at the site, however, are 5 MW turbines with a maximum tip height of 198.4 m. There are several types of foundation that may be used in the construction of the turbines, including piled or gravity base solutions depending on seabed conditions. The turbines, once in place, will have navigation and aviation markings and lighting as required;
- **Scour protection -** Static scour protection is likely to be required around the base of each foundation, which involves a layer of fine grade rock or gravel being placed on the seabed prior to the installation of the foundation. An armour layer is then installed once the structure is in place. The armour layer will most likely comprise rock boulders;
- **Substructure -** This structure serves as a transition piece between the foundation and the turbine and sits part below sea level and part above sea level in order that the whole turbine sits above sea level;
- **Offshore substation platforms (OSPs) -** Up to a maximum of three alternating current (AC) OSPs may be required depending on the electrical system. OSP locations are currently unknown and will be determined once the size, type and number of turbines have been established and each potential location will be subject to a full geotechnical site investigation prior to installation;
- **Intra-array cabling -** up to 150km of inter-array cabling linking turbines and OSPs. The size and voltage of cables along with the final layout and total length will be dependent on the final number and layout of turbines. The inter-array cables will either be buried below the surface of the seabed or laid on the seabed surface and covered with cable protection (most likely a form of protection by rocks) where feasible; and
- **Export cable -** The export cable consists of the cabling that connect the wind farm to the landfall north of Broadhaven. Up to four 132kV AC export cables will run parallel to each other, and be installed with a separation distance (between cables) of approximately four times water depth. The cables will be buried to a depth of 2m where practicable. Where cables are surface laid, they will be protected with rock armour or concrete mattressing. The corridor within which the trenches will lie is approximately 10km in length and will vary in width to reflect the spacing requirements associated with the varying water depths along the length of the corridor.

The first step in the CIA framework involves defining the main environmental changes or pressures brought about by activities associated with the proposed offshore wind farm through the project life cycle. Using a generic ‘activities versus pressure’ matrix provides us with a list of key pressures (Table E1).

Table E1. Key pressures associated with the proposed offshore wind farm

Pressure		Spatiotemporal Description of Pressure	Pre-construction (survey)	Construction	Operational	Decommissioning
Hydrological changes	Water flow (e.g. tidal current) changes	Pressure arises from the presence of the wind turbine (friction effect causes change in tidal current). This pressure is mainly local, within the immediate vicinity of each turbine (i.e. within the OWF site) and decreases with distance from the turbine. The pressure from individual devices can accumulate to produce an 'array scale' pressure which may extend outside the OWF site boundary. The magnitude of the pressure depends upon the foundation type, dimension, spacing, total number of devices and orientation in relation to the incoming tidal axis.			h	
	Wave exposure changes	Pressure arises from the presence of the turbine (friction effect causes change in wave height). This pressure is mainly local, within the immediate vicinity of each turbine (i.e. within the OWF site) and decreases with distance from the turbine. The pressure from individual devices can accumulate to produce an 'array scale' pressure which may extend outside the OWF site boundary. The magnitude of the pressure depends upon the foundation type, dimension, spacing, total number of devices and orientation in relation to the incoming wave direction.			h	
	Water clarity changes	Disturbance from piling and cable installation and decommissioning activities may increase suspended sediments and result in water clarity changes; pressure is short term and localised. Presence of the wind turbine during operation may result in localised changes in tidal currents and surface abrasion (scour), which in turn could result in an increase in suspended sediments.		h	l	l
Pollution and other chemical changes	Non-synthetic compound contamination (inc. heavy metals, hydrocarbons, produced water)	Low risk of accidental discharges of fuel oil from machinery and vessels. Exposure to environmental change from spillage is low and significance of any change is likely to be low.	l	l	l	l
	Synthetic compound contamination (inc. pesticides, antifoulants, pharmaceuticals)	Low risk of accidental discharges of synthetic materials (e.g. antifoulants) from machinery and vessels. Exposure to environmental change from spillage is low and significance of any change is likely to be low.	l	l	l	l
Physical loss/ introduction	Physical change (to another substrate type)	Change in substrate occurs within footprint of device and cables due to presence of a new substrate. Pressure exists until decommissioning (semi-permanent). Spatial extent of device footprint will depend on the nature of the device and its foundation: OWF monopiles generally 4-6m in diameter; gravity base foundations generally 20-40m in diameter.			h	

Pressure		Spatiotemporal Description of Pressure	Pre-construction (survey)	Construction	Operational	Decommissioning
Physical damage	Siltation rate changes	Disturbance from piling and cable installation and decommissioning activities may increase suspended sediments and result in siltation rate changes; change is short term and localised.		h		l
	Structural abrasion/penetration	This includes any benthic sampling during pre-construction surveys, and piling and cable installation during construction and decommissioning. Extent of pressure from sampling and cable installation is short term and spatially minor. Presence of device during operation results in scour which may require scour protection.	h	h	h	l
	Surface abrasion: damage to seabed surface features	Cable installation during construction and decommissioning may result in surface abrasion.		h		l
Other physical pressures	Electromagnetic changes	Electromagnetic changes arising from operational cables likely to be confined to the immediate vicinity of the cable (within 20m).			h	
	Introduction of light	Lighting of wind turbine structures during operation.			h	
	Underwater noise	Seismic exploration during pre-construction survey will only be for a short duration. Construction and decommissioning activities (i.e. drilling, pile driving, explosives, vessels) will be semi-continuous or impulsive noise, and transient. Operational noise is transmitted from the operating machinery, through the tower to the foundation, from where it is radiated into the water. Normally of low intensity, with energy concentrated at low frequencies (below a few kilohertz).	h	h	h	l
	Barrier to species movement (behaviour, reproduction)	During construction/decommissioning, this pressure mainly arises from noise during piling activities. Pressure is short term and localised. During operation, this pressure arises from presence of devices and scour protection.		m	m	l
	Death or injury by collision	During operation, this relates to collision with moving blades. Pressure is restricted to immediate vicinity of device/array and associated pressure fields. During other phases of the development, this relates to collision with vessel propellers.	m	m	m	m
Biological pressures	Visual disturbance (behaviour)	Extent of this pressure is likely confined to array and any vessels during all phases of project.	m	m	m	m
	Introduction or spread of non-indigenous species & translocations (competition)	The presence of structure provides a new substratum that may increase the risk of introducing non-indigenous species by providing a 'stepping-stone' between habitats and/or across marine regions. Introduction and ingress of invasive non-native species as biofouling species on the surfaces of vessels or construction plant.	l	l	l	l
Level of confidence in the pressures is indicated as high (h), medium (m) and low (l) based on the scheme details available at the scoping phase. Note that there will be a lack of detailed geotechnical site investigation (including sediment quality) information at the scoping phase.						

- *Has the project been adequately defined (all potential project elements, activities and components, Project Design Envelope)? An actual scoping document would be expected to provide significantly more detail than presented here, but covering the same general project elements.*
- *Have all the potential pressures associated with project activities been identified? Using an 'activities versus pressure' matrix as a checklist, all the potential pressures have been clearly provided in a table.*
- *Have the pressures been clearly defined as far as is practicable both spatially and temporally? At this early stage in the assessment, no information has been provided on the construction programme, however, the pressures have been identified according to the main phases of the development (pre-construction, construction, operational and decommissioning phases). A qualitative description of the spatiotemporal distribution of pressures is provided where sufficient project scheme definition is available.*
- *Have any uncertainties associated with the pressures been identified and defined? These have been presented at a high level within the table of key pressures based on the level of project scheme information available. These will need to be clearly defined as part of the CIA once further project details and survey information are available at the assessment phase.*

Step 2: Defining Spatiotemporal Scale of MPA Receptors

Habitats

There are no MPAs within a full tidal ellipse of the wind farm site. Along the proposed export cable route to Broadhaven, there is a potential Scottish Nature Conservation MPA (Noss Head potential Scottish Nature Conservation MPA) that is designated for horse mussels (Figure E2). East Caithness Cliffs potential Scottish Nature Conservation MPA also occurs within a full tidal ellipse of the cable route, however, this is not designated for any habitat features, only bird features (see next section on birds).

Based on information available on the JNCC UKSEA map[18], the predicted habitat types within the project area is a mixture of faunal communities on deep moderate energy circalittoral rock (A4.27), Atlantic and Mediterranean moderate energy circalittoral rock (A4.2), circalittoral coarse sediment (A5.14), infralittoral coarse sediment (A5.13) and Atlantic and Mediterranean high energy infralittoral rock (A3.1). A benthic grab and video survey will be undertaken to confirm and further characterise the seabed habitat for the purposes of the EIA. This will involve sampling both within and outside of the footprint of the project design envelope to take account of both potential direct and indirect pressures. A survey design will be prepared in the early stages of the assessment phase, supported by outputs from a wider geophysical survey (swathe bathymetry, side scan sonar, sub-bottom profiler.

- *Has the spatiotemporal scale of MPA receptors been defined in relation to project pressures? A full tidal excursion has been used to identify any MPA habitat features that could potentially be affected by the development and this has been clearly presented on a figure for transparency. The applicant will also need to consider any long-term trends in the horse mussel bed extent and the relative sensitivity of horse mussel beds at different phases of their life cycle (e.g. larval phases) in the assessment phase.*
- *Has the level of uncertainty associated with the distribution of receptors been identified? Yes, only predicted habitat information is currently available and a benthic grab and video survey is proposed to supplement the baseline characterisation at the assessment phase.*
- *Has a suitably precautionary approach been adopted to identifying sites and features for inclusion within the assessment? In the light of the requirements of the Habitats and Wild Birds Directives, a sufficiently precautionary approach has been followed. This will need to be reviewed once more detailed project scheme information is available at the assessment phase.*
- *Is any further survey work required to define the baseline environmental character of the area for the purposes of the CIA? Yes, further survey work has been proposed by the developer and the draft survey design should be agreed with key stakeholders (in particular, Scottish Natural Heritage).*

[18] http://jncc.defra.gov.uk/page-2117. Building on the modelling work of the INTERREG IIIB-funded MESH project and UKSeaMap 2006, UKSeaMap 2010 has produced a new seabed habitat map using improved input physical data layers to predict benthic habitats under the EUNIS classification. This interactive map contains a broadscale predicted seabed habitat map for the UK continental shelf and the data used in the modelling process.

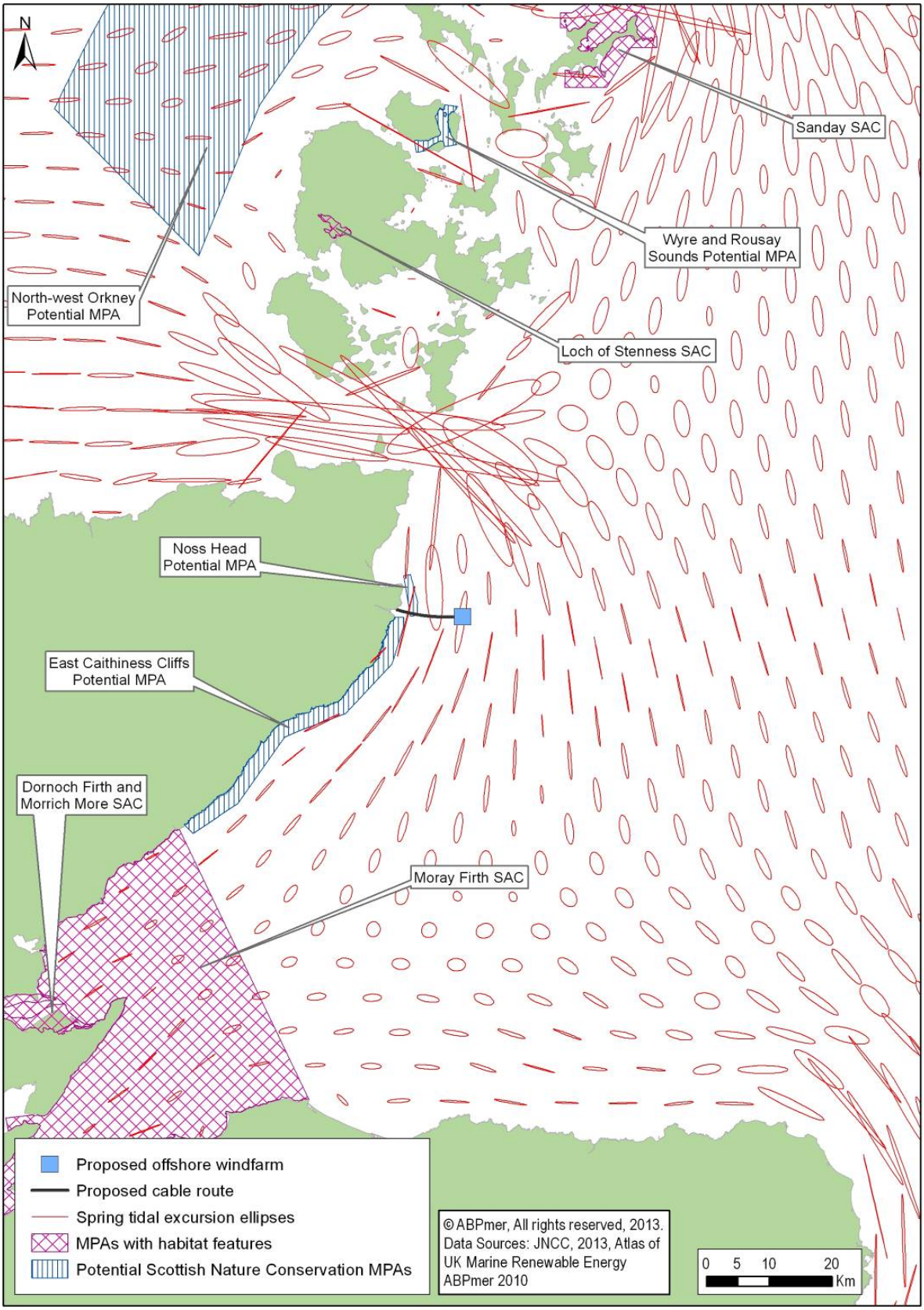

Figure E2. Map showing the location of MPAs with habitat features in relation to the direct and indirect project pressures

Birds

All designated sites within a 100km buffer zone which support birds as a qualifying feature have automatically been scoped into the assessment. These are shown in Figure E3 and are as follows:

- Pentland Firth Islands SPA – Arctic Tern;
- Caithness & Sutherland Peatlands SPA – Wood Sandpiper, Merlin, Black-throated Diver, Red-throated Diver, European Golden Plover, Short-eared Owl, Dunlin;
- Caithness Lochs SPA – Whooper Swan, Greylag Goose, Greenland White-fronted Goose;
- North Sutherland Coastal Islands SPA – Barnacle Goose;
- Lairg and Strathbrora Lochs SPA – Black-throated Diver;
- Loch Eye SPA – Whooper Swan, Greylag Goose;
- Dornoch Firth and Loch Fleet SPA – Greylag Goose;
- Moray & Nairn Coast SPA – Osprey, wintering waterfowl assemblage, Common Redshank, Greylag Goose, Pink-footed Goose;
- Loch Spynie SPA – Greylag Goose;
- East Sanday Coast SPA – Bar-tailed Godwit, Purple Sandpiper, Turnstone;
- Auskerry SPA – European Storm Petrel, Arctic Tern;
- Switha SPA – Barnacle Goose;
- Orkney Mainland Moors SPA – Red-throated Diver, Short-Eared Owl;
- Calf of Eday SPA – Breeding seabird assemblage, Black-legged Kittiwake, Common Guillemot, Northern Fulmar, Great Cormorant, Great Black-backed Gull;
- Copinsay SPA – Breeding seabird assemblage, Black-legged Kittiwake, Common Guillemot, Northern Fulmar, Great Black-backed Gull;
- East Caithness Cliffs SPA – Breeding seabird assemblage, Herring Gull, Black-legged Kittiwake, Common Guillemot, Northern Fulmar, European Shag, Great Cormorant, Great Black-backed Gull, Atlantic Puffin, Razorbill, Peregrine Falcon;
- Hoy SPA – Breeding seabird assemblage, Black-legged Kittiwake, Common Guillemot, Northern Fulmar, Red-throated Diver, Great Black-backed Gull, Atlantic Puffin, Peregrine Falcon, Arctic Skua, Great Skua;
- Marwick Head SPA – Breeding seabird assemblage, Black-legged Kittiwake, Common Guillemot;
- North Caithness Cliffs SPA – Breeding seabird assemblage, Black-legged Kittiwake, Common Guillemot, Northern Fulmar, Atlantic Puffin, Razorbill, Peregrine Falcon;
- Rousay SPA – Breeding seabird assemblage, Black-legged Kittiwake, Common Guillemot, Arctic Tern, Northern Fulmar, Arctic Skua;
- Troup, Pennan and Lion's Heads SPA – Breeding seabird assemblage, Herring Gull, Black-legged Kittiwake, Common Guillemot, Northern Fulmar, Razorbill;
- West Westray SPA – Breeding seabird assemblage, Common Guillemot, Arctic Tern;
- East Caithness Cliffs potential Scottish Nature Conservation MPA – Black Guillemot; and
- Papa Westray potential Scottish Nature Conservation MPA – Black Guillemot.

The Morangie Forest SPA and Strath Carnaig and Strath Fleet Moors SPA also occur within 100km buffer but have been scoped out of the assessment on the basis that they are designated for terrestrial birds (Western Capercaillie and Hen Harrier respectively) which do not interact with the marine environment.

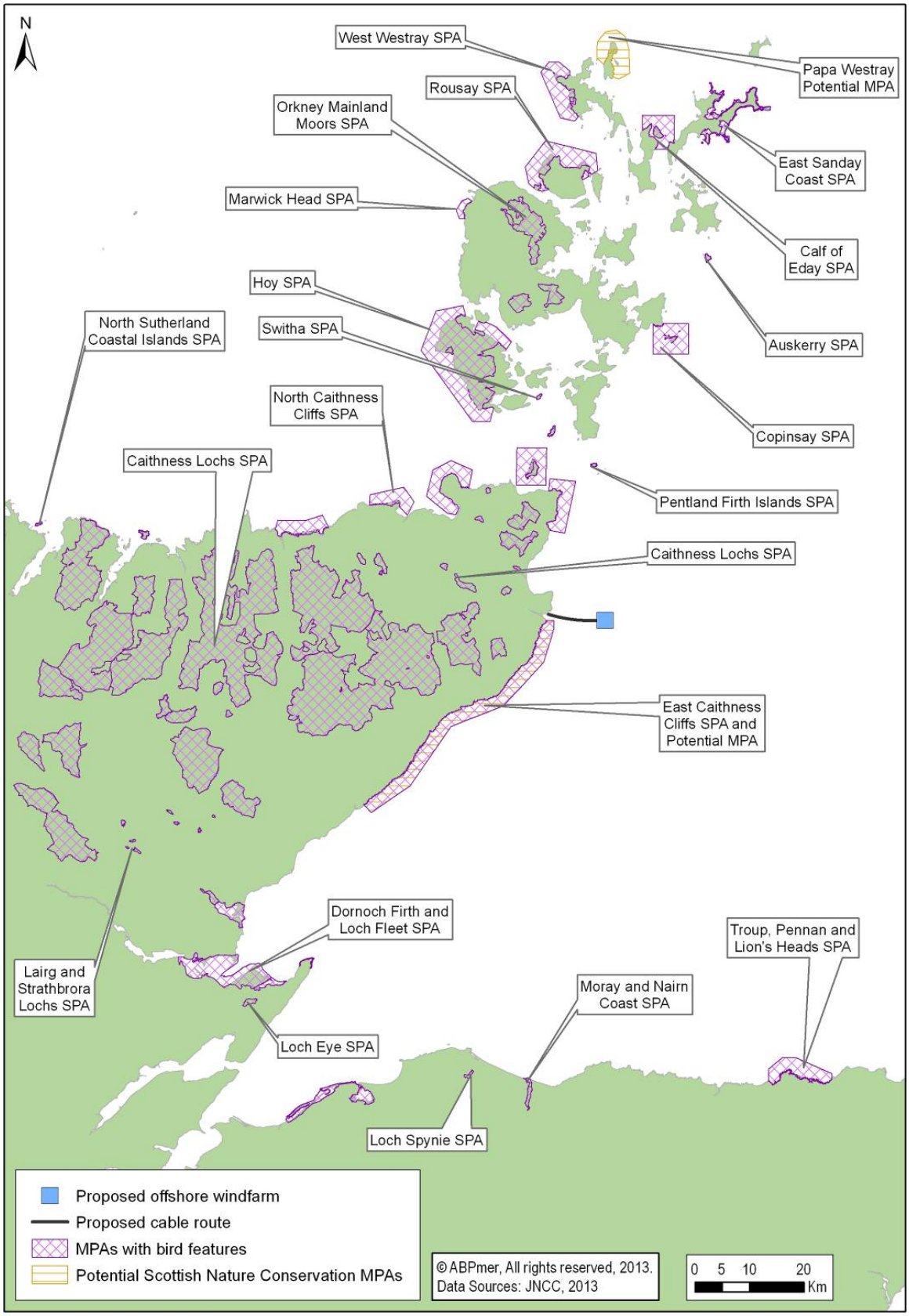

Figure E3. Map showing the location of MPAs with bird features within 100km of the project boundary

The next stage was to consider the foraging behaviour of coastal and offshore bird colonies (whether these are overwintering or breeding populations) to identify SPAs lying outside of the 100km buffer which might be affected by the project. It is known that most birds typically forage within 100km of breeding sites and these will, therefore, already be included. However, those species that forage over greater distances and could be affected by the project even though they lie outside the 100km screening buffer zone were identified based on a detailed literature review (ABPmer 2011; 2013). These species and the maximum recorded distances that they forage are included in Table E2.

Table E2. Maximum foraging ranges for MPA bird features

Species	Estimate of maximum breeding season foraging range (km)	Source
Northern Fulmar	400	Birdlife International (2010)
Manx Shearwater	400	Birdlife International (2010)
Leach's Storm-petrel	120	Thaxter et al. (2012)
Northern Gannet	400	Birdlife International (2010)
Great Skua	219	Thaxter et al. (2012)
Black-legged Kittiwake	200	Birdlife International (2010)
Common Guillemot	200	Birdlife International (2010)
Razorbill	312	FAME project; ABPmer (2013)
Atlantic Puffin	200	Thaxter et al. (2012)

The SPAs supporting birds with maximum foraging distances greater than 100km are shown in Figure E4 and are as follows:

- Hermaness, Saxa Vord and Valla Field SPA – Northern Fulmar, Northern Gannet;
- Foula SPA – Atlantic Puffin, Black-legged Kittiwake, Common Guillemot, Great Skua, Northern Fulmar, Razorbill;
- Fetlar SPA – Northern Fulmar;
- Noss SPA – Great Skua, Northern Fulmar, Northern Gannet;
- Sule Skerry and Sule Stack SPA – Atlantic Puffin, Common Guillemot, Storm Petrel, Northern Gannet;
- North Rona and Sula Sgeir SPA – Atlantic Puffin, Black-legged Kittiwake, Common Guillemot, Northern Fulmar, Northern Gannet, Razorbill;
- Sumburgh Head SPA – Black-legged Kittiwake, Common Guillemot, Northern Fulmar;
- Fair Isle SPA – Atlantic Puffin, Black-legged Kittiwake, Common Guillemot, Great Skua, Northern Fulmar, Northern Gannet, Razorbill;
- Flannan Isles SPA – Northern Fulmar, Razorbill;
- St Kilda SPA – Manx Shearwater, Northern Fulmar, Northern Gannet;
- Cape Wrath SPA – Atlantic Puffin, Black-legged Kittiwake, Common Guillemot, Northern Fulmar, Razorbill;
- Handa SPA – Black-legged Kittiwake, Common Guillemot, Great Skua, Northern Fulmar, Razorbill;
- Shiant Isles SPA – Northern Fulmar, Razorbill;
- Buchan Ness to Collieston Coast SPA – Black-legged Kittiwake, Common Guillemot, Northern Fulmar;
- Fowlsheugh SPA – Black-legged Kittiwake, Common Guillemot, Northern Fulmar, Razorbill;
- Rum SPA – Manx Shearwater;
- Mingulay and Berneray SPA – Northern Fulmar;
- St Abb's Head to Fast Castle SPA – Razorbill;
- Ailsa Craig SPA – Northern Gannet; and
- Forth Islands SPA – Northern Fulmar, Northern Gannet.

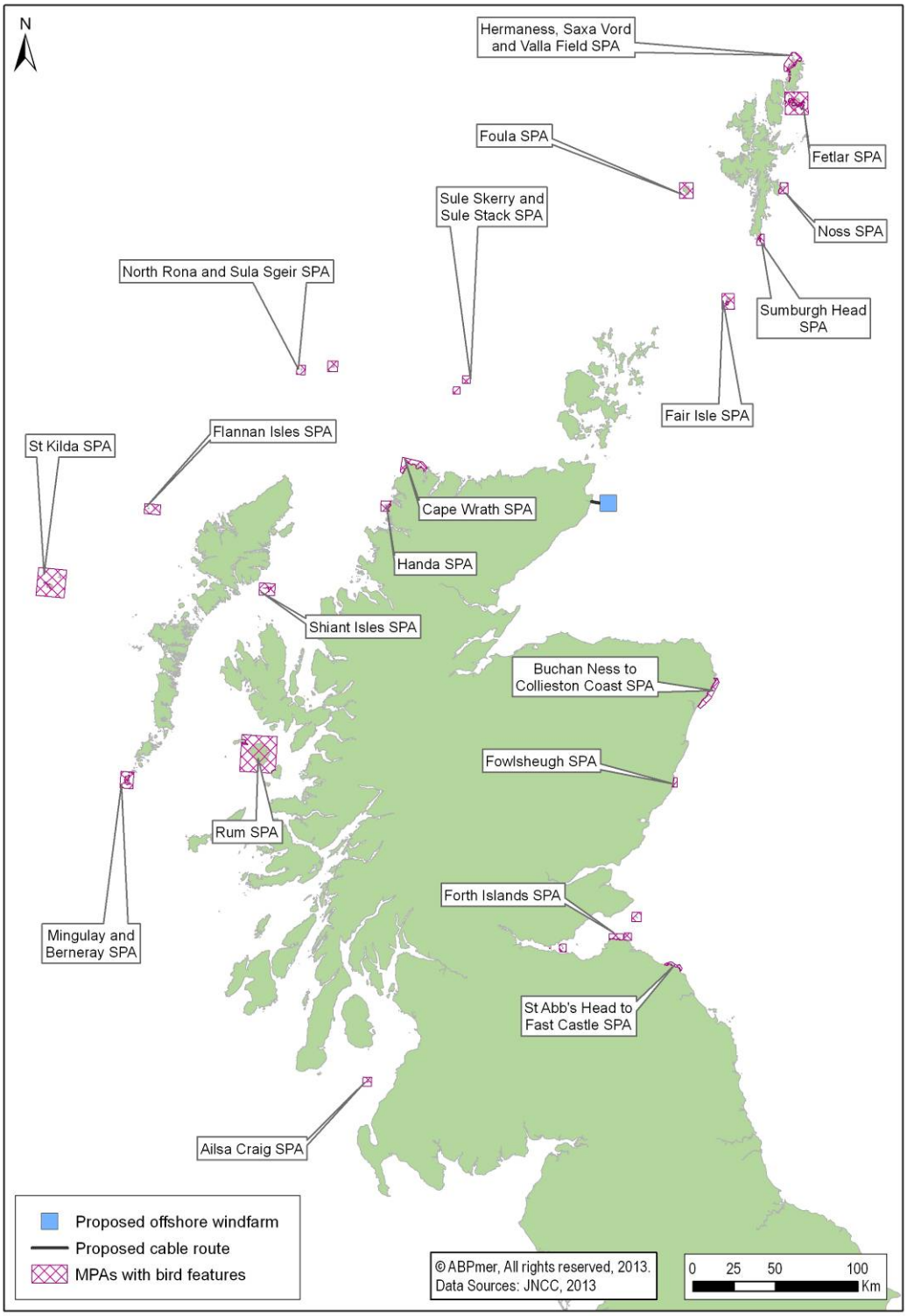

Figure E4. Map showing the location of MPAs with seabird features with maximum foraging distances >100km from the project boundary

The bird resource will be characterised using a programme of boat based and digital aerial surveys, as well as a ground based surveys focusing on waders and wildfowl. Historical datasets will be studied and collated to gain an understanding of the wider Moray Firth region and to provide a longer term dataset for the area of potential effect. From these studies, using techniques such as density surface modelling, quantifying spatial and

temporal distributions and densities of species will be achieved. Tracking studies of waterbirds could also help to explore linkages between SPA colonies and the wind farm site.

- *Has the spatiotemporal scale of MPA receptors been defined in relation to project pressures? Information is provided on MPA bird features that occur within 100km of project boundary and also those that forage over 100km and should be scoped into the assessment on the basis that they might overlap with the potential effects of the project. Temporal aspects of each of the MPA receptors will need to be provided once more project scheme information is available (e.g. construction timetable and project programme) to identify degree of overlap and relevance to assessment.*
- *Has the level of uncertainty associated with the distribution of receptors been identified? This has not been specifically addressed at this stage and will need to be considered as part of the full baseline characterisation at the assessment phase.*
- *Has a suitably precautionary approach been adopted to identifying sites and features for inclusion within the assessment? A very precautionary approach has been initially applied at this stage to account for the maximum foraging range of bird interest features.*
- *Is any further survey work required to define the baseline environmental character of the area for the purposes of the CIA? An outline of the proposed survey work for the purposes of the EIA is provided. The developer will need to agree the proposed survey design with relevant stakeholders (in particular, Scottish Natural Heritage).*

Marine Mammals

A summary of the distribution, abundance and range of each of the main MPA marine mammal interest features that are commonly recorded in the region is presented in Table E3.

Based on the likely distribution of marine mammals occurring in the region and functional use of their territory, the following MPAs with marine mammal interest features occur within up to 100km from the project and have been initially scoped into the assessment (Figure E5):

- Faray and Holm of Faray SAC – grey seal;
- Dornoch Firth and Morrich More SAC – common seal;
- Moray Firth SAC – bottlenose dolphin; and
- Sanday SAC – common seal.

Dornoch Firth and Morrich More SAC, River Borgie, Loch of Isbister and River Spey SACs occur within 100km and are designated for otters, however, given that the functional range of otters is less than 10km these sites have been scoped out of the assessment (ABPmer 2011; 2013).

Although Caithness and Sutherland Peatlands SAC occurs within 100km of the project boundary it has been scoped out of the assessment on the basis that there is no connectivity with the marine environment.

Particular consideration should also be given to harbour porpoise given that this species can forage/migrate over long distances and is currently not a qualifying species for any designated UK site. In consultation with other Member States, MPAs occurring outside this 100km, including transnational sites in Skagerrak (Denmark), the North Sea and the English Channel, may also need to be scoped into the assessment to account for the long distances travelled by harbour porpoise.

Table E3. Distribution and known spatial ranges of MPA marine mammal features recorded off the East Coast of Scotland

Species	Longevity of species	Distribution and Spatial Range
Grey seal	15-35 years	Breeding colonies of grey seals are located at Helmsdale and Berriedale. A range of studies have shown that grey seals can undertake long distance travel (up to 1200km) between different haul-out sites but foraging trips are generally much smaller (generally within 100km).
Common Seal	20-30 years	Several large breeding populations with the significant population found in the Dornoch Firth. Common seals have been shown to travel over 100km between haul-out sites although most common seals typically return to the same haul-out site from which they departed. Most seals forage up to 40-60km from their haul-out site with trips usually less than this.
Harbour porpoise	15 years	The harbour porpoise is the most commonly recorded cetacean recorded in the area. Harbour porpoise often show large seasonal variations in the distribution. These seasonal changes may be linked to migrations/changes in the distribution of prey. Recent satellite-tracking data has shown evidence of several animals moving from northern Denmark to the western part of the North Sea and Shetland (travelling approximately 800-1000km away from the point they were first tagged).
Bottlenose dolphin	25 years	The population of bottlenose dolphins on the north east coast of Scotland is estimated at around 190 animals. The East coast population appears to be largely isolated, with individuals ranging from Caithness as far south as the Firth of Forth and Northumberland. Almost all bottlenose dolphin sightings occur within 15 km of the coast within the Inner Moray Firth SAC or in the coastal strip along the southern Moray Firth coast.
Otter	10-20 years	Widely distributed in coastal areas. Typically feeds in shallow water within 100m of the shore with the majority of otter dives closer to shore (within 50m of the coast).

The marine mammal resource will be characterised using boat-based and aerial surveys, passive acoustic monitoring (PAM) and telemetry studies. Survey data will be collected as part of a site-specific survey programme of the wind farm site and surrounding area, supplemented with historical data from studies undertaken throughout the wider Moray Firth region (including those undertaken for more recent offshore wind farm developments e.g. Beatrice OWF) to provide a long-term dataset for the area of potential effect. This information will be used to characterise the distribution and density of key species within the study area, including their seasonality and year-to-year variability. In addition, the data will be used to assess the likelihood of exchange between the SACs that have been scoped into the assessment and the project area.

- *Has the spatiotemporal scale of MPA receptors been defined in relation to project pressures? At this early stage in the assessment, the geographic distribution of the MPA marine mammal features has been described qualitatively for the wider region off the East Coast of Scotland. Some limited information on seasonal distribution is also provided. It will be particularly important to define the temporal aspects of each of the MPA receptors once more project scheme information is available (e.g. construction timetable and project programme) to identify degree of overlap and relevance to assessment.*
- *Has the level of uncertainty associated with the distribution of receptors been identified? This has not been specifically addressed at this stage and will need to be considered as part of the full baseline characterisation at the assessment phase.*
- *Has a suitably precautionary approach been adopted to identifying sites and features for inclusion within the assessment? A very precautionary approach has been initially applied at this stage to account for the full foraging/migration range of marine mammal interest features. Some of the sites and associated features may be scoped out at the assessment phase once the scale of project pressures have been more clearly defined and consultation with other Member States has been*

undertaken.

- *Is any further survey work required to define the baseline environmental character of the area for the purposes of the CIA? An outline of the proposed survey work for the purposes of the EIA is provided. The developer will need to agree the proposed survey design with relevant stakeholders (in particular, Scottish Natural Heritage).*

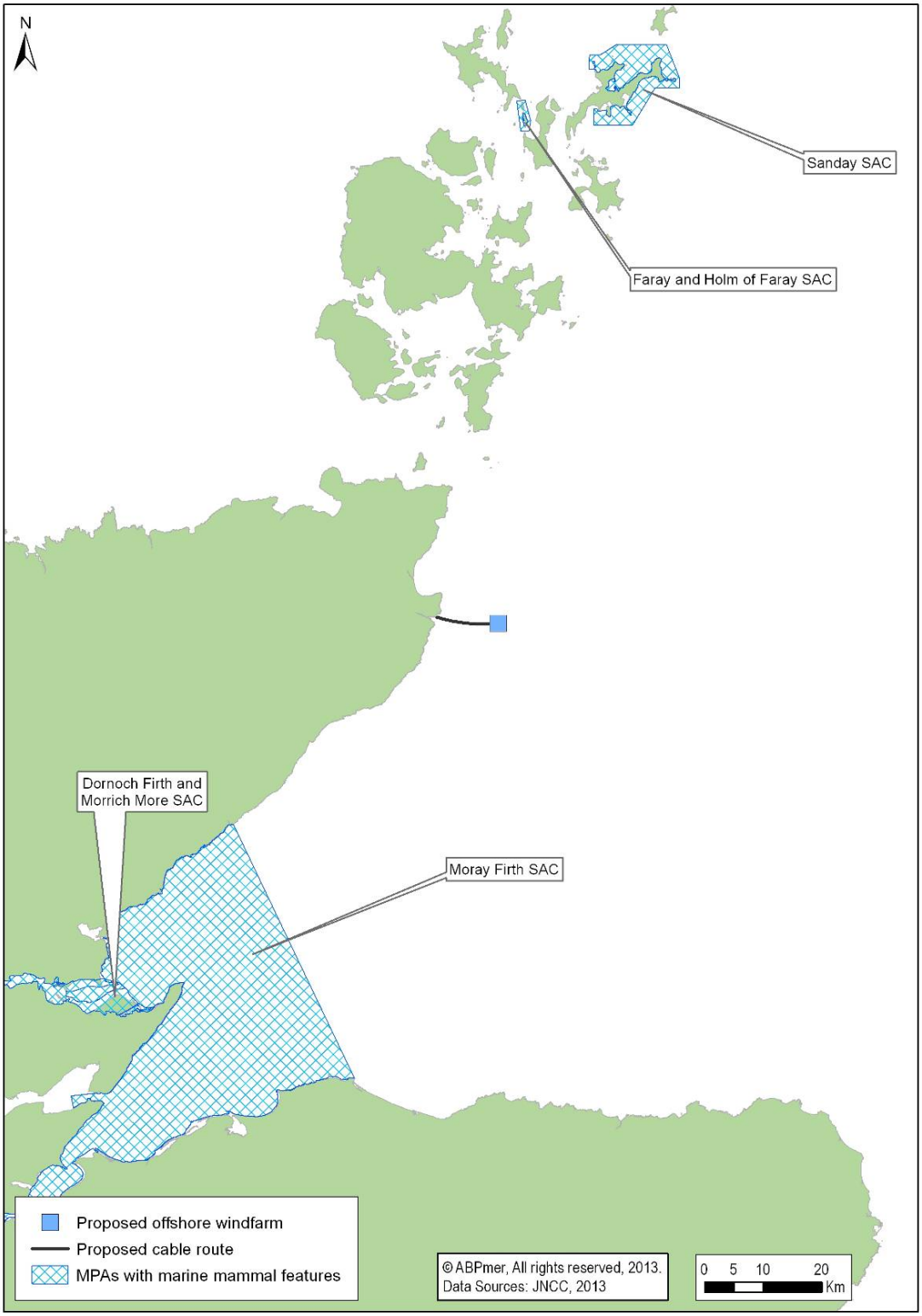

Figure E5. Map showing the location of MPAs with marine mammal features within 100km of the project boundary

Step 3: Scoping of Relevant Receptor-Pressure Interactions

Habitats

The impact pathways that are considered potentially relevant to MPA habitat interest features (i.e. horse mussel beds designated at Noss Head potential Scottish Nature Conservation MPA) are provided in Table E4.

Table E4. Impact pathways considered potentially relevant to MPA habitat features

Pressure		Pre-construction (survey)	Construction	Operational	Decommissioning
Hydrological changes	Water flow (e.g. tidal current) changes			✓	
	Wave exposure changes			✓	
	Water clarity changes		✓	✓	✓
Pollution and other chemical changes	Non-synthetic compound contamination (inc. heavy metals, hydrocarbons, produced water)	✓	✓	✓	✓
	Synthetic compound contamination (inc. pesticides, antifoulants, pharmaceuticals)	✓	✓	✓	✓
Physical loss/introduction	Physical change (to another substrate type)			✓	
Physical damage	Siltation rate changes		✓		✓
	Structural abrasion/penetration	✓	✓	✓	✓
	Surface abrasion: damage to seabed surface features		✓		✓
Biological pressures	Introduction or spread of non-indigenous species and translocation (competition)	✓	✓	✓	✓

- *Is there a clear audit trail of the impact pathways that have been scoped in and out of the assessment? The key impact pathways relating to the MPA habitat interest feature have been clearly provided in a table. This will need to be reviewed and confirmed in light of any new project scheme information.*

Birds

Table E5 highlights the impact pathways which are considered relevant to MPA bird receptor species, such as Guillemot, Pink-footed goose, Great Black-backed gull and Kittiwake.

Table E5. Impact pathways considered potentially relevant to MPA bird features

Pressure		Pre-construction (survey)	Construction	Operational	Decommissioning
Pollution and other chemical changes	Non-synthetic compound contamination (inc. heavy metals, hydrocarbons, produced water)	✓	✓	✓	✓
	Synthetic compound contamination (inc. pesticides, antifoulants, pharmaceuticals)	✓	✓	✓	✓
Hydrological changes	Water clarity changes		✓		✓
Other physical pressures	Introduction of light		✓	✓	✓
	Barrier to species movement (behaviour, reproduction)		✓	✓	✓
	Death or injury by collision		✓	✓	✓
Biological pressures	Visual disturbance (behaviour)		✓	✓	✓

- *Is there a clear audit trail of the impact pathways that have been scoped in and out of the assessment? The key impact pathways relating to MPA bird interest features have been clearly provided in a table. This will need to be reviewed and confirmed in light of any new project scheme information.*

Marine Mammals

The impact pathways that are considered potentially relevant to MPA marine mammals interest features (i.e. grey seal, common seal, harbour porpoise, bottlenose dolphin and otter) are provided in Table E6.

Table E6. Impact pathways considered potentially relevant to MPA marine mammal features

Pressure		Pre-construction (survey)	Construction	Operational	Decommissioning
Pollution and other chemical changes	Non-synthetic compound contamination (inc. heavy metals, hydrocarbons, produced water)	✓	✓	✓	✓
	Synthetic compound contamination (inc. pesticides, antifoulants, pharmaceuticals)	✓	✓	✓	✓
Physical loss/introduction	Physical change (to another substrate type)			✓	
Physical damage	Siltation rate changes		✓		✓
	Structural abrasion/penetration	✓	✓	✓	✓
	Surface abrasion: damage to seabed surface features		✓		✓
Other physical pressures	Electromagnetic changes			✓	
	Underwater noise	✓	✓	✓	✓
	Barrier to species movement (behaviour, reproduction)		✓	✓	✓
	Death or injury by collision	✓	✓	✓	✓
Biological pressures	Visual disturbance (behaviour)	✓	✓	✓	✓

- *Is there a clear audit trail of the impact pathways that have been scoped in and out of the assessment? The key impact pathways relating to MPA marine mammal interest features have been clearly provided in a table. This will need to be reviewed and confirmed in light of any new project scheme information.*

Step 4: Initial Study Area

Habitats

The initial study area comprises the spatiotemporal extent of pressures associated with the proposed project which will be different for each receptor (see Section 3.4 of main report). In terms of habitat features, this effectively equates to the direct impact (e.g. removal of habitat) under the footprint of the project boundary and the indirect impacts (e.g. changes in flows, turbidity and water quality), which occur within a full tidal ellipse of the project boundary.

The only MPA habitat feature that has been scoped into the assessment at this stage is the horse mussel bed associated with the Noss Head potential Scottish Nature Conservation MPA as it overlaps with the export cable route (Figure E2). The existing surface sediment types along the route are predominantly rocky and coarse sediments, and therefore, it is considered likely that the export cables will be placed directly on the seabed and covered with protection (i.e. rock dumping or mattressing). This indicates that there will only be some limited potential for the physical processes to be locally affected.

- *Has the initial study area taken account of both significant and insignificant pressures associated with the proposed project alone? Although the significance of impacts has not been assessed at the scoping phase, a precautionary approach has been followed given that all potential impact pathways have been initially scoped into the assessment. The applicant should review the initial study area in the assessment phase once there is more detail on the spatiotemporal scale of impacts and also, the sensitivity of features to potential impacts have been considered.*
- *Can the spatial boundaries of the initial study area be shown on a figure? An initial study area for MPA habitat features has been provided based on where the cable overlaps with the Noss Head potential Scottish Nature Conservation MPA.*
- *Have the temporal boundaries of the initial study area been defined? At this stage the temporal boundaries have not been defined given the lack of detailed project scheme information (e.g. construction timetable).*
- *Has the full suite of MPA sites and associated interest features within the defined initial study area been scoped into the CIA? Yes, the Noss Head potential Scottish Nature Conservation MPA has been scoped into the CIA which is designated for horse mussels and this site is clearly shown on a figure.*

Birds

The initial study area for MPA bird features comprises a 100km buffer around the project boundary (Figure E3), and also includes MPA bird features that forage beyond the 100km buffer (Figure E4). This incorporates the likely spatiotemporal extent of pressures associated with the proposed project, including direct impact (e.g. collision) and indirect impacts (e.g. changes in invertebrate prey availability). Breeding colonies of seabirds and wintering locations of wildfowl of species which occur within the core study area are also included in the initial study area.

The MPA bird features that have been scoped into the assessment at this stage are described in the Defining Spatiotemporal Scale of MPA Receptors Section.

- *Has the initial study area taken account of both significant and insignificant pressures associated with the proposed project alone? Although the significance of impacts has not been assessed at the scoping phase, a precautionary approach has been followed given that all potential impact pathways have been initially scoped into the assessment. The applicant should review the initial study area in the assessment phase once there is more detail on the spatiotemporal scale of impacts and also, the sensitivity of features to potential impacts have been considered.*
- *Can the spatial boundaries of the initial study area be shown on a figure? An initial study area for MPA bird features has been provided based on a 100km buffer around the project boundary, extending beyond this zone for wide ranging foraging MPA bird features.*
- *Have the temporal boundaries of the initial study area been defined? At this stage the temporal boundaries have not been defined given the lack of detailed project scheme information (e.g. construction timetable).*
- *Has the full suite of MPA sites and associated interest features within the defined initial study area been scoped into the CIA? Yes, all MPAs with associated bird features that occur in the defined initial study area have been scoped into the CIA.*

Marine Mammals

The initial study area for MPA marine mammal features comprises a 100km buffer around the project boundary to account for their wide ranging functional use of the region (Figure E5). This incorporates the likely spatiotemporal extent of pressures associated with the proposed project, including direct impact (e.g. collision) and indirect impacts (e.g. behavioural response due to underwater noise generated by piling).

The MPA marine mammal features that have been scoped into the assessment at this stage are grey seal, common seal and bottlenose dolphin. Harbour porpoise has also been scoped in on the basis that it migrates long distances (up to 1000km) and could be using MPAs in other Member States.

- *Has the initial study area taken account of both significant and insignificant pressures associated with the proposed project alone? Although the significance of impacts has not been assessed at the scoping phase, a precautionary approach has been followed given that all potential impact pathways have been initially scoped into the assessment. The applicant should review the initial study area in the assessment phase once there is more detail on the spatiotemporal scale of impacts and also, the sensitivity of features to potential impacts have been considered.*
- *Can the spatial boundaries of the initial study area be shown on a figure? An initial study area for MPA marine mammals has been provided based on a 100km buffer around the project boundary.*
- *Have the temporal boundaries of the initial study area been defined? At this stage the temporal boundaries have not been defined given the lack of detailed project scheme information (e.g. construction timetable).*
- *Has the full suite of MPA sites and associated interest features within the defined initial study area been scoped into the CIA? Yes, all MPAs with associated marine mammals features that occur in the defined initial study area have been scoped into the CIA. The applicant has also initially scoped in harbour porpoise into the assessment based on the long distances that this species travels and the possibility that MPA features from other Member States could be using the study area. This is considered to be a suitably precautionary approach at this stage.*

Step 5: Identifying Scope of Other Plans, Projects and Activities

Past, present and future plans, projects and activities in the study area will need to be considered as part of the CIA. It will be necessary to agree the scope of the assessment with relevant stakeholders early on in the consultation process for the EIA. Relevant plans, projects and activities that have been identified at the scoping phase as potentially having cumulative impacts with the proposed development (i.e. they overlap with the spatiotemporal boundaries of the receptors and/or the spatiotemporal boundaries of the project pressures) are:

- The Pentland Firth and Orkney Waters plan strategic area for wave and tidal developments;
- Proposals for additional wave and tidal development lease areas including through the Further Scottish Leasing Rounds;
- Demonstrator wave and tidal energy projects;
- Areas of search for wave and tidal development (Scottish Government Plan for offshore renewables);
- Short Term Offshore Wind Energy Projects in Scottish territorial waters (in particular Beatrice, Inch Cape and Neart-na-Gaoithe OWFs);
- Round 3 offshore wind farms (in particular Moray Firth and Firth of Forth);
- Areas of search for offshore wind development (Scottish Government Plan for offshore renewables);
- Onshore wind farms;
- The National Renewables Infrastructure Plan (N-RIP) (proposed development at the Ports of Leith, Dundee, Nigg, Ardesier, Aberdeen and Peterhead; possible opportunities also at Port of Wick);
- Other harbour, port and marina developments;
- Waterfront regeneration projects (e.g. Edinburgh and Dundee);
- Bo'ness foreshore redevelopment;
- Dundee, Grangemouth, Rosyth and Leith Biomass projects;
- Middle Bank, Firth of Forth - licensed aggregate extraction area;
- Proposals for the offshore grid and other proposed cable routes (including SHETL, East Coast HVDC, North Connect (Scotland-Norway interconnector));
- Container transhipment hub at Scapa Flow;
- Other proposals included within the emerging Pentland Firth Marine Spatial Plan;
- Oil and gas development activities;
- National Planning Framework for Scotland 2;
- Aquaculture developments;
- Increased vessel activity from all sources (no specific plan), including offshore development and shipping from other ports;
- Fishing; and
- Climate change.

- *Have other relevant plans, projects and activities been identified following the advice provided by existing regulatory guidance documents? The applicant has identified possible past, present and future plans, project and activities that could overlap with the project pressures and/or spatiotemporal boundaries of the receptors. This has been done at a relatively high level at the scoping phase with only specific plans or projects being referred to where they are known to be in the planning domain. Other developments, where details are not easily available prior to consultation with relevant sectors, have only been defined at a high level e.g. aquaculture developments. Interrogation of the Marine Scotland licence portal, will confirm the extant projects that are in the planning system. Consultation with relevant stakeholders will also help to identify any other developments or activities that should be included in the CIA.*

Step 6: Defining Pressures of Other Plans, Projects and Activities

Habitats

The following anthropogenic pressures are considered to have the potential to cause changes to MPA habitat features:

- Hydrological changes – temperature changes, salinity changes, water flow, emergence regime changes, wave exposure changes, water clarity changes;
- Pollution and other chemical changes – non-synthetic compound contamination (including heavy metals, hydrocarbons, produced water), synthetic compound contamination (including pesticides, antifoulants), radionuclide contamination, de-oxygenation, nitrogen and phosphorus enrichment, organic enrichment;
- Physical loss/introduction – physical change (to another substrate type), physical loss (to land or freshwater habitat);
- Physical damage – siltation rate changes, structural abrasion/penetration, surface abrasion: damage to seabed surface features, physical removal (extraction of substratum); and
- Biological pressures – introduction or spread of non-indigenous species and translocation (competition).

Table E7 identifies the above pressures associated with other plans, projects and activities (identified in Identifying Scope of Other Plans, Projects and Activities Section) that could have a potential cumulative impact with the proposed offshore wind farm. Onshore wind farms have been scoped out of the CIA on the basis that there are no interactive cumulative effects on MPA habitat interest features. Impacts associated with the Pentland Firth Marine Spatial Plan and National Planning Framework for Scotland 2 covers all marine sectors and have, therefore, not been included in the table to avoid repetition.

Table E7. Key pressures associated with other plans, projects and activities that are potentially relevant to MPA habitat features

Other Plan, Project or Activity	Hydrological changes	Pollution and other chemical changes	Physical loss/ introduction	Physical damage
Energy Production (wind) – short term offshore wind energy projects in Scotland; Round 3 offshore wind farms; areas of search for offshore wind development; onshore wind farms	✓	✓	✓	✓
Energy Production (wave) - The Pentland Firth and Orkney Waters plan strategic area for wave developments; proposals for additional wave development lease areas; demonstrator wave energy projects; areas of search for wave development	✓	✓	✓	✓
Energy Production (tidal) - The Pentland Firth and Orkney Waters plan strategic area for tidal developments; proposals for additional wave development lease areas; demonstrator tidal energy projects; areas of search for tidal development	✓	✓	✓	✓
Energy production (biofuels) – Biomass projects	✓	✓	✓	✓
Extraction (capital, maintenance dredging) – N-RIP; other harbour, port and marina developments	✓	✓	✓	✓
Extraction (sand and gravel) – licensed aggregate extraction area	✓	✓	✓	✓
Extraction (oil and gas) – oil and gas development activities	✓	✓	✓	✓
Extraction (living resources) - fishing	✓		✓	✓
Food Production (aquaculture) – aquaculture developments	✓	✓	✓	✓

Other Plan, Project or Activity	Hydrological changes	Pollution and other chemical changes	Physical loss/ introduction	Physical damage
Transport (maritime shipping) – container transhipment hub at Scapa Flow, general increased vessel activity associated with offshore development and shipping from other ports	✓	✓	✓	✓
Transport (telecoms and power cables) - proposals for the offshore grid and other proposed cable routes	✓		✓	✓
Reclamation –N-RIP; other harbour, port and marina developments; Waterfront regeneration projects; Bo'ness foreshore redevelopment	✓	✓	✓	✓
Climate change	✓			✓

Based on the level of available information at this stage in the assessment, the other plans, projects and activities that are likely to have spatiotemporal overlap and to interact with the MPA habitat feature that has been scoped into the assessment (see Initial Study Area Section and Figure E2) are as follows:

- Increased vessel activity from all sources (no specific plan), including offshore development and shipping from other ports;
- Fishing; and
- Climate change.

- *Have all the pressures associated with other plans, projects and activities been identified? Use 'activities versus pressure' matrix as a checklist Key cumulative pressures associated with the various plans, projects and activities that have been scoped into the assessment have been identified at a high level.*
- *Have the pressures been clearly defined both spatially and temporally? At this stage, only the relevance of pressures that overlap with the proposed offshore wind farm have been identified to inform the scope of the CIA. The assessment will need to define the spatiotemporal overlap of pressures depending on the level of detail available for the various plans, projects and activities. The pressures have been defined at a level considered appropriate at the scoping phase.*
- *Have any data gaps and/or uncertainties associated with the pressures been identified and defined? This will need to be defined at the assessment phase and will be dependent on the level of detail available for the other plans, projects and activities.*

Birds

The following pressures are considered to have the potential to cause changes to MPA bird features through direct or indirect routes:

- Pollution and other chemical changes – non-synthetic compound contamination (including heavy metals, hydrocarbons, produced water), synthetic compound contamination (including pesticides, antifoulants), radionuclide contamination, de-oxygenation, nitrogen and phosphorus enrichment, organic enrichment;
- Hydrological changes – temperature changes, salinity changes, water flow, wave exposure changes, water clarity changes;
- Other physical pressures – litter, underwater noise, barrier to species movement (behaviour, reproduction), death or injury by collision; and
- Biological pressures – visual disturbance (behaviour).

Table E8 identifies the above pressures associated with other plans, projects and activities (in Identifying Scope of Other Plans, Projects and Activities Section) that could have a potential cumulative impact with the proposed offshore wind farm. Impacts associated with the Pentland Firth Marine Spatial Plan and National Planning Framework for Scotland 2 covers all marine sectors and have, therefore, not been included in the table to avoid repetition.

Table E8. Key pressures associated with other plans, projects and activities that are potentially relevant to MPA bird features

Other Plan, Project or Activity	Pollution and other chemical changes	Hydrological changes	Other physical pressures	Biological pressures
Energy Production (wind) – short term offshore wind energy projects in Scotland; Round 3 offshore wind farms; areas of search for offshore wind development; onshore wind farms	✓	✓	✓	✓
Energy Production (wave) - The Pentland Firth and Orkney Waters plan strategic area for wave developments; proposals for additional wave development lease areas; demonstrator wave energy projects; areas of search for wave development	✓	✓	✓	✓
Energy Production (tidal) - The Pentland Firth and Orkney Waters plan strategic area for tidal developments; proposals for additional wave development lease areas; demonstrator tidal energy projects; areas of search for tidal development	✓	✓	✓	✓
Energy production (biofuels) – Biomass projects	✓	✓		✓
Extraction (capital, maintenance dredging) – N-RIP; other harbour, port and marina developments	✓	✓	✓	✓
Extraction (sand and gravel) – licensed aggregate extraction area	✓	✓	✓	✓
Extraction (oil and gas) – oil and gas development activities	✓	✓	✓	✓
Extraction (living resources) - fishing		✓		✓
Food Production (aquaculture) – aquaculture developments	✓	✓	✓	✓
Transport (maritime shipping) – container transhipment hub at Scapa Flow, general increased vessel activity associated with offshore development and shipping from other ports	✓	✓	✓	✓
Transport (telecoms and power cables) - proposals for the offshore grid and other proposed cable routes		✓	✓	
Reclamation –N-RIP; other harbour, port and marina developments; Waterfront regeneration projects; Bo'ness foreshore redevelopment	✓	✓	✓	✓
Climate change		✓		

Based on the level of available information at this stage in the assessment, the other plans, projects and activities that are likely to spatiotemporally overlap and interact with the MPA bird features that have been scoped into the assessment (see Initial Study Area Section and Figures E3-E4) are as follows:

- The Pentland Firth and Orkney Waters plan strategic area for wave and tidal developments;
- Proposals for additional wave and tidal development lease areas including through the Further Scottish Leasing Rounds;
- Demonstrator wave and tidal energy projects;
- Areas of search for wave and tidal development (Scottish Government Plan for offshore renewables);

- Short Term Offshore Wind Energy Projects in Scottish territorial waters (in particular Beatrice, Inch Cape and Neart-na-Gaoithe OWFs);
- Round 3 offshore wind farms (in particular Moray Firth and Firth of Forth);
- Areas of search for offshore wind development (Scottish Government Plan for offshore renewables);
- Onshore wind farms;
- The National Renewables Infrastructure Plan (N-RIP) (proposed development at the Ports of Leith, Dundee, Nigg, Ardesier, Aberdeen and Peterhead; possible opportunities also at Port of Wick);
- Other harbour, port and marina developments;
- Waterfront regeneration projects (e.g. Edinburgh and Dundee);
- Bo'ness foreshore redevelopment;
- Dundee, Grangemouth, Rosyth and Leith Biomass projects;
- Middle Bank, Firth of Forth - licensed aggregate extraction area;
- Proposals for the offshore grid and other proposed cable routes (including SHETL, East Coast HVDC, North Connect (Scotland-Norway interconnector));
- Container transhipment hub at Scapa Flow;
- Other proposals included within the emerging Pentland Firth Marine Spatial Plan;
- Oil and gas development activities;
- National Planning Framework for Scotland 2;
- Aquaculture developments;
- Increased vessel activity from all sources (no specific plan), including offshore development and shipping from other ports;
- Fishing; and
- Climate change.

- *Have all the pressures associated with other plans, projects and activities been identified? Use 'activities versus pressure' matrix as a checklist Key cumulative pressures associated with the various plans, projects and activities that have been scoped into the assessment have been identified at a high level.*
- *Have the pressures been clearly defined both spatially and temporally? At this stage, only the relevance of pressures that overlap with the proposed offshore wind farm have been identified to inform the scope of the CIA. The assessment will need to define the spatiotemporal overlap of pressures depending on the level of detail available for the various plans, projects and activities. The pressures have been defined at a level considered appropriate at the scoping phase.*
- *Have any data gaps and/or uncertainties associated with the pressures been identified and defined? This will need to be defined at the assessment phase and will be dependent on the level of detail available for the other plans, projects and activities.*

Marine Mammals

The following pressures are considered to have the potential to cause impacts to MPA marine mammal features:

- Pollution and other chemical changes – non-synthetic compound contamination (including heavy metals, hydrocarbons, produced water), synthetic compound contamination (including pesticides, antifoulants), radionuclide contamination, de-oxygenation, nitrogen and phosphorus enrichment, organic enrichment;
- Physical loss/introduction – physical change (to another substrate type), physical loss (to land or freshwater habitat);

- Physical damage – siltation rate changes, structural abrasion/penetration, surface abrasion: damage to seabed surface features, physical removal (extraction of substratum);
- Other physical pressures – electromagnetic changes, litter, underwater noise, barrier to species movement (behaviour, reproduction), death or injury by collision; and
- Biological pressures – visual disturbance (behaviour).

Table E9 identifies the above pressures associated with other plans, projects and activities (in Identifying Scope of Other Plans, Projects and Activities Section) that could have a potential cumulative impact with the proposed offshore wind farm. Onshore wind farms have been scoped out of the CIA on the basis that there are no interactive cumulative effects on MPA marine mammals interest features. Impacts associated with the Pentland Firth Marine Spatial Plan and National Planning Framework for Scotland 2 covers all marine sectors and have, therefore, not been included in the table to avoid repetition.

Table E9. Key pressures associated with other plans, projects and activities that are potentially relevant to MPA marine mammal features

Other Plan, Project or Activity	Pollution and other chemical changes	Physical loss/ introduction	Physical damage	Other physical pressures	Biological pressures
Energy Production (wind) – short term offshore wind energy projects in Scotland; Round 3 offshore wind farms; areas of search for offshore wind development	✓	✓	✓	✓	✓
Energy Production (wave) - The Pentland Firth and Orkney Waters plan strategic area for wave developments; proposals for additional wave development lease areas; demonstrator wave energy projects; areas of search for wave development	✓	✓	✓	✓	✓
Energy Production (tidal) - The Pentland Firth and Orkney Waters plan strategic area for tidal developments; proposals for additional wave development lease areas; demonstrator tidal energy projects; areas of search for tidal development	✓	✓	✓	✓	✓
Energy production (biofuels) – Biomass projects	✓	✓	✓		✓
Extraction (capital, maintenance dredging) – N-RIP; other harbour, port and marina developments	✓	✓	✓	✓	✓
Extraction (sand and gravel) – licensed aggregate extraction area	✓	✓	✓	✓	✓
Extraction (oil and gas) – oil and gas development activities	✓	✓	✓	✓	✓
Extraction (living resources) - fishing		✓	✓	✓	✓
Food Production (aquaculture) – aquaculture developments	✓	✓	✓	✓	✓
Transport (maritime shipping) – container transhipment hub at Scapa Flow, general increased vessel activity associated with offshore development and shipping from other ports	✓	✓	✓	✓	✓
Transport (telecoms and power cables) - proposals for the offshore grid and other proposed cable routes		✓	✓	✓	
Reclamation –N-RIP; other harbour, port and marina developments; Waterfront regeneration projects; Bo'ness foreshore redevelopment	✓	✓	✓	✓	✓
Climate change			✓		

Based on the level of available information at this stage in the assessment, the other plans, projects and activities that are likely to spatiotemporally overlap and interact with the MPA marine mammals features that have been scoped into the assessment (see Initial Study Area Section and Figure E5) are as follows:

- The Pentland Firth and Orkney Waters plan strategic area for wave and tidal developments;
- Proposals for additional wave and tidal development lease areas including through the Further Scottish Leasing Rounds;
- Demonstrator wave and tidal energy projects;
- Areas of search for wave and tidal development (Scottish Government Plan for offshore renewables);
- Short Term Offshore Wind Energy Projects in Scottish territorial waters (in particular Beatrice, Inch Cape and Neart-na-Gaoithe OWFs);
- Round 3 offshore wind farms (in particular Moray Firth and Firth of Forth);
- Areas of search for offshore wind development (Scottish Government Plan for offshore renewables);
- The National Renewables Infrastructure Plan (N-RIP) (proposed development at the Ports of Leith, Dundee, Nigg, Ardesier, Aberdeen and Peterhead; possible opportunities also at Port of Wick);
- Other harbour, port and marina developments;
- Waterfront regeneration projects (e.g. Edinburgh and Dundee);
- Bo'ness foreshore redevelopment;
- Dundee, Grangemouth, Rosyth and Leith Biomass projects;
- Middle Bank, Firth of Forth - licensed aggregate extraction area;
- Proposals for the offshore grid and other proposed cable routes (including SHETL, East Coast HVDC, North Connect (Scotland-Norway interconnector));
- Container transhipment hub at Scapa Flow;
- Other proposals included within the emerging Pentland Firth Marine Spatial Plan;
- Oil and gas development activities;
- National Planning Framework for Scotland 2;
- Aquaculture developments;
- Increased vessel activity from all sources (no specific plan), including offshore development and shipping from other ports;
- Fishing; and
- Climate change.

- *Have all the pressures associated with other plans, projects and activities been identified? Use 'activities versus pressure' matrix as a checklist Key cumulative pressures associated with the various plans, projects and activities that have been scoped into the assessment have been identified at a high level.*
- *Have the pressures been clearly defined both spatially and temporally? At this stage, only the relevance of pressures that overlap with the proposed offshore wind farm have been identified to inform the scope of the CIA. The assessment will need to define the spatiotemporal overlap of pressures depending on the level of detail available for the various plans, projects and activities. The pressures have been defined at a level considered appropriate at the scoping phase.*
- *Have any data gaps and/or uncertainties associated with the pressures been identified and defined? This will need to be defined at the assessment phase and will be dependent on the level of detail available for the other plans, projects and activities.*

Step 7: Scoping of Relevant Receptor-Pressure Interactions of Other Plans, Projects and Activities

Habitats

The other plans, projects and/or activities and associated impact pathways that are considered potentially relevant to MPA habitat interest features that have been scoped into the CIA (i.e. horse mussel beds designated at Noss Head potential Scottish Nature Conservation MPA) are outlined in Defining Pressures of Other Plans, Projects and Activities Section.

- *Is there a clear audit trail of the impact pathways that have been scoped in and out of the assessment? The key impact pathways relating to other plans, projects and activities and their relevance to the MPA habitat interest feature have been provided following source-pathway-receptor model. This will need to be reviewed and confirmed in light of any new available information on the project itself and other plans, projects and activities. A cut-off date should be agreed after which no further scoping reviews should be carried out to allow the applicant sufficient time to complete the assessment.*

Birds

The other plans, projects and/or activities and associated impact pathways that are considered potentially relevant to MPA bird interest features that have been scoped into the CIA are outlined in Defining Pressures of Other Plans, Projects and Activities Section.

- *Is there a clear audit trail of the impact pathways that have been scoped in and out of the assessment? The key impact pathways relating to other plans, projects and activities and their relevance to the MPA bird interest features have been provided following source-pathway-receptor model. This will need to be reviewed and confirmed in light of any new available information on the project itself and other plans, projects and activities. A cut-off date should be agreed after which no further scoping reviews should be carried out to allow the applicant sufficient time to complete the assessment.*

Marine Mammals

The other plans, projects and/or activities and associated impact pathways that are considered potentially relevant to MPA marine mammal interest features that have been scoped into the CIA are outlined in Defining Pressures of Other Plans, Projects and Activities Section.

- *Is there a clear audit trail of the impact pathways that have been scoped in and out of the assessment? The key impact pathways relating to other plans, projects and activities and their relevance to the MPA marine mammal interest features have been provided following source-pathway-receptor model. This will need to be reviewed and confirmed in light of any new available information on the project itself and other plans, projects and activities. A cut-off date should be agreed after which no further scoping reviews should be carried out to allow the applicant sufficient time to complete the assessment.*

Step 8: CIA Study Area

Habitats

The CIA study area equates to the spatiotemporal extent of cumulative pressures on MPA habitat interest features associated with the proposed project together with other relevant plans, projects and activities. The full scope of the CIA at the scoping phase of the assessment is defined in Table E10.

Table E10. Overview of scope of CIA for MPA habitat feature

Other Plan, Project or Activity	Cumulative Pressures	MPA Sites	MPA Feature
Extraction (living resources) - fishing **Transport (maritime shipping)** – general increased vessel activity associated with offshore development and shipping from other ports **Climate change**	Hydrological changes Pollution and other Chemical Changes Physical loss/ introduction Physical damage Biological pressures	Noss Head potential Scottish Nature Conservation MPA	Horse mussel beds

- *Has the CIA study area taken account of both significant and insignificant pressures associated with other plans, projects and activities? At the scoping phase, the CIA study area has taken account of any potential pressures associated with other activities (both significant and insignificant).*
- *Can the spatial boundaries of the CIA study area be shown on a figure? Given the fixed boundaries of the habitat interest features, the CIA study area covers the same extent as the initial study area **i.e. the tidal ellipses presented in** Figure E2. The spatial boundaries of the other activities that have been scoped into the CIA will need to be defined as far as practicable as part of the assessment.*
- *Have the temporal boundaries of the CIA initial study area been defined? This is not relevant given that the activities that have been scoped into the assessment are ongoing.*
- *Has the full suite of MPA sites and associated interest features within the defined CIA study area been scoped into the CIA? Use MPA sites versus features of potential concern matrix as a checklist Yes, these are clearly shown in Figure E2 and Table E10.*

Birds

The CIA study area equates to the spatiotemporal extent of cumulative pressures on MPA bird interest features associated with the proposed project together with other relevant plans, projects and activities. The full scope of the CIA at the scoping phase of the assessment is defined in Table E11.

Table E11. Overview of scope of CIA for MPA bird features

Other Plan, Project or Activity	Cumulative Pressures	MPA Sites	MPA Features
Energy Production (wind) – short term offshore wind energy projects in Scotland; Round 3 offshore wind farms; areas of search for offshore wind development; onshore wind farms **Energy Production (wave)** - The Pentland Firth and Orkney Waters plan strategic area for wave developments; proposals for additional wave development lease areas; demonstrator wave energy projects; areas of search for wave development **Energy Production (tidal)** - The Pentland Firth and Orkney Waters plan strategic area for tidal developments; proposals for additional wave development lease areas; demonstrator tidal energy projects; areas of search for tidal development **Energy production (biofuels)** – Biomass projects **Extraction (capital, maintenance dredging)** – N-RIP; other harbour, port and marina developments **Extraction (sand and gravel)** – licensed aggregate extraction area **Extraction (oil and gas)** – oil and gas development activities **Extraction (living resources)** - fishing **Food Production (aquaculture)** – aquaculture developments **Transport (maritime shipping)** – container transhipment hub at Scapa Flow, general increased vessel activity associated with offshore development and shipping from other ports **Transport (telecoms and power cables)** - proposals for the offshore grid and other proposed cable routes **Reclamation** –N-RIP; other harbour, port and marina developments; Waterfront regeneration projects; Bo'ness foreshore redevelopment **Climate change**	Pollution and other chemical changes Hydrological changes Other physical pressures Biological pressures	Pentland Firth Islands SPA Caithness & Sutherland Peatlands SPA Caithness Lochs SPA North Sutherland Coastal Islands SPA Lairg and Strathbrora Lochs SPA Loch Eye SPA Dornoch Firth and Loch Fleet SPA Moray & Nairn Coast SPA Loch Spynie SPA East Sanday Coast SPA Auskerry SPA Switha SPA Orkney Mainland Moors SPA Calf of Eday SPA Copinsay SPA East Caithness Cliffs SPA Hoy SPA Marwick Head SPA North Caithness Cliffs SPA Rousay SPA Troup, Pennan and Lion's Heads SPA West Westray SPA Hermaness, Saxa Vord and Valla Field SPA Foula SPA Fetlar SPA Noss SPA Sule Skerry and Sule Stack SPA North Rona and Sula Sgeir SPA Sumburgh Head SPA Fair Isle SPA Flannan Isles SPA St Kilda SPA Cape Wrath SPA Handa SPA Shiant Isles SPA Buchan Ness to Collieston Coast SPA Fowlsheugh SPA Rum SPA Mingulay and Berneray SPA St Abb's Head to Fast Castle SPA Ailsa Craig SPA Forth Islands SPA East Caithness Cliffs potential Scottish Nature Conservation MPA Papa Westray potential Scottish Nature Conservation MPA	Osprey Wood Sandpiper Herring Gull Black-legged Kittiwake Common Guillemot Merlin Black-throated Diver European Storm Petrel Arctic Tern Northern Fulmar Northern Gannet European Shag Red-throated Diver European Golden Plover Short-Eared owl Dunlin Great Cormorant Great Black-backed Gull Atlantic Puffin Razorbill Manx Shearwater Peregrine Falcon Arctic Skua Great Skua Black Guillemot Common Redshank Whooper Swan Barnacle Goose Greylag Goose Greenland White-fronted Goose Pink-footed Goose Bar-tailed Godwit Purple Sandpiper Turnstone

- *Has the CIA study area taken account of both significant and insignificant pressures associated with other plans, projects and activities? At the scoping phase, the CIA study area has taken account of any potential pressures associated with other plans, projects and activities (both significant and insignificant).*
- *Can the spatial boundaries of the CIA study area be shown on a figure? The spatial boundaries of pressures associated with the other plans, projects and activities that have been scoped into the CIA and overlap with MPA bird features will need to be considered as far as practicable as part of the assessment.*
- *Have the temporal boundaries of the CIA initial study area been defined? The temporal boundaries of pressures associated with the other plans, projects and activities that have been scoped into the CIA and overlap with MPA bird features have not been defined at the scoping phase. These will need to be considered as far as practicable as part of the assessment.*
- *Has the full suite of MPA sites and associated interest features within the defined CIA study area been scoped into the CIA? Use MPA sites versus features of potential concern matrix as a checklist Yes, these are clearly shown in Figures E3-E4 and Table E11.*

Marine Mammals

The CIA study area equates to the spatiotemporal extent of cumulative pressures on MPA marine mammal interest features associated with the proposed project together with other relevant plans, projects and activities. The full scope of the CIA at the scoping phase of the assessment is defined in Table E12.

Table E12. Overview of scope of CIA for MPA marine mammal features

Other Plan, Project or Activity	Cumulative Pressures	MPA Sites	MPA Features
Energy Production (wind) – short term offshore wind energy projects in Scotland; Round 3 offshore wind farms; areas of search for offshore wind development **Energy Production (wave)** - The Pentland Firth and Orkney Waters plan strategic area for wave developments; proposals for additional wave development lease areas; demonstrator wave energy projects; areas of search for wave development **Energy Production (tidal)** - The Pentland Firth and Orkney Waters plan strategic area for tidal developments; proposals for additional wave development lease areas; demonstrator tidal energy projects; areas of search for tidal development **Energy production (biofuels)** – Biomass projects **Extraction (capital, maintenance dredging)** – N-RIP; other harbour, port and marina developments **Extraction (sand and gravel)** – licensed aggregate extraction area **Extraction (oil and gas)** – oil and gas development activities **Extraction (living resources)** - fishing **Food Production (aquaculture)** – aquaculture developments **Transport (maritime shipping)** – container transhipment hub at Scapa Flow, general increased vessel activity associated with offshore development and shipping from other ports	Pollution and other chemical changes Physical loss/introduction Physical damage Other physical pressures Biological pressures	Faray and Holm of Faray SAC Dornoch Firth and Morrich More SAC Moray Firth SAC Sanday SAC	Grey seal Common seal Bottlenose dolphin Harbour porpoise*

Other Plan, Project or Activity	Cumulative Pressures	MPA Sites	MPA Features
Transport (telecoms and power cables) - proposals for the offshore grid and other proposed cable routes **Reclamation** –N-RIP; other harbour, port and marina developments; Waterfront regeneration projects; Bo'ness foreshore redevelopment **Climate change**			
*Harbour porpoise has been initially scoped into the assessment despite it not being a qualifying species for any designated UK site given that this species can forage/migrate over long distances. Consultation with other Member States will confirm whether any additional international MPAs, e.g. in Skagerrak (Denmark), the North Sea and the English Channel, may also need to be scoped into the assessment to account for the long distances travelled by harbour porpoise.			

- *Has the CIA study area taken account of both significant and insignificant pressures associated with other plans, projects and activities? At the scoping phase, the CIA study area has taken account of any potential pressures associated with other plans, projects and activities (both significant and insignificant).*
- *Can the spatial boundaries of the CIA study area be shown on a figure? The CIA study area has been initially defined by a 100km area of search which is represented by the map displayed in Figure E5 . Consultation with other Member States will confirm the need to extend this area and include international MPAs that are designated for harbour porpoise. The spatial boundaries of pressures associated with the other plans, projects and activities that have been scoped into the CIA and overlap with MPA marine mammal features will need to be considered as far as practicable as part of the assessment.*
- *Have the temporal boundaries of the CIA initial study area been defined? The temporal boundaries of pressures associated with the other plans, projects and activities that have been scoped into the CIA and overlap with MPA marine mammal features have not been defined at the scoping phase. These will need to be considered as far as practicable as part of the assessment.*
- *Has the full suite of MPA sites and associated interest features within the defined CIA study area been scoped into the CIA? Use MPA sites versus features of potential concern matrix as a checklist Yes, these are clearly shown in Figure E5 and Table E12.*

Step 9: Assessment Tools

Habitats

A range of assessment tools will be used to inform the CIA on MPA habitat features. These are as follows:

- Professional judgement will be used in both identifying and assessing cumulative impacts;
- Consultation with fishing industry, in particular local fishermen, to determine importance of CIA study area for fishermen; and
- GIS analysis of Automatic Identification System (AIS) shipping data to determine past, present and likely future shipping use in CIA study area.

- *What is the rationale for the selection of particular assessment tools for the CIA? A brief explanation as to the reason for using particular tools has been provided. This is considered sufficient at the scoping phase. The detailed assessment will need to provide further information on the approach that has been applied.*
  Are the assessment tools fit for purpose and proportionate to the scale of risk? Given the level of detail available with the activities that have been scoped into the CIA, it is considered that the above tools are proportionate to the scale of environmental risk.

Birds

A number of techniques will be used to assess bird populations in order to inform the CIA on MPA bird features. These are as follows:

- Professional judgement will be used in both identifying and assessing cumulative impacts;
- Density Surface Modelling will be used to predict densities of birds in a specified areas, using data from places sampled nearby;
- Collision Risk Modelling will be used to estimate collision risk with wind turbines and therefore potential bird mortality. Avoidance factors can be applied to reflect the ability of bird species to deliberately change course, time their passage in between rotors or take emergency action in order to miss turbine blades; and
- Population Viability Analysis will be used to assess how many birds can be lost from a population on a regular basis before it ceases to be self sustaining.

- *What is the rationale for the selection of particular assessment tools for the CIA? A brief explanation as to the reason for using particular tools has been provided. This is considered sufficient at the scoping phase. The detailed assessment will need to provide further information on the approach that has been applied.*
  Are the assessment tools fit for purpose and proportionate to the scale of risk? Given the level of detail available with the activities that have been scoped into the CIA, it is considered that the above tools are proportionate to the scale of environmental risk.

Marine Mammals

A range of assessment tools are considered appropriate to inform the CIA on MPA marine mammal features. These are as follows:

- Professional judgement will be used in both identifying and assessing cumulative impacts;
- Consultation with other Member States to determine likely potential effects on international MPAs with harbour porpoise interest features;
- Underwater noise modelling to assess potential cumulative physiological and behavioural effects on marine mammal features;
- GIS and spatial analysis techniques to define likely pressures associated with other plans, projects and activities e.g. underwater noise mapping; and
- Review of latest available scientific literature, particularly issues with a certain degree of uncertainty e.g. electromagnetic issues, underwater noise effects, and collision risk.

- *What is the rationale for the selection of particular assessment tools for the CIA? A brief explanation as to the reason for using particular tools has been provided. This is considered sufficient at the scoping phase. The detailed assessment will need to provide further information on the approach and results.*
  Are the assessment tools fit for purpose and proportionate to the scale of risk? Given the level of detail available with the other plans, projects and activities that have been scoped into the CIA, it is considered that the above tools are proportionate to the scale of environmental risk.