Marine Management Organisation

East of England Marine Plans

Habitats Regulations Assessment

Appropriate Assessment Information Report

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Habitats Regulations Assessment

Appropriate Assessment Information Report

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This report has been prepared for Marine Management Organisation in accordance with the terms and conditions of appointment for Habitats Regulations Assessment dated 24 March 2011.

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1 Non-Technical Summary

1.1 Introduction

This report has been prepared on behalf of the Marine Management Organisation (MMO) by ABP Marine Environmental Research Ltd (ABPmer). It presents the results of an Appropriate Assessment Information Review (AAIR) for the East Inshore and East Offshore Marine Plans. This document represents the third reporting output from a 13-stage iterative Habitats Regulations Appraisal (HRA) process which was carried out to accompany these Marine Plans (see Diagram NTS1). The locations of the East Inshore and East Offshore Plan areas are shown in Image NTS1 and a single HRA process is being undertaken to cover both Marine Plans together (hereafter referred to as the East Marine Plans).

This document follows on from previous pre-screening and screening reports which were issued, respectively, on 24 February 2012 and 21 September 2012 (MMO, 2012a-b). These two reports have been updated, where required, and issued along with this AAIR report in March 2013 (MMO, 2013a-c). Together these reports inform the final Appropriate Assessment that was produced by the MMO (2013d) and collectively, all four final documents represent the full HRA record for the East Marine Plans.

The first of the three main HRA reports, the pre-screening review, set out, in very broad terms, the designated sites and interest features for which there was a possibility of a likely significant effect (LSE) from the Plans and, therefore, they needed to be considered during this HRA process. Within the subsequent screening report, this original list of designated sites and interest features was further reviewed to clarify whether there was a LSE from the plan in either ecological terms or from the Marine Plan policies which were developed concomitantly with this HRA process. In other words, the first stage of the screening review involved selecting out sites and features for which there was a possibly ecological impact pathway from any activities that might take place within the East Marine Plan Areas. Then, in the second stage of the screening review, the East Marine Plan policies were reviewed to select out those activities that would be influenced by the Plan and which needed to be assessed under this HRA.

The policy screening process was developed by ABPmer to supplement existing HRA guidance and meet the specific requirements of this policy-based Marine Plan HRA. Of the 55 draft Marine Plan policies, this process identified a final list of four policies (TIDE1, CCS1, AGG1 and AGG2) which needed to be assessed because they are not ‘criteria-based’ and which result in a material change to existing activities for which there may be a LSE and for which there had been no previous HRA.

Following the completion of this screening process, an assessment of the impacts was carried out and this report presents the outcome of that review which, in turn, informed the production of an Appropriate Assessment. Throughout all of this work, regular consultations were held with key stakeholders, in particular Natural England (NE) and the Joint Nature Conservation Committee (JNCC). These consultations were held to discuss and agree the methods employed. These methods are based on the available guidance and on past Plan-level HRA precedents; however, there were some novel issues associated with this project (due to it representing the first such HRA of a Marine Plan in the UK) which were addressed and reviewed during the consultations.

This Non-Technical Summary is designed to present a stand-alone overview of the full HRA process.

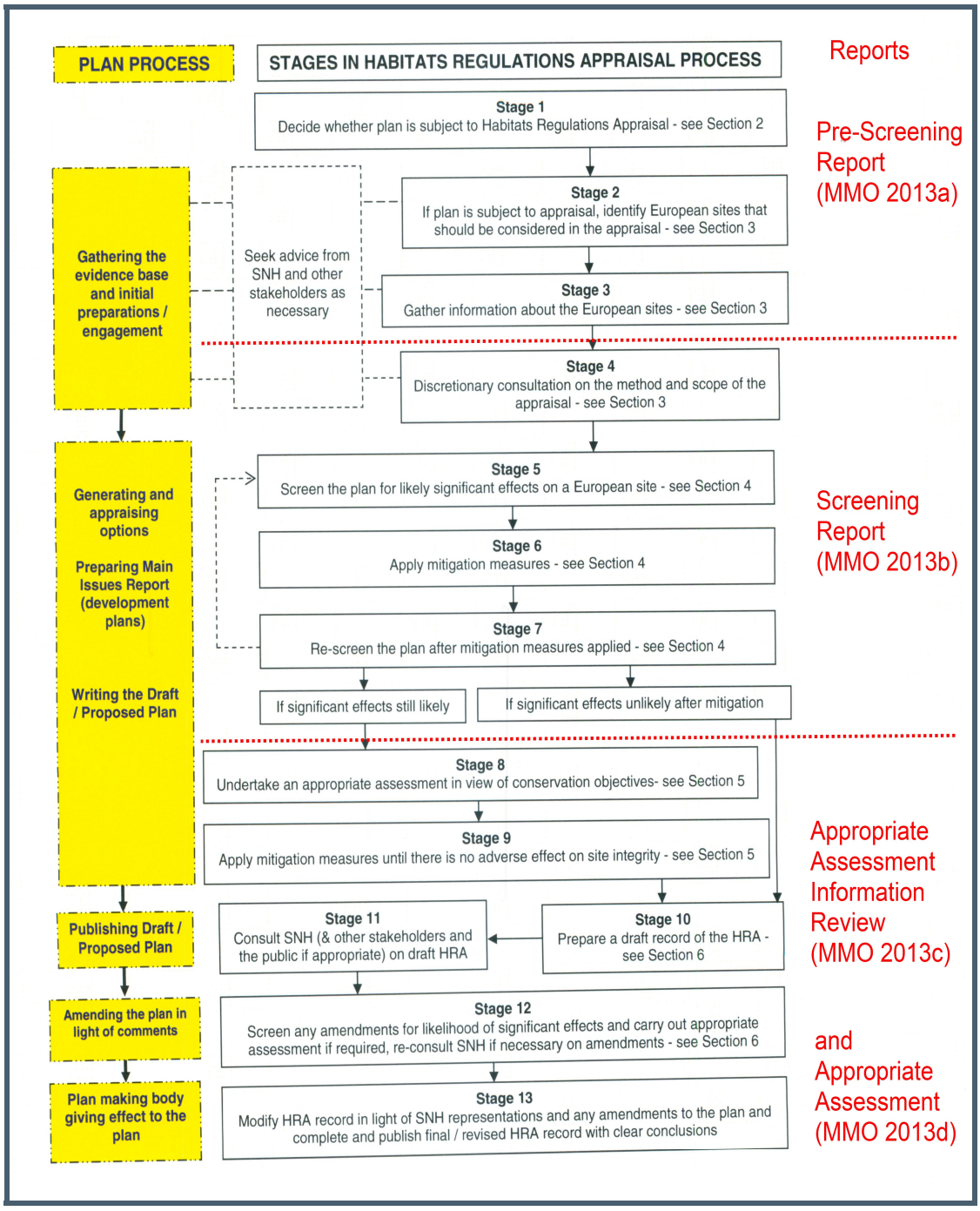


Diagram NTS1: Stages of the HRA process for plans (showing the four key reporting outputs for the East Marine Plans HRA) (from David Tyldesley Associates 2012)

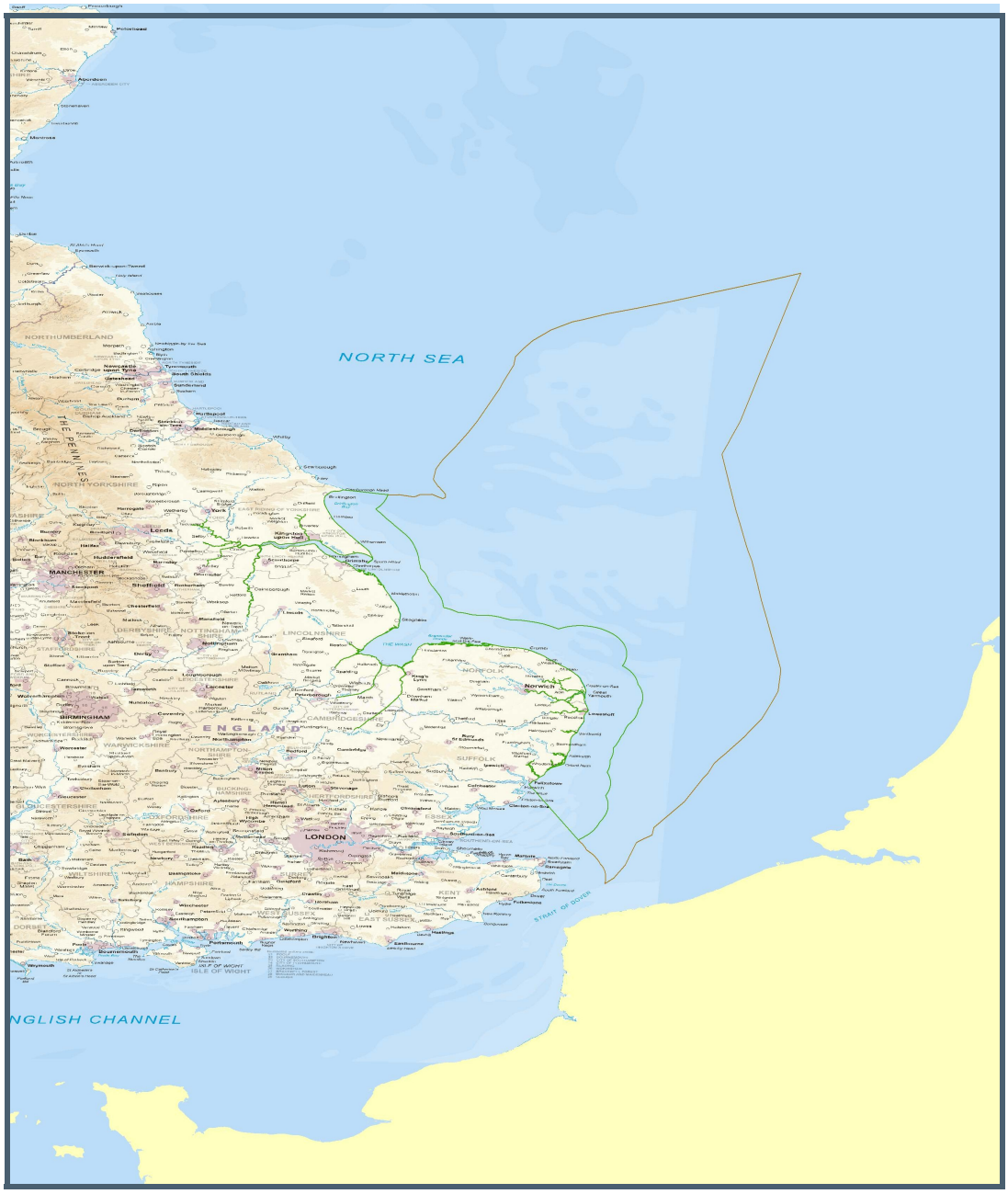


Image NTS1: Location of the East Inshore and Offshore Marine Plan Areas

1.2 Plan and Report Background

Through the Marine and Coastal Access Act 2009[1] (MCAA), the UK Government introduced a number of measures that will help to deliver its vision for the marine area of "clean, healthy, safe, productive and biologically diverse oceans and seas". These included establishing the legal basis for a marine planning system. The relevant Secretary of State is the marine planning authority but, through the act, delegated the MMO as the statutory body to undertake marine planning in England.

In response, the MMO will publish the first draft marine plans for the East Inshore and Offshore marine English waters in May 2013. Their purpose is to form part of a new plan-led system for marine activities on the east coast and to provide greater coherence in policy and a forward-looking, proactive and spatial planning approach to the management of the marine areas. The Plans provide detailed policy and spatial guidance for the area and are designed to help ensure that decisions within a plan area contribute to delivery of UK, national and any area specific policy objectives. All public authorities taking authorisation or enforcement decisions that affect or might affect the English marine area must do so in accordance with the marine plans, unless relevant considerations indicate otherwise (MMO, 2013d).

To accompany this Plan, the MMO are carrying out a HRA and producing an Appropriate Assessment (AA) in fulfilment of obligations under the Habitats Regulations and the Offshore Habitats Regulations. These Regulations implement the European Commission (EC) Habitats and Birds Directives in UK waters and require that an AA should be undertaken where a plan or project is not directly connected with or necessary for management of designated European sites or offshore European sites, including Special Areas of Conservation (SACs) and Special Protection Areas (SPAs), and where the possibility of a LSE on these sites cannot be excluded, either alone or in combination with other plans or projects. In the UK, these requirements are also extended to the consideration of effects on Ramsar sites and to sites that are proposed for designation such as potential SPAs (pSPAs), candidate SACs (cSACs) and Sites of Community Importance (SCIs). As a matter of policy, developers are advised to also be mindful of possible SAC (pSAC) designations.

ABPmer was commissioned to lead this HRA, with technical support from Hartley Anderson and Hyder Consulting (UK) Limited. The following sections summarise the methods applied for the HRA and the results of the assessment process.

1.3 Habitats Regulations Appraisal Approach

The HRA was carried out in an iterative, auditable and transparent manner by using the key guidance for assessing plans produced by Scottish Natural Heritage (SNH) (David Tyldesley and Associates, 2012) and, also, by following the practices adopted for previous Plan-level HRAs (e.g. ABPmer, 2010a-b; 2011a-b; 2013; Entec UK Ltd, 2009a-b). The guidance identifies a 13-step process for undertaking Plan-level HRAs which has been followed in this case. As described above, the work was reviewed in three separate reports which addressed the following stages:

- Report 1 Pre-screening Review (Stages 1 to 3) - (MMO, 2013a);
- Report 2 Screening Review (Stages 4 to 7) - (MMO, 2013b); and

[1] http://www.legislation.gov.uk/ukpga/2009/23/pdfs/ukpga_20090023_en.pdf

- Report 3 Appropriate Assessment Information (Stages 8 to 13) - (this report) (MMO, 2013c).

In addition, there is the final Appropriate Assessment (Stages 12 and 13) as prepared separately by the MMO (2013d). The work undertaken to complete this stage and the results presented within each of the three reports are outlined in following sections.

1.3.1 Pre-screening (Stages 1 to 3) - Report 1

For the pre-screening report (MMO, 2013a), an initial broad review was made of the internationally designated sites and nature conservation interest features for which the East Marine Plans could have a LSE. This was pending a secondary sifting of these sites at the screening stages.

For this work, a 100 kilometre (km) buffer zone was drawn around the East Marine Plan Areas, and the UK and Transnational designated European and Ramsar sites that lay within that buffer were identified. A 100km buffer is deemed to be a quantifiable and objective area that is likely to encompass many of the mobile species interest features (fish, seabirds and mammals) within designated sites that could be indirectly affected by the Marine Plans. However, it was not used to limit further review of more distant locations or to presume that all relevant features within this area, for which impact pathways exist, are necessarily affected. In particular, it is recognised that impacts (especially to migratory and foraging bird species, marine mammals and anadromous fish) may extend to sites beyond this 100km boundary and this aspect was considered during subsequent stages of the assessment process.

The key output of the pre-screening report were two tables which summarised the UK and Transnational sites that were located within the 100km buffer area. Through this review, a total of **270 designated sites were identified which were taken forward into the screening process**.

1.3.2 Screening (Stages 4 to 7) - Report 2

For the screening report (MMO, 2013b), the results of the pre-screening review were consulted upon in detail and a final list was identified of designated sites and nature conservation interest features for which the East Marine Plans could have a LSE. The first step (Stage 4) in this process involved clarifying and consulting upon the technical aspects of the screening methods. The agreed screening methods essentially involved the following two phases: an ecological and a policy screening process.

For the **ecological screening process**, the original list of designated sites and interest features (as identified at pre-screening) were reviewed to select out those for which a potential impact pathway exists from any activities taking place within the Marine Plan areas. Part of this process involved the screening out of a range of terrestrial and freshwater habitat and species interest features (and, if relevant, their associated designated sites) which do not occupy the coastal zone and for which there is no impact pathway. It also involved the addition of sites with colonies/populations of marine mammals and overwintering or breeding bird interest features (and their associated designated sites) that lie outside the boundary of the original 100km pre-screening buffer zone. These species could forage within, or migrate through, the East Marine Plan Areas and, therefore, could be affected by activities within the region.

Through this ecological screening process, a total 157 designated sites were removed from the original pre-screening list (these were predominately terrestrial/inland sites) but a further 69 national and translational SPA and SAC sites were added which support colonies of birds and

marine mammals beyond the 100km buffer area and which forage over long distances and could enter and use the Marine Plan areas.

The presumption throughout this screening work (and indeed for the whole HRA process) has been to screen designated sites and interest features into the assessment unless a definitive judgement of no LSE can be made, in which case they could then be excluded. As a result of this process, the original list of 270 designated sites identified at pre-screening was refined to a final list of **182 designated sites for which there is the potential for a LSE from any plan or project within the East Marine Plan areas**. The designated sites for which there was an identified LSE from the Marine Plans) are presented in Table NTS1. While these were predominantly in the UK, this list also included sites from other Member States in Belgium, Germany, France and the Netherlands.

Table NTS1: Number of designated sites added/removed during pre-screening and screening of the East Marine Plan Areas

Site	Sites Selected at Pre-Screening Stage*	Sites Removed at Screening Stage	Sites Added at Screening Stage	Final List Screened Into Appropriate Assessment Phase
SPA	75	30		45
SAC	153	121		32
Ramsar	37	6		31
SCI	3			3
cSAC	2			2
SPA (>100km)			14	14
SAC (>100km)			55	55
Total	**270***	**157**	**69**	**182****

* The original pre-screening Review (as issued for consultation in Feb 2012 identified an list of **248** sites, but a further **22** sites were added during the screening to make the total **270** when it was agreed that the Inshore and Offshore Plan Areas would be treated as a single East Plan Area for this HRA and therefore this analysis was revisited (MMO, 2013a).

** As shown, a total of **182** sites were identified following the screening of the Inshore and Offshore Plan Areas together (157 removed and 69 added to the 270 sites identified at pre-screening). The sites removed were mainly the terrestrial habitats and features for which there was no impact pathway from marine activities while the added sites were from areas beyond 100km that support long-distance foraging or migrating species (mammals, seabirds and fish interest features). [Further screening was undertaken during the AAIR phase based on activities influenced by the plan as described below, this reduced the total number of screened in sites to **122** as noted below]

A second **policy screening phase** was undertaken in which the 55 draft Marine Plan policies were reviewed to identify those polices (and the resulting developmental activities) that needed to be assessed, This was based on agreed pre-determined criteria and, in essence, involved a three step process in which the following three 'Screening Criteria' questions are asked sequentially:

- **Screening Criteria 1**: Is the policy general or 'criteria-based' such that it has no specific spatially-definable implications for activities (i.e. it doesn't direct, influence or clarify the nature and location of activities) within the Marine Plan area?
- **Screening Criteria 2**: Has the policy been subject to previous Habitats Regulations Appraisal (e.g. encapsulated with a Sectoral Plan such as the Round 3 Offshore Windfarm)?
- **Screening Criteria 3**: Does the Policy change what was previously assessed or bring greater clarity to elements such as the location of cable alignments or landfalls?

This process is illustrated in Diagram NTS2.

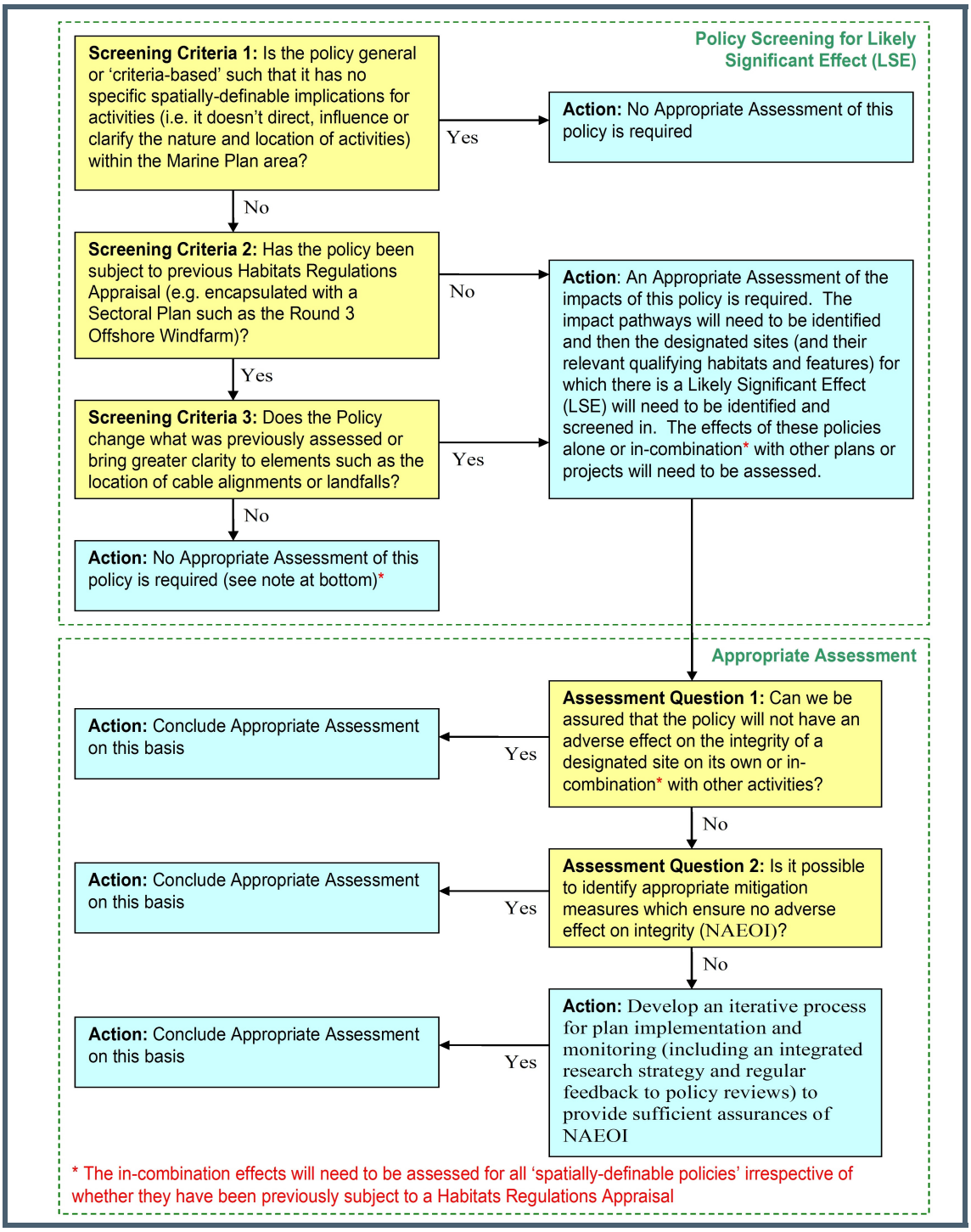


Diagram NTS2: Policy screening process for the East Marine Plans HRA

This resulted in a final list of those policies which are not 'criteria-based' and which result in a material change to existing activities and for which there may be a LSE. There were four policies (and three associated development sectors[2]) which were screened into the Appropriate Assessment as follows:

- Tidal Energy Generation Sector Policy 'TIDE1';
- Carbon Capture and Storage Sector 'CCS1'; and
- Aggregates Extraction Sector Policies 'AGG1' and 'AGG2'.

The development and application of these screening methods were tasks that, respectively, met the requirements of Stages 4 and 5 of the available HRA guidance. In this case, Stages 6 and 7 of the HRA process (re-screening in the light of available mitigation measures) were not separately applied. This is because no specific statutory mitigation measures are available (this aspect was considered further during the assessment process as summarised below).

1.3.3 Appropriate Assessment Information Review (Stages 8 to 13) - Report 3

In fulfilment of Stages 8 to 13 of the relevant Plan-level HRA guidance, the third report (this document) presents the information required by the MMO to complete an AA of the screened in sites, policies and developmental activities. Once again, a phased implementation process was followed to ensure that there was clarity and auditability in the assessment. In particular, the following five key steps were undertaken:

- **Step 1: Impact Pathways Review** - Identification of the impact pathways that are relevant for each of the three relevant 'screened in' sectors (i.e. tidal energy generation, carbon capture storage, and aggregates extraction);
- **Step 2: Identify activities to which features are sensitive** - A review of the activities undertaken in each of the three sectors, and the environmental changes arising, which could have an impact of designated sites or interest features via the identified impact pathways;
- **Step 3: Activity-based screening of European/Ramsar Sites** - Identification (screening) of those European/Ramsar sites and their relevant interest features for which there is a LSE, or for which a LSE cannot be excluded, from the relevant sector activities and impact pathways;
- **Step 4: Detailed pathway-feature sensitivity review** - A review of the sensitivities of the relevant interest features to the identified impact pathways and sector activities;
- **Step 5: Assessment of the effects on European/Ramsar sites** - Assessment of impacts via each of the activities across the three sectors that are influenced by the 'screened in' East Marine Plan policies followed by the identification of available mitigation measures for each identified impact pathway and the identification, where required, of additional mitigation measures which ensure that these activities have no adverse effects on integrity (NAEOI).

[2] Hereafter, these sectors are simply referred to as 'TIDE', CCS and AGG except where a distinction between licensed extraction work (AGG1) and potential future extraction areas (AGG2) need to be made.

Based on the approaches adopted for previous Plan-level HRA work and also on the advice of NE and JNCC during the consultation work on this HRA, many of the results of this phased assessment work are presented in tables and matrices. These matrices are presented within the main report text and in Appendices A and B. Following the 5-step assessment process described above, the key outputs in each case are presented as follows:

- **Step 1: Table 1 (in Section 4 of this Report) and Table A1 in Appendix A**: A list of 25 generic Impact Pathways[3] by which the screened in sites and their interest features could be affected by activities which are directed by the East Marine Plans;

- **Step 2: Table A2 in Appendix A**: A review of individual activities across the TIDE, CCS and AGG sectors and the associated environmental changes that could have an impact on the key marine habitats and species groups;

- **Step 3: Table A3 to A6 in Appendix A**: A revised list of the 'screened in' designated sites and their interest features which could be affected by activities across the TIDE, CCS and AGG sectors[4];

- **Step 4: Tables 2, 3, 4, 5, 7, 11, 12, 13 and 15 (in Sections 4.4 to 4.7 of this Report):** A review of the sensitivities to impact of the key marine habitats and species groups;

- **Step 5: Tables 16, 17, 18 and 19 (in Section 4.8 of this Report) and Table A7 in Appendix A**: A table-based assessment of the impacts to each habitat and species group in view of the available (and generic) conservation objectives and in the context of the standard mitigation measures.

To inform Step 5 and especially to allow judgements about effects via the identified pathways a **separate review of the available mitigation measures was carried out and is presented in Appendix B.** These are measures that the MMO may draw upon as part of their consents and licensing responsibilities taking into account recommendations from Statutory Nature Conservation Bodies (SNCBs).

The key conclusion from this assessment work is that it is not possible, without the application of mitigation measures, to be certain that there will be NAEOI on any European/Ramsar site. Firstly this is because many details about how the East Marine Plans and the individual plans or projects affecting the area will be implemented are not fully understood at this stage. Of the three sectors that need to be assessed (i.e. TIDE, CCS and AGG), the uncertainties are especially prevalent for the former two activities as these are emerging sectors with either very little (in the case of TIDE) or no (in the case of CCS) previous developments within the East Marine Plan Areas. There are a greater number of uncertainties about how developments in these sectors might progress. These include the possible technologies that will be applied, the generation capacities of tidal turbines or their spatial densities, the size and shape of seabed structures that will be required to deliver carbon to aquifers and, perhaps most importantly, details about the location of possible cable/pipeline alignments and their landfall locations. There are also a further number of uncertainties which relate to the sensitivities of qualifying

[3] The mechanisms by which an activity arising from TIDE, CCS of AGG activities (that are proposed within the East Marine Plan area) could affect any relevant habitat or species.

[4] As a result of this process, the total number of screened in designated sites was reduced to 122 for which there could be a LSE from the three sectors reviewed in this AAIR (see also Table NTS1). The original 182 screened in sites still applies to all activities across all sectors and is therefore relevant to the in-combination assessment.

features to activities in these sectors (e.g. the impacts of turbine arrays on seabirds foraging underwater) and the future changes to the number and location designated sites.

By contrast, aggregate extraction (AGG) is a mature industry and the impacts arising from activities within this sector are relatively well understood. Also, the locations in which aggregate extraction will and may take place are relatively well defined. However, even for this sector there are a number of uncertainties in respect of the individual effects for future projects; the in-combination effects across multiple aggregate extraction sites and the in-combination effects of aggregate extraction with all other sectors in the East Marine Plan Areas.

When considering in-combination effects, a high uncertainty exists about the future impacts which apply not just to the three sectors that are materially influenced by the Marine Plans and have been assessed in this document, but to all activities across all sectors. Such uncertainty about in-combination effects is typically a characteristic in all strategic coastal and offshore plans where the full extent of future developments cannot be anticipated; however, it is especially prevalent for the Marine Plan because of its broad spatial extent, its multi-Sectoral nature and because of the absence of any statutory mitigation measures as described above.

In order to resolve these uncertainties and achieve the necessary level of certainty that there will be NAEOI of designated sites (as required by the Habitats Regulations), mitigation measures have been identified that will need to be applied. The main measure that has been identified is the **need for a clear, phased and auditable process for managing the implementation of the East Marine Plans which is referred to as Iterative Plan Review (IPR).** In particular, the process needs to be linked to ongoing reviews, through licensing and monitoring, of the projects and plans within the East Marine Plan Areas. What this will mean is that, as plan and project-level assessment and monitoring review work is undertaken over time (to validate the conclusions (including in-combination assessments) of AAs) then the resulting lessons and information will inform successive phases of work as future developments are identified, assessed and implemented. In addition to this temporal component, the process will inherently also require consideration of the spatial/regional context (e.g. an understanding of effects across different parts of the East Marine Plan Areas or the effects at transnational sites) to ensure that there are no adverse effects on the integrity of European/Ramsar sites from projects either individually or in-combination with other plans or projects.

The resulting Iterative Plan Review (IPR) process is described in Diagram NTS3, and is based on similar approaches that have been identified for other strategic plan such as the Scottish Government's Offshore Wind Energy and Wave and Tidal Energy Plans (ABPmer 2011a; 2013). This process includes a mechanism to review the findings from monitoring work undertaken for individual plan or projects and the opportunity to review and revise the Marine Plans in the future. It also includes options for directing, influencing and undertaking, where required, strategic field survey and data review work to fill any scientific gaps that are identified about the behavioural ecology or sensitivity of interest features. Such gaps are likely to exist with respect to species such as cetaceans and seabirds that migrate and forage over long distances and could be affected across multiple sectors and many locations with the Marine Plan areas. Providing a centralised mechanism for this iterative review process will allow lessons to be learned on an ongoing basis and will provide assurance that the impacts from projects and plans affecting the East Marine Plan areas (whether alone or in-combination with other plans or projects) will be identified and that unacceptable impacts can be avoided.

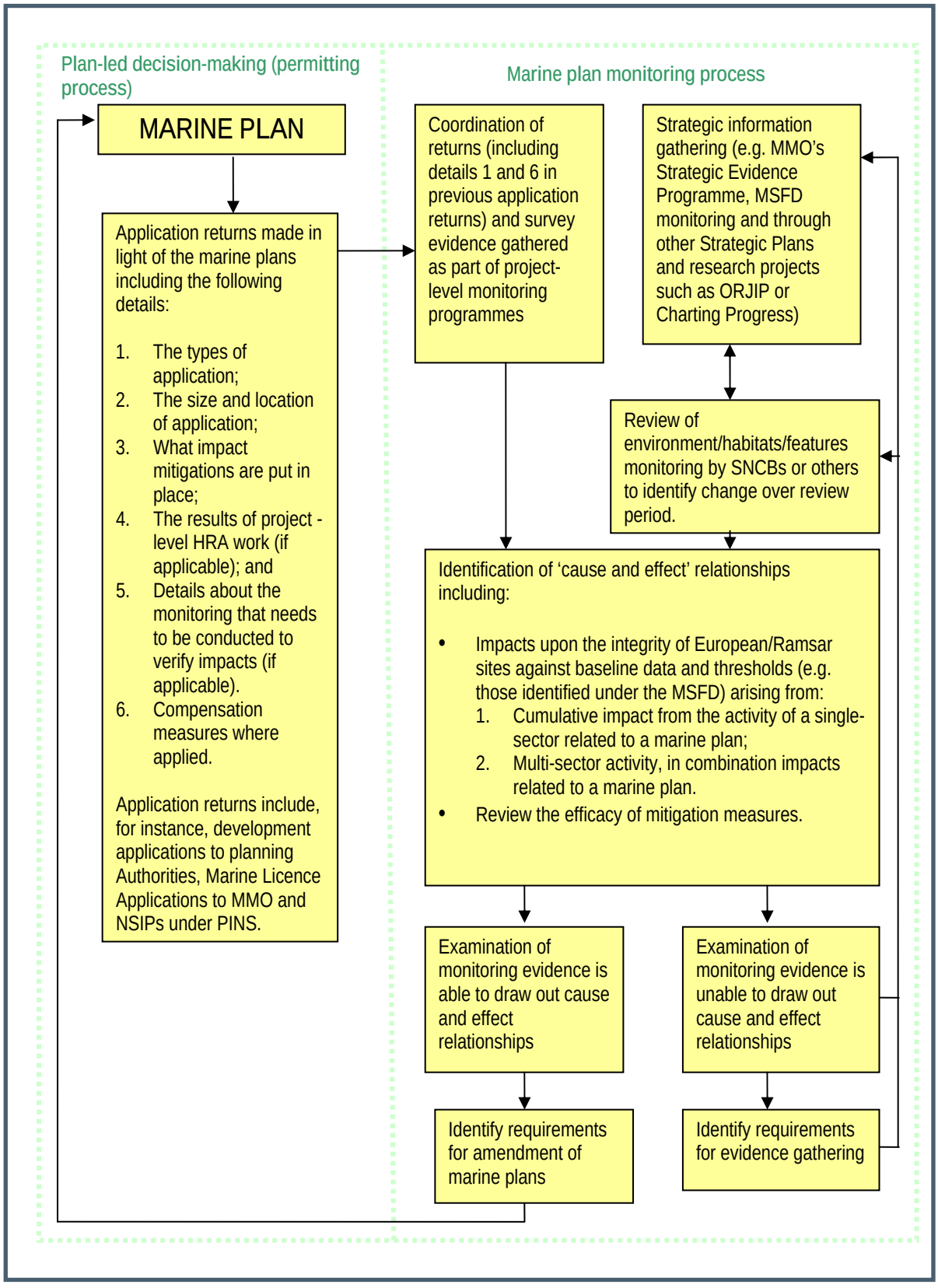


Diagram NTS3: Iterative Plan Review (IPR) process for management of the East Marine Plans

In addition to IPR, another key mitigation measures is that, as a matter of law, any new plan or project should be required to undertake and HRA process and to produce and AA wherever the possibility of LSE on a European/Ramsar site cannot be excluded. Each individual plan or project will need to review the baseline conditions and undertake work in a manner that does not have an adverse effect on site integrity. This is expected to include, for instance, the fishing sector which is expected to be subject to HRAs at plan and project level in order for there to be assurances that there is NAEOI of designated sites. The Plan-level AA document and the IPR process by which the East Marine Plans will be implemented can be used to give direction to future plan and project-level HRAs and, where required, AAs.

In addition to these two key plan-wide mitigation measures, there will clearly also be a need to apply mitigation measures to individual developments affecting the East Marine Plan Areas. The IPR process includes a process by which the effectiveness of mitigation measures are reviewed over time and the lessons learned from their application will be fed into future marine licence applications.

1.3.4 Assessment Conclusion

On the basis of the application of these two key mitigation measures (IPR and Project-level HRA) it can be advised that it will be possible for the East Marine Plans not to have an adverse effect on the integrity of a European/Ramsar site either alone or in-combination with other plans or projects, subject to the application of appropriate mitigation measures.

2 Introduction

2.1 Report Background

This annex has been prepared on behalf of the Marine Management Organisation (MMO) by ABP Marine Environmental Research Ltd (ABPmer) with Hartley Anderson and Hyder Consulting (UK) Limited. It presents the information required by the MMO to undertake an Appropriate Assessment (AA) of the East Inshore and East Offshore Marine Plans. This represents the third reporting stage of an iterative Habitats Regulations Appraisal (HRA) process which was carried out to accompany these Marine Plans. The locations of the East Inshore and East Offshore Plan Areas are shown in Figure 1 and a single HRA process is being undertaken to cover both Marine Plans together (hereafter referred to as the East Marine Plans).

This HRA process has been undertaken according to the standard iterative process for undertaking Plan-level HRAs (David Tyldesley Associates, 2012). This guidance identifies the steps and processes to be followed and these are shown in Diagram 1. It is also based on approaches that have been adopted for previous Plan-level HRAs that have applied this guidance. These include The Crown Estate's (TCE's) Round 3 Offshore Wind Energy Plan HRA (Entec, 2009a-b), TCE's Pentland Firth Wave and Tidal Energy Plan HRA (ABPmer, 2010a-b); the Scottish Government's Offshore Wind Energy HRA (ABPmer, 2011a) and Wave and Tidal Energy HRA (ABPmer, 2013). Guidance has also been produced by the European Commission (EC) on the 'Assessment of plans and projects significantly affecting Natura 2000 sites' (EC, 2001).

To address the particular challenges associated with undertaking an HRA for marine planning, an iterative process for pursuing the screening and assessment phases was also developed by ABPmer. This process is illustrated in Figure 2. It presents a mechanism for reviewing marine planning policies to identify those that need to be reviewed within the AA. Further details about the rationale and content of this report in the context of the full HRA process is presented in the following section.

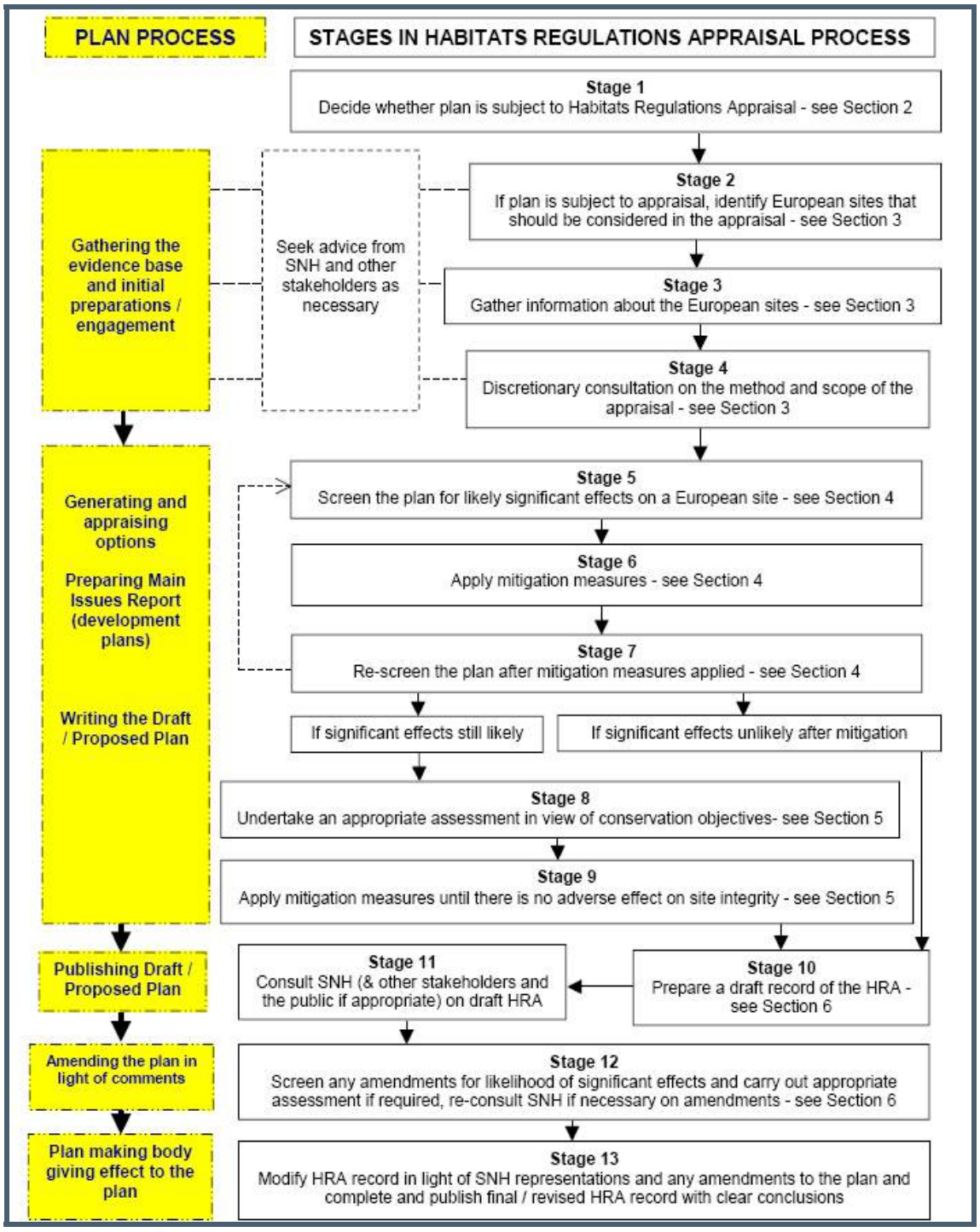


Diagram 1: Stages of the Habitats Regulations Appraisal process for plans (Source: David Tyldesley Associates, 2012)

2.2 East Marine Plan HRA Process

This Appropriate Assessment Information Review (AAIR) report represents the third major step in the overall HRA process. The two preceding stages were reported separately and involved an initial pre-screening followed by a more detailed screening review. In summary, the scope and results of these studies were as follows:

- The initial pre-screening document was issued on 24 February 2012 (MMO, 2012a) and this set out, in very broad terms, the designated sites and interest features that may need to be considered during this HRA; and

- The screening document was then produced on 21 September 2012 (MMO, 2012b). This reviewed the methods that were applied for the screening work as derived in the context of available guidance and through a series of meetings and consultations with the key stakeholders (and especially with Natural England (NE) and the Joint Nature Conservation Committee (JNCC)). This essentially involved the following two-stage process:

    1) **An ecological screening process** in which the original list of designated sites and interest features (as identified at pre-screening) were reviewed to select out those for which a potential impact pathway exists from any activities taking place within the East Marine Plan Areas; and

    2) **A policy screening process** in which the 55 draft East Marine Plan policies were reviewed to identify those that need to be assessed (based on agreed pre-determined criteria that are explained further below). This resulted in a final list of those policies which are not 'criteria-based' and which result in a material change to existing activities and for which there may be a likely significant effect (LSE).

Following this two-stage screening process a final list of designated sites and interest features was identified for which a LSE could occur from relevant East Marine Plan policies. The relevant polices for which a LSE could occur were those which fulfil Screening Criteria 1 to 3 (as shown in Figure 2), because they identify discrete areas where distinct activities will, or may, take place as a consequence of the East Marine Plans (but for which no Sectoral HRA has been undertaken). These polices are as follows:

- Tidal Energy Generation Sector Policy 'TIDE1';

- Carbon Capture and Storage Sector 'CCS1'; and

- Aggregates Extraction Sector Policies 'AGG1' and 'AGG2'.

Hereafter these sectors are simply referred to as 'TIDE', CCS and AGG except where a distinction between licensed extraction work (AGG1) and potential future extraction areas (AGG2) need to be made.

The areas where these Sectoral activities would take place have been defined within the Plan and are illustrated in Figures 3 to 5 for the TIDE, CCS and AGG policies, respectively. This report now presents the information required to assess the impacts of these polices. For the development of this assessment, there has been an ongoing process of dialogue with the key stakeholders.

- Telecom meeting between the MMO and NE to review the working version of the AAIR (7 December 2012);

- Meeting between MMO, NE, JNCC and ABPmer at the MMO offices in Newcastle to discuss the principles of the AAIR approach and to identify the status of, and requirements for, mitigation (6 February 2013); and

- Telecom meeting between the MMO, ABPmer and NE to review the AAIR approach and the IPR process (1 March 2013).

Compared against the David Tyldesley Associates (2012) HRA process, as described in Diagram 1, the preceding screening stage of the HRA process covered Stages 1 to 7 of the relevant Plan-Level guidance[5]. In fulfilment of Stages 8 to 13 of this guidance, this report now presents the information required by the Competent Authority (i.e. MMO) to complete an AA against this scope. In outline, it includes the following information:

- An overview of activities and changes that will arise from the four relevant East Marine Plan policies that could have an impact on the key marine habitats and species groups;

- A review of the sensitivities to impact of the key marine habitats and species groups;

- An assessment of the impacts to each habitat and species groups in view of the available (and generic) conservation objectives; and

The identification of mitigation measures which will ensure that the East Marine Plans will have no adverse effect on site integrity on any designated sites either alone or in-combination with other plans or projects.

2.3 Report Structure and Outputs

The methods and results of this AAIR are set out within two key sections. Section 3 presents a review of the methods that were applied and Section 4 reviews the results of the assessment process. The results are presented in a series of tabular matrices and maps which are reviewed in the following section.

[5] In this case, no initial mitigation measures were available as part of the Marine Plan and, therefore, the iterative steps of screening in the context of such measures (Stages 6 and 7) were not undertaken.

3 Assessment Methods Review

3.1 Assessment Scope Key Considerations

Where strategic plans are prepared for the marine environment there is often limited information on the precise location and scale of development or about the relevant construction methods and associated activities. This applies across the three policy sectors that need to be assessed for the East Marine Plans. The broad areas in which aggregate extraction, carbon capture storage and tidal energy generation activities could occur have been identified but further details are lacking at this early stage about the specific locations that will be selected for inshore and offshore developments or for the associated coastal and terrestrial activities (e.g. locations for cable landfall). This uncertainty about the details of the work at a project level has been recognised throughout the screening and assessment work.

The assessment has, therefore, taken account of the likely range of development options and activities and it recognises that the broad spatial scope of optional activities and a long-term ongoing nature of the marine planning process. It is also recognised that for the relatively new sectors of carbon capture storage and tidal energy generation there are likely to be technological advances that occur over time which cannot be foreseen at this time.

Given this broad scope and the range of uncertainties that exist, it is has been essential for this assessment that no specific assumptions about project-level activities and, instead, that the potential impacts that are identified encompass the full envelope of potential change (through the application of a precautionary approach). The potential envelope of changes from the three sectors have therefore been determined to identify the potential effects on features and any requirements for restrictions on development or for mitigation measures. Documentation of these constraints has been undertaken and the requirements for additional mitigation measures have been highlighted. These are viewed as being very important in providing the audit trail as the plan is implemented. In particular, this approach provides transparency in the process and ensures that developers are fully aware of any European/Ramsar constraints associated with particular locations or activities and also provides confidence in delivering the requirements of the Habitats Regulations.

The original screening process matrices (which are reproduced and updated within Appendices A and B of this report) have identified where features within individual sites are at risk of LSE (or where the risk on LSE cannot be excluded). The detailed assessment presented in this report has built on this screening process by considering the particular environmental pressures and changes that give rise to these risks and then providing a generic assessment of the impact having regard to site conservation objectives.

3.2 Key Stages of the Assessment Process

3.2.1 Introduction

To prepare the information that is needed for the AA, a step-wise process has been followed and, where relevant, tabular and mapped outputs were produced which clearly summarise the findings. The information is presented according to the relevant qualifying features and sub-features that are affected. Following the approach adopted during screening, the interest features are divided into the following four categories throughout:

- Coastal, intertidal and subtidal habitats and associated species;
- Seabird species;
- Marine mammal species (cetaceans, seals and otter); and
- Migratory anadromous fish and freshwater pearl mussel[6].

The specific interest features (species and habitat types) comprising these groups are considered in more detail in the following sections. To assess the impacts to each of these interest feature groups, a standardised iterative assessment process has been undertaken. The individual steps in this process (as also described in the Concluding comments (Section 3.3) of the Screening Report (MMO, 2013c) are as follows:

- **Step 1: Impact Pathways Review** - Identification of the impact pathways that are relevant for each of the three relevant 'screened in' sectors (i.e. tidal energy generation, carbon capture storage, and aggregates extraction);
- **Step 2: Identify activities to which features are sensitive** - A review of the activities undertaken in each of the three sectors, and the environmental changes arising, which could have an impact of designated sites or interest features via the identified impact pathways;
- **Step 3: Activity-based screening of European/Ramsar Sites** - Identification (screening) of those European/Ramsar sites and their relevant interest features for which there is a LSE, or for which a LSE cannot be excluded, from the relevant sector activities and impact pathways;
- **Step 4: Detailed pathway-feature sensitivity review** - A review of the sensitivities of the relevant interest features to the identified impact pathways and sector activities;
- **Step 5: Assessment of the effects on European/Ramsar sites** - Assessment of impacts via each of the activities across the three sectors that are influenced by the 'screened in' East Marine Plan policies followed by the identification of available mitigation measures for each identified impact pathway and the identification, where required, of additional mitigation measures which ensure that these activities have NAEOI.

Based on the approaches adopted for previous Plan-level HRA work and also on the advice of NE and JNCC during the consultation work on this HRA, many of the results of this phased assessment work are presented in table/matrix. These matrices are presented within the main report text and in Appendices A and B. Following the 5-step assessment process described above, the key putouts in each case are presented as follows:

- **Step 1: Table 1 (in Section 4 of this Report) and Table A1 in Appendix A**: A list of 25 generic Impact Pathways[7] by which the screened in sites and their interest features could be affected by activities which are directed by the East Marine Plans;

[6] Bat species were also considered within the Screening Report and one site supporting this species was screened into the assessment within this preceding report. However, this site was screened out of this assessment (see Section 4.3).

[7] The mechanisms by which an activity arising from TIDE, CCS of AGG activities (that are proposed within the East Marine Plan area) could affect any relevant habitat or species.

- **Step 2: Table A2 in Appendix A**: A review of individual activities across the TIDE, CCS and AGG sectors and the associated environmental changes that could have an impact on the key marine habitats and species groups;

- **Step 3: Table A3 to A6 in Appendix A**: A revised list of the 'screened in' designated sites and their interest features which could be affected by activities across the TIDE, CCS and AGG sectors;

- **Step 4: Tables 2, 3, 4, 5, 7, 11, 12, 13 and 15 (in Sections 4.4 to 4.7 of this Report):** A review of the sensitivities to impact of the key marine habitats and species groups;

- **Step 5: Tables 16, 17, 18 and 19 (in Section 4.8 of this Report) and Table A7 in Appendix A**: A table-based assessment of the impacts to each habitat and species groups in view of the available (and generic) conservation objectives and in the context of the standard mitigation measures.

To inform Step 5, and especially to allow judgements about effects via the identified pathways, a separate review of the available mitigation measures was carried out and that is presented in Appendix B.

In keeping with best practice adopted for other Plan-level HRAs (as listed above), no designated sites or features are removed/deleted from the screening tables. Instead, the sites which are screened in or out of the assessment process are highlighted. This ensures that the approach and conclusions of this impact assessment process are fully auditable in the future.

In addition, mapped outputs showing the screening process are presented in Figures 6 to 13.

3.2.2 Step 1: Impact Pathways Review

Typically the first stage of any HRA involves identifying and understanding the pathways by which a proposed activity might have an effect on designated sites and their associated interest features. This applies to project-level and single sector Plan-level HRAs. In the case of marine planning, however, it is the potential impacts of the Plan's policies that need to be considered first before the potential activities can be identified. The Screening Report (MMO, 2013b) has already reviewed the policies and identified those activities for which there could be a LSE and for which an AA is required.

As described above, these 'screened in' policies relate to three different sectors aggregates, carbon capture storage and tidal energy generation. Having identified these sectors, it was a necessary first step in this Appropriate Assessment process, to clarify the specific activity-based impact pathways that are relevant. To make sure it is as compatible as possible with other UK Plan-level HRAs, the following documents were reviewed and used as the basis for preparing this impact pathway table:

Tidal Energy

- ABPmer (2013). Habitats Regulations Appraisal for Wave and Tidal Energy in Scottish Territorial Waters; and

- Scottish Executive (2007). Scottish Marine Renewables: Strategic Environmental Assessment (SEA).

Carbon Capture Storage[8]

- DECC (2011). Guidance notes for industry. Guidance notes on the offshore petroleum production and pipelines (assessment of environmental effects) regulations 1999 (as amended) Version No: 2011/0, URN11D/856 Date of Issue: October 2011;

- DECC (2009). UK Offshore Energy Strategic Environmental Assessment (SEA): Future Leasing for Offshore Wind Farms and Licensing for Offshore Oil & Gas and Gas Storage; and

- EC (2008). Impact Assessment for the Proposal for a Directive of The European Parliament and of the Council on the geological storage of carbon dioxide.

Aggregates

- Emu (2012). Anglian Marine Aggregate Regional Environmental Assessment (MAREA) Report for the Anglian Offshore Dredging Association; and

- ABPmer (2012). Licence Renewal Environmental Statement for Areas 212, 328B 328C and 240.

A tabulated list of relevant generic impact pathways was produced which followed the format, and where relevant the content, of the plan-level impact matrices which were created for Marine Scotland's draft Offshore Wind Energy HRA Generation (ABPmer, 2011a) and, the above listed, HRA for Wave and Tidal Energy generation (ABPmer, 2013). According to these previously applied methods, the pathways were separated into the standard 'categories of operations which may cause deterioration or disturbance'. These categories were derived from the list identified by the UK Marine SAC Project (2001) and are based on those applied within 'Regulation 33' advice documents:

- **Physical Loss (of habitats)** from removal or smothering;

- **Physical Damage (of habitats and species)** from siltation, erosion or physical injury/death;

- **Non-Physical (indirect)** disturbance from noise or visual presence and reduced availability or displacement of species (including prey);

- **Toxic Contamination** from the introduction of synthetic compounds, introduction of non-synthetic contaminants;

- **Non-Toxic Contamination** from nutrient enrichment, organic enrichment, changes in suspended sediment and turbidity, changes in salinity or changes to the thermal regime; and

- **Biological Disturbance** from introduction of microbial pathogens, the introduction of invasive non-native species and translocation, or from selective extraction of selected species.

[8] The carbon storage sector is relatively new and has not been subject to detailed project and strategic assessments (in contrast to the tidal energy and aggregates sectors). However, the oil and gas sector is seen as having implications for the marine environment comparable to carbon storage.

3.2.3 Step 2: Identify Activities to Which Features are Sensitive

Having identified the relevant generic impact pathways in Step 1, the next stage in the analysis was to review the individual activities that might affect designated sites and their interest features. The activities and the relevant environmental changes arising from them across each of the three sectors were reviewed, and relevant interest feature groups that are sensitive to these changes were indicated. The results were presented again in a single tabular/matrix format in which the generic pathways were highlighted and grouped under the relevant standard '*categories of operations which may cause deterioration or disturbance'* which were listed above.

3.2.4 Step 3: Activity-based Screening of European/Ramsar Sites

The preceding screening report has previously identified the full list of sites that could potentially be affected by the East Marine Plans in advance of a review of the specific activities that need to be assessed. For Step 3 of this assessment, there was a need to consider which of these sites will be affected by activities that are materially influenced by the Plan across the tidal energy, carbon storage and aggregate extraction sectors. Therefore the original screening process was revisited to identify these designated sites and their interest features.

As a first stage of this analysis, an updated review of the status of European/Ramsar sites was undertaken to identify any new sites that had been identified since the completion of the screening review. During this period, further areas qualifying as Special Protection Areas (SPAs) (including for seabirds) had been identified as part of the ongoing review being undertaken by JNCC and the four country nature conservation agencies (Kober *et al*., 2012). No new potential marine SPA areas were identified within the boundary of the East Marine Plan Areas. However, eight new sites were identified where the East Marine Plan Areas lies within the area potentially covered by long-distance foraging seabird species they support. These sites are located primarily in northern England and the Outer Hebrides with one site off the south west coast near Plymouth.

Once a full final list of sites had been produced, an updated list of 'screened in' sites and features was created to identify those for which there was a LSE from the activities within each sector. The site and feature lists from the screening report were reproduced and notes made on each about whether there was a LSE from either the tidal energy, carbon capture storage or aggregate extraction. No sites or features were removed from these tables because it is important that they continue to provide a full and transparent audit of this screening and assessment process. In addition to presenting these comprehensive lists of all the sites and their features, a final overall summary screening schedule was created which focuses on illustrating only those designated sites, and their relevant interest features, which could potentially be affected (i.e. subject to a possible LSE) by the East Marine Plans.

The process of identifying the sites and features that could be affected across each sector was the same as that followed for the full Plan-level screening work. However at this stage in the assessment extra detail is available about the locations and potential effects, of activities across the three sectors under review. Using this information and the results of past Environmental Impact Assessment work additional sector-specific screening criteria were developed. For this work, as with all other elements of this Plan-level assessment, a precautionary approach was adopted and sites were only screened out where there is certainty that there will be no LSE.

3.2.5 Step 4: Detailed Pathway-Feature Sensitivity Review

Step 4 involved a more detailed review of the sensitivities of the qualifying habitats and species (i.e. their intolerance from damage or death from an external factor) to the relevant project-level activities. This review also identifies in greater detail the external factors or environmental changes which influence these sensitivities and presents initial details about the aggregate extraction, carbon capture storage and tidal energy generation activities that will, or might, cause these changes.

The results are also presented in a series of 'pathway-sensitivity' tables for each key habitat or species group. In each of these tables a judgment is made about the interest feature's level of sensitivity to each impact pathway (i.e. whether low, medium or high sensitivity). Once again, in these tables the standard Natura 2000 sensitivity categories (as listed in the preceding section) were identified.

In this matrix-based assessment, it is only sensitivity that is considered. It should be emphasised that high sensitivity does not equate to a high risk. Instead the risk will be determined by the degree of exposure (e.g. there would be a high degree of exposure for designated habitats were a development to occur within or near a designated site). However, there is very little information for the East Marine Plans about exposure and, therefore, it is considered appropriate in this assessment to base impact consideration on sensitivities only and assume, that exposure will occur, taking a precautionary approach.

The judgments that are made here about sensitivity are based on the ecology of qualifying habitats and species as well as on details about the activities and changes arising from each of the three sectors that need to be assessed. For many of the more common impact pathways (e.g. direct impacts to the seabed or water quality effects from contaminant release) the levels of sensitivity are well understood based on past studies and available literature. The sensitivities of some species to other pathways (e.g. underwater noise impacts on marine mammals or underwater collision impacts on birds foraging at sea) are less well supported by available information but can be derived based on an understanding of species' behavioural ecology. For instance, sensitivity to underwater noise is dependent upon the frequency of occurrence of marine mammals in the East Marine Plan Areas for which there is selected data but not a detailed understanding (further details about site and feature proximity are addressed in the following stage of the analysis).

While there are variations in sensitivity, and differences in the level of scientific certainty associated with determining these levels, a precautionary approach has been taken for this assessment, as required under the Habitats Regulations, and all potential impact pathways are addressed irrespective of these sensitivity variations. Ongoing research work will help to inform future judgements about these sensitivities and also where individual projects are undertaken as part of this Plan then the exposure levels and hence the risks rather than just the sensitivities will be understood.

These 'pathway-sensitivity' tables as presented within this assessment review, also indicate the stages in the implementation process for individual projects at which the impact pathways are relevant (i.e. survey, construction, operation or decommissioning). The sensitivity levels associated with each of these stages are also indicated in these tables.

Within each impact assessment and feature sensitivity table, the impact pathway reference number (from 1 to 25) is included that relates to the generic impact pathways that were identified in Table 1 (Step 1 of the analysis). As noted above, this number is included for this HRA in order to make comparisons within and between tables as easy as possible and so that any party interrogating these details (e.g. regulator, stakeholder or developer) can readily cross-refer between these tabular outputs.

3.2.6 Step 5: Assessment of Effects on European/Ramsar Sites

As a final stage of the analysis, an assessment is made about the impacts that will or could occur via each of the identified pathways. This assessment is made, as required against the Conservation Objectives. The Conservation Objectives were identified from online sources such as the JNCC, NE and EU websites, and through consultation with both NE and JNCC. As agreed with NE and JNCC it was not possible to identify and review the individual and specific objectives for each designated site given the large number of sites that have been screened into this assessment. Therefore, a series of typical and generic objectives were identified which could be applied across all European/Ramsar sites.

Based on these generic objectives, the potential effects on the designated sites via each of the relevant impact pathways were reviewed. An initial view was then taken and advice provided (in advance of the formal judgment that is to be made by the MMO, in consultation with the key stakeholders for the AA in Stage 12 of the HRA) about the effect on site integrity of the East Marine Plans both alone and in-combination with other extant plans or projects. The views expressed about the effects on site integrity are based on current scientific understanding and the proposed manner in which the Plan is to be implemented. Typically, this judgement usually needs to be made in the context of the available (called 'initial') mitigation measures that exist to avoid or reduce impacts. However for the East Marine Plans, no formal 'initial' mitigation measures exist because there are no strategic environmental assessments which frame such measures for the TIDE, CCS and AGG sectors and therefore none that have any statutory role. This means that the assessment of impacts needs to be made based on there being no such statutory measures available[9]. However, it is recognised that non-statuary mitigation measures clearly exist and have been identified for previous projects and associated licensing. It is considered to be important that such measures are identified not least because collating such information will assist with future project developments in the Marine Plan areas and will provide an initial framework for further developing these measures over time.

Where the information indicates that there could be an effect on integrity (or where the possibility of such effects cannot be excluded) then typically additional mitigation measures are applied to avoid such an effect (Stage 9 of the HRA). In this case, given in the absence of initial mitigation measures, then such additional mitigation measures will be the sole and primary measures to be adopted and these are presented at the end of this AAIR (in the Conclusions chapter (Section 5) and within the assessment tables (Tables 16, 17, 18 and 19) in Section 4.8 of this Report. These mitigation measures have been applied and the plan re-assessed to seek to further avoid any adverse effect on site integrity. This report, with these measures included, provides a draft record of the HRA assessment (Stage 10 of the HRA) to inform subsequent consultations and the preparation of a final AA (Stages 11-13 of the HRA).

[9] This also meant that Stages 6 and 7 of the HRA (see Diagram 1) were not separately addressed during the Screening Report (MMO, 2013b)

4 Assessment Results

4.1 Step 1: Impact Pathways

Following the review of impacts arising across the three relevant sectors, a total of 25 generic impact pathways were identified. This list is presented in Table 1 below and also in Table A1 in Appendix A. To ensure full auditability throughout the assessment process a distinct 'pathway reference number' is identified from 1 to 25. This pathway reference number is then cited throughout the assessment and within, particularly, the subsequently produced feature sensitivity and assessment matrices.

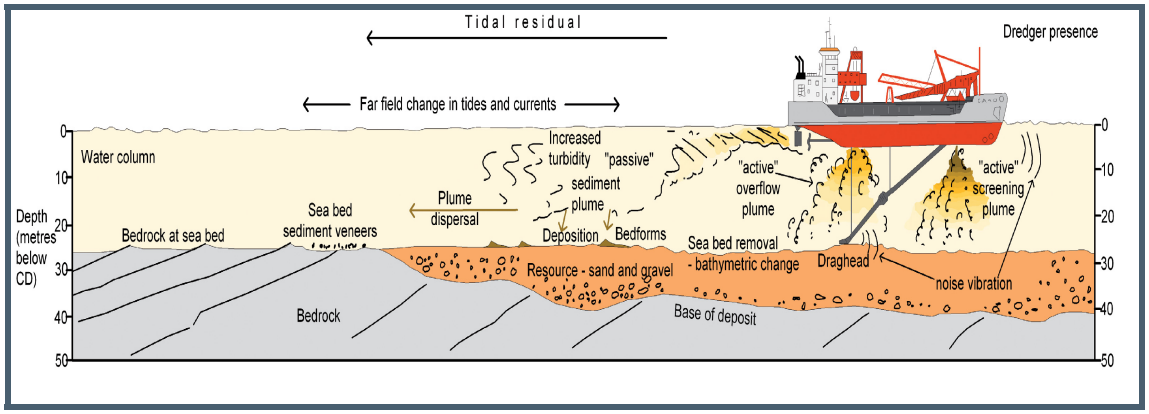
The impact pathways that are associated with tidal energy generation (TIDE) include especially the risk of under water collision with mobile species (fish and mammals) and the direct and indirect effects upon the coastal and offshore seabed habitats that occur from installing the tidal devices and power cabling connections. While the areas of potential device deployment have been identified, the locations of the landfall grid connections and the areas of the coast that could be affected are not yet known. This uncertainty about grid connection location is a key consideration for the Appropriate Assessment. However, it is also recognised that there will be many other uncertainties associated with this emerging sector. These include the location of devices and, of particular relevance for this emerging sector, the specific technologies that might be used and the impacts that could arise. These uncertainties will also need to be highlighted in this assessment review.

With respect to Carbon Capture and Storage (CCS), for the purposes of this assessment, only the effects associated with the 'transport' and 'storage' phase of this work have been screened in because it is only these elements that could have a definable impact on the marine environment. By contrast, the impacts associated with the 'capture' phase will be confined to the relevant inland industrial installations. These elements will be subject to separate legal controls/licenses under Integrated Pollution and Prevention and Control (IPPC), Environmental Impact Assessment and, where required, Habitats Regulations.

The transport of captured CO_2 will be via pipeline or by ship with the former resulting in impacts to coastal and offshore habitats that are directly analogous to those that would arise from installation of natural gas transport routes (EC, 2008). Both during transport and storage there are the risks associated with leakage. Released CO_2 would dissolve to form carbonic acid and this could potentially acidify the immediate water column. The broader 'global' risks from accidental releases of fugitive emissions or the other 'upstream effects' (EC, 2008) associated capture whether that is the storage of materials or the provisions of additional full requirements have not been screened in. As with the tidal energy generation, there are a number of uncertainties associated with the impacts that could occur in this emerging sector and, in particular, with respect to the alignment and landfall locations of carbon delivery pipelines.

By contrast, aggregate extraction (AGG) is a well established sector and the impacts associated with this work, and the spatial extent of their effect, are much more clearly understood than they are for the other two sectors. These direct and indirect physical impacts of aggregate dredging on the environment are conceptualised in Image 1. Direct impacts occur within the footprint of the dredge areas due to the passage of the draghead over the seabed, the removal of deposits and the creation of suspended sediment plumes in the water column (Tillin *et al*., 2011). Water quality and habitat effects arising from plume dispersion can have effects on mobile species (fish and mammals) as can the effects of noise during the aggregate extraction process. Wider indirect physical and ecological effects can also occur outside the dredge area as a result of changes to the hydrodynamic (wave and tide) regime caused by the changing bedform brought about by the excavation work.

Image 1: Direct and indirect impacts of aggregate dredging on the marine environment[10] (Source: Emu, 2012)



Also, for this sector there are no impact pathways under the 'habitat loss' category but only under the 'physical damage' category. This is because there are no requirements for permanent seabed infrastructure and maintenance of the sea bed substratum after completion of an aggregate campaign is a licence condition.

For all these sectors, the impacts associated with undertaking survey work have been screened in. This is an element of assessments that can often be overlooked and yet significant impacts could arise if, for example, there is need for seismic exploration with associated noise disturbance effects in their own right. Depending on a site's location, it may even be that an HRA needs to be undertaken for the survey elements themselves as part of any future development application (ABPmer, 2011a and 2013).

4.2 Step 2: Impacting Activities and Sensitive Features

The results of the activity impact review are presented in Table A2 in Appendix A. In this table, the relevant activities (and the environmental changes that result from them) are initially presented alongside the full generic impact pathway category that applies. The relevant sectors in which these activities take place are shown and these activities are separated according to whether they occur within each of the key phases of a project's implementation (survey, construction/decommissioning and operation). Alongside the activities, changes and pathways that are then presented for each project phase, the particularly interesting features that could be affected are also highlighted in this table.

The resulting 'activity-impact-sensitivity' table is a key element of the impact assessment process because it allows clear linkages to be drawn between the activities influenced by the plan and the full range of potential effects. In doing so, this table can be used as the basis for a final auditing the assessment conclusions and, particularly, for ensuring that appropriate mitigation measures are in place for all pathway-feature impacts.

[10] It is important to note that the tidal residual and far field change in tides and current are not necessarily limited to the areas encompassed by the arrows shown in Diagram 2.

Table 1: Generic impact pathways associated with tidal energy, carbon capture storage and aggregate extraction projects

Pathway Ref No.	Sector T= TIDE C = CCS A = AGG	Potential Sensitivity Category		Impacts Arising from Tidal Energy Generation (Summary Impact Pathway Description)
		Categories of Deterioration or Disturbance	Code	
1	T, C	Physical Loss/Gain of Habitat (loss of habitat in development footprint)	PLG	Loss of coastal and offshore habitat under the footprint of devices, power cables, CO_2 pipelines and also cable/pipeline armouring arising from the installation, operation and decommissioning of these structures.
2	T, C	Physical Loss/Gain of Habitat (change to landward habitat in development footprint)	PLG	Loss of onshore habitat (including bird breeding and roosting grounds, freshwater habitats, otter holts or shelters) under the footprint of power cables, CO_2 pipelines, cable/pipeline armouring and landside infrastructure due to the installation, operation and decommissioning of these structures.
3	T, C	Physical Loss/Gain of Habitat (direct change to habitat around the development footprint)	PLG	Loss of foraging areas from a reduction in coastal and offshore habitat due to installation of devices, power cables, CO_2 pipelines and/or cable/pipeline armouring both at the development footprint and outside from bed scour and indirectly from changes to the hydrodynamic (wave and tide) regime.
4	T	Physical Loss/Gain of Habitat (direct change to habitat around the development footprint)	PLG	Presence of tidal generation (or other) structures on seabed for the duration of the project resulting in changes to prey and species behaviour (e.g. acting as FAD (Fish Aggregating Device), artificial reef or bird roost).
5	T, C, A	Physical Damage to Habitat (indirect and temporary damage to habitat)	PD	Changes to coastal and offshore habitat as result of damage from baseline surveys (e.g. boreholes/trawls); from equipment use causing abrasion, damage or smothering during installation and from maintenance and removal of cables/pipelines/devices (e.g. jack-up legs, vessels, anchors, mooring chain).
6	A	Physical Damage to Habitat (direct and temporary damage to habitat)	PD	Damage to offshore seabed habitat at the site of extraction during the period of the works.
7	A	Physical Damage to Habitat (indirect and temporary damage to habitat)	PD	Damage to the areas surrounding the site of extraction as a result of sediment redistribution and settlement.
8	T, C, A	Physical Damage to Habitat (indirect and longer-term damage to habitat)	PD	Changes to coastal and offshore habitat as a result of alterations to the wave climate or hydrodynamic (wave and tide) regime from the presence of tidal devices, CO_2 pipelines, power cables or cable/pipeline armouring causing physical changes (including alterations to sediment transport/scour) or from changes to seabed/sandbank morphology at the extraction site(s) (including alterations to sediment transport/scour).
9	T, C	Physical Damage to Habitat (indirect and temporary damage to habitat)	PD	Damage to onshore habitat (including bird breeding grounds, freshwater habitats, otter holts or shelters) by excavation, piling and construction work associated with the installation, operation and decommissioning of cables, CO_2 pipelines and landside infrastructure.
10	T, C, A	Physical Damage to Habitat (indirect and temporary damage to habitat)	PD	Reduction in quality of foraging areas as result of damage to coastal and offshore habitat from baseline surveys (e.g. boreholes and trawls); from equipment use causing abrasion, damage or smothering during installation; from maintenance and removal of cables, pipeline, tidal/devices or from scour, sediment transport and hydrodynamic change during operation.
11	A	Physical Damage to Species (direct and temporary damage to habitat)	PD	Reduction in quality of foraging areas as result of damage to coastal and offshore habitat within and surrounding the aggregate sites during the extraction process.
12	T, C	Physical Damage to Species (direct and temporary damage to habitat)	PD	Damage to seal haul out locations during the installation, decommissioning and operation of the cables, pipeline and/or cable/pipeline armouring.
13	T, C, A	Physical Damage to Species (direct damage to species from collision risk)	PD	Collision risk and possible mortality of species due to the presence of tidal devices or from vessels travelling to and from the site (including propeller collision risk).
14	C	Physical Damage to Species (direct damage to species from collision risk)	PD	Presence of above water structures, and any associated lighting, influencing migration/foraging of bird species.
15	T	Non-Physical Disturbance (barrier to species movement)	NPD	Presence of sub-surface structures and disturbance (noise or visual) associated with tidal devices may present a barrier to movement and block migratory pathways or access to feeding grounds depending on array design.

Pathway Ref No.	Sector T= TIDE C = CCS A = AGG	Potential Sensitivity Category		Impacts Arising from Tidal Energy Generation (Summary Impact Pathway Description)
		Categories of Deterioration or Disturbance	Code	
16	T, C, A	Non-Physical Disturbance (disturbance to species)	NPD	Visual disturbance and exclusion from areas as a result of surveying; cable, pipeline or tidal device installation/operation and decommissioning activities (including movements of vessels).
17	T, C, A	Non-Physical Disturbance (disturbance to species)	NPD	Noise/vibration disturbance and exclusion from areas as a result of vessels and other activities during survey work (e.g. seismic exploration and geophysical surveys), construction (e.g. piling, drilling, cable laying), operation (e.g. device noise), maintenance or decommissioning. Also includes noise/vibration disturbance from vessels and draghead during aggregate extraction.
18	T	Non-Physical Disturbance (disturbance to species)	NPD	Impacts from Electromagnetic Fields (EMF) on electromagnetically sensitive fish and cetaceans interfering with prey location and mate detection in some species and creating barriers to migration.
19	T, C, A	Toxic Contamination (reduction in water quality)	TC	Spillage of fluids, fuels and/or construction materials (inc. from surface coatings/treatments) during installation or removal of structures (devices and cables), during survey/maintenance or during aggregate extraction.
20	T, C, A	Toxic Contamination (reduction in water quality)	TC	Release of contaminants associated with the dispersion of suspended sediments during installation or removal of structures (devices, pipelines and cables) or from the aggregate extraction process.
21	C	Toxic Contamination (reduction in water quality)	TC	Release of CO_2 into the water column and its acidification from the formation of carbonic acid.
22	T, C, A	Non-Toxic Contamination (elevated turbidity)	NTC	Increase in turbidity (and possibly reduced dissolved oxygen) associated with suspended sediments release during installation or removal of structures (devices, pipelines and cables) or from aggregate extraction.
23	T, C, A	Biological Disturbance (introduction of non-native species)	BD	Predation by introduced rats/mink through the positioning of static devices (turbines, rigs) close to breeding seabird sites.
24	T, C	Biological Disturbance (introduction of non-native species)	BD	Introduction of new structures (tidal devices or construction platforms) on the seabed providing new substratum that facilitates the colonisation and ingress of invasive non-native species.
25	T, C, A	Biological Disturbance (introduction of non-native species)	BD	Introduction and ingress of invasive non-native species as biofouling species on the surfaces of vessels or construction plant.

* As derived from the standard 'categories of operations which may cause deterioration or disturbance' (UK Marine SAC Project, 2001).

This table is also reproduced within Appendix A (as Table A1a) which brings together all the screening and assessment tables.

4.3 Step 3: European/Ramsar Sites to be Considered

During the full screening of the East Marine Plans (MMO, 2013b), a large number of European/Ramsar sites were identified for which it was not possible to conclude that there would be no LSE from the East Marine Plans for some, or all, of the qualifying habitat features specifically. This is because of the large extent and broad scope of the East Marine Plans. In total, there were 182 sites that were screened in as shown in Table 2 which summarises the screening process.

Table 2: Number of designated sites added/removed during pre-screening and screening of the East Marine Plan Areas

Site	Sites Selected at Pre-Screening Stage*	Sites Removed at Screening Stage	Sites Added at Screening Stage	Final List Screened Into Appropriate Assessment (MMO, 2013c)
SPA	75	30		45
SAC	153	121		32
Ramsar	37	6		31
SCI	3			3
cSAC	2			2
SPA (>100km)			14	14
SAC (>100km)			55	55
Total	**270***	**157**	**69**	**182****

* The original pre-screening Review (as issued for consultation in Feb 2012 identified a list of **248** sites, but a further **22** sites were added during the screening to make the total **270** when it was agreed that the Inshore and Offshore Plan Areas would be treated as a single East Marine Plan Area for this HRA and, therefore, this analysis was revisited (MMO, 2013a).

** As shown, a total of **182** sites were identified following the screening of the Inshore and Offshore Plan Areas together (157 removed and 69 added to the 270 sites identified at pre-screening). The sites removed were mainly the terrestrial habitats and features for which there was no impact pathway from marine activities while the added sites were from areas beyond 100km that support long-distance foraging or migrating species (mammals, seabirds and fish interest features). [In Step 3 of the assessment, process further screening was undertaken during the AAIR phase based on activities influenced by the plan as described below, this reduced the total number of screened in sites to **122**].

These sites are listed across four separate screening tables (Tables A3 to A6 in Appendix A) that present the following information and highlighting the 'screened in' sites throughout:

- **Table A3** - List of all the sites in the UK that lie within the East Marine Plan Areas and within a 100km buffer surrounding;
- **Table A4** - List of other transnational EC sites within the 100km buffer surrounding the East Marine Plan Areas;
- **Table A5** - All UK and other transnational EC sites lying beyond the initial 100km buffer (that support long-distance foraging and migrating interest feature species); and
- **Table A6** - A single final matrix of 'screened in' sites and features.

The first three of these tables are reproduced from equivalent matrices within the screening report, but for this report an additional highlight has been made to identify those sites which have been screened in because they are potentially affected by activities within the tidal energy, carbon storage and aggregates extraction sectors (as described below in this section). The

fourth table (i.e. Table A3d) has been additionally produced for this assessment review. It provides a final summary screening for the three sectors being reviewed in this report.

The approaches that were applied here to screen for activities across the TIDE, CCS and AGG sectors follow the rationale for these screening methods that were presented within the screening report (MMO, 2013b). The details of the activity-based screening (highlighting any differences between sectors) are as follows:

- **Direct effects on seabed habitats (all three sectors)**: Include all designated sites whose habitats would be directly affected because they lie within the zone allocated for tidal energy, carbon storage or aggregate extraction. This includes the areas under the footprint of any structures introduced on to the sea bed by tidal and carbon storage (including cables and pipelines) and the 'Primary Impact Zone' (PIZ) the area where dredging is predicted to occur as defined by the aggregate sector.

- **Indirect (near-field) effects on seabed and water quality (all three sectors)**: Include all designated sites whose water quality or habitats conditions would be affected by turbidity, water-borne contamination release, water column acidification change and/or the settlement out of suspension (benthic smothering) of plume sediments. These areas are defined by the fact that they lie within one tidal ellipse distance of the zone allocated for tidal energy generation, carbon storage or aggregate extraction. These ellipses show the maximum distance which could theoretically be travelled by a particle over the course of a spring tide. This approach can be seen as worst-case high-level screening process because the tidal ellipses range from around 5 to 15km in length, whereas for aggregates sector EIAs (ABPmer, 2012) and the Anglian MAREA (Emu, 2012; HR Wallingford, 2011) the maximum spatial extent of this secondary effect is typically set at 500m for smothering of the sea bed and 0.25 to 4km for changes to the Particle Size Analysis from fine sediment dispersal. For example, changes in substrate composition are predicted to occur as far as 3.9km outside of the boundary for Areas 240 and 328 B through the dispersion of fine sand, largely extending to the north (ABPmer, 2012).

- **Indirect (near-field) effects on coastal habitats (tidal energy and carbon storage)**: Include (in the screening schedules for TIDE and CCS) all designated sites that are located inshore of areas defined for tidal energy and carbon storage sector, but also along the full coast of the East Marine Plan Areas. This is because there is no certainty as to where the cable/pipelines would be located or where their landfall location would be. Therefore, all inshore designated sites need to be included until it can be a guaranteed that they will not be affected.

- **Indirect (far-field) effects on coastal habitats (aggregates)**: Include (in the screening schedules for AGG1&2) all designated sites that are located within 20km of a proposed aggregated extraction area. These are sites which could be indirectly affected by changes to the wave and/or tidal climate as a result of alterations to the seabed within the dredge area. The distance of 20km is considered to be relatively large (and hence precautionary) because the evidence from past EIAs, Regional Environmental assessments and Coastal Impact Statements (CISs) for aggregate extraction work (ABPmer, 2012; Emu, 2012) is that such indirect effects are localised and do not occur beyond a few kilometres at most. For instance, no wave environment changes to coastal habitats are anticipated from dredging within License Area 240 which is around 10km from the coast (ABPmer, 2012; Emu, 2012). Similarly, no wave effect is predicted to the inshore 'South Cross Sand' bank which is 2.5km inshore of this extraction area and any tidal flow or sediment supply changes are confined to the extraction area (ABPmer, 2012; Emu, 2012). It is also recognised that these predictions are made with

a high confidence and are based on worst-case (precautionary) predictions that much greater volumes of material will be excavated than is actually anticipated in reality.

- **Direct effects of foraging/migrating seabird species (all three sectors)**: Include all SPA sites with seabird interest features that could be affected by a loss or reduction in the quality of feeding grounds or which could be affected (e.g. by lighting on platforms) during migratory movements. This includes those SPAs that lie within the distance covered by foraging birds, including all that lie within 100km of any area that is defined and any that also lie at greater distances but support the following interest feature species:

    - Sites within 200km supporting for Atlantic Puffin, Black-Legged Kittiwake and Common Guillemot;

    - Sites within 219km supporting for Great Skua;

    - Sites within 120km supporting for Leach's Storm Petrel;

    - Sites within 400km supporting for Manx Shearwater, Northern Fulmar and Northern Gannet; and

    - Sites within 312km supporting for Razorbill.

- **Marine Mammals (cetaceans)**: Include all designated sites that were originally 'screened in' within the Screening Report (MMO, 2013b) for the full East Marine Plans. This encompassed all sites supporting either harbour porpoise (*Phocoena phocoena*) or bottlenose dolphin across the North Sea (including Skagerrak, North Sea, Channel) that lie within approximately 600km of the East Marine Plans boundary. Given the current lack of a detailed understanding about cetacean movements, which are thought to be larger than previously predicted (e.g. Robinson *et al*., 2012), it was not possible to further screen out these sites at this time.

- **Marine Mammals (seals)**: Include all designated sites that support grey seal (*Halichoerus grypus*) or common seal (*Phoca vitulina)*, that lie within 100km of a zone allocated for tidal energy, carbon storage or aggregate extraction as well as all coastal SACs that lie outside this area where a cable or pipeline might be aligned.

- **Migratory Fish and Freshwater Pearl Mussel**: Include all designated sites that were originally 'screened in' within the Screening Report for the full East Marine Plans. This encompassed all sites supporting Atlantic salmon, sea lamprey and river lamprey either along the east coast adjacent to the East Marine Plan Areas and also sites along the south east coast of Scotland which could be used by fish species that have migrated up the northward direction through the English Channel and up along the east coast.

- **Bats**: Exclude the one SAC that was identified at screening which supports Barbastelle bat species (The Paston Great Barn SAC). This site was originally screened in because it lies within a distance of 50km from the coastline along the East Marine Plan Areas and there was a risk that bat species can collide/interact with offshore wind turbine blades. However, because the East Marine Plans will not materially affect offshore windfarm activities (and a Plan and HRA already exist for Round 3 Offshore Wind Farms), this interest feature and this site can be removed from the assessment stage.

The main outcome of this process is that some of the offshore designated sites which will not be affected any of the relevant sector activities have been screened out. However, most of the sites have remained screened in because of uncertainties associated with many aspects of the possible activities (e.g. the locations where cable or pipelines might be aligned to serve the tidal energy or carbon capture storage sectors). In addition, most of the sites that support mobile species (seabirds, marine mammals and fish) remain in the scope because of uncertainties about their migration routes and the value of areas used for foraging. The sites supporting mobile species include those in the plan area as well as in the distant national and international sites both within and beyond the arbitrary 100km buffer area.

In total, 59 UK sites (see Table A6 in Appendix A) were screened in along with a further 62 transnational sites supporting harbour porpoise and bottlenose dolphin. Therefore, a total of 122 sites have been screened in for activities that are influenced by the Marine Plan.

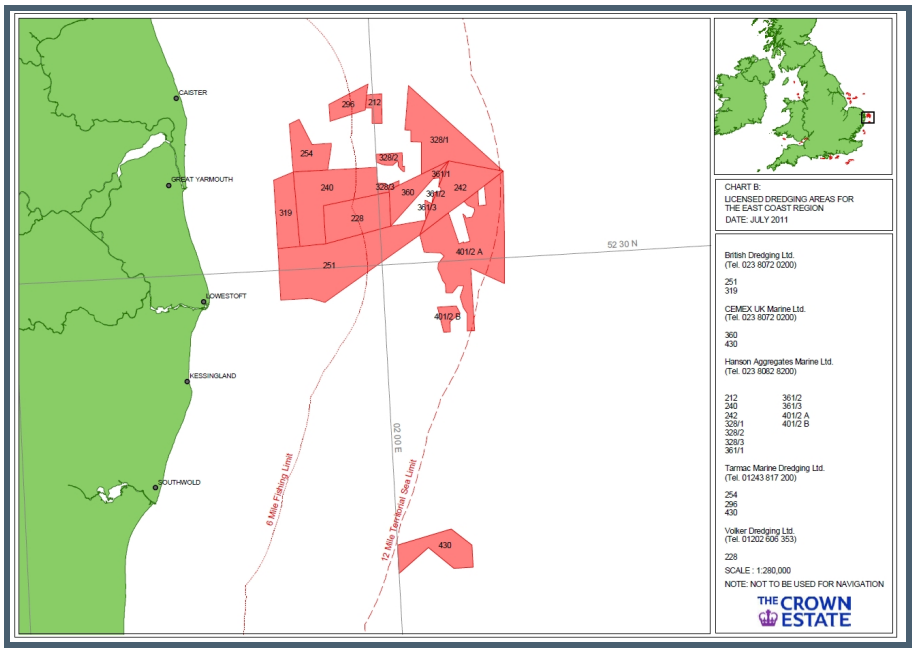
It is recognised that the list of sites is more extensive than would typically be screened into an individual project-level Habitats Regulations Appraisal. As an example from aggregate sector, advice from NE and JNCC is that there could be an LSE on 18 designated sites from the continuation of Marine Aggregate extraction from 9 Licence Areas in the east coast region (Areas 228, 240, 296, 251, 360, 328, 319, 242/361 and 212 – see Image 2). These 18 designated sites are as follows:

- **Special Areas of Conservation**: Haisborough, Hammond and Winterton; Winterton-Horsey Dunes; Great Yarmouth North Denes; Corton Cliffs; Benacre to Easton Bavents Lagoons; Minsmere- Walberswick Heaths and Marshes; Orfordness-Shingle Street;

- **Special Protection Areas**: The Wash; North Norfolk; Humber Estuary; Flamborough Head and Bempton Cliff; Great Yarmouth North Denes; Breydon Water; Benacre to Easton Bavents; Minsmere-Walberswick; Alde-Ore Estuary; the Outer Thames Estuary; and

- **Ramsar sites**: Minsmere-Walberswick.

Image 2: Licensed dredge areas for the East Coast Region



In this context, it is important to emphasise that, for plan-levels HRAs, the use of an arbitrary 100km buffer is an appropriate and objective tool for selecting out designated sites in the early screening stages. However, when screening at a project level, this first step is not essential and it is more appropriate to begin the screening of sites and interest features according to informed parameters and in the light of the more detailed information that is available at a project level (and, if applicable, using the screening schedules within this report).

Having reviewed and refined the sites to be considered in this assessment, the following chapters (Section 4.4 to 4.7) review the potential for adverse effects on the following four qualifying features within these sites:

- Habitats and associated species (Section 4.4);
- Seabirds (Section 4.5);
- Marine mammals including cetaceans, seals and otters (Section 4.6); and
- Migratory anadromous fish and freshwater pearl mussels (Section 4.7).

Given the broad area covered by the East Marine Plans and the large number of sites screened into this assessment, a large number of qualifying features and sub-features have been screened in. Where possible, these features are recorded in the assessment review text that follows and within the screening schedule this is shown in Table A6 (in Appendix A). However, it has been agreed (with NE and JNCC) that it is not necessary within this assessment to individually review the full list of all sites and all qualifying features that they support. Instead, the features are grouped into broader categories for review which are defined in each of the following chapters.

4.4 Step 4(1): Habitat Sensitivities

4.4.1 Designated Sites with Habitat Features

Following the plan-level screening process (MMO, 2013b), a total of 182 European/Ramsar sites were identified for which there is a LSE (or the potential for a LSE cannot be excluded). Of these sites, there were a large number (92 SACs, SCIs, cSACs and a further 31 Ramsar Sites) which had qualifying habitat interest features that were screened in.

Following the above screening process for activities (Section 4.3), the total number of 'screened in' sites was reduced to 122 European/Ramsar sites of which there are 16 SACs, SCIs, cSACs and 6 Ramsar sites with qualifying habitat interest features.

The relevant qualifying habitat features within these sites includes a range of coastal, intertidal and sublittoral interests and these interests are summarised and grouped into categories in Section 4.4.2. The habitats within designated SPAs also warrant consideration and they are addressed separately within Section 4.5 (dealing with the impacts to seabird qualifying features).

4.4.2 Interest Features Summary List

For the purposes of this review, the range of Annex 1 qualifying habitat features within the screened in sites have been divided into five broad categories as follows:

1) **Morphological features encompassing a range of habitats**:

- Estuaries (1130) which will encompass sub-feature habitats such as Saltmarsh, Eelgrass, Mussel Reefs as well as many of the other Annex 1 habitats that are cited separately below; and
- Large shallow inlets and bays (1160) which, as with estuaries, encompass a range of other feature and sub-feature habitats.

2) **Subtidal habitats with typically soft-sediment habitat**:

- Subtidal sandbanks (i.e. 'Sandbanks which are slightly covered by seawater at all time') (1110).

3) **Subtidal habitats with typically hard-substratum habitat**:

- Reefs (1170);
- Submarine structures made by leaking gases (1180); and
- Submerged or partially submerged sea caves (8330).

4) **Intertidal habitats (including saltmarshes)**:

- Intertidal mudflats and sandflats (i.e. 'Mudflats and sandflats not covered by seawater at low tide') (1140);
- Annual vegetation of drift lines (1210);
- Salicornia and other annuals colonising mud and sand (1310);
- Spartina swards (1320);
- Atlantic salt meadows (1330); and
- Mediterranean and thermo-Atlantic halophilous scrubs (*Sarcocornetea fruticosi*) (1420).

5) **Supralittoral habitats**:

- Coastal lagoons (1150);
- Supralittoral dune habitats, encompassing the following:

  - Fixed dunes with herbaceous vegetation ('grey dunes') (2130);
  - Atlantic decalcified fixed dunes (*Calluno-Ulicetea*) (2150);
  - Dunes with *Salix repens* spp. *argentea* (*Salicion arenariae*) (2170);
  - Coastal dunes with *Juniperus* spp. (2250); and
  - Shifting dunes along the shoreline with *Ammophila arenaria* ('white dunes') (2120).

- Perennial vegetation of stony banks (1220); and
- Vegetated sea cliffs (1230).

In addition to these habitats, there will also be individual habitats that are identified within Ramsar citations (e.g. “sand and shingle spit”), although these individual features are not listed. In addition, there will be sub-features of SACs which will include a range of habitats such as rocky shore or mussel bed communities. The impact pathways for these supporting features are considered to be the same as for the qualifying habitat interest features, with particular distinctions being possible between soft sediment, hard substratum, intertidal and supralittoral categories as identified above. Therefore, the impacts to these specific habitats have not been considered separately as part of this assessment.

To assess whether there is any adverse effect on the integrity of the European/Ramsar sites that were identified, Sections 4.4.3 and 4.4.4 review the sensitivities of these habitat features. Section 4.8.2 then identifies the conservation objectives for these features and assesses, in tabular format, the effects arising in the context of the proposed additional plan-level mitigation measures.

4.4.3 Sensitivities of Habitats to Plan Activities

This section reviews the sensitivities that are relevant for the habitat interest features. Initially, a generic review of the sensitivities is presented under each of the following impact pathways identified during the screening phase:

- Physical Loss/Gain of Habitat (Loss of Onshore or Offshore Habitat) (Section 4.4.3.1);
- Physical Damage to Habitat (Damage of Onshore or Offshore Habitat) (Section 4.4.3.2);
- Toxic Contamination (Contamination and Spillages) (Section 4.4.3.3);
- Non-Toxic Contamination (Elevated Turbidity) (Section 4.4.3.4); and
- Biological Disturbance (Introduction of Non-Native Species) (Section 4.4.3.5).

4.4.3.1 Physical Loss/Gain of Habitat (Loss of Onshore or Offshore Habitat; Impact Pathways 1 and 2)

Intertidal, subtidal and supralittoral interest feature habitats are sensitive to a physical loss or gain of habitat at locations where new structures are introduced to, or removed from, the sea bed or coastal habitats (i.e. within the development ‘footprint’ of these structures). Thus, the key activities that are relevant are those which introduce permanent or temporary structures that lie on or protrude from the seabed and cause a direct loss (whether permanent or temporary) of habitat. For the East Marine Plans, the main activities causing habitat loss or gain will clearly be the installation, presence and then removal of the bases for tidal devices, cables and CO_2 pipelines on the sea bed where these are located within the area of an interest feature habitat. However the extent to which such direct effects could occur is not known at this stage given the broad area that could be affected by this pathway. Potentially suitable CCS sites, for example, occur throughout much of the northern Plan area. This pathway is not, however, relevant to the extraction of aggregates because there are no requirements for permanent seabed infrastructure and restoration of the seabed substratum after completion of an aggregate campaign is assumed.

It is recognised that direct loss of habitat can be mitigated by avoiding designated habitats at the project planning and design phase. There are no mitigation measures which formally state this although the plan recognises that ‘decision-makers should note the need to ensure that appropriate weight is attached to designated sites; to protected species; habitats and other species of principal importance for the conservation of biodiversity’.

In addition to the consideration about whether the Plan activities will occur within the designated site itself, the sensitivity of the habitats from direct effects (whether from device placement or pipeline/ cabling work) and the magnitude of any effects arising are also dependent on a range of factors such as the habitat type, the extent of habitat affected, the location and the nature of activities (e.g. non-intrusive Horizontal Direction Drilling (HDD) approaches can be adopted) and whether they are temporary or permanent. In the future it will also be dependent on technological advances that could occur within both the CCS and tidal energy sector. It is also recognised in designing the bases for devices or the pipelines or armouring for cable, the potential also exists for the structures themselves to become surfaces for the settlement of reef forming species and thus there could be impacts from both the initial installation and at the removal phase. In addition, cables/pipelines may be allowed to 'self bury' over time in soft sediments, thus changing the amount of available hard substrate through time.

Wilson *et al*. (2010) noted in reviewing offshore wind farms that the marine system is able to adjust to new structures in the sea, and they may even have the potential to act as a benefit to their receiving environment. Work has shown how scour protection and towers may create hard substrata and thus act as artificial reefs, thereby increasing production on these 'reefs' and creating organic material as enrichment for the local marine environment. However, this potential benefit needs to be studied in greater detail, allowing it to be taken into consideration when undertaking impact assessments on the benthic community.

4.4.3.2 Physical Damage to Habitat (Damage of Onshore or Offshore Habitat; Impact Pathways 5 to 9)

In addition to the direct impacts within the footprint of the structures, pipelines and cables outlined in the preceding section, intertidal and subtidal interest feature habitats are sensitive to direct and indirect physical damage from a range of activities associated with aggregate extraction and device and cable/pipeline installation and removal activities.

Damage can also occur during the baseline surveys where these occur in the vicinity of designated interest features and where they involve the physical retrieval of samples or bed materials, including borehole surveying or ecological trawl sampling. For device bases that require piling, surveys to assess subsurface geological structure and suitability for installation can involve the collection of a large number of cores and the use of drilling equipment from jack-up barges, in addition to activities associated with the installation of the device.

The construction activities associated with tidal and CCS schemes will cause damage to the seabed outwith the direct losses/gains caused within the footprint. Such activities will/could include the use of jack-up legs, piling, and activities involved in cable/ pipeline installation. During the operation phase of the Plan activities, the presence of the structures (piled device, pipelines, cable armouring, anchorages, etc) have the potential to cause scour effects in soft sediment systems. The mooring chains associated with anchored turbines also have the potential to cause abrasion of the adjacent substratum. The magnitude of the scour effects will depend on the size of the structures and the associated risk will depend upon the composition of the seabed substratum, the hydrodynamic conditions, and the distance of the structures from designated interest feature habitats.

In terms of aggregate extraction, physical damage will occur through the direct removal of seabed by the draghead (and associated physical and biological changes), overspill resulting in sediment plumes and deposition, screening and hopper washing. The recoverability of benthic resources following the cessation of dredging is influenced by many factors including sediment type and hydrodynamics. It is thought that the natural sediment mobility in the Anglian region is likely to result in the rapid infilling of dredge tracks in most dredging Areas (Emu, 2012). In areas adjacent to aggregate extraction increased suspended sediment concentrations (SSC)

may have both positive and negative effects on benthic habitats. The degree and type of effect varies with distance from the extraction site.

Direct effects on the seabed habitats could affect all designated sites under the footprint of any structures introduced on to the seabed by tidal and carbon storage and Primary Impact Zone (i.e. where aggregate dredging is predicted to occur). In relation to indirect near field effects, a distance of one tidal ellipse away from a zone allocated for tidal energy generation, carbon storage or aggregate extraction was used to identify (and screen) the potential zone of indirect influence of activities associated with each of the sectors (MMO, 2012b and Section 4.3 of this report). This was based on evidence from plume studies that even fine particles mobilised from the sea bed settle out again to a large extent within the distance of one tidal excursion. While a plume may be visible beyond this point the concentrations of suspended solids are usually within the range of natural variation and much of the visible plume is due to lipids from damaged benthic animals (Coastline Surveys Ltd, 1998; Clay *et al*., 2008). With regard to aggregate extraction all designated sites that are located within 20km of a proposed extraction area were also screened in. A precautionary distance of 20km was used as a buffer to determine sites that could be indirectly affected by changes to the wave and/ or tidal climate as a result of changes to the bedform (ABPmer, 2012; Emu, 2012). Indirect effects on coastal habitats (as a result of tidal energy and CCS) could potentially impact on all designated sites that are located inshore of areas defined for tidal energy and carbon storage, but also along the full coastal zone of the East Marine Plans.

There are also sensitivities to activities associated with maintenance visits because the vessels used are likely to cause small-scale localised damage from shipwash or from chains and anchor. The magnitude of the changes will be dependent upon the amount of shipping activity as well as the size and speed of the vessels with the risk being dependent upon the distance of such activities from the designated interest features (which will determine the extent of exposure to any change).

For all of the above activities, the rate at which habitats recover from damage will also be a key factor influencing the magnitude of any impact. This will be strongly related to the ecology of the habitats and reef features and richer mudflat habitats for instance are likely to be more susceptible and take longer to recover than sandflats. The recoverability of benthic resources following the cessation of aggregate dredging has been widely studied (e.g. Foden *et al*., 2009) and, in general, conform with well-known principles of ecological succession. In general, this is influenced by many factors including sediment type and hydrodynamics. It is thought that the natural sediment mobility in the Anglian region is likely to result in the rapid infilling of dredge tracks in most dredging Areas (Emu, 2012).

There is also the risk that changes to the bedform from aggregate extraction will have consequential changes to the adjacent coastline from alterations to the hydrodynamic regime. As noted above (Section 4.3) Coastal Impact Statements (CISs) are undertaken for all aggregate extraction work to evaluate such indirect effects. These generally indicate that such effects do not occur beyond a few kilometres from the site of excavation.

4.4.3.3 Toxic Contamination (Contamination and Spillages; Pathways 19 to 20)

Intertidal and subtidal interest feature habitats are sensitive to toxic contamination (where concentrations of contaminants exceed sensitivity thresholds) as a result of either the release of synthetic contaminants such as fuels, oils, construction material or from the releases of sediments (and any contaminants that may be present with these) during all stages of the construction and decommissioning work.

Spillage of oils and fluids from vessels and machinery into the marine environment could adversely affect sediment or water quality potentially impacting on benthic communities. In addition, in the areas being excavated or disturbed for the installation/removal of turbines or cables and/ or pipelines there will be an increase in suspended sediment concentrations during the period of the activity. Aggregate dredging also results in the re-suspension of sediments.

Where this release of suspended sediments occurs then the potential also exists for the release of mobilisation of sediment-bound contaminants into the water column. The likelihood of mobilising sediments and contaminated sediments and the magnitude of any effect is dependent upon the level of contamination; the proximity of the Plan activity to the designated site(s); the type of activity occurring; the manner in which that activity is pursued (including the extent and duration); the particle size of the disturbed sediments and the hydrodynamic conditions.

Sediment contamination is only likely to be evident in areas close to the coastline of industrial locations or in coastal areas where water and sediments have been subject to historical contamination. Furthermore, the sand and gravel substrates in areas of aggregate dredging contain/adsorb relatively low concentrations of contaminants compared to finer sediments. For activities taking place outside areas of sediment contamination then there is unlikely to be a LSE on relevant interest features.

It has been indicated that settlement of sediment is most likely to occur within 20 to 200m of a cable for a wind farm (BERR, 2008) but contaminants are almost always associated with fine sediments and could travel further than this in some areas where there is a large tidal excursion and strong tidal flows. However, over the greater distances, concentrations will often not be significant.

The release of CO_2 from carbon delivery pipelines also could results in acidification of the local water column. Such releases are expected to arise only from 'abnormal' events (EA, 2013) and the effects confined to the local water column before dispersion. There is a potential that shellfish species (and hence reef features such as mussel beds) in the locality could be affected. While the risk of this effect is likely to be low, it will be related to the approaches taken and the technologies used. This pathway clearly warrants consideration in this AAIR[11] and is a topic area that is the subject to ongoing research to clarify these issues.

4.4.3.4 Non-Toxic Contamination (Elevated Turbidity; Pathway 22)

The increases in suspended sediments from aggregate extraction and the construction and decommissioning activities associated with tidal energy generation and CCS are typically expected to result in short-term, localised changes to the marine environment. In the event of a substantial resuspension, then the potential exists from the settlement of materials to cause a smothering of the seabed to which reef habitats may be sensitive.

With respect to tidal energy the potential for damage from smothering is highest in areas where there is dredging for the placement of device foundations and the accompanying disposal of waste sedimentary materials on the sea bed. Settlement of coarse material is most likely to occur within 20 to 200m (BERR, 2008) and, thus, there is unlikely to be a significant smothering from excavation activities at distances of greater than 200m. Similarly for aggregates the potential smothering 'Secondary Impact Zone' (SIZ) typically comprises a 400 to 500m buffer

[11] And, for this AAIR, on a precautionary basis it has been assumed that there are potential, consequences also for foraging species via this pathway although here to the risks will be low.

around the Licence Areas in the Anglian region (a precautionary zone beyond which the fine sediment plume will not exceed 50mg/l above background levels).

4.4.3.5 Biological Disturbance (Introduction of Non-Native Species; Pathways 24 and 25)

The introduction of new surfaces in the form of new turbine bases, pipelines, cable armouring or anchorages (or the clearing of seabed habitats to allow the introduction of these components) has the potential to facilitate the encroachment of invasive non-native species. This is because they will be initially barren with no competition from indigenous species which could allow invasive non-native species to potentially colonise these surfaces. This is based on the assumption that the current spread of such species is limited by the prevailing physical regime and lack of new colonising substrata. Therefore, any development which causes a change in physical processes or provides new colonising space (especially large expanses of such space) could create a potential sensitivity to this impact. The species composition and the rate of colonisation will depend upon the location of the structure, time of year and the availability of larval/juvenile stages.

4.4.4 Habitat Interest Features

The individual characteristics and sensitivities for each of the relevant habitat interest features are presented and reviewed against the relevant Plan activities that could cause a LSE (recognising that there are no initial mitigation measures in this case). Information on the relative sensitivities of habitat features have been based on professional judgment and sensitivity assessments available for relevant habitat biotopes on the Marine Life Information Network (MarLIN) website[12] and as presented within the sensitivity matrix as prepared for Marine Protected Areas and wider marine spatial planning (Defra, 2010). These interest feature reviews are set out in the following five sections, which are representative of the broad categories identified above and have been used to understand the impact pathways and sensitivities that are pertinent to the full list of habitats that have been screened into this assessment:

- Estuaries (as an example of feature encompassing a range of habitats) (Section 4.4.4.1);
- Reefs (i.e. Hard-substratum Habitat) (Section 4.4.4.2);
- Subtidal Sandbanks (i.e. Soft-sediment Habitat) (Section 4.4.4.3);
- Intertidal Habitats (Including Saltmarshes) (Section 4.4.4.4); and
- Supralittoral Habitats (Section 4.4.4.5).

4.4.4.1 Estuaries

Estuaries are defined as the downstream part of a river valley, subject to the tide and extending from the limit of brackish waters (EC, 2007). River estuaries are coastal inlets where, unlike ‘large shallow inlets and bays’ there is generally a substantial freshwater influence. The mixing of freshwater and sea water and the relatively reduced current flows in the shelter of the estuary lead to deposition of fine sediments, often forming extensive intertidal sand and mudflats (Section 4.4.4.4). The character of sediment deposition will also be a function of the tidal

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

character of the estuary with flood dominant systems tending to act as net importers of sediment while ebb dominant systems act as sources of sediment to the coast. The patterns of flood and ebb dominance are often complex and operate in a dynamic equilibrium that is influenced by anthropogenic and natural factors. Together, these factors can result in complex spatial and temporal patterns of sedimentation.

The sensitivity of this Annex 1 habitat to the relevant East Marine Plan activities that might affect it are not presented separately in this section. Instead these sensitivities are considered to be reflected in the sensitivities of the component habitats (reefs, subtidal sandbanks, intertidal mudflats, sandflats and saltmarshes and supralittoral/coastal habitats); and these are presented in the following sections. This consideration will also apply to 'Large shallow inlets and bays' as a feature which encompasses a range of other features and sub-feature habitats.

4.4.4.2 Reefs (i.e. Hard-substratum Habitat)

Reefs can be either biogenic concretions or of geogenic origin (EC, 2007). They are hard, compact substrata on solid and soft bottoms, which arise from the sea floor in the sublittoral and littoral zone. Reefs may support a zonation of benthic algal communities of algae and animal species, as well as concretions of corallogenic organisms. The sensitivities of this Annex 1 habitat to the relevant East Marine Plan activities that might affect it are shown in Table 3. The highest sensitivity relates to direct habitat loss because, in instances where devices, pipelines or cables are placed on qualifying reef feature habitats, then an effect must occur. Reef habitat is also highly sensitive to the physical habitat changes within the PIZ associated with aggregate extraction. *Sabellaria* reefs in the Anglian region are protected through the use of exclusion zones. However in general habitats can be expected to recover following aggregate extraction and are not permanently lost, for instance, evidence indicates that dredging activities do not alter the seabed in a way that is detrimental to the re--colonisation of *Sabellaria spinulosa* (Pearce *et al*., 2007).

Table 3: Potential sensitivities of reef features to the East Marine Plans

Sensitivity Category	Sensitivities	Pathway Ref. No.	**Impact Pathway from East Marine Plans across TIDE, CCS & AGG Activities** (Summary Impact Pathway Description)	Survey	Construction	Operation	Decomm
PLG	Physical Loss/Gain of Habitat	**1**	Loss of coastal and offshore habitat under the footprint of devices, power cables, CO_2 pipelines and also cable/pipeline armouring arising from the installation, operation and decommissioning of these structures.	No impact from any sector	No impact from any sector	TIDE CCS AGG	No impact from any sector
PD	Physical Damage to Habitat	**5**	Changes to coastal and offshore habitat as result of damage from baseline surveys (e.g. boreholes/trawls); from equipment use causing abrasion, damage or smothering during installation and from maintenance and removal of cables/pipelines/devices (e.g. jack-up legs, vessels, anchors, mooring chain).	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG
PD	Physical Damage to Habitat	**6**	Damage to offshore seabed habitat at the site of extraction during the period of the works.	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG
PD	Physical Damage to Habitat	**7**	Damage to the areas surrounding the site of extraction as a result of sediment redistribution and settlement.	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG
PD	Physical Damage to Habitat	**8**	Changes to coastal and offshore habitat as a result of alterations to the wave climate or hydrodynamic (wave and tide) regime from the presence of tidal	No impact from any	No impact from any	TIDE CCS AGG	No impact from any

Sensitivity Category	Sensitivities	Pathway Ref. No.	Impact Pathway from East Marine Plans across TIDE, CCS & AGG Activities (Summary Impact Pathway Description)	Survey	Construction	Operation	Decomm
			devices, CO_2 pipelines, power cables or cable/pipeline armouring causing physical changes (including alterations to sediment transport/scour) or from changes to seabed/sandbank morphology at the extraction site(s) (including alterations to sediment transport/scour).	sector	sector		sector
TC	Toxic Contamination (Reduction in water quality)	19	Spillage of fluids, fuels and/or construction materials (inc. from surface coatings/treatments) during installation or removal of structures (devices and cables), during survey/ maintenance or during aggregate extraction.	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG
TC	Toxic Contamination (Reduction in water quality)	20	Release of contaminants associated with the dispersion of suspended sediments during installation or removal of structures (devices, pipelines and cables) or from the aggregate extraction process.	No impact from any sector	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG
TC	Toxic Contamination (Reduction in water quality)	21	Release of CO_2 into the water column and its acidification from the formation of carbonic acid.	No impact from any sector	No impact from any sector	TIDE CCS AGG	No impact from any sector
NTC	Non-Toxic Contamination (Elevated turbidity)	22	Increase in turbidity (and possibly reduced dissolved oxygen) associated with suspended sediments release during installation or removal of structures (devices, pipelines and cables) or from aggregate extraction.	No impact from any sector	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG
BD	Biological Disturbance (Introduction of non-native species)	24	Introduction of new structures (tidal devices or construction platforms) on the seabed providing new substratum that facilitates the colonisation and ingress of invasive non-native species.	No impact from any sector	No impact from any sector	TIDE CCS AGG	No impact from any sector
BD	Biological Disturbance (Introduction of non-native species)	25	Introduction and ingress of invasive non-native species as biofouling species on the surfaces of vessels or construction plant.	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG
In this table only the estimated sensitivity levels are shown. The level of risk will be dependent upon exposure. For instance there would be a high degree of exposure for designated habitats were a development to occur within or near a designated site. However, at the present time, there is very little information about exposure within the East Marine Plan Areas.							
No Impact							
Low Sensitivity							
Low to Medium Sensitivity							
Medium Sensitivity							
High Sensitivity							

4.4.4.3 Subtidal Sandbanks (i.e. Soft-sediment Habitat)

Sandbanks are defined as elevated, elongated, rounded or irregular topographic features, permanently submerged and predominantly surrounded by deeper water (EC, 2007). They consist mainly of sandy sediments, but larger grain sizes, including boulders and cobbles, or smaller grain sizes including mud may also be present on a sandbank. Banks where sandy sediments occur in a layer over hard substrata are classed as sandbanks if the associated biota are dependent on the sand rather than on the underlying hard substrata. "*Slightly covered by sea water all the time*" means that above a sandbank the water depth is seldom more than 20m below chart datum. Sandbanks can, however, extend beneath 20m below chart datum. It can, therefore, be appropriate to include in designations such areas where they are part of the

feature and host its biological assemblages. The sensitivities of this Annex 1 habitat to the activity that might affect it are shown in Table 4. These are very much the same as for reef features although there is recognition that soft sediment habitats will have a lower sensitivity to sediment smothering events during construction work.

Table 4: Potential sensitivities of sandbank features to the East Marine Plans

Sensitivity Category	Sensitivities	Pathway Ref. No.	Impact Pathway from East Marine Plans across TIDE, CCS & AGG Activities (Summary Impact Pathway Description)	Survey	Construction	Operation	Decomm
PLG	Physical Loss/Gain of Habitat	1	Loss of coastal and offshore habitat under the footprint of devices, power cables, CO_2 pipelines and also cable/pipeline armouring arising from the installation, operation and decommissioning of these structures.	No impact from any sector	No impact from any sector	TIDE CCS AGG	No impact from any sector
PD	Physical Damage to Habitat	5	Changes to coastal and offshore habitat as result of damage from baseline surveys (e.g. boreholes/trawls); from equipment use causing abrasion, damage or smothering during installation and from maintenance and removal of cables/pipelines/devices (e.g. jack-up legs, vessels, anchors, mooring chain).	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG
PD	Physical Damage to Habitat	6	Damage to offshore seabed habitat at the site of extraction during the period of the works.	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG
PD	Physical Damage to Habitat	7	Damage to the areas surrounding the site of extraction as a result of sediment redistribution and settlement.	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG
PD	Physical Damage to Habitat	8	Changes to coastal and offshore habitat as a result of alterations to the wave climate or hydrodynamic (wave and tide) regime from the presence of tidal devices, CO_2 pipelines, power cables or cable/pipeline armouring causing physical changes (including alterations to sediment transport/scour) or from changes to seabed/sandbank morphology at the extraction site(s) (including alterations to sediment transport/scour).	No impact from any sector	No impact from any sector	TIDE CCS AGG	No impact from any sector
TC	Toxic Contamination (Reduction in water quality)	19	Spillage of fluids, fuels and/or construction materials (inc. from surface coatings/treatments) during installation or removal of structures (devices and cables), during survey/ maintenance or during aggregate extraction.	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG
TC	Toxic Contamination (Reduction in water quality)	20	Release of contaminants associated with the dispersion of suspended sediments during installation or removal of structures (devices, pipelines and cables) or from the aggregate extraction process.	No impact from any sector	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG
TC	Toxic Contamination (Reduction in water quality)	21	Release of CO_2 into the water column and its acidification from the formation of carbonic acid.	No impact from any sector	No impact from any sector	TIDE CCS AGG	No impact from any sector

Sensitivity Category	Sensitivities	Pathway Ref. No.	Impact Pathway from East Marine Plans across TIDE, CCS & AGG Activities (Summary Impact Pathway Description)	Survey	Construction	Operation	Decomm
NTC	Non-Toxic Contamination (Elevated turbidity)	22	Increase in turbidity (and possibly reduced dissolved oxygen) associated with suspended sediments release during installation or removal of structures (devices, pipelines and cables) or from aggregate extraction.	No impact from any sector	TIDE	TIDE	TIDE
					CCS	CCS	CCS
					AGG	AGG	AGG
BD	Biological Disturbance (Introduction of non-native species)	24	Introduction of new structures (tidal devices or construction platforms) on the seabed providing new substratum that facilitates the colonisation and ingress of invasive non-native species.	No impact from any sector	No impact from any sector	TIDE	No impact from any sector
						CCS	
						AGG	
BD	Biological Disturbance (Introduction of non-native species)	25	Introduction and ingress of invasive non-native species as biofouling species on the surfaces of vessels or construction plant.	TIDE	TIDE	TIDE	TIDE
				CCS	CCS	CCS	CCS
				AGG	AGG	AGG	AGG

In this table only the estimated sensitivity levels are shown. The level of risk will be dependent upon exposure. For instance there would be a high degree of exposure for designated habitats were a development to occur within or near a designated site. However, at the present time there is very little information about exposure within the East Marine Plan Areas.

No Impact
Low Sensitivity
Low to Medium Sensitivity
Medium Sensitivity
High Sensitivity

4.4.4.4 Intertidal Habitats (Including Saltmarshes)

Intertidal mudflats and sandflats are defined as the sands and muds of the coasts of the oceans, their connected seas and associated lagoons, not covered by sea water at low tide, devoid of vascular plants, usually coated by blue-green algae and diatoms (EC, 2007). They are of particular importance as feeding grounds for wildfowl and waders. Saltmarshes occur in stable intertidal environments typically with fine sediment above the mean high water neap level where vascular plants can survive and can further stabilise the habitat (Boorman, 2003). Once a cover of vegetation has become established the rate of sedimentation (accretion) often increases as more of the incoming sediment is intercepted and trapped by the increased surface roughness. In addition, the vegetation also reduces the resuspension of deposited material and, at the same time, organic matter is added to the marsh surface.

There is a range of Annex 1 saltmarsh habitats depending upon the tidal height and vegetation type, as listed in Section 4.4.2. The sensitivities of these habitats to the activity that might affect it are shown in Table 5. This sensitivities table is similar to those for soft sediment sandbank habitats with the impacts being associated principally with the laying of pipelines/ cables across the intertidal areas. Again, the highest sensitivity relates to direct habitat loss because, in instances where devices or pipelines/cables are placed on qualifying intertidal habitats, then an effect must occur.

Table 5: Potential sensitivities of intertidal features to the East Marine Plans

Sensitivity Category	Sensitivities	Pathway Ref. No.	Impact Pathway from East Marine Plans across TIDE, CCS & AGG Activities (Summary Impact Pathway Description)	Survey	Construction	Operation	Decomm
PLG	Physical Loss/Gain of Habitat	1	Loss of coastal and offshore habitat under the footprint of devices, power cables, CO_2 pipelines and also cable/pipeline armouring arising from the installation, operation and decommissioning of these structures.	No impact from any sector	No impact from any sector	TIDE CCS AGG	No impact from any sector
PD	Physical Damage to Habitat	5	Changes to coastal and offshore habitat as result of damage from baseline surveys (e.g. boreholes/trawls); from equipment use causing abrasion, damage or smothering during installation and from maintenance and removal of cables/pipelines/devices (e.g. jack-up legs, vessels, anchors, mooring chain).	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG
PD	Physical Damage to Habitat	8	Changes to coastal and offshore habitat as a result of alterations to the wave climate or hydrodynamic (wave and tide) regime from the presence of tidal devices, CO_2 pipelines, power cables or cable/pipeline armouring causing physical changes (including alterations to sediment transport/scour) or from changes to seabed/sandbank morphology at the extraction site(s) (including alterations to sediment transport/scour).	No impact from any sector	No impact from any sector	TIDE CCS AGG	No impact from any sector
TC	Toxic Contamination (Reduction in water quality)	19	Spillage of fluids, fuels and/or construction materials (inc. from surface coatings/treatments) during installation or removal of structures (devices and cables), during survey/ maintenance or during aggregate extraction.	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG
TC	Toxic Contamination (Reduction in water quality)	20	Release of contaminants associated with the dispersion of suspended sediments during installation or removal of structures (devices, pipelines and cables) or from the aggregate extraction process.	No impact from any sector	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG
TC	Toxic Contamination (Reduction in water quality)	21	Release of CO_2 into the water column and its acidification from the formation of carbonic acid.	No impact from any sector	No impact from any sector	TIDE CCS AGG	No impact from any sector
NTC	Non-Toxic Contamination (Elevated turbidity)	22	Increase in turbidity (and possibly reduced dissolved oxygen) associated with suspended sediments release during installation or removal of structures (devices, pipelines and cables) or from aggregate extraction.	No impact from any sector	TIDE CCS AGG	No impact from any sector	TIDE CCS AGG
BD	Biological Disturbance (Introduction of non-native species)	24	Introduction of new structures (tidal devices or construction platforms) on the seabed providing new substratum that facilitates the colonisation and ingress of invasive non-native species.	No impact from any sector	No impact from any sector	TIDE CCS AGG	No impact from any sector
BD	Biological Disturbance (Introduction of non-native species)	25	Introduction and ingress of invasive non-native species as biofouling species on the surfaces of vessels or construction plant.	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG
In this table only the estimated sensitivity levels are shown. The level of risk will be dependent upon exposure. For instance there would be a high degree of exposure for designated habitats were a development to occur within or near a designated site. However, at the present time, there is very little information about exposure within the East Marine							

Sensitivity Category	Sensitivities	Pathway Ref. No.	Impact Pathway from East Marine Plans across TIDE, CCS & AGG Activities (Summary Impact Pathway Description)	Survey	Construction	Operation	Decomm
Plan Areas.							
No Impact							
Low Sensitivity							
Low to Medium Sensitivity							
Medium Sensitivity							
High Sensitivity							

4.4.4.5 Supralittoral Habitats

The range of coastal habitat interest features were scoped into this assessment because they could be affected by pipeline/cable laying operations or other landside works such as onshore substations. The relevant qualifying habitat features include dune habitats, vegetated cliffs and coastal lagoons. The sensitivities of these habitats to the activity that might affect them are shown in Table 6. For most cases issues such as the impacts associated with surveys or hydrodynamic effects are not relevant and it is mainly the potential habitat loss/damage from cabling/ pipeline installations and any landside infrastructure that are applicable. Also, the potential for a construction spillage is relevant at all such locations while the issue of sediment resuspension will also be pertinent for lagoonal habitats.

Table 6: Potential sensitivities of supralittoral habitats to the East Marine Plans

Sensitivity Category	Sensitivities	Pathway Ref. No.	Impact Pathway from East Marine Plans across TIDE, CCS & AGG Activities (Summary Impact Pathway Description)	Survey	Construction	Operation	Decomm
PLG	Physical Loss/Gain of Habitat	2	Loss of onshore habitat (including bird breeding and roosting grounds, freshwater habitats, otter holts or shelters) under the footprint of power cables, CO_2 pipelines, cable/pipeline armouring and landside infrastructure due to the installation, operation and decommissioning of these structures.	No impact from any sector	No impact from any sector	TIDE CCS AGG	No impact from any sector
PD	Physical Damage to Habitat	9	Damage to onshore habitat (including bird breeding grounds, freshwater habitats, otter holts or shelters) by excavation, piling and construction work associated with the installation, operation and decommissioning of cables, CO_2 pipelines and landside infrastructure.	No impact from any sector	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG
TC	Toxic Contamination (Reduction in water quality)	19	Spillage of fluids, fuels and/or construction materials (inc. from surface coatings/treatments) during installation or removal of structures (devices and cables), during survey/ maintenance or during aggregate extraction.	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG
TC	Toxic Contamination (Reduction in water quality)	20	Release of contaminants associated with the dispersion of suspended sediments during installation or removal of structures (devices, pipelines and cables) or from the aggregate extraction process.	No impact from any sector	TIDE CCS AGG	No impact from any sector	TIDE CCS AGG

NTC	Non-Toxic Contamination (Elevated turbidity)	**22**	Increase in turbidity (and possibly reduced dissolved oxygen) associated with suspended sediments release during installation or removal of structures (devices, pipelines and cables) or from aggregate extraction.	No impact from any sector	TIDE CCS AGG	No impact from any sector	TIDE CCS AGG

In this table, only the estimated sensitivity levels are shown. The level of risk will be dependent upon exposure. For instance there would be a high degree of exposure for designated habitats were a development to occur within or near a designated site. However, at the present time, there is very little information about exposure within the East Marine Plan Areas.

No Impact
Low Sensitivity
Low to Medium Sensitivity
Medium Sensitivity
High Sensitivity

4.5 Step 4(2): Seabird Sensitivities

4.5.1 Designated Sites with Seabird Features

Following the plan-level screening process (MMO, 2013b), a total of 182 European/Ramsar sites were identified for which there is a LSE (or the potential for a LSE cannot be excluded). Of these sites, a large number had qualifying bird interest features specifically because of the large extent and broad scope of the East Marine Plans, as well as the long-distances covered by foraging seabirds In total, there were 51 SPAs and a further 31 Ramsar Sites with qualifying bird interest features that were originally screened in.

Following the above screening process for activities (Section 4.3) this has been reduced to 122 European/Ramsar sites of which there are 28 SPAs and 9 Ramsar sites with qualifying habitat interest features.

The SPA and Ramsar sites also contain other interest features and/or the habitats within them are an important component of the functionality of the designated sites (e.g. because they provide foraging ground for bird species) and therefore have assigned conservation objectives. The effects on these other features are reviewed separately under the relevant section(s) of the AAIR that deal with these other habitat/species groups.

4.5.2 Interest Features Summary List

Given the large number of sites screened into this assessment, the individual sites and the qualifying bird interest features that they support have not been reviewed in detail within this report. However, the screening and assessment tables in Appendix A (Tables A3 and A6) present a list about the key species that have been included in the scope of this assessment[13].

To assess whether there is any adverse effect on the integrity of relevant European/Ramsar sites, Sections 4.5.3 and 4.5.4 review the sensitivities of the associated bird features via the identified impact pathways. Section 4.8.3 then identifies the conservation objectives and assesses, in tabular format, the effects arising in the context of the proposed additional plan-level mitigation measures.

[13] The lists of bird interest features as presented throughout this HRA process have been derived from the standard Natura 2000 data forms that are available online. This is because these represent the legally binding numbers and species lists and based on advice from JNCC. It is recognised that the JNNC designated site websites contain more up to date being based on the SPA review conducted more recently and these can identify different key species.

4.5.3 Sensitivities of Seabirds to Plan Activities

This section reviews the sensitivities that are relevant for the qualifying seabird interest features. A generic review of the sensitivities of relevant bird features is presented under the following impact pathways identified during the screening phase:

- Physical Loss/Gain of Habitat (Foraging and Onshore Habitat Loss) (Section 4.5.3.1);
- Physical Loss/Gain of Habitat (Fish Aggregation or Artificial Reef) (Section 4.5.3.2);
- Physical Damage to Habitat (Reduction in Habitat Quality) (Section 4.5.3.3);
- Physical Damage to Species (Collision Risk) (Section 4.5.3.4);
- Non-Physical Disturbance (Noise/Visual Disturbance Causing Exclusion Effects) (Section 4.5.3.5);
- Toxic Contamination (Contamination and Spillages) (Section 4.5.3.6);
- Non-Toxic Contamination (Increased Turbidity) (Section 4.5.3.7); and
- Biological Disturbance (Introduced Predation) (Section 4.5.3.8).

4.5.3.1 Physical Loss/Gain of Habitat (Foraging and Onshore Habitat Loss; Pathways 2 and 3)

Seabed habitat important for foraging seabirds and their prey may be lost as a result of the installation of cables, pipelines and devices (for TIDE and CCS sectors). Similar temporary losses of habitat will also occur during decommissioning. This pathway is not, however, relevant to the extraction of aggregates because there are no requirements for permanent seabed infrastructure and restoration of the seabed substratum after completion of an aggregate campaign is assumed.

The direct loss of onshore habitats as a result of cable/pipeline installation or any landside infrastructure works also poses a risk. Loss of breeding habitat within any designated site would obviously cause a significant effect that would be likely to be more detrimental than any loss of foraging habitat. Wintering waterbird species (such as Bar-tailed Godwit, Purple Sandpiper, Turnstone, Ringed Plover and Sanderling) also may be affected by any loss of intertidal habitat due to onshore activities and developments associated with any scheme.

The direct loss of seabed habitat may affect all seabird species considered in this assessment due to effects on the availability of their prey. In advance of any details about exposure levels, birds are considered to have a high sensitivity during these phases. All species could potentially be affected by any loss of onshore habitat (e.g. breeding species by a loss of breeding sites or wintering species by loss of intertidal habitat). While all species are considered to be of high sensitivity to this risk, there is also a likelihood (although no certainty) that key sites would be avoided such that the residual significance of such effects would be negligible.

4.5.3.2 Physical Loss/Gain of Habitat (Fish Aggregating Effects; Impact Pathway 4)

The construction of devices/structures on the sea bed and including any armouring around them could generate localised new habitat for fish and benthic communities (i.e. Fish Aggregation Devices (FADs) or artificial reefs). This in turn could affect the prey availability in the immediate

vicinity of such structures and create new foraging opportunities for diving bird species. Such an effect could occur, especially, around larger tidal energy arrays (which would be most likely to occur in the large tidal resource areas identified off the North Norfolk Coast as shown in Figure 3). Smaller and discrete sub-surface structures acting as FADs could include armoured tidal power cables and carbon pipeline pipelines or subsurface structures associated with carbon delivery to aquifers. No effects would occur from aggregate extraction as there will be no introduced infrastructure.

The extent of this effect is unknown, though it is likely to be small for all species and, if it attracts seabirds to areas with sub-surface moving tidal generation devices, then the increased risk of collision (see Section 4.5.3.4) needs to be considered. Furthermore, additional above-surface structures may provide habitat for seabirds such as gulls and terns to perch or rest on, or even potential breeding locations themselves. Overall, species are considered to have a low sensitivity to the creation of new habitat in this manner.

4.5.3.3 Physical Damage to Habitat (Damage of Onshore or Offshore Habitat; Impact Pathways 9 to 11)

As described in Section 3.2.2, the potential exists for damage to occur to onshore or offshore habitats with implications for breeding sites, overwintering areas or foraging habitats. Physical damage to supporting habitats through aggregate extraction has the potential to reduce prey availability (a small proportion of this reduction will be due to the direct uptake during the extraction process) and affect prey spawning habitat. It is, however, possible that the organic enrichment effects from damaged benthos in the outwash and overflow might mitigate, to some extent, this loss (Tillin *et al*., 2011). Changes in bathymetry under the footprint of the dredging could also potentially affect the foraging success of seabirds given the birds need to dive in deeper water to reach their prey species; thus potentially affecting energy budgets by lowering food intake rates.

Scouring of seabed habitats during a range of survey, maintenance and construction actives will be pertinent across all the sectors. Although damage from the TIDE and CCS sectors could occur through range of onshore, coastal and offshore habitats such effects for aggregate extraction will be largely confined to offshore areas. Sandy sediments may be important for seabirds as a large proportion of the species that have been screened into the assessment rely heavily on sandeels for feeding both themselves and their young (Winslade, 1974). The risk and magnitude of such direct effects on the seabed habitats will be dependent on a range of factors such as the habitat type, the extent of habitat affected, the location and the nature of activities and whether they are temporary or permanent. In advance of any details about he exposure levels the sensitivities of seabirds are considered to be medium to such effects and during the construction and decommissioning phases of tidal energy and CCS schemes when activities on site will be greatest.

4.5.3.4 Physical Damage to Species (Collision Risk; Pathway 13 and 14)

Seabirds could potentially collide with structures both above and, especially, below the sea-surface during surveying, construction, operation and decommissioning of any tidal power device or carbon storage infrastructure. Collision risk and mortality will depend on a range of factors related to bird species, abundance, foraging modes (e.g. locations and methods), foraging timings (e.g. day or night), topography, weather conditions the value of the area as a feeding ground, the consistency with which it is used for foraging and the nature (especially the underwater mobility) of the structures themselves including the use of lighting for above-surface components (DECC, 2009). The issues associated with each of the key stages of individual projects within the Plan are described in the following sections.

Collision risk with vessels throughout all stages of the activities being assessed within the East Marine Plans (including propeller collision risk) would be expected to be low given the highly mobile nature of such bird species. It is also likely that any visual and noise disturbance caused by the vessel movements themselves would limit the potential for collision incidents.

During surveying, construction and decommissioning

Collisions underwater could occur during baseline surveys involving the physical retrieval of samples or bed materials, including borehole surveying or ecological trawl sampling. There is also a risk of birds colliding above the water with machinery and vessels during the construction phase, and whilst birds are generally manoeuvrable, they are nonetheless at risk, especially during the night. Although many breeding birds remain at their nest sites on land at night, some may roost at sea (Gaston, 2004). However, the collision risk with vessels is thought to be minimal, and operational construction vessels pose less threat than commercial shipping due to slow travelling speeds. The sensitivity of seabirds during the surveying, construction and decommissioning is considered to be low.

During operation

Schemes visible from above the surface could create a barrier effect and, therefore, birds in flight may alter their flight route, avoiding structures to a greater degree at night (Desholm & Kahlert, 2005). As above surface structures associated with tidal devices of carbon delivery will be largely static (unlike wind turbines), the likelihood of collision will typically be small in most cases. However, the risk may be greater in sounds and channels where topography may prevent flying birds avoiding structures. For schemes placed in open waters, more detailed information on the location of the project proposals and the related movements of species between their breeding colonies and foraging areas would be required for assessment of any proposed scheme.

During operation, collision with turbine blades underwater may potentially pose the highest risk to diving foraging seabirds, though the significance of this will depend on whether birds will be able to detect and avoid the blades. The design of devices and use of features such as cowling around rotors will also affect collision risk. As with above surface structures, the risk posed may be greater in sounds and channels where topography restricts avoidance. The risk of collision in such sites will also depend on topography and whether birds will be able to detect and avoid the blades, and also the orientation of any scheme. The risk of collision will also be increased if schemes alter flow characteristics; birds are attracted to flow gradients due to prey association, and any alteration could present a higher risk for diving species.

Underwater collision risk will also be greater in areas with moderate to high turbidity where visibility for birds is reduced. For instance, a very small increase in turbidity can negatively affect the vision of cormorants (Strod *et al*., 2004). In comparison to turbine blades, fixed moorings (i.e. anchor blacks and plinths) should present no greater risk to diving seabirds than natural barriers, and cables, chains, and considering the small cross-sectional area, power lines extending through the water column should not provide a major threat of entanglement.

Overall, the sensitivity of seabirds to collision risk during operational phase of tidal energy generation is considered to be high but further details on exposure levels will be needed to fully understand site-specific risk levels. Sensitivities at a population-level are also likely to be inherently lower than for individuals. For the carbon storage and aggregates sectors a low sensitivities are anticipated during the operational phase.

Species sensitivities

All species scoped into this assessment are at some risk of collision during the survey, construction, operation (highest especially for the tidal energy sector) and decommissioning phases but this will vary according to the nature of the environment, and species foraging modes. It is those diving bird species which forage on coastal and offshore waters, whether at the surface or through diving and pursuit (see Tables 7 and 8), that are at the greatest risk of colliding with surface and sub-surface structures.

Some species such as shag forage only during daylight, whereas a proportion of foraging activity of guillemots and razorbills occurs around dawn and dusk (Daunt *et al*., 2006; Thaxter *et al*., 2009) possibly increasing the risk of effects. Moreover, Manx shearwaters and both petrel species arrive at breeding burrows overnight (thus, travelling at sea overnight), rendering these species more at risk with surface collisions. This may be exacerbated by their low flight trajectory.

During survey, construction and decommissioning, those seabirds that fly and forage during the night are considered to be of low sensitivity from collision with structures, e.g. due to activities of cable/pipeline and device installation. During operation the same species are considered to be of medium sensitivity from collision mortality due to the presence of above sea-surface surface structures and vessels. Diurnally foraging species can be considered at lower risk of collision mortality in all phases (Table 8).

During turbine operation, collision risk will particularly depend on the size and positioning of devices in the water column. Species that dive underwater, and hence spend time travelling through or foraging within the water column, will be at the greatest overall risk of collision with below sea-surface structures. Hence, these species are considered to be of high sensitivity; surface feeders will be least at risk (classed as low), as they are not likely to interact with underwater turbine blades (Table 8).

Individual species that may be considered to be of medium sensitivity include plunge divers such as the Gannet, together with species that dive from the surface but use the whole water column including common guillemot, razorbill, puffin, shag and cormorant. Surface feeders such as gulls, skuas and terns are only likely to be of low sensitivity to collision and only at risk from floating devices and above surface structures.

Collision rates are variable and while an accurate quantitative understanding about the impacts is not possible, Collision Risk Modelling (CRM) tools has been extensively used for both onshore and offshore sites globally, including a range of UK offshore developments, and these can be useful guidance but they will need to be verified though in-situ monitoring in the future.

It is however difficult to assess the collision risk of birds as species may make random migration and forage flights or may repeatedly fly over the same routes. Identifying distinct flyway routes is complex both because of the nature and limitations of available information on the subject and because these movements are likely to occur across broad fronts rather than along clearly definable routes. There are also a number of variables involved in flight direction including:

- Spatial variation in food abundance (including anthropogenic factors such as fishing vessels);
- The risk of predation/kleptoparasitism by other bird species;
- The importance of nest attending to incubate eggs and protect nest from predators; and
- Weather and climatological factors.

Gannets have also been observed on occasion repeatedly foraging over a narrow range of bearings in the North Sea. However, conversely to this, in the Celtic Sea, birds at a much smaller site did not show this pattern. It was concluded that differences in the consistency of foraging locations were related mainly to differences in the spatial and temporal predictability of prey resources in the two study areas (Hamer *et al*., 2007).

Lighting

As noted above the risk of collision with static surface structures (from tidal energy of carbon storage structures) and vessels (for all sectors) is much lower than for surface moving turbines. However, the role of lighting of such structures needs to be considered in evaluating the overall effects. This issue has been given a lot of consideration as part of investigations into the collision risk posed by very high wind farms towers (>200m) where the above-water collision risk is clearly much greater (than for the sectors being reviewed in this assessment).

Early work carried out by Cochran and Graber (1958) found that lights on tall communication towers attracted migratory birds which often resulted in collision. A more recent study also found strong positive link between lighting and collision rate (Evans & Manville, 2000). Therefore it has been concluded that offshore wind farms, when lit at night, could pose a risk that is similar to communication towers (Ecology Consulting, 2001). It is likely that only modest (if any) such above water features will be present for the tidal energy generation and carbon storage sectors. However, the possibility cannot be excluded (depending upon project scale, duration and relevant technologies) that large above-surface rig structures may be used for carbon storage (e.g. reusing old oil/gas platforms) in which event they then they may pose the greatest risks of collision (or a distraction to migratory birds).

Navigational lighting (applicable across all three sectors) has also been identified as potentially increasing collision risks and studies of different species have indicated that altering the type of lighting (e.g. flashing/strobing) and/or the light's colour spectrum can reduce the risk of attracting birds and therefore reduce such collision risks.

4.5.3.5 Non-Physical Disturbance (Noise/Visual Disturbance Causing Exclusion Effects; Pathways 16 and 17)

Disturbance

Noise and/ or visual disturbance may occur during the pre-construction survey work (seismic exploration, geophysical surveys), construction/decommissioning (installation/removal of cable, pipelines and turbines or vessel movements) and the operation (mainly maintenance vessel and aggregate extraction vessel movements) phases of any work. The extent to which birds are affected by sources of noise and visual disturbance has been the subject of a lot of previous research and monitoring work. Disturbance can result in birds flying away or ceasing to feed which could in turn cause an increase in their energy requirements or result in them moving to alternative, less suitable feeding or roosting sites. Such a response would affect energy budgets and food intake rates, and possibly survival (Kaiser, 2002). The effect of such disturbance is linked to the amount of times it occurs and the status of the conditions that are prevalent.

Studies generally show that birds are disturbed by a sudden large noise but have the ability to habituate (become accustomed to) to regular noises. For instance, with respect to piling specifically, it has been concluded that although piling has the potential to create most noise during construction, it often consists of rhythmic "bangs", which, after a short period, birds are likely to become accustomed to (ABP Research & Consultancy Ltd, 2001). Other research has also indicated that, in general, birds appear to habituate to continual noises as long as there is no large amplitude 'startling' component (Hockin *et al*., 1992).

As part of the construction work for ABB Power Generation Ltd (Pyewipe), winter bird monitoring showed that there was no large-scale disturbance due to construction work on the site. Although some localised disturbance was recorded in response to two sudden events, this was not considered to have a major effect on surrounding bird populations and was found to be no greater than the effect arising from third party disturbance, including walkers and stopped cyclists, which were unrelated to the work carried out by ABB (ERM, 1996). Observations suggested that it was the initial sudden bang during piling activities, which caused the disturbance, and that subsequent bangs typically resulted in reduced disturbance, demonstrating habituation.

These findings were supported by the studies carried out for the Humber International Terminal development, which again indicated that the key factor in triggering disturbance was human presence (ABP Research & Consultancy Ltd, 2000). Over 12 separate visits, disturbance by construction activities (which involved piling and reclamation of part of the foreshore) was observed on 3 occasions and in each case birds were disturbed over a small area and then rapidly resettled within the zone of disturbance (i.e. they did not leave the area). More recently, surveys of the birds around the Immingham Outer Harbour in the Humber (using the same methods) have also indicated that such disturbance events are limited and are often attributable to non-Port related activities such as the presence of Peregrine Falcons or walkers on the mudflat (ABPmer, 2010c).

The ABP Teignmouth Quay Development estimated an approximate zone within which birds may be affected by disturbance from construction works (piling and dredging) to be typically about 200m (ABPmer, 2002). The startling effects of sudden noise were quantified, based on published research, by the Environment Agency for the Humber Estuary Tidal Defences scheme. It was concluded that a sudden noise in the region of 80 dB appears to elicit a flight response in waders up to 250m from the source, with levels below this of approximately 70 dB causing flight or anxiety behaviour in some species.

Drilling/piling activity both during preliminary surveys and construction could disrupt seabird foraging and directly affect the senses of species diving underwater for prey. Seabirds hunt visually underwater, but evidence from on land suggests they may also have acute hearing, and thus marine noise could potentially disorientate and upset foraging rhythms, and cause permanent damage to hearing.

A recent bird disturbance field project examined their responses to marine recreational activities at 20 different locations along the Solent coastline during the period December 2009 to February 2010 (Liley 2011). Data recorded included all recreational activity, counts of birds and detailed behavioural observations. A total of 44 different bird species (including waders, ducks, geese, herons, cormorants, divers, grebes and rails) were recorded during the fieldwork. Most human activity involved people staying on the shore/seawall rather than on the intertidal or on the water. A total of 2,507 potential disturbance events were recorded, with 4,064 species specific observations. A total of 17% of these resulted in disturbance. In general, across all species, and for most individual species, disturbance tended to occur when the activity was relatively close to the birds, and birds tended to respond less the further away the activity was. Activities that took place on the intertidal were more likely to result in disturbance than those on the water or on the shore. The magnitude of response was, however, typically greater in response to water based activities.

There is limited data available regarding noise and vibration during dredging, although underwater noise levels are generally comparable to other types of commercial marine traffic. In the context of aggregate extraction the presence of the dredger may cause an increase in noise and vibration levels which could result in disturbance to seabirds. Seaducks, auks, divers, grebes and mergansers are regularly occurring migratory species in the region (Emu, 2012) and have the potential to be impacted by vessel presence and noise and vibration. This disturbance

would, however, only occur across a relatively small proportion of the foraging ranges of the respective bird species.

Overall a lot is known as to the reaction to, and sensitivity of, species to marine noise but it sis highly dependent upon location and impact type. Thus, it is not fully possible to assess the likelihood or magnitude of noise effects at any phase of the scheme. However, diving species are probably at greater risk and hence provisionally considered to be of medium sensitivity compared to low sensitivity for surface-feeders.

Exclusion from Areas

As a result of disturbance, avoidance of areas of habitat by birds may occur during the pre-construction survey, construction, operation and decommissioning phases of any tidal energy of carbon storage development. For aggregate dredging regular vessel movement (in addition to seabed damage) could result in the localised displacement of seabirds. Exclusion from habitats essentially prevents access to prey sources. Such exclusion could reduce other effects, notably collision mortality. However, reductions in the availability of habitat and access to prey could lead to many changes in the way individuals forage, including increased individual stress levels and alterations to individual time budgets owing to travelling further to find food (Scottish Executive, 2007).

Although alternative foraging areas may exist, the quality of the foraging habitat that species are forced to use may be lower, as well as more distant, thus increasing searching and foraging time needed to meet energetic needs. Species may have little flexibility to alter their time budgets to encompass extra foraging/travel to destinations. Species may also be reliant on a particular prey source at a location and may have less ability to switch to a different prey source. Effects at the colony and nest sites would be experienced through a reduced attendance time (due to lower feeding rates of chicks and longer foraging trips), possibly with increased neglect of chicks increasing predation risk or attacks from conspecifics. Furthermore, reduction in available habitat can generate increased competition to find food with knock-on implications for neighbouring areas (i.e. not included in the assessment). These disturbances may, therefore, cause a reduction in foraging success, decreases in breeding success, and effects on individual fitness.

All seabird species screened into the assessment are at some risk of disturbance from the indirect loss of foraging habitat although it is clearly the case that this is dependent upon foraging locations used by different species (i.e. whether they feed on intertidal or offshore locations) and the area of development activity. In general, the effects will be temporary during initial survey phases, causing minimal disruption. However, more significant effects may occur in the construction, operation and decommissioning phases.

The effect that these changes have on birds will depend on how flexible the species are at coping with changes. For instance, Garthe and Hüppop (2004) evaluated the sensitivity of species to offshore wind farms, and their score for flexibility in habitat use provides a useful measure to the sensitivity of species to this effect. As suggested by evidence from offshore wind farms, red-throated divers and common scoters (both diving species) may be particularly sensitive to disturbance and thus the effects of indirect habitat loss. Displacement studies around turbines and boat related activity reported in NE and JNCC (2010) showed that up to 80 to 100% of red-throated divers were displaced from the development footprint and surrounding area. Disturbance associated with marine aggregate extraction and related vessel presence could have similar effects for these seabirds (Emu, 2012).

The breeding success of some surface-feeding species, such as terns and kittiwakes, is negatively affected by changes in food availability due to reliance of prey brought to the sea surface (Furness & Tasker, 2000). However, those species with higher burdens to energy costs

of flight and foraging (such as auks) may find it harder to increase foraging ranges to more distant prey resources (if such a change were to occur), than for instance gannets that are generally less sensitive to natural changes in the availability of food, and can forage over a much wider area. Diving species with high wing loading have high energetic cost during flight, thought to be linked with adaptation of wings for underwater locomotion (Gaston and Jones 1998; Thaxter *et al*., 2010). Thus, while they have the potential to forage far from colonies, their typical ranges may be smaller than those of other species, i.e. 20-40km (Thaxter *et al*., 2009; 2010), and may be less flexible in making changes in the event of reduced prey availability (Enstipp *et al*., 2006). In summary, diving species are considered to have a medium sensitivity to this effect, and surface-feeding species have a low sensitivity.

The effect of disturbance and habitat exclusion during construction will depend on its extent of construction and operational activities, as well as the time of year; a potential mitigation is to avoid construction at vital times (i.e. before and during breeding) when prey is needed by adult birds and for provisioning to offspring.

4.5.3.6 Toxic Contamination (Contamination and Spillages; Pathways 19 to 21)

Spillage of oils and fluids from construction or aggregate extraction vessels and machinery into the marine environment could adversely affect sediment or water quality during all phases, and across a wide range of areas at the development sites and along the access route, for any scheme developed in the East Marine Plan Areas; for instance, through vessel collision, or improper construction or maintenance. Marine birds are particularly sensitive to contamination by oil (Votier *et al*., 2008), as the oil can cause considerable damage to waterproofing and flight (Wernham *et al*., 1997), as well as additional physiological damage of birds ingesting oil.

Seabirds are also at risk of contaminated sediments that are resuspended into the water column. The magnitude of the effect is dependent upon the level of contamination; the proximity of the East Marine Plans activity to a designated site and species foraging areas; the type of activity occurring; the manner in which that activity is pursued (including the extent and duration); the particle size of the disturbed sediments and the hydrodynamic conditions. It has been indicated that settlement of sediment is most likely to occur within 20-200m of a cable for a wind farm (BERR, 2008) but contaminants are almost always associated with fine sediments and could travel further than this in some areas where there is a large tidal excursion and strong tidal flows.

The sensitivity of species to oil contamination is considered to be medium during construction, operation, and decommissioning, but a low risk during surveying, and is dependent on the general behaviour and distribution of species (e.g. the proportion of time spent on the sea surface relative to flying or feeding locations). Auks, in particular, may spend a considerable amount of time on the sea surface or foraging (Thaxter *et al*., 2010), and thus have a higher risk of being adversely affected by 'at sea' spillages of contamination events (e.g. Votier *et al*., 2008). By contrast waders would only be affected by contamination events that affect their intertidal foraging zones.

Ingestion of contaminated sediments either through direct poisoning or bio-magnification of pollutants through ingestion of contaminated prey would increase the probability of mortality of all species being considered. The precise risk would again depend on the use of the area by foraging seabirds. All species are sensitive to this effect, however the overall sensitivity of species is considered low during all phases of the East Marine Plan's implementation.

Ingestion of contaminated sediments either through direct poisoning or bio-magnification of pollutants through ingestion of contaminated prey would increase the probability of mortality of all species being considered. The precise risk would depend on the use of the area by foraging

seabirds. The overall sensitivity of species to this effect is considered low during all phases (Table 8).

4.5.3.7 Non-Toxic Contamination (Increased Turbidity; Pathway 22)

Activities involved during the construction and decommissioning of tidal devices, pipelines or cabling (e.g. use of jack-up legs, piling activities and cable installation) as well aggregate extraction can/will result in an increase in suspended sediments and turbidity, potentially leading to effects on (diving) seabird foraging success and predator-prey interactions. The suspended sediment plumes generated through aggregate extraction in this region are considered temporary and likely to last at most a few hours after the cessation of dredging.

The worst case footprints of the plume from aggregate extraction are typically localised, around the Licence Areas. The extent of any effect will be determined by the environment itself (i.e. by the strength of currents dispersing the sediment and background suspended sediment levels). The nature, scale and location of the structures will be the key determinants of the risk and magnitude of the effect.

In addition to changes in turbidity, there will also be a change in hydrodynamic regime around any feature that may affect diving seabirds. Fish are attracted to areas of high flow gradients and fronts. Thus, a change in local turbidity and flow of currents during all phases of construction and operation may influence the distribution of prey resources for all diving seabird species resulting in change of use of an area.

Species diving underwater are at greatest risk of having foraging activity disrupted by sediment mobilisation and suspension, and this is most likely to occur during the construction and decommissioning phases. Diving species such as Auks, Shags and Cormorants use much of the water column thus are considered to have a medium sensitivity to this effect, whereas surface-feeding seabirds are considered to have a low sensitivity. However, all species are at risk of disruption due to likely prey avoidance of areas that have been disturbed. All species are also at medium risk from changes to prey distribution areas associated with changes in hydrodynamics. Nevertheless, given the high energy of the environment, the sensitivities of species to this effect are considered to be low.

4.5.3.8 Biological Disturbance (Introduced Predation; Pathway 23)

Mink and rat predation is considered to be a key problem for seabird colonies. Mink, in particular, can swim between islands that are less than 2 km apart and, thus, any structures above the water line (associated with tidal energy generation of carbon delivery) could allow these predators access to more distant, previously undisturbed locations (Scottish Executive, 2007). Should such constructions reduce the distance between islands to less than 2km, this effect should be considered of potential high significance.

Should mammalian predators such as rats or mink be capable of reaching undisturbed locations as a result of placement of devices, then there is a potential significant risk to seabird colonies. Burrow nesters such as Puffins, Manx Shearwaters, and petrels, ground nesters such as gulls and terns, and species that nest in boulder fields (such as Razorbill) can be considered to be of high sensitivity during operation, given that their nests are more easily accessed by ground predators than cliff-nesting species (classed as being of medium sensitivity during operation, Table 8). Appropriate mitigation (e.g. raising platforms above sea-level to restrict access to mammalian predators) would greatly reduce the residual effect.

Sensitivities for this pathway are clearly greatest in areas with islands or in more confined estuary channels. Such sites are limited for the East Marine Plan Areas as a whole and, therefore, the risks via this route are considered to be very low.

4.5.4 Seabird Interest Features

The general characteristics and sensitivities of relevant seabird interest features are presented against the relevant East Marine Plan activities that could cause a LSE (recognising that there are no initial mitigation measures in this case). Information on the relative sensitivities of habitat features have been based on professional judgment and past Plan-level HRA case examples. It should be noted throughout this section that different species will have different sensitivities to effects according to a number of factors including:

- Whether they forage by diving or at the surface;
- Whether they forage nocturnally/crepuscularly or diurnally; and
- Whether they are ground/burrow/crevice-nesting species or cliff-nesters.

This categorisation of species is summarised in Table 7. However, it should be noted that these categories are not mutually exclusive.

Table 7: Breeding/foraging parameters of breeding seabirds which influence sensitivities

Breeding Receptors	Foraging Mode	Nocturnal Flight/ Diving Activity	Nesting Location
Red-throated Diver	Pursuit-diver	No	Ground
Fulmar	Surface feeder	Yes	Cliff
Manx Shearwater	Surface/pursuit-diver	Yes	Burrow/crevice
Storm Petrel	Surface feeder	Yes	Burrow/crevice
Leach's Petrel	Surface feeder	Yes	Burrow/crevice
Gannet	Plunge/pursuit-diver	No	Ground/cliff
Cormorant	Pursuit-diver	No	Cliff/above ground
Shag	Pursuit-diver	No	Cliff
Common Scoter	Diver/pursuit-diver	No	Ground
Arctic Skua	Surface feeder	No	Ground
Great Skua	Surface feeder	No	Ground
Herring Gull	Surface feeder	Yes	Ground
Great Black-backed Gull	Surface feeder	Yes	Ground
Kittiwake	Surface feeder	Yes	Cliff
Arctic Tern	Surface feeder	No	Ground
Guillemot	Pursuit-diver	Crepuscular	Cliff
Razorbill	Pursuit-diver	Crepuscular	Cliff
Puffin	Pursuit-diver	Crepuscular	Burrow/crevice

(Sources: Gaston & Jones, 1998; Garthe & Hüppop, 2004)

4.5.4.1 Seabird Sensitivities

The sensitivities of qualifying bird interest features species to the activities associated with the East Marine Plans are shown in Table 8. Some of the highest risks are associated with habitat loss, reduced foraging area, collision risk and disturbance. The levels of risk will be different depending upon the life history and foraging behaviour of the species in questions. Diving birds (such as those listed in Table 7) for instance will be at a greater risk of collision risk and foraging habitat loss than those which feed on intertidal habitats. This level of risk for different species is indicated within Table 8. To additionally provide an indication of which birds species are at risk from different project components, the screening schedules for each of the five short-term wave

and tidal energy generating options (as shown in Table A6 in Appendix A) include a reference to the general location of key species (i.e. whether they are landward, intertidal of offshore).

Table 8: Potential sensitivities of bird interest features to the East Marine Plans

Sensitivity Category	Sensitivities	Pathway Ref. No.	Impact Pathway from East Marine Plans across TIDE, CCS & AGG Activities (Summary Impact Pathway Description)	Survey	Construction	Operation	Decomm
PLG	Physical Loss/Gain of Habitat	2	Loss of onshore habitat (including bird breeding and roosting grounds, freshwater habitats, otter holts or shelters) under the footprint of power cables, CO_2 pipelines, cable/pipeline armouring and landside infrastructure due to the installation, operation and decommissioning of these structures. [applies to all seabirds]	No impact from any sector	No impact from any sector	TIDE CCS AGG	No impact from any sector
PLG	Physical Loss/Gain of Habitat	3	Loss of foraging areas from a reduction in coastal and offshore habitat due to installation of devices, power cables, CO_2 pipelines and/or cable/pipeline armouring both at the development footprint and outside from bed scour and indirectly from changes to the hydrodynamic (wave and tide) regime. [applies to all seabirds]	No impact from any sector	No impact from any sector	TIDE CCS AGG	No impact from any sector
PLG	Physical Loss/Gain of Habitat	4	Presence of tidal generation (or other) structures on seabed for the duration of the project resulting in changes to prey and species behaviour (e.g. acting as FAD (Fish Aggregating Device), artificial reef or bird roost). [diving and surface feeding seabirds are most sensitive]	No impact from any sector	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG
PD	Physical Damage to Habitat	9	Damage to onshore habitat (including bird breeding grounds, freshwater habitats, otter holts or shelters) by excavation, piling and construction work associated with the installation, operation and decommissioning of cables, CO_2 pipelines and landside infrastructure. [applies to all seabirds]	No impact from any sector	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG
PD	Physical Damage to Habitat	10	Reduction in quality of foraging areas as result of damage to coastal and offshore habitat from baseline surveys (e.g. boreholes and trawls); from equipment use causing abrasion, damage or smothering during installation; from maintenance and removal of cables, pipeline, tidal/devices or from scour, sediment transport and hydrodynamic change during operation. [applies to all seabirds]	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG
PD	Physical Damage to Habitat	11	Reduction in quality of foraging areas as result of damage to coastal and offshore habitat within and surrounding the aggregate sites during the extraction process [diving seabirds are most sensitive]	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG
PD	Physical Damage to Species	13	Collision risk and possible mortality of species due to the presence of tidal devices or from vessels travelling to and from the site (including propeller collision risk).[diving birds and nocturnal species are the most sensitive]	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG

Sensitivity Category	Sensitivities	Pathway Ref. No.	Impact Pathway from East Marine Plans across TIDE, CCS & AGG Activities (Summary Impact Pathway Description)	Survey	Construction	Operation	Decomm
PD	Physical Damage to Species	14	Presence of above water structures, and any associated lighting, influencing migration/foraging of bird species. [nocturnal species are the most sensitive]	TIDE	TIDE	TIDE	TIDE
				CCS	CCS	CCS	CCS
				AGG	AGG	AGG	AGG
NPD	Non-Physical disturbance	16	Visual disturbance and exclusion from areas as a result of surveying; cable, pipeline or tidal device installation/operation and decommissioning activities (including movements of vessels). [applies to all seabirds although diving and surface feeding seabirds are most sensitive]	TIDE	TIDE	TIDE	TIDE
				CCS	CCS	CCS	CCS
				AGG	AGG	AGG	AGG
NPD	Non-Physical disturbance	17	Noise/vibration disturbance and exclusion from areas as a result of vessels and other activities during survey work (e.g. seismic exploration and geophysical surveys), construction (e.g. piling, drilling, cable laying), operation (e.g. device noise), maintenance or decommissioning. Also includes noise/vibration disturbance from vessels and draghead during aggregate extraction. [applies to all seabirds although surface feeders generally more sensitive than divers to changes in prey availability but divers may be less able to increase foraging range]	TIDE	TIDE	TIDE	TIDE
				CCS	CCS	CCS	CCS
				AGG	AGG	AGG	AGG
TC	Toxic Contamination (Reduction in water quality)	19	Spillage of fluids, fuels and/or construction materials (inc. from surface coatings/treatments) during installation or removal of structures (devices and cables), during survey/ maintenance or during aggregate extraction. [at-sea diving seabirds are most sensitive]	TIDE	TIDE	TIDE	TIDE
				CCS	CCS	CCS	CCS
				AGG	AGG	AGG	AGG
TC	Toxic Contamination (Reduction in water quality)	20	Release of contaminants associated with the dispersion of suspended sediments during installation or removal of structures (devices, pipelines and cables) or from the aggregate extraction process. [at-sea diving seabirds are most sensitive]	No impact from any sector	TIDE	TIDE	TIDE
					CCS	CCS	CCS
					AGG	AGG	AGG
TC	Toxic Contamination (Reduction in water quality)	21	Release of CO_2 into the water column and its acidification from the formation of carbonic acid. . [applies to all seabirds but at-sea diving seabirds are most sensitive]	No impact from any sector	No impact from any sector	TIDE	No impact from any sector
						CCS	
						AGG	
NTC	Non-Toxic Contamination (Elevated turbidity)	22	Increase in turbidity (and possibly reduced dissolved oxygen) associated with suspended sediments release during installation or removal of structures (devices, pipelines and cables) or from aggregate extraction. [at-sea diving seabirds are most sensitive]	No impact from any sector	TIDE	TIDE	TIDE
					CCS	CCS	CCS
					AGG	AGG	AGG
BD	Biological Disturbance (Introduction of non-native species)	23	Predation by introduced rats/mink through the positioning of static devices (turbines, rigs) close to breeding seabird sites. [ground nesting birds most sensitive]	No impact from any sector	TIDE	TIDE	TIDE
					CSS	CSS	CSS
					AGG	AGG	AGG

In this table, only the estimated sensitivity levels are shown. The level of risk will be dependent upon exposure. For instance there would be a high degree of exposure for seabirds were a development to occur within or near a designated site or an important foraging area. However, at the present time, there is very little information about exposure within the East Marine Plan Areas.

Sensitivity Category	Sensitivities	Pathway Ref. No.	Impact Pathway from East Marine Plans across TIDE, CCS & AGG Activities (Summary Impact Pathway Description)	Survey	Construction	Operation	Decomm
No Impact							
Low Sensitivity							
Low to Medium Sensitivity							
Medium Sensitivity							
High Sensitivity							

4.6 Step 4(3): Marine Mammal Sensitivities

4.6.1 Designated Sites with Marine Mammal Features

Following the plan-level screening process (MMO, 2013b), a total of 182 European/Ramsar sites were identified for which there is a LSE (or the potential for a LSE cannot be excluded). Of these sites, a large number had qualifying marine mammal interest features specifically.

Following the screening process for activities (Section 4.3), the total number of screened in sites was reduced to 122 European/Ramsar sites of which there are 60 SACs and 2 Ramsar sites (all but one of which are non-UK sites) with qualifying marine mammal interest features.

The relevant qualifying marine mammal features are summarised below in Section 4.6.2.

4.6.2 Interest Features Summary List

In summary, the screening phase concluded that there was a possibility of a LSE for the following qualifying marine mammal interest features:

- Common (Harbour) Seal (1365);
- Grey Seal (1364);
- Bottlenose Dolphin (1349);
- Harbour Porpoise (1351); and
- Otter (1355).

To assess whether there is any adverse effect on the integrity of the relevant European sites, Sections 4.6.3 and 4.6.4 review the sensitivities of these marine mammal features and identifies the conservation objectives for these features. Section 4.8.4 then identifies the conservation objectives for these features and assesses, in tabular format, the effects arising in the context of the proposed additional plan-level mitigation measures.

4.6.3 Sensitivities of Marine Mammals to Plan Activities

This section reviews the sensitivities that are relevant for the marine mammal interest features. Initially a generic review of the sensitivities is presented under the following impact pathways identified during the screening phase:

- Physical Loss/Gain of Habitat (Loss of Foraging area) (Section 4.6.3.1);
- Physical Loss/Gain of Habitat (Fish Aggregating Effects) (Section 4.6.3.2);
- Physical Damage to Habitat (Reduction in Foraging Habitat Quality) (Section 4.6.3.3);
- Physical Damage to Species (Damage to Seal Haul-Outs) (Section 4.6.3.4);
- Physical Damage to Species (Collision Risk) (Section 4.6.3.5);
- Non-Physical Disturbance (Noise/Visual Disturbance causing Barrier and Exclusion effects) (Section 4.6.3.6);
- Non-Physical Disturbance (Electromagnetic Fields) (Section 4.6.3.7);
- Toxic Contamination (Contamination and Spillages) (Section 4.6.3.8); and
- Non-Toxic Contamination (Increased Turbidity) (Section 4.6.3.9).

4.6.3.1 Physical Loss/Gain of Habitat (Loss of Foraging Area; Impact Pathway 3)

The loss of offshore seals or cetacean foraging grounds or onshore otter holts could occur from a wide range of structure installation and maintenance work (cable/pipeline laying) associated with tidal energy generation of carbon capture storage work. However, there will be no loss through aggregate extraction (see also Section 4.4.3.1).

Marine mammals have extensive ranges and cover very large distances to forage in the pelagic environment. Critical (key) habitats for marine mammals are those that are essential for day-to-day well-being and survival, as well as for maintaining a healthy population growth rate. Areas that are regularly used for feeding, breeding, raising calves and socialising, as well as, sometimes, migrating, are the key components of critical habitat (WDCS, 2010). In addition to places used regularly for feeding, breeding, raising calves and socialising, locations where associated and supporting activities such as hunting, courtship, singing, calving, nursing, resting, playing and communication take place are important to consider. For a complete consideration of critical habitat, it should also extend to the critical habitat of marine mammal prey and areas where important ecosystem processes occur such as productive upwellings and fish spawning grounds. These critical habitat areas will be the most sensitive parts of a marine mammal range to any developments that cause loss (or gain) of habitat.

Otter are vulnerable to the loss of their shelters (including those on the shoreline) and to the loss of habitat which, in turn, can leave them more exposed to disturbance effects. Therefore, habitat loss and disturbance are interlinked factors.

4.6.3.2 Physical Loss/Gain of Habitat (Fish Aggregating Effects; Impact Pathway 4)

As described in Section 4.5.3.2, the construction of devices/structures on the seabed, including any armouring around them, could generate localised new habitat for fish and benthic communities (i.e. Fish Aggregation Devices (FADs) or artificial reefs). Any large-scale effect is most likely to occur around tidal energy generation arrays which would then pose collision risk issues for marine mammals (see Section 4.6.3.5).

Marine mammals feed on a variety of pelagic and demersal prey. The diet of seals, bottlenose dolphin and harbour porpoise species around the UK is summarised in Table 9.

Table 9: Prey species commonly consumed by the marine mammals around the UK

Species	Diet
Common Seal	Sandeels with octopus, gadoids and clupeids also consumed
Grey Seal	Sandeels, gadoids (particularly cod), flatfish (particularly plaice) and sculpins
Harbour Porpoise	Sandeels, gadoids such as whiting *(Merlangius merlangus)* and clupeids (herring and sprats)
Bottlenose Dolphin	Primarily feed on gadoids such as cod, saithe and whiting as well as Atlantic salmon and cephalopods

(Based on information from DECC, 2009; Reid *et al*., 2003; Santos *et al*., 2004; MacLeod *et al*., 2007)

Fish are often attracted to solid man-made structures placed on the seabed and artificial reefs are often deployed to enhance fisheries (Sayer *et al*., 2005). These modify the habitat and provide food and shelter for fish and invertebrate species leading to increased fish abundance and enhancement of the local seabed habitat (Wilhelmsson *et al*., 2006). Structures can change local abiotic conditions allowing species assemblages to form that are different from natural communities present. Therefore, the potential for prey items of marine mammals to be attracted to underwater structures which could act as a Fish Aggregating Device (FAD) will largely be dependant on the habitat preference of specific species. For example, pelagic species such as salmon which undertake large migrations and seasonal movements are less likely to aggregate around structures as demersal species such as gadoids which show a greater association with the seabed.

4.6.3.3 Physical Damage to Habitat (Damage to Offshore Foraging Grounds and Onshore Otter Holts; Impact Pathway 9 to 11)

Damage to offshore seals or cetacean foraging grounds or onshore otter holts could occur from a wide range of structure installation and maintenance work (cable/pipeline laying) as well as through aggregate extraction. Foraging areas are a critical habitat for marine mammals. The Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area (ACCOBAMS) described critical habitat as 'a place or area regularly used by a cetacean group, population or species to perform tasks essential for survival and equilibrium maintenance' (WDCS, 2010). Marine mammals use very large ranges typically to undertake foraging but can often be aggregated in 'hotspot' areas where key prey resources are found in high densities. For example, important foraging habitat for harbour porpoises includes areas of strong tidal currents, usually near islands or headlands, where the currents combine with the seafloor topography and seem to create conditions where a higher abundance of prey are recorded (Pierpoint, 2008; Marubini *et al*., 2009; DECC, 2009). Spawning and nursery sites for prey species will be particularly sensitive to any environmental change.

Landside development, including cable alignments, pipelines and grid connections have the potential to have a direct effect on onshore freshwater habitats. When assessing the impacts of construction work the sensitivities of otter to habitat damage are gauged by the presence or absence of otter activity (e.g. spraints) and, in particular, by evidence of otter shelters, as it is usually these which ultimately constrain a development in terms of licensing. The scales of the developmental work allied to the level of otter activity dictate the potential risks that exist. However, even relatively small-scale developments such as bridge repairs or bank works have the potential to impact on otters while larger developments spread over extensive areas pose a greater risk and require more detailed surveys and investigations into otter sensitivity.

4.6.3.4 Physical Damage to Species (Damage to Seal Haul-Outs; Impact Pathway 12)

Impacts to intertidal areas from cable/pipelines laying, or other infrastructure work, could affect established seal haul out location. Seals use haul-outs for resting between foraging trips, giving birth (pupping) in the moulting season and also as a nursery for pups (SCOS, 2009). In the UK, grey seals typically breed on remote uninhabited islands or coasts and in small numbers in caves. Harbour seals come ashore in sheltered waters, typically on sandbanks and in estuaries, but also in rocky areas. Harbour seals haul out on land in a pattern that is often related to the tidal cycle. In general both grey and common seals are highly sensitive to disturbance by humans hence their preference often for remote breeding sites (SCOS, 2009).

Grey seals in the UK spend longer hauled out during their annual moult (between December and April) and during their breeding season (between August and December). Common seals give birth to their pups in June and July and moult in August. At these times of the year seals will be the most susceptible to human disturbance at haul out sites. These potential impacts are restricted to the tidal energy and CCS sectors.

4.6.3.5 Physical Damage to Species (Collision Risk; Impact Pathway 13)

The main collision risks to marine mammals are posed by the moving turbines on tidal energy generation devices and the propellers (especially ducted) of vessels used for all sectoral activities. Marine mammals have quick reflexes, good sensory capabilities and fast swimming speeds (over 6m/s for harbour porpoise). These species also can be very agile (Carter, 2007; Hoelzel, 2002). These are all attributes which increase the chance of close range evasion with an object that could cause a collision risk. It is well documented, however, that marine mammals have collided with anthropogenic structures such as fishing gear and ships (Pace *et al*., 2006; Zollett & Rosenberg, 2005). Reduced perception levels of a collision threat through distraction, whilst undertaking other activities such as foraging and social interactions, are possible reasons why collisions are recorded in marine mammals (Wilson *et al*., 2007).

Young grey seal pups, which are inexperienced at sea, could be particularly vulnerable to collision risk. Marine mammals can also be very curious of new foreign objects placed in their environment and so curiosity around an object could also increase the risk of collision. Marine mammals are relatively robust to potential strikes as they have a thick sub-dermal layer of blubber which would defend their vital organs from the worst of any blows (Wilson *et al*., 2007). Nevertheless, a direct collision with a sharp object such as a moving blade still has the potential to cause injury to marine mammals.

In the context of marine aggregate extraction species are most susceptible to collision where vessels display erratic behaviour and/or operate at high speeds (Hazel *et al*., 2007; Scottish Executive, 2007). The typical speed of a dredger when in operation is 0.5 to 1.5 knots and the vessel will transit along a pre-determined route to the area and then dredge within defined dredging areas generally aligning runs to the tide. Ships travelling at 14 knots (~7m/s) or faster are most likely to cause lethal or serious injuries if there is a collision (Scottish Executive, 2007). These factors are likely to mitigate against any potential collision risks. Furthermore, elevated underwater noise levels during operation may be beneficial as they can alert species to the presence of the ship thereby reducing the risk of collisions.

There is no available evidence to suggest whether otters have collided with anthropogenic structures, such as vessels. However, otters are highly mobile which indicates that they have an increased chance of close range evasion with an object that could cause a collision risk. The risk of any effects will also be dependent upon the location (especially the distance of any device from a holt or foraging ground) and the type of devices being deployed.

4.6.3.6 Non-Physical Disturbance (Noise/Visual Disturbance Causing Barrier and Exclusion Effects; Impact Pathways 15 to 17)

Disturbance to marine mammals will come from a variety of sources, construction activities and vessel movements across all of the three sectors. However, only tidal energy generation, and especially the construction of larger arrays, have the potential to present a significant physical obstruction that might act as a barrier to migration. The potential sensitivities to mammals from visual and noise disturbances as well the effects of barriers to movement are presented below.

Visual disturbance

Disturbance caused by an external visual influence can cause marine mammals to stop feeding, resting, travelling and/or socialising, with possible long term effects of repeated disturbance including loss of weight, condition and a reduction in reproductive success (ABPmer, 2009; JNCC, 2008). The group which are most at risk from visual disturbance are seals (when they are on land resting or breeding). In general, ships more than 1,500m away from grey seal haul out areas are unlikely to evoke any reactions from grey seals. Between 900m and 1,500m, grey seals could be expected to detect the presence of vessels and at closer than 900m a flight reaction could be expected (Scottish Executive, 2007).

In the UK, there are currently no good-practice guidelines for minimisation of disturbance by shipping or commercial vessels (JNCC, 2008). However, the Scottish Marine Wildlife Watching Code that was designed for recreational water users advises that the minimum approach distance for vessels to avoid visual and noise disturbance to dolphins and porpoises is 50m (200-400m for mothers and calves, or for animals that are clearly actively feeding or in transit).

Disturbance to otter can occur in locations with intense human disturbance such as recreational areas, especially where there are dogs present (SNH, 2010). The other kinds of activity that can cause disturbance to otter populations include:

- Finfish, shellfish and other aquaculture activities (and associated human and vessel movements);
- Coastal civil engineering project where these cause a loss of shoreline holts; and
- The use of creels/pots in water shallower than 10m which have has potential to cause injury or mortality to otters.

As otters also move along established paths between open-water habitats, including freshwater sites near the coast, they are also sensitive to any proposals that cause obstruction to these traditional routes.

Noise disturbance

Marine mammals (particularly cetaceans) are considered to be the most sensitive receptors in relation to acoustic disturbance in the marine environment, due to their use of echolocation and vocal communication (DECC, 2009). In comparison to fish, marine mammal species are sensitive to a very broad bandwidth of sound (being responsive at frequencies from 100Hz to 170kHz and possessing sensitive hearing over the frequency range from 20kHz to 150kHz).

The impacts of noise on marine mammals can broadly be split into lethal and physical injury, auditory injury and behavioural response. In terms of Lethality and Physical Injury, at very high exposure levels, such as those typical close to underwater explosive operations or offshore impact piling (pile driving) operations, fatality may occur in species of marine mammal where the incident peak to peak sound level exceeds 240dB re. 1µPa. The likelihood of fatality increases with levels above 240dB re. 1µPa. As the time period of the exposure increases (represented

by the impulse), there is also an increase in likelihood of fatality. It is recognised though that the received levels around which lethality, physical damage and disturbance occurs are not well understood (Sarah Dolman, Whale and Dolphin Conservation Society (WDCS) Pers. Comm.).

With respect to auditory injury, at sound levels in excess of 180dB re. 1µPa, and particularly where there are repeated high level exposures from activities such as impact pile driving, seismic operations, or for continuous wave sound such as sonar, underwater sound has the potential to cause hearing impairment in marine species. This can take the form of a temporary loss in hearing sensitivity, known as a Temporary Threshold Shift (TTS), or a permanent loss of hearing sensitivity, known as a Permanent Threshold Shift (PTS) (Nedwell *et al*., 2007a).

In terms of their behavioural response, it has been observed that this can occur at relatively low sound pressure levels. These reactions may include the animals leaving the area for a period of time, or a startle reaction may be observed. Behavioural response from underwater sound is often assessed by comparing the received sound level with the auditory threshold of marine mammals. For example, Richardson *et al*. (1995) used critical bands, normally octave or third octave band received levels of noise in comparison with the corresponding marine mammal hearing threshold in order to estimate the range of audibility and zones of influence from underwater sound sources.

This form of analysis has been taken a stage further by Nedwell *et al*. (2007b), where the underwater noise is compared with receptor hearing threshold across the entire receptor auditory bandwidth in the same manner that the dB(A) is used to assess noise source in air for human subjects. The criteria used in these studies is behavioural based, where received sound levels of 90dB above hearing threshold are considered to cause a strong behavioural avoidance, and levels of 50dB above hearing threshold a mild behavioural response by a minority of individuals (Table 10). It should be noted that these criteria reflect the initial response and do not reflect the complexity of behavioural, physiological and auditory impacts over the short and long-term. Furthermore, this criterion has not been validated by experimental study. The potential effects of anthropogenic underwater noise on the behaviour of marine mammals are difficult to determine as they are context dependent, and must be statistically based.

Table 10: Criteria suggested for the effects of underwater noise on marine mammals and fish

Level in dBht (Species)	Effect
Less than 0	None
0 to 50	Mild reaction by minority of individuals
50 to 90	Stronger reaction by majority of individuals but habituation at lower levels may limit effect
90 and above	Strong avoidance reaction by all individuals
Above 110	Tolerance limit of sound; unbearably loud
Above 130	Possibility of traumatic hearing damage from single event

(Source: Nedwell *et al*., 2007b)

One of the greatest potential impacts on marine mammals from noise is during construction through pile driving and drill blast techniques (in order to allow removal of bedrock) which would be associated with the tidal energy and carbon storage sectors. A number of studies have investigated the distances at which marine mammals may be disturbed as a result of piling and blast noise associated with offshore wind farms (Table 11). Based on the findings from these studies it is apparent that, although hearing injuries from construction are only likely to occur within several hundred metres of pile driving activity, strong avoidance responses could occur

several kilometres from the piling with masking of vocalization and mild behavioural changes (e.g. change in swimming direction) occurring as far away as 50km or more from a wind farm development.

Table 11: Summary of research on the spatial extent of piling noise impacts on marine mammals

Activity	Study	Background Information	Reference
Pile driving	Empirical study on underwater noise levels during pile-driving at turbines in NE Scotland and potential effects on marine mammals.	Pile-driving noise was measured at distances of 0.1 to 80km (when background noise was no longer distinguishable above ambient). The study concluded that for bottlenose dolphins auditory injury would only have occurred within 100m of the pile-driving and behavioural disturbance (defined as modifications in behaviour) could have occurred up to 50km away.	Bailey *et al*. (2010)
	Empirical studies of porpoise behaviour during construction of offshore wind farms at Horns Rev (North Sea) and Nysted (Baltic).	At the wind farms, acoustic activity of porpoises decreased shortly after each pile-driving event and returned to baseline conditions after 3-4h. This effect was not only observed in the direct vicinity of the construction site but also at monitoring stations approximately 15km away. Behavioural observations showed that during pile-driving, porpoises exhibited relatively more directional swimming patterns. This effect was found at distances of more than 11km, and possibly also up to 15km from the construction site.	Tougaard *et al*. (2003a; 2003b)
	Assessment of the likely sensitivity of bottlenose dolphins to pile-driving noise.	Research concluded that at 9kHz, masking of strong vocalisations could potentially occur within 10 to 15km. The potential masking radius was predicted to reduce with increasing frequency to 6km at 50kHz and 1.2km at 115kHz.	David (2006)
	Attenuation of modelled pile-driving noise at different distances from the source levels.	Study concluded that pile-driving noise, under realistic North Sea conditions, would be audible to harbour porpoises and seals over distances of at least 80km. Thomsen *et al*. (2006) also applied the dBht metric which indicated that mild behavioural reactions (e.g. subtle change in swimming direction) in harbour porpoises might occur between 7 and 20km distance from the pile-driving source.	Thomsen *et al*. (2006)
	A two-zone model of effect from pile-driving noise based on measurements from North Hoyle, Scroby Sands, Kentish Flats, Barrow and Burbo Bank.	A Noise Injury Zone, bounded by the 130dBht contour, defines the area in which hearing injury can occur, and, in addition, the areas in which lethal and physical injury could occur, since the ranges at which these will occur are much less than those for hearing injury. This area typically extends to a few hundred metres from pile driving. The Behavioural Effect Zone is bounded by the 90dBht level contour. Within this area, the modelling suggested that harbour porpoise show strong avoidance within ranges of a few kilometres. Milder behavioural effects could occur at ranges of the order of 10 kilometres or more. Noise from pile driving operations can remain above the background underwater noise to ranges of 25km or more.	Nedwell *et al*. (2003; 2007a)
	Assessment of lethal and physical injury of marine mammals and requirements for Passive Acoustic Monitoring.	The estimated likely impact ranges from a 4.7m diameter pile (252 dB re: 1 µPa source level) were predicted to be 4m for lethal range and 81m for injury range. A 6m diameter pile (260dB re: 1 µPa source level) had a lethal range of 65m and an injury range of 530m.	Parvin *et al*. (2007)
Blasting	Sensitivity of marine mammals to blasting.	In this study an impulse of 69 Pas is given as leading to a low incidence of trivial blast injuries with no eardrum ruptures. The report found that for a 45kg charge the blast impulse will fall to this level at a range of about 2.2km. In addition to these figures, dBht levels were calculated from the stand off distances measurements at 600m, these are given as 135dBht (*Phocoena phocoena*) harbour seal, 152dBht (*Phocoena vitulina*) harbour porpoise and 158 dBht (*Orcinus orca*) killer whale. The linear SPL at this range was 217dB re 1 µPa. These figures are in excess of the 90 dBht reaction threshold.	Nedwell *et al*. (2007a)
	Assessment of lethal and physical injury of marine mammals and requirements for Passive Acoustic Monitoring.	Blast source levels were found to have lethal ranges of 6-110m and injury ranges of 48-900m.	Parvin *et al*. (2007)

As for aggregate extraction, the increased noise and activity during dredging activities could lead to potential behavioural and stress related reactions in marine mammals (e.g. avoidance of migration route). Factors such as age, condition, sex, behaviour, season and social state influence the level of stress experienced (Götz *et al*., 2009).

Dredging produces broadband and continuous sound, mainly at low frequencies of less than 1000Hz and source sound pressure levels of around 160 to >180dB re 1µPa at 1m (Götz *et al*., 2009). Marine aggregate extraction off the UK is generally undertaken by trailer suction hopper dredgers (TSHD). For most dredging activities, the main source of noise relates to the vessel engine, with additional higher frequency sound generated by sand and gravel rising up through the suction pipe, the movement of the draghead on the seabed and splashing from the spillways. The source levels for different TSHDs used in marine aggregate extraction vary depending on the size of the dredger and local environmental factors (e.g. seabed substrate). Götz *et al*. (2009) estimated source levels for TSHDs to be between 179 and 187dB re 1µPa at 1m.

The key finding of a recent MALSF study was that the noise output of dredging vessels is similar to a 'noisy merchant vessel' at frequencies less than 500Hz and is substantially quieter in terms of acoustic energy output than some other anthropogenic noise sources such as seismic airguns and marine pile driving (Robinson *et al*., 2011). Dredgers also generate higher levels of noise at frequencies above 1kHz than a typical merchant vessel. Analysis of the measured data for differing operation modes leads to the conclusion that the major source of this higher frequency noise is the impact/abrasion of the aggregate material passing through the draghead, suction pipe and pump (possibly with some additional contribution due to cavitation noise).

Noise attenuation from source depends upon a number of environmental factors including the level of background noise at a site. For this reason, the effects of dredging noise on sensitive receptors vary significantly from site to site. Moreover, limited data exist regarding underwater noise production during dredging operations and the effects on marine mammals.

Parvin *et al*. (2008) provided data on the behavioural response of certain marine mammal species to noise levels generated by suction dredging operations. These data show that a strong behavioural avoidance reaction in marine mammals present in the study area would occur up to 500m from the source of dredger noise. The range beyond which the noise levels would not result in a behavioural response in any marine mammals is 7km.

Blocking pathways and displacement from habitat and food source

Presence of sub-surface tidal structures may present a barrier to movement and migratory pathways depending on array design. Cetaceans are highly mobile, pelagic species which can undergo large seasonal movements and migrations (Reid *et al*., 2003; Learmonth *et al*., 2006). They can therefore be particularly vulnerable to any structures which could act as a barrier, preventing movement to these key foraging or nursery grounds.

4.6.3.7 Non-Physical Disturbance (Electromagnetic Fields; Impact Pathway 18)

Electromagnetic fields arise from power cables for transmitting electricity (associated with tidal energy power cabling) as a result of the current passing along the conductor and the voltage differential between the conductor and earth ground, which is nominally at zero volts. The nature and strength of the fields produced, depends on the system voltage and the current passing through. The effects on the surrounding environment depend on the cable construction, configuration and orientation in space.

In order to standardise terminology, Gill *et al*. (2005) proposed the term EMF should be used to describe the direct electromagnetic field. The two constituent fields of the EMF should be clearly defined as the E (Electric) field and the B (Magnetic Field) field, whilst the induced electric field should be labelled the iE field.

Magnetic Fields are produced from alternating current (AC) or direct current (DC) passing through the conductor and these emanate outwards from the cable in a circular plane, perpendicular to its longitudinal axis. The field strength produced as a result of the operation of electricity transmission (AC or DC) decreases rapidly with distance away from the source (the decay curve follows the inverse square law). The magnetic field around an AC cable is constantly changing at the same frequency as the AC that is producing it, which means that the modulation it produces in the Earth's field will also be constantly variable.

Marine mammals are not considered to be electrosensitive species (Gill *et al*., 2005) and there is an apparently low risk of cetacean species being affected. For magnetosensitive species, sensitivity to the geomagnetic field is associated with a direction finding ability e.g. migration. Gill *et al*. (2005) listed cetaceans including the harbour porpoise as magnetosensitive; no evidence was found to suggest that pinnipeds (e.g. Grey seals) are magnetoreceptive. The underlying assumption that cetaceans have ferromagnetic organelles capable of determining small differences in relative magnetic field strength remains, however, unproven and is based on circumstantial information. There is also no apparent evidence that existing cables have influenced migration of cetaceans. Migration of the harbour porpoise in and out of the Baltic Sea necessitates several crossings over operating subsea HVDC cables in the Skagerrak and western Baltic Sea without any apparent effect on their migration pattern (Scottish Executive, 2007).

4.6.3.8 Toxic Contamination (Contamination and Spillages; Pathways 19 to 21)

As discussed in preceding sections, there is a risk of contamination and spillages across all sectors (especially from vessel movements/accidents). In addition there is the potential for leaching of toxic compounds from sacrificial anodes, antifouling paints or leakage of hydraulic fluids (if present) from tidal devices. A small number of tidal devices are expected to use antifouling coatings, and whilst organotins are now banned, the use of copper is still permitted. Leakages from offshore carbon injection operations can also affect the water quality through the requirement of oily water discharges and the use of chemicals (EA, 2013). Injection also has the potential to displace large quantities of paleowater that may be hypersaline or of low quality (EA, 2012). Seals and cetaceans in the study area generally have a low sensitivity to contamination, although the sensitivity rises to medium around seal breeding sites (Scottish Executive, 2007).

Marine mammals are also exposed to a variety of anthropogenic contaminants, through the consumption of prey. As top predators, they are at particular risk from contaminants which biomagnify through the food chain (i.e. are found at increasing concentrations at higher trophic levels). Most research has focused on two main groups of contaminants: the persistent organic pollutants (POPs) and the heavy metals. However, there is some information on other contaminants including polyaromatic hydrocarbons (PAHs), butyl tins and perfluorinated chemicals (DECC, 2009). POPs accumulate in fatty tissues, are persistent and commonly resistant to metabolic degradation; they are often found in high concentrations in marine mammal blubber. They may affect the reproductive, immune and hormonal systems.

Cadmium, lead, zinc and mercury are the heavy metals of greatest importance in marine mammals. They are frequently present in the highest concentrations in the liver, kidney and bone, with levels varying considerably with the geographic location of the species. Marine mammals are able to produce certain proteins (metallothioneins) which can sequester certain metal ions into less toxic complexes; this enables many species to cope with relatively high

dietary exposures to certain metals. Whilst there are few studies that show major impacts of heavy metals, it is possible that they may have combined effects as they often co-occur with the persistent organic contaminants (DECC, 2009).

4.6.3.9 Non-Toxic Contamination (Increased Turbidity; Pathway 22)

Increased turbidity could affect foraging, social and predator/prey interactions of marine mammals. However, marine mammals are known to have acute hearing capabilities which allow them to function as predators in low visibility, turbid conditions. Seals just use passive listening while Odontocetes are known to use both passive and active listening when navigating and foraging (echolocation). Marine mammals also have well developed vision which also helps them operate in low light levels (Scottish Executive, 2007). Seals hunting in poor visibility waters also use fish-generated water movements for locating prey, which they can detect using their highly sensitive mystacial vibrissae (Schulte-Pelkum *et al*., 2007). Marine mammals are therefore well adapted to living in areas with a high suspended sediment load and are regularly recorded in such environments in the UK e.g. estuaries and tidal steams.

4.6.4 Marine Mammal Interest Features

The individual characteristics and sensitivities for each of the relevant qualifying marine mammal interest features are presented and the activities that could cause an impact are identified and tabulated (recognising that there are no initial mitigation measures in this case). These interest feature reviews are set out in the following three sections:

- Grey and Common Seal (Pinnipeds) (Section 4.6.4.1);
- Bottlenose Dolphin and Harbour Porpoise (Cetaceans) (Section 4.6.4.2); and
- Otter (Section 4.6.4.3).

4.6.4.1 Grey and Common Seal (Pinnipeds)

The sensitivities of qualifying seal interest features species (namely common and grey seals) to the activities associated with the East Marine Plans are shown in Table 12.

Table 12: Potential sensitivities of seal features from the East Marine Plans

Sensitivity Category	Sensitivities	Pathway Ref. No.	**Impact Pathway from East Marine Plans across TIDE, CCS & AGG Activities** (Summary Impact Pathway Description)	Survey	Construction	Operation	Decomm
PLG	Physical Loss/Gain of Habitat	**3**	Loss of foraging areas from a reduction in coastal and offshore habitat due to installation of devices, power cables, CO_2 pipelines and/or cable/pipeline armouring both at the development footprint and outside from bed scour and indirectly from changes to the hydrodynamic (wave and tide) regime.	No impact from any sector	No impact from any sector	TIDE CCS AGG	No impact from any sector
PLG	Physical Loss/Gain of Habitat	**4**	Presence of tidal generation (or other) structures on seabed for the duration of the project resulting in changes to prey and species behaviour (e.g. acting as FAD (Fish Aggregating Device), artificial reef or bird roost).	No impact from any sector	No impact from any sector	TIDE CCS AGG	No impact from any sector

Sensitivity Category	Sensitivities	Pathway Ref. No.	Impact Pathway from East Marine Plans across TIDE, CCS & AGG Activities (Summary Impact Pathway Description)	Survey	Construction	Operation	Decomm
PD	Physical Damage to Habitat	10	Reduction in quality of foraging areas as result of damage to coastal and offshore habitat from baseline surveys (e.g. boreholes and trawls); from equipment use causing abrasion, damage or smothering during installation; from maintenance and removal of cables, pipeline, tidal/devices or from scour, sediment transport and hydrodynamic change during operation.	TIDE	TIDE	TIDE	TIDE
				CCS	CCS	CCS	CCS
				AGG	AGG	AGG	AGG
PD	Physical Damage to Habitat	11	Reduction in quality of foraging areas as result of damage to coastal and offshore habitat within and surrounding the aggregate sites during the extraction process.	No impact from any sector	No impact from any sector	TIDE	No impact from any sector
						CCS	
						AGG	
PD	Physical Damage to Habitat	12	Damage to seal haul out locations during the installation, decommissioning and operation of the cables, pipeline and/or cable/pipeline armouring.	No impact from any sector	TIDE	TIDE	TIDE
					CCS	CCS	CCS
					AGG	AGG	AGG
PD	Physical Damage to Species	13	Collision risk and possible mortality of species due to the presence of tidal devices or from vessels travelling to and from the site (including propeller collision risk).	TIDE	TIDE	TIDE	TIDE
				CCS	CCS	CCS	CCS
				AGG	AGG	AGG	AGG
NPD	Non-Physical disturbance	15	Presence of sub-surface structures and disturbance (noise or visual) associated with tidal devices may present a barrier to movement and block migratory pathways or access to feeding grounds depending on array design.	No impact from any sector	No impact from any sector	TIDE	No impact from any sector
						CCS	
						AGG	
NPD	Non-physical disturbance	16	Visual disturbance and exclusion from areas as a result of surveying; cable, pipeline or tidal device installation/operation and decommissioning activities (including movements of vessels).	TIDE	TIDE	TIDE	TIDE
				CCS	CCS	CCS	CCS
				AGG	AGG	AGG	AGG
NPD	Non-physical disturbance	17	Noise/vibration disturbance and exclusion from areas as a result of vessels and other activities during survey work (e.g. seismic exploration and geophysical surveys), construction (e.g. piling, drilling, cable laying), operation (e.g. device noise), maintenance or decommissioning. Also includes noise/vibration disturbance from vessels and draghead during aggregate extraction.	TIDE	TIDE	TIDE	TIDE
				CCS	CCS	CCS	CCS
				AGG	AGG	AGG	AGG
TC	Toxic Contamination (Reduction in water quality)	19	Spillage of fluids, fuels and/or construction materials (inc. from surface coatings/treatments) during installation or removal of structures (devices and cables), during survey/ maintenance or during aggregate extraction.	TIDE	TIDE	TIDE	TIDE
				CCS	CCS	CCS	CCS
				AGG	AGG	AGG	AGG
TC	Toxic Contamination (Reduction in water quality)	20	Release of contaminants associated with the dispersion of suspended sediments during installation or removal of structures (devices, pipelines and cables) or from the aggregate extraction process.	No impact from any sector	TIDE	TIDE	TIDE
					CCS	CCS	CCS
					AGG	AGG	AGG

Sensitivity Category	Sensitivities	Pathway Ref. No.	Impact Pathway from East Marine Plans across TIDE, CCS & AGG Activities (Summary Impact Pathway Description)	Survey	Construction	Operation	Decomm
TC	Toxic Contamination (Reduction in water quality)	21	Release of CO_2 into the water column and its acidification from the formation of carbonic acid.	No impact from any sector	No impact from any sector	TIDE CCS AGG	No impact from any sector
NTC	Non toxic Contamination (Elevated turbidity)	22	Increase in turbidity (and possibly reduced dissolved oxygen) associated with suspended sediments release during installation or removal of structures (devices, pipelines and cables) or from aggregate extraction.	No impact from any sector	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG

In this table only the estimated sensitivity levels are shown. The level of risk will be dependent upon exposure. For instance there would be a high degree of exposure for marine mammals were a development to occur within or near a designated site. However, at the present time, there is very little information about exposure within the East Marine Plan Areas.

No Impact
Low Sensitivity
Low to Medium Sensitivity
Medium Sensitivity
High Sensitivity

4.6.4.2 Bottlenose Dolphin and Harbour Porpoise (Cetaceans)

The sensitivities of qualifying seal interest features species (namely bottlenose dolphin and harbour porpoise) to the activities associated with the East Marine Plans are shown in Table 13.

Table 13: Potential sensitivities of cetacean features from the East Marine Plans

Sensitivity Category	Sensitivities	Pathway Ref. No.	Impact Pathway from East Marine Plans across TIDE, CCS & AGG Activities (Summary Impact Pathway Description)	Survey	Construction	Operation	Decomm
PLG	Physical Loss/Gain of Habitat	3	Loss of foraging areas from a reduction in coastal and offshore habitat due to installation of devices, power cables, CO_2 pipelines and/or cable/pipeline armouring both at the development footprint and outside from bed scour and indirectly from changes to the hydrodynamic (wave and tide) regime.	No impact from any sector	No impact from any sector	TIDE CCS AGG	No impact from any sector
PLG	Physical Loss/Gain of Habitat	4	Presence of tidal generation (or other) structures on seabed for the duration of the project resulting in changes to prey and species behaviour (e.g. acting as FAD (Fish Aggregating Device), artificial reef or bird roost).	No impact from any sector	No impact from any sector	TIDE CCS AGG	No impact from any sector
PD	Damage to habitat	10	Reduction in quality of foraging areas as result of damage to coastal and offshore habitat from baseline surveys (e.g. boreholes and trawls); from equipment use causing abrasion, damage or smothering during installation; from maintenance and removal of cables, pipeline, tidal/devices or from scour, sediment transport and hydrodynamic change during operation.	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG

Sensitivity Category	Sensitivities	Pathway Ref. No.	**Impact Pathway from East Marine Plans across TIDE, CCS & AGG Activities** (Summary Impact Pathway Description)	Survey	Construction	Operation	Decomm
PD	Physical Damage to Habitat	**11**	Reduction in quality of foraging areas as result of damage to coastal and offshore habitat within and surrounding the aggregate sites during the extraction process.	No impact from any sector	No impact from any sector	TIDE CCS AGG	No impact from any sector
PD	Damage to species	**13**	Collision risk and possible mortality of species due to the presence of tidal devices or from vessels travelling to and from the site (including propeller collision risk).	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG
NPD	Non-physical disturbance	**15**	Presence of sub-surface structures and disturbance (noise or visual) associated with tidal devices may present a barrier to movement and block migratory pathways or access to feeding grounds depending on array design.	No impact from any sector	No impact from any sector	TIDE CCS AGG	No impact from any sector
NPD	Non-physical disturbance	**16**	Visual disturbance and exclusion from areas as a result of surveying; cable, pipeline or tidal device installation/operation and decommissioning activities (including movements of vessels).	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG
NPD	Non-physical disturbance	**17**	Noise/vibration disturbance and exclusion from areas as a result of vessels and other activities during survey work (e.g. seismic exploration and geophysical surveys), construction (e.g. piling, drilling, cable laying), operation (e.g. device noise), maintenance or decommissioning. Also includes noise/vibration disturbance from vessels and draghead during aggregate extraction.	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG
NPD	Non-physical disturbance	**18**	Impacts from Electromagnetic Fields (EMF) on electromagnetically sensitive fish and cetaceans interfering with prey location and mate detection in some species and creating barriers to migration.	No impact from any sector	No impact from any sector	TIDE CCS AGG	No impact from any sector
TC	Toxic Contamination (Reduction in water quality)	**19**	Spillage of fluids, fuels and/or construction materials (inc. from surface coatings/treatments) during installation or removal of structures (devices and cables), during survey/ maintenance or during aggregate extraction.	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG
TC	Toxic Contamination (Reduction in water quality)	**20**	Release of contaminants associated with the dispersion of suspended sediments during installation or removal of structures (devices, pipelines and cables) or from the aggregate extraction process.	No impact from any sector	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG
TC	Toxic Contamination (Reduction in water quality)	**21**	Release of CO_2 into the water column and its acidification from the formation of carbonic acid.	No impact from any sector	No impact from any sector	TIDE CCS AGG	No impact from any sector
NTC	Non-toxic Contamination (Elevated turbidity)	**22**	Increase in turbidity (and possibly reduced dissolved oxygen) associated with suspended sediments release during installation or removal of structures (devices, pipelines and cables) or from aggregate extraction.	No impact from any sector	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG

Sensitivity Category	Sensitivities	Pathway Ref. No.	Impact Pathway from East Marine Plans across TIDE, CCS & AGG Activities (Summary Impact Pathway Description)	Survey	Construction	Operation	Decomm
In this table only the estimated sensitivity levels are shown. The level of risk will be dependent upon exposure. For instance there would be a high degree of exposure for marine mammals were a development to occur within or near a designated site. However, at the present time, there is very little information about exposure within the East Marine Plan Areas.							
No Impact							
Low Sensitivity							
Low to Medium Sensitivity							
Medium Sensitivity							
High Sensitivity							

4.6.4.3 Otter

The sensitivities of qualifying otter interest features species to the activities associated with the East Marine Plans are shown in Table 14.

Table 14: Potential sensitivities of otter to the East Marine Plans

Sensitivity Category	Sensitivities	Pathway Ref. No.	Impact Pathway from East Marine Plans across TIDE, CCS & AGG Activities (Summary Impact Pathway Description)	Survey	Construction	Operation	Decomm
PLG	Physical Loss/Gain of Habitat	2	Loss of onshore habitat (including bird breeding and roosting grounds, freshwater habitats, otter holts or shelters) under the footprint of power cables, CO_2 pipelines, cable/pipeline armouring and landside infrastructure due to the installation, operation and decommissioning of these structures.	No impact from any sector	No impact from any sector	TIDE CCS AGG	No impact from any sector
PD	Physical Damage to Habitat	9	Damage to onshore habitat (including bird breeding grounds, freshwater habitats, otter holts or shelters) by excavation, piling and construction work associated with the installation, operation and decommissioning of cables, CO_2 pipelines and landside infrastructure.	No impact from any sector	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG
PD	Physical Damage to Species	13	Collision risk and possible mortality of species due to the presence of tidal devices or from vessels travelling to and from the site (including propeller collision risk).	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG
NPD	Non-Physical Disturbance	16	Visual disturbance and exclusion from areas as a result of surveying; cable, pipeline or tidal device installation/operation and decommissioning activities (including movements of vessels).	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG
NPD	Non-Physical Disturbance	17	Noise/vibration disturbance and exclusion from areas as a result of vessels and other activities during survey work (e.g. seismic exploration and geophysical surveys), construction (e.g. piling, drilling, cable laying), operation (e.g. device noise), maintenance or decommissioning. Also includes noise/vibration disturbance from vessels and draghead during aggregate extraction.	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG

Sensitivity Category	Sensitivities	Pathway Ref. No.	Impact Pathway from East Marine Plans across TIDE, CCS & AGG Activities (Summary Impact Pathway Description)	Survey	Construction	Operation	Decomm
In this table only the estimated sensitivity levels are shown. The level of risk will be dependent upon exposure. For instance there would be a high degree of exposure for otter were a development to occur within or near a designated site or an important foraging area. However, at the present time, there is very little information about exposure within the East Marine Plan Areas.							
No Impact							
Low Sensitivity							
Low to Medium Sensitivity							
Medium Sensitivity							
High Sensitivity							

4.7 Step 4(4): Fish and Pearl Mussel Sensitivities

4.7.1 Designated Sites with Fish and Pearl Mussel Features

Following the plan-level screening process (MMO, 2013b), a total of 182 European/Ramsar sites were identified for which there is a LSE (or the potential for a LSE cannot be excluded). Of these sites, several support qualifying fish and freshwater pearl mussel interest features and these are mainly located to the north of the Marine Plan area.

Following the above screening process for activities (Section 4.3) the total number of 'screened in site' was reduced to 122 European/Ramsar sites of which there are 7 SACs and 1 Ramsar site with qualifying habitat interest features.

The relevant qualifying habitat features within these sites are summarised in Section 4.7.2.

4.7.2 Interest Features Summary List

In summary, the screening phase concluded that there is a possibility of a LSE (or that it was not possible to conclude no LSE) for the following fish and freshwater pearl mussel features:

- Atlantic salmon *Salmo salar* (1106);
- Sea lamprey *Petromyzon marinus* (1095);
- River lamprey *Lampetra fluviatilis* (1099);
- Allis shad *Alosa alosa* (1102);
- Twaite shad *Alosa fallax* (1103); and
- Freshwater pearl mussel *Margaritifera margaritifera* (1029).

To assess whether there is any adverse effect on the integrity of the relevant European sites, Section 4.7.3 and 4.7.4 review the sensitivities of these fish features. These sections focus on the fish species because any effect on freshwater pearl mussel will only arise as an indirect consequence of effects on Atlantic salmon. Section 4.8.5 then identifies the conservation objectives for these features and assesses, in tabular format, the effects arising in the context of the proposed additional plan-level mitigation measures.

4.7.3 Sensitivities of Fish and Pearl Mussel to Plan Activities

This section reviews the sensitivities that are relevant for the fish interest features. Initially a generic review of the sensitivities is presented under the following impact pathways identified during the screening phase:

- Physical Loss/Gain of Habitat (Damage to Onshore and Offshore Habitat) (Section 4.7.3.1);
- Physical Loss/Gain of Habitat (Fish Aggregation) (Section 4.7.3.2);
- Physical Damage to Habitat (Damage to Offshore Foraging Grounds and Onshore Habitats) (Section 4.7.3.3);
- Physical Damage to Habitat (Collision Risk) (Section 4.7.3.4);
- Non-Physical Disturbance (Noise/Visual Disturbance Causing Barrier and Exclusion Effects (Section 4.7.3.5);
- Non-Physical Disturbance (Electromagnetic Fields) (Section 4.7.3.6);
- Toxic Contamination (Contamination and Spillages) (Section 4.7.3.7); and
- Non-Toxic Contamination (Increased Turbidity) (Section 4.7.3.8).

4.7.3.1 Physical Loss/Gain of Habitat (Damage to Onshore and Offshore Habitat; Impact Pathways 2 and 3)

Where there is a need for landside development whether that is hydro-electric power generation infrastructure or cable/pipeline alignments and grid connections (for tidal energy or carbon transfer infrastructure), then the potential exists to have a direct effect on the onshore freshwater habitats. This could be habitat that is designated for migratory fish or freshwater pearl mussel qualifying features (in which case there would be the highest risk of an effect) or it could be located along the migratory routes. It is anticipated that any sensitive habitats would be avoided wherever possible and that the worst case effects would involve a temporary effects during the construction period.

Damage to offshore habitats during any projects may influence foraging areas for migratory fish species. Fish occupy many trophic levels of the estuarine food chain, feeding on phytoplankton, zooplankton, algae, invertebrates or other fish. In order to forage for these food items, their feeding habits comprise grazers, plankton filter feeders (e.g. shad, smelt), suckers and parasites (e.g. sea lamprey) and predators (e.g. gobies). Many demersal fish are opportunistic predators and their prey choice reflects the species that are available in the area (Elliott *et al*., 1998). Fish generally feed on a range of food items and, therefore, their sensitivity to the temporary change in a particular food resource is considered to be low. Furthermore, the high mobility of fish enables them to move freely to avoid areas of adverse conditions and to use other food sources.

4.7.3.2 Physical Loss/Gain of Habitat (Fish Aggregation; Impact Pathways 4)

As discussed in Sections 4.5.3.2 and 4.6.3.2, fish are often attracted to solid man-made structures placed on the seabed (in this case as part of tidal energy or carbon storage infrastucture) and artificial reefs are often deployed to enhance fisheries (Sayer *et al*., 2005). Structures constructed for other purposes such as oil platforms and breakwaters (Helvey, 2002)

can also serve as new habitats for fish. Structures can change local abiotic conditions allowing species assemblages to form that are different from natural communities present. The monopiles of turbines, for example, become encrusted with epibiota such as mussels and barnacles (Linley *et al*., 2007). These modify the habitat and provide food and shelter for fish and invertebrate species leading to increased fish abundance and enhancement of the local seabed habitat (Wilhelmsson *et al*., 2006).

Fish aggregations have been observed around numerous other objects, including; vessels (Røstad *et al*., 2006); structures associated with marinas and pontoons in urban areas (Clynick, 2008); net cages used for aquaculture (Oakes & Pondella, 2009); sunken vessels (Arena *et al*., 2007); and underwater depuration systems (Cattaneo-Vietti *et al*., 2003).

The literature on this subject is dominated by studies of Fish Aggregating Devices (FADs) and artificial reefs. Fish Aggregating Devices are floating or moored devices placed in the water that attract fish (Dempster & Kingsford, 2004). To determine the degree to which objects act as FADs it is useful to identify the factors that attract fish to aggregate around devices. Freon and Dagorn (2000) identified a number of hypotheses to explain the association with floating objects, these include:

- Shelter from predators;
- Concentration of food supply;
- Spatial reference in otherwise featureless environments;
- Resting;
- Indicators of other characteristics, such as productive areas; and
- Meeting points.

Whenever water flows past a structure, velocity gradients are created which form vortices. Depending on hydrodynamic conditions, fish can be attracted to or repelled by the turbulence (Liao, 2007). Extremely high levels of shear stress can damage fish (Odeh *et al*., 2002) and turbulence can increase the energy costs of swimming (Enders *et al*., 2003). Alternatively, altered flows that remain steady, or maintain an aspect of predictability, can be exploited by swimming fish to reduce locomotion cost. Fish can seek refuge from main currents by 'flow refuging' behind structures. In tidally swept locations bentho-pelagic fish such as cod, have been found to use sand ripples as flow refuges to hold station, reducing energetic costs (Gerstner, 1998).

4.7.3.3 Physical Damage to Habitat (Damage to Offshore Foraging Grounds and Onshore Habitats; Impact Pathways 9 to 11)

As per the discussion on onshore habitat loss, damage to inland freshwater habitats could arise from land-side works and this could include the indirect and temporary effects arising from water quality changes and sediment redistribution. In offshore locations, baseline survey work (e.g. boreholes and trawls), installation, maintenance and removal of pipelines, cables and turbines could all potentially result in a reduction in foraging habitat quality and prey species availability through smothering and physical disturbance.

4.7.3.4 Physical Damage to Species (Collision Risk; Impact Pathway 13)

The main collision risks to fish are posed by the moving turbines on tidal energy generation devices. The ability for fish to avoid a potential collision with an object is dependant on sensory capabilities (such as vision and hearing), perception levels and swimming speeds of the

species. As lamprey could be attached to a range of different pelagic and demersal species while undertaking the marine phase of the lifecycle, general information on fish sensitivity to collisions has been included.

Marine animals in high latitude coastal areas have to contend with variable and often poor visual conditions, resulting from fluctuations in ambient light levels and in the light transmission properties of the water. Fish have well developed eyes and the variety of colour patterns and specific movements that they display invites comparisons between the most visually orientated species among birds and mammals (Guthrie & Muntz, 1993; Brawn, 1969).

Fish have been recorded colliding or becoming entrapped within a range of anthropogenic structures such as fishing nets and power station intakes (Johnson *et al*., 1976; Wardle, 1986). The level of light and clarity of water are important on the extent a fish might collide with an object. In poor visibility conditions, fish have been observed only just avoiding collision with an obstacle, whereas in good visibility conditions, fish react further away from trawl otter boards and swim over/under/around trawls (Wardle, 1986). More recent experiments quantified the light level thresholds for the visual reactions of mackerel to monofilament netting were -1 log lux and - 4 log lux (1-0.001 lux) for multifilament (Cui *et al*., 1991). At light levels below these thresholds, fish were unaware of the netting barriers and swam straight through them.

Fish may avoid collisions with an object through "startle" (or "C-start") responses. The C-start response can be initiated by transient sound, visual or touch stimuli. For example, herring escape behaviour is a reflex response stimulated by transient sound stimuli, detected in the labyrinth (inner ear) (Blaxter *et al*., 1981). 'Visually looming' objects will also trigger evasion behaviour in most if not all species, with a greater response rate to edges moving horizontally rather than vertically (Wilson *et al*., 2007). The behavioural response to an approaching net is to turn and swim in the direction of the moving net, using the minimum swimming speed to avoid the object (resulting in them 'holding position' at the mouth of the net) whilst reserving energy for an escape response. However, on exhaustion, the fish turn and allow the net mouth to overtake them (Wilson *et al*., 2007).

4.7.3.5 Non-Physical Disturbance (Noise/Visual Disturbance Causing Barrier and Exclusion Effects; Impact Pathways 15 and 17)

Disturbance to fish could come from a variety of sources, construction activities and vessel movements across all of the three sectors. Most activities could have a temporary disturbance effect and could create a possible barrier. However, as with the corresponding effects on marine mammals (see Section 4.6.3.6) it is only through tidal energy generation, and especially the construction of larger arrays, that a potential exists for a significant physical obstruction or barrier effects to occur. The potential sensitivities of fish from visual and noise stimuli as well the effects of barriers to movement are presented below.

Response to underwater noise

Fish typically respond strongly to lower frequencies of noise as opposed to marine mammals that are sensitive to a broader bandwidth of sound (see Section 4.6.3.6). Fish that have specialist structures (e.g. Weberian ossicles, swimbladder diverticulae and gas filled bullae) that enhance hearing have been referred to as hearing "specialists", whereas fish that do not have such specialisation's are referred to as hearing "generalists".

Salmon can detect and respond to underwater noise and their audiograms have been well documented (Nedwell *et al*., 2004). Salmon are considered to be hearing generalists that are able to hear frequencies in the low to infrasound ranges at threshold levels of around 95 to 130dB re 1µPa in the region of 10Hz to 380Hz. Small fish (i.e. smolts and exceptionally small

grilse) are generally considered to be most vulnerable to noise impacts (Hastings & Popper, 2005).

There are no reported audiograms of lamprey. However, given that they both lack any specialist hearing structures, they are considered to be hearing generalists. There is potential however that lamprey may be able to hear infrasound. The hearing of lamprey is complicated by the fact that they do not have otolith organs and no known work has been undertaken on the response of lamprey to sound in relation to their statoliths or labyrinth organs. Work has been undertaken on cephalopods however, which also have statolith organs for the detection of linear accelerations including gravity (Packard *et al*., 1990). This investigation confirmed that cephalopods could detect the kinetic component of low frequency sounds and it is believed that the statoliths are the sensory organs involved (Packard *et al*., 1990). It was stated within this article that 'gross acceleration of the whole animal, as occurs in an under water sound field, is an ideal stimulus for the statolith organ'. On this basis, it is considered likely that lamprey will be sensitive to infrasound. Nonetheless, studies have shown that sea lamprey respond to frequencies between 20 and 100Hz (Lenhardt & Sismour, 1995).

Shad have been also been shown to be sensitive to acoustic noise. High frequency noise (70-300kHz) can prove a complete barrier to migration, with shad adopting a flee response.

Those species at greatest risk of being affected by sound sources are likely to be hearing specialists which have a threshold over a wide spectrum of frequencies. Of the hearing specialists it will be those that have a threshold at relatively low sound levels which will be at greatest risk. It has been suggested that for a fish species with no swim bladder such as flatfish (and lamprey) tissue damage may occur at a high impulse level of 180dB re 1 µPa.

Similar to marine mammals, the impacts of noise on fish can broadly be split into lethal and physical injury, auditory injury and behavioural response. Richardson *et al*. (1995) defined four zones of noise influences, depending on the distance between source and receiver. These are as follows:

- Zone of hearing loss, discomfort or injury, the zone within which hearing or other severe damage results;
- Zone of masking, the region within which noise is strong enough to interfere with detection of other sounds, such as communication or echolocation clicks;
- Zone of responsiveness, the region in which the animal reacts; and
- Zone of audibility, the area within which the animal is able to detect the sound.

At very high exposure levels, such as those close to typical underwater explosive operations or offshore impact piling (pile driving) operations, fatality may occur in species of fish. The likelihood of fatality increases with levels above 240dB re 1 µPa. As the time period of the exposure increases (represented by the impulse), there is also an increase in likelihood of fatality.

With respect to auditory injury (rather than lethality), at sound levels in excess of 180dB re 1µPa, and particularly where there are repeated high level exposures from activities such as impact pile driving underwater sound has the potential to cause hearing impairment in marine species. This can take the form of a temporary loss in hearing sensitivity, known as TTS, or a permanent loss of hearing sensitivity, known as PTS.

In terms of their behavioural response, at lower sound levels it has been observed that a behavioural response in fish may occur. These reactions may include the animals leaving the area for a period of time or a startle reaction.

Nedwell *et al*. (2007b) have developed a generic decibel (dB) scale, which enables better estimates of the effects of sound on marine species to be made. In their decibel hearing Threshold (dBht, species) scale a frequency dependent filter is used to weight the sound. The suffix 'ht' relates to the fact that the sound is weighted by the hearing threshold of the species. A set of criteria based on the use of the dBht (species) was proposed by Nedwell *et al*. (2007b) that allows the likelihood of behavioural effects and damage to hearing to be assessed for a wide range of species (Table 15). Of significance for this assessment, is the conclusion that at 90dBht (species) and above there will be a strong avoidance reaction by all individuals of that species, and that below 50dBht (species) there will be a mild reaction by a minority of individuals.

It should be noted that these criteria reflect the initial response and do not reflect the complexity of behavioural, physiological and auditory impacts over the short and long-term. Furthermore, this criterion has not been validated by experimental study. The potential effects of anthropogenic underwater noise on the behaviour of fish are difficult to determine as they are context dependent, and must be statistically based.

Table 15: Criteria suggested for the effects of underwater noise on marine mammals and fish

Level in dBht (Species)	Effect
Less than 0	None
0 to 50	Mild reaction by minority of individuals
50 to 90	Stronger reaction by majority of individuals but habituation at lower levels may limit effect
90 and above	Strong avoidance reaction by all individuals
Above 110	Tolerance limit of sound; unbearably loud
Above 130	Possibility of traumatic hearing damage from single event

(Source: Nedwell *et al*., 2007b)

Barrier or exclusion effects

Salmon and lamprey are highly mobile species that undergo large seasonal movements and migrations to forage and breed (DECC, 2009; Hendry & Cragg-Hine, 2003; Maitland, 2003). They can, therefore, be particularly vulnerable to any structures which could act as a barrier, preventing movement to key foraging or nursery grounds. Their sensitivity will depend on their ability to move and avoid barrier structures e.g. structures placed in a highly confined estuary will more of an issue than in the open coast.

4.7.3.6 Non-Physical Disturbance (Electromagnetic Fields; Impact Pathway 18)

Power export cables generate an electromagnetic field (EMF) with two components: an electric (E) field contained within the cable by armouring and a magnetic (B) field that can be detected outside of the cable. The magnetic field also produces an induced electric field (iE) outside the cable.

Potential impacts could result from repulsion effects, leading to exclusion of animals from an area of seabed, attraction effects and disruption to migrations for magnetically sensitive species such as eels and salmonids that may use the earth's geomagnetic field for navigational cues (DECC, 2009). Although Atlantic salmon may be sensitive to the magnetic fields associated with operational cables, their navigation and migration is unlikely to be affected based on existing evidence (CMACS, 2003; Scottish Executive, 2007).

River lamprey and sea lamprey are considered to be magnetically and electrically sensitive (Gill *et al*., 2005). However, like most UK species that are EM-sensitive, knowledge of their interaction with anthropogenic EMFs is limited. This impact pathway is not applicable to either aggregate extraction or CCS.

4.7.3.7 Toxic Contamination (Contamination and Spillages; Pathways 19 to 21)

Leaching of toxic compounds from sacrificial anodes, antifouling paints or leakage of hydraulic fluids (if present) from the device is a potential effect during offshore wind farm operation. Any chemical or microbiological contaminants associated with sediments being resuspended into the water column may be dispersed, redistributed and deposited elsewhere.

There is a risk that some of these contaminants may be temporarily bioaccumulated in the tissues of certain fish prey, such as polychaete worms and marine bivalves, and made available for uptake by feeding fish. The accumulation of moderate or high levels of contaminants in fish can cause or contribute to a range of lethal and sublethal effects, including genetic, reproductive and growth changes. There is less information available on the effects of low levels of contaminants. Pelagic fish, including Atlantic salmon, would experience a lower exposure to contaminated sediments than demersal fish species which remain close to the seabed and feed mainly on benthic organisms. Lampreys attach onto a variety of pelagic and demersal fish species in the marine phase of their lifecycle and so their movements and distribution are largely dictated by their host.

4.7.3.8 Non-Toxic Contamination (Increased Turbidity; Pathway 22)

Suspended sediment levels, and resulting increased turbidity, are reported to affect salmonids, although estuarine fish generally show tolerance to variations in suspended sediment loadings and turbidity as a result of natural adaptation to living in a dynamic and environmentally variable habitat such as an estuary (ABPmer, 2005). In general, the mobile nature of fish species allows avoidance of areas of adverse conditions which will be unlikely to significantly affect a population provided such conditions are temporary. In the case of migratory fish species, however, the significance of such occurrences is potentially heightened as a result of the potential for such conditions to constitute a barrier to the movement of fish should such occur on a migration route. The occurrence of such conditions would, however, only be significant should the conditions extend across the entire width of the water body comprising the migration route at any given point, otherwise fish would be expected to be able to move around the adverse condition area, avoiding impacts, and thus not inhibiting migration up (or down) stream. Some delay in migration may result from such avoidance, and this is of note as delays have been reported as being potentially associated with reduced survival rates. It is also important to note that suspended sediment levels also affect the level of dissolved oxygen (DO), higher suspended sediment levels can lead to depleting DO concentrations.

The effects of suspended sediment levels on fish have been considered in a number of studies, including that undertaken by the European Inland Fisheries Advisory Commission (FARL, 1995). Lethal effects were seldom observed, with Pacific salmon and trout juveniles surviving for 3-4 weeks in suspended sediment concentrations of 300-750mg/l, which were increased to 2300-6500mg/l for short periods. Sub lethal pathological effects included increased mucus

production over the body and gills, and at very high suspended sediments, evidence of abrasion and damage to the gill filaments was noted (FARL, 1995).

There are a wide range of background suspended sediment concentrations in UK estuaries through which salmon runs occur. For example, salmon and lamprey successfully pass through estuaries with extremely high suspended sediments such as the Severn and its sub estuaries the Wye, Usk and Parrett, which naturally contain up to several thousand milligrams per litre (FARL, 1995), concentrations as high as 9,000mg/l have been recorded in the path of runs in the Usk Estuary (Alabaster, 1993).

4.7.4 Migratory Fish and Freshwater Pearl Mussel Interest Features

Following this review, the general characteristics and sensitivities for the relevant interest features are presented and the activities that could cause an impact are identified and tabulated. These reviews are set out in the following section:

- Migratory Fish and Freshwater Pearl Mussel (Section 4.7.4.1).

As mentioned earlier, this review focuses on the fish species because any effect on freshwater pearl mussel will only arise as an indirect consequence of effects on Atlantic salmon.

4.7.4.1 Migratory Fish and Freshwater Pearl Mussel Sensitivity

Table 16 shows the sensitivities of Atlantic salmon (and freshwater pearl mussel by associations) as well as river lamprey, sea lamprey and shad species to the activities associated with the East Marine Plans.

Table 16: Potential sensitivities of Atlantic salmon, lamprey and shad features from the East Marine Plans

Sensitivity Category	Sensitivities	Pathway Ref. No.	Impact Pathway from East Marine Plans across TIDE, CCS & AGG Activities (Summary Impact Pathway Description)	Survey	Construction	Operation	Decomm
PLG	Physical Loss/Gain of Habitat	2	Loss of onshore habitat (including bird breeding and roosting grounds, freshwater habitats, otter holts or shelters) under the footprint of power cables, CO_2 pipelines, cable/pipeline armouring and landside infrastructure due to the installation, operation and decommissioning of these structures.	No impact from any sector	No impact from any sector	TIDE CCS AGG	No impact from any sector
PLG	Physical Loss/Gain of Habitat	3	Loss of foraging areas from a reduction in coastal and offshore habitat due to installation of devices, power cables, CO_2 pipelines and/or cable/pipeline armouring both at the development footprint and outside from bed scour and indirectly from changes to the hydrodynamic (wave and tide) regime.	No impact from any sector	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG
PLG	Physical Loss/Gain of Habitat	4	Presence of tidal generation (or other) structures on seabed for the duration of the project resulting in changes to prey and species behaviour (e.g. acting as FAD (Fish Aggregating Device), artificial reef or bird roost).	No impact from any sector	TIDE CCS AGG	TIDE CCS AGG	TIDE CCS AGG

Sensitivity Category	Sensitivities	Pathway Ref. No.	Impact Pathway from East Marine Plans across TIDE, CCS & AGG Activities (Summary Impact Pathway Description)	Survey	Construction	Operation	Decomm
PD	Physical Damage to Habitat	9	Damage to onshore habitat (including bird breeding grounds, freshwater habitats, otter holts or shelters) by excavation, piling and construction work associated with the installation, operation and decommissioning of cables, CO_2 pipelines and landside infrastructure.	No impact from any sector	TIDE	TIDE	TIDE
					CCS	CCS	CCS
					AGG	AGG	AGG
PD	Physical Damage to Habitat	10	Reduction in quality of foraging areas as result of damage to coastal and offshore habitat from baseline surveys (e.g. boreholes and trawls); from equipment use causing abrasion, damage or smothering during installation; from maintenance and removal of cables, pipeline, tidal/devices or from scour, sediment transport and hydrodynamic change during operation.	TIDE	TIDE	TIDE	TIDE
				CCS	CCS	CCS	CCS
				AGG	AGG	AGG	AGG
PD	Physical Damage to Habitat	11	Reduction in quality of foraging areas as result of damage to coastal and offshore habitat within and surrounding the aggregate sites during the extraction process.	No impact from any sector	No impact from any sector	TIDE	No impact from any sector
						CCS	
						AGG	
PD	Physical Damage to Species	13	Collision risk and possible mortality of species due to the presence of tidal devices or from vessels travelling to and from the site (including propeller collision risk).	TIDE	TIDE	TIDE	TIDE
				CCS	CCS	CCS	CCS
				AGG	AGG	AGG	AGG
NPD	Non-Physical Disturbance	15	Presence of sub-surface structures and disturbance (noise or visual) associated with tidal devices may present a barrier to movement and block migratory pathways or access to feeding grounds depending on array design.	No impact from any sector	No impact from any sector	TIDE	No impact from any sector
						CCS	
						AGG	
NPD	Non-Physical Disturbance	17	Noise/vibration disturbance and exclusion from areas as a result of vessels and other activities during survey work (e.g. seismic exploration and geophysical surveys), construction (e.g. piling, drilling, cable laying), operation (e.g. device noise), maintenance or decommissioning. Also includes noise/vibration disturbance from vessels and draghead during aggregate extraction.	TIDE	TIDE	TIDE	TIDE
				CCS	CCS	CCS	CCS
				AGG	AGG	AGG	AGG
NPD	Non-Physical Disturbance	18	Impacts from Electromagnetic Fields (EMF) on electromagnetically sensitive fish and cetaceans interfering with prey location and mate detection in some species and creating barriers to migration.	No impact from any sector	No impact from any sector	TIDE	No impact from any sector
						CCS	
						AGG	
TC	Toxic Contamination	19	Spillage of fluids, fuels and/or construction materials (inc. from surface coatings/treatments) during installation or removal of structures (devices and cables), during survey/ maintenance or during aggregate extraction.	TIDE	TIDE	TIDE	TIDE
				CCS	CCS	CCS	CCS
				AGG	AGG	AGG	AGG

Sensitivity Category	Sensitivities	Pathway Ref. No.	Impact Pathway from East Marine Plans across TIDE, CCS & AGG Activities (Summary Impact Pathway Description)	Survey	Construction	Operation	Decomm
TC	Toxic Contamination	20	Release of contaminants associated with the dispersion of suspended sediments during installation or removal of structures (devices, pipelines and cables) or from the aggregate extraction process.	No impact from any sector	TIDE CCS AGG	No impact from any sector	TIDE CCS AGG
TC	Toxic Contamination (Reduction in water quality)	21	Release of CO_2 into the water column and its acidification from the formation of carbonic acid.	No impact from any sector	No impact from any sector	TIDE CCS AGG	No impact from any sector
NTC	Non-Toxic Contamination	22	Increase in turbidity (and possibly reduced dissolved oxygen) associated with suspended sediments release during installation or removal of structures (devices, pipelines and cables) or from aggregate extraction.	No impact from any sector	TIDE CCS AGG	No impact from any sector	TIDE CCS AGG
In this table, only the estimated sensitivity levels are shown. The level of risk will be dependent upon exposure. For instance there would be a high degree of exposure for fish species were a development to occur within or near a designated site. However, at the present time, there is very little information about exposure within the East Marine Plan Areas.							
No Impact							
Low Sensitivity							
Low to Medium Sensitivity							
Medium Sensitivity							
High Sensitivity							

4.8 Step 5: Assessment of Effects on Designated Sites

4.8.1 Introduction

On the basis of the sensitivities of the relevant interest features as reviewed in the preceding sections, the following sections review the conservation objectives for these features and review the potential effects arising for each of the European/Ramsar sites.

4.8.2 Potential Effects on Habitat Features

The conservation objectives for the qualifying habitats that are relevant to this HRA will be very similar and in many instances identical for all European sites that have been screened in. The relevant objectives seek to avoid deterioration of the qualifying habitats, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features. As discussed in Section 3.2.6, it is appropriate to apply generic objectives for the Plan-level HRA.

The conservation objectives are to ensure for the qualifying habitats that the following are maintained in the long term:

- Extent of the habitat with the site;
- Distribution of the habitat within the site;
- Structure and function of the habitat;

- Processes supporting the habitat;
- Distribution of typical species of the habitat;
- Viability of typical species as components of the habitat; and
- No significant disturbance of typical species of the habitat.

Taking account of these conservation objectives and the Plan-level activities to which the key interest features are sensitive, the effects of East Marine Plans on the integrity of the designated sites with habitats qualifying features is reviewed in Table 17.

Table 17: Assessment of the potential effects of the East Marine Plans on habitat features

Sites at Which These Qualifying Features are Present and are Considered for the East Marine Plans are Reviewed in Tables A3, A4, A5 and A6 in Appendix A					
Qualifying and Supporting Feature (See also Section 4.4 and Screening Tables A3-A5 in Appendix A)	**Summary Impact Pathway** (See also Table 1 above and Table A1 in Appendix A)	**Pathway Ref. No.**	**Sensitivity Level(s) Commentary and Relevant Conservation Objective**	**Is There an Adverse Effect on Integrity With Initial Mitigation Measures?** (See also Table A7 in Appendix A)	**Is There an Adverse Effect on Integrity With Additional Mitigation Measures?**
▪ Morphological Features encompassing a range of habitats ▪ Subtidal habitats with typically soft-sediment habitat ▪ Subtidal habitats with typically hard-substratum habitat (Reefs) ▪ Intertidal habitats (including saltmarshes)	**Physical Loss/Gain of Habitat** Loss of coastal and offshore habitat under the footprint of devices, power cables, CO_2 pipelines and also cable/pipeline armouring arising from the installation, operation and decommissioning of these structures.	1	**Sensitivity Level(s)** maximum considered to be high (see Tables 3-6 for detail and colour code) **Commentary/Review** Habitat will only be lost from the introduction of TIDE of CCS infrastructure. The amount of habitat that is lost will clearly be influenced by the size and type of the structures (cables/pipelines/devices), as well as their location. For instance, the amount of habitat directly lost from the presence of a pile (estimated $12m^2$) is generally less than that for a mooring block or gravity base (estimated $40m^2$) (Scottish Executive, 2007). Any new structures may also change the species compositions locally and become new habitats in their own right (the potential for introduction of invasive non-native species is considered separately). However, the potential for introducing new habitat is generally considered to be of limited value for offsetting these losses partly because the environmental attributes suitable for tidal devices tend to minimise the potential for natural colonisation. Nonetheless, it is expected that during the early stages in the design of any development, a primary consideration will be to try and avoid designated habitats and minimise exposure/risk. **Relevant Conservation Objectives** (see Section 4.8.2) Of the 7 COs listed, the majority are considered to be relevant to impacts from the loss/gain during the operational phase of the project with only the objective relating to the processes affecting habitats being less pertinent. Therefore, the following 6 COs all need to be considered: ▪ Extent of the habitat on site; ▪ Distribution of the habitat within site; ▪ Structure and function of the habitat; ▪ Distribution of typical species of the habitat; ▪ Viability of typical species as components of the habitat; and ▪ No significant disturbance of typical species of the habitat.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; • The generic nature of those 'standard' MMO mitigation measures that are available (see MMO Measures 1 and 2 in Appendix B); and • The residual gaps that exist in these 'standard' mitigation measures. See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.
▪ Morphological Features encompassing a range of habitats ▪ Supralittoral habitats	**Physical Loss/Gain of Habitat** Loss of onshore habitat (including bird breeding and roosting grounds, freshwater habitats, otter holts or shelters) under the footprint of power cables, CO_2 pipelines, cable/pipeline armouring and landside infrastructure due to the installation, operation and decommissioning of these structures.	2	**Sensitivity Level(s)** maximum considered to be high (see Tables 3-6 for detail and colour code). **Commentary/Review** The amount of onshore habitat that is lost will be influenced by the size of the landside works and their location. This will only relate to the TIDE and CCS sectors and the associated cable pipeline and landfall works. The pipeline/cabling alignment will have a limited footprint and may even be done through HDD to avoid any effect (see MMO Mitigation Measure 10 in Appendix B). However, grid connectors and onshore hydroelectric power generation and carbon pumping stations will be more substantial in size. It is expected that during the early stages in the design of any development, a primary consideration will be to try and avoid designated habitats and minimise exposure and risk although no mitigation measure to this effect currently exists. **Relevant Conservation Objectives** (see Section 4.8.2) Of the 7 COs listed, the majority are considered to be relevant to impacts from the loss/gain during the operational phase of the project with only the objective relating to the processes affecting habitats being less pertinent. Therefore, the following 6 COs all need to be considered: ▪ Extent of the habitat on site; ▪ Distribution of the habitat within site; ▪ Structure and function of the habitat; ▪ Distribution of typical species of the habitat; ▪ Viability of typical species as components of the habitat; and ▪ No significant disturbance of typical species of the habitat.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; • The generic nature of those 'standard' MMO mitigation measures that are available (see MMO Measure 10 in Appendix B); and • The residual gaps that exist in these 'standard' mitigation measures. See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.
▪ Morphological Features encompassing a range of habitats ▪ Subtidal habitats with typically soft-sediment habitat ▪ Subtidal habitats with typically hard-substratum habitat (Reefs) ▪ Intertidal habitats (including saltmarshes)	**Physical Damage to Habitat** Changes to coastal and offshore habitat as result of damage from baseline surveys (e.g. boreholes/trawls); from equipment use causing abrasion, damage or smothering during installation and from maintenance and removal of cables/pipelines/devices (e.g. jack-up legs, vessels, anchors, mooring chain).	5	**Sensitivity Level(s)** maximum considered to be medium (see Tables 3-6 for detail and colour code) **Commentary/Review** During the survey phases of a development, for the most part, any changes are likely to be localised and of short-term consequence due to the small amount of material extracted for research and the short duration of activity compared to construction. It is recognised that the East Marine Plan Areas have a large extent, but the effects of surveys within extant and future developments are still considered to be low given the small, localised and temporary nature of the effects. The developmental works during installation, maintenance and decommissioning are likely to be more significant but in general, most of the construction activities of concern, such as the use of jack-up legs, piling and activities involved in cable installation, are still likely to result in short-term, localised changes to the marine environment (e.g. increased suspended sediments and turbidity, disturbance of contaminated sediments and direct disturbance). The disposal of construction material from shoreline installations and piled devices also has the potential to cause loss of, or change to, habitats. In some cases, the material can be re-used locally as scour protection around piles (e.g. Pulse Generation's oscillating hydrofoil in the Humber estuary) (IECS, 2007). The effect is likely to be temporary and localised and with appropriate site selection unlikely to have any adverse effect on the integrity of a designated site. It is also likely that the benthic communities will recover quickly from such effects (e.g. PMSS Ltd, 2007; IECS, 2007), although this is strongly influenced by the ecology and recoverability of the habitats that are affected. In general, research has found that the physical impact from small scale tidal stream generation pilot projects is reversible on decommissioning, especially as the areas most suitable for tidal power generation are located where high current flow causes natural disturbance to the sediments (Frid *et al*., 2012). The type of activity is also a major consideration; piled devices tend to require greater use of heavy machinery and jack-up barges for drilling and pile-driving, compared to anchored or weighted devices. In some cases, it may be necessary to level the seabed where the jack-up feet and gravity bases will sit on the seabed (Scottish Executive, 2007) resulting in longer-term impacts on substrata, habitat and species. Mooring blocks are more easily installed on the seabed, compared to piles, minimising levels of disturbance and suspended sediments. Activities involved in decommissioning are similar to those of construction, but generally of	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; • The generic nature of those 'standard' MMO mitigation measures that are available (see MMO Measures 2 and 8 in Appendix B); and • The residual gaps that exist in these 'standard' mitigation measures.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.

Sites at Which These Qualifying Features are Present and are Considered for the East Marine Plans are Reviewed in Tables A3, A4, A5 and A6 in Appendix A					
Qualifying and Supporting Feature (See also Section 4.4 and Screening Tables A3-A5 in Appendix A)	**Summary Impact Pathway** (See also Table 1 above and Table A1 in Appendix A)	**Pathway Ref. No.**	**Sensitivity Level(s) Commentary and Relevant Conservation Objective**	**Is There an Adverse Effect on Integrity With Initial Mitigation Measures?** (See also Table A7 in Appendix A)	**Is There an Adverse Effect on Integrity With Additional Mitigation Measures?**
			shorter duration and, therefore, potentially resulting in less significant impacts. It is anticipated that following removal of the devices and associated cables, the local benthic community will recover rapidly to its original state due to the high energy of the environment, the presence of existing material and local sources of benthic fauna. Any changes from survey work are likely to be localised and of short-term consequence due to the small amount of material extracted for research and the short duration of activity compared to construction. The largest impacts will be at locations that have a lower energy condition or are on stable/exposed substrata (with an epifauna-dominated assemblage). **Relevant Conservation Objectives** (see Section 4.8.2) Of the 7 COs listed, the majority are considered to be relevant to impacts from physical damage during construction and decommissioning work. However, the following 4 COs are most pertinent because they relate to the composition and distribution of the habitats and species present rather than the broader extent, structure, function of the habitats and the processes affecting them: ▪ Distribution of the habitat within site; ▪ Distribution of typical species of the habitat; ▪ Viability of typical species as components of the habitat; and ▪ No significant disturbance of typical species of the habitat.	See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	
▪ Morphological Features encompassing a range of habitats ▪ Subtidal habitats with typically soft-sediment habitat ▪ Subtidal habitats with typically hard-substratum habitat (Reefs) ▪ Intertidal habitats (including saltmarshes)	**Physical Damage to Habitat** Damage to offshore seabed habitat at the site of extraction during the period of the works.	6	**Sensitivity Level(s)** maximum considered to be low-medium (see Tables 3-6 for detail and colour code) **Commentary/Review** Marine aggregate dredging has the potential to cause changes in the physical environment, both directly, through the removal of seabed sediments, and indirectly, through changes in waves, tidal currents and suspended sediment concentrations. All the biotopes present will potentially be impacted by seabed extraction. This includes sublittoral coarse sediment (SS.SCS) habitat complexes which fall under the UK BAP priority habitat 'subtidal sands and gravels'; they are also contained on lists of broad-scale habitats and Features of Conservation Importance in MCZs and are widespread both within the East Marine Plan Areas (Emu, 2012). The potential impacts on *Sabellaria spinulosa* reefs often needs to be considered. Recent burial and elevated suspended particulate matter experiments (Last *et al*., 2011) have found that *S. spinulosa* is highly tolerant of short-term burial in fine sand with no significant effect (including mortality) is thought to result from different burial treatments. Recovery can also be accelerated if some of the reef is left intact, as this will facilitate localised larval production and settlement (e.g. Vorberg, 2000). Removal of seabed is restricted to areas where dredging occurs and the higher dredging intensity is, the more pronounced is the impact (Boyd & Rees, 2003). Seabed removal can result in a change to benthic biotopes and their associated fauna and can impact prey/food items available to higher trophic organisms (Moulaert *et al*., 2005). Subsequently, the rate at which the resulting depressions caused by dredging are infilled to pre-dredging conditions represents the recovery time. Monitoring studies (e.g. Cooper *et al*., 2005) have found that the depressions are typically degraded within 7 years. However, natural sediment mobility of often likely to result in the rapid infilling of dredge tracks in most of the potential aggregate extraction areas (Emu, 2012). Aggregate extraction typically has the immediate effect of making the seabed sediments finer (through preferential removal of coarser sediment fractions); however, over time water currents may remove these finer sediments so that the seabed will become coarser again, dependent on the prevailing hydrographic regime. **Relevant Conservation Objectives** (see Section 4.8.2) Of the 7 COs listed, the majority are considered to be relevant to impacts from physical damage during construction and decommissioning work. However, the following 4 COs are most pertinent because they relate to the composition and distribution of the habitats and species present rather than the broader extent, structure, function of the habitats and the processes affecting them: ▪ Distribution of the habitat within site; ▪ Distribution of typical species of the habitat; ▪ Viability of typical species as components of the habitat; and ▪ No significant disturbance of typical species of the habitat.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; • The generic nature of those 'standard' MMO mitigation measures that are available (see MMO Measures 4 and 5 in Appendix B); and • The residual gaps that exist in these 'standard' mitigation measures. See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.
▪ Morphological Features encompassing a range of habitats ▪ Subtidal habitats with typically soft-sediment habitat ▪ Subtidal habitats with typically hard-substratum habitat (Reefs) ▪ Intertidal habitats (including saltmarshes)	**Physical Damage to Habitat** Damage to the areas surrounding the site of extraction as a result of sediment redistribution and settlement.	7	**Sensitivity Level(s)** maximum considered to be low-medium (see Tables 3-6 for detail and colour code) **Commentary/Review** In areas adjacent to aggregate extraction, increased suspended sediment concentrations may have both positive and negative effects on benthic habitats. The degree and type of effect will vary with distance from the extraction site, related to settling rates of the suspended sediment. Sediment released into the water column through overspill and/or screening is dispersed both laterally and vertically by waves, tides and gravitational settling, at the same time being advected by tidal currents to form a turbid plume. The spatial extent of this plume is largely determined by the resource composition and the local hydrodynamic regime, with heavier gravel-sized particles settling rapidly at the discharge point, whilst sand-sized particles generally settle within about 250-500m (<5km where tidal currents are strong) (Hitchcock & Drucker, 1996; Newell *et al*., 2004). Potential positive effects of the suspended sediment plume include the organic particulate component providing an additional food resource for filter and surface deposit feeders. A narrow zonation of habitats may occur with increased distance from a dredge area. However, the tidally-induced sediment mobility and abrasive effects of sand in suspension are likely to inhibit the formation of a well-developed epifaunal community (Emu, 2012). A change in seabed depth associated with sediment deposition could lead to significant alterations in the benthic habitat biotopes**.** From previous EIAs (ABPmer, 2012) and the Anglian MAREA (Emu, 2012; HR Wallingford, 2011) maximum spatial extent of this secondary effect is typically set at 500m for smothering of the sea bed and 0.25 to 4km for changes to the Particle Size Analysis from fine sediment dispersal. This area of secondary effect is shown in Figure 14 (from ABPmer 2012). **Relevant Conservation Objectives** (see Section 4.8.2) Of the 7 COs listed, the majority are considered to be relevant to impacts from physical damage during construction and decommissioning work. However, the following 4 COs are most pertinent because they relate to the composition and distribution of the habitats and species present rather than the broader extent, structure, function of the habitats and the processes affecting them: ▪ Distribution of the habitat within site; ▪ Distribution of typical species of the habitat; ▪ Viability of typical species as components of the habitat; and ▪ No significant disturbance of typical species of the habitat.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; • The generic nature of those 'standard' MMO mitigation measures that are available (see MMO Measures 4 and 5 in Appendix B); and • The residual gaps that exist in these 'standard' mitigation measures. See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.
▪ Morphological Features encompassing a range of habitats ▪ Subtidal habitats with typically soft-sediment habitat ▪ Subtidal habitats with typically hard-substratum	**Physical Damage to Habitat** Changes to coastal and offshore habitat as a result of alterations to the wave climate or hydrodynamic (wave and tide) regime from the presence of tidal	8	**Sensitivity Level(s)** maximum considered to be low-medium (see Tables 3-6 for detail and colour code) **Commentary/Review** Theses impacts relate to TIDE devices and cables or CCS pipelines. The extent of the effects arising will be greatly influenced by the type and location of the structures that are introduced. The hydrodynamic changes can be large, particularly for arrays of tidal devices, as they tend to result in a re-distribution of tidal flow locally and cause reductions in energy both upstream and downstream of the device (ABPmer, 2006; IECS, 2007). Deposition of fine sediments may occur in areas of reduced tidal flow and scouring of benthic communities may result on the seabed directly beneath the turbine rotors. Cumulative impacts from multiple devices are likely to be additive.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of:	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures:

Sites at Which These Qualifying Features are Present and are Considered for the East Marine Plans are Reviewed in Tables A3, A4, A5 and A6 in Appendix A					
Qualifying and Supporting Feature (See also Section 4.4 and Screening Tables A3-A5 in Appendix A)	**Summary Impact Pathway** (See also Table 1 above and Table A1 in Appendix A)	**Pathway Ref. No.**	**Sensitivity Level(s) Commentary and Relevant Conservation Objective**	**Is There an Adverse Effect on Integrity With Initial Mitigation Measures?** (See also Table A7 in Appendix A)	**Is There an Adverse Effect on Integrity With Additional Mitigation Measures?**
habitat (Reefs) ▪ Intertidal habitats (including saltmarshes)	devices, CO_2 pipelines, power cables or cable/pipeline armouring causing physical changes (including alterations to sediment transport/scour) or from changes to seabed/sandbank morphology at the extraction site(s) (including alterations to sediment transport/scour).		Across the East Marine Plan Areas there are only two areas currently defined for tidal energy generation (one relatively small at mouth of the Humber). In general though benthic communities in tide-swept sandy environments where devices would be placed are well adapted to high levels of disturbance and, therefore, may recover quickly from short-term, localised disturbance. Providing that the sediments and benthos in the wider environment do not change over time, benthic communities should also recover quickly following decommissioning. The potential impact on the reef and mudflat habitats will depend on the sensitivity of the habitats/biotopes found in the area and the intensity, spatial extent and distribution of disturbance. Localised scouring of seabed and benthic communities may result in damage directly beneath the turbine rotors. Scour of sediments around devices and their associated moorings is generally of low significance (PMSS Ltd, 2007). Mooring blocks and gravity-weighted devices will tend to bury themselves in the sediment reducing potential for scour. However, in slack-moored systems, the mooring chain (and associated scour on the seabed) can increase the area of habitat lost and/or disturbed. Scour is more often a concern for piled devices and the potential for impact (substratum loss) is dependent on the particular abiotic environment (tidal flow, seabed sediments) of a development site. However, areas suitable for device deployment generally tend to have low amounts of fine sediments due to the high energy of the environment. Micro-siting of devices and re-use of arisings from drillings as scour protection can reduce the likelihood of any impacts. Encouraging results have recently been obtained from field based observations of benthic conditions in the Narrows of Strangford Lough, Northern Ireland. These were undertaken as part of the monitoring for the SeaGen tidal turbine and they recorded no deleterious effect of the installation with the changes in benthos gradual and in-line with natural variation (Royal Haskoning, 2011). **Relevant Conservation Objectives** (see Section 4.8.2) All of the 7 COs listed are considered to be relevant to impacts from hydrodynamic changes during the operational phase of the project because the potential exists to alter the balance extent and functionality of habitats and species. Therefore, the full list of 7 COs is set out below: ▪ Extent of the habitat on site; ▪ Distribution of the habitat within site; ▪ Structure and function of the habitat; ▪ Processes supporting the habitat; ▪ Distribution of typical species of the habitat; ▪ Viability of typical species as components of the habitat; and ▪ No significant disturbance of typical species of the habitat.	• The level of uncertainty associated with this effect; • The generic nature of those 'standard' MMO mitigation measures that are available(see MMO Mitigation Measure 9 in Appendix B and the absence of measures dealing with abrasion); and • The residual gaps that exist in these 'standard' mitigation measures. See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps..	• The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.
▪ Morphological Features encompassing a range of habitats ▪ Supralittoral habitats	**Physical Damage to Habitat** Damage to onshore habitat (including bird breeding grounds, freshwater habitats, otter holts or shelters) by excavation, piling and construction work associated with the installation, operation and decommissioning of cables, CO_2 pipelines and landside infrastructure.	9	**Sensitivity Level(s)** maxuimum considered to be medium (see Tables 3-6 for detail and colour code) Damage to onshore habitats (from TIDE or CCS activities), will be dependent upon the scale and location of the works undertaken. In general, it is expected that any landward works will seek to avoid designated sites and/or areas of clear value to designated species (e.g. otter holts and bird breeding grounds), but in an event where this is not possible then appropriate mitigation measures will need to be adopted. Particular concern will relate to impacts arising to watercourses which could have a widespread effect beyond the footprint. **Relevant Conservation Objectives** (see Section 4.8.2) All of the 7 COs listed are considered to be relevant to impacts from hydrodynamic changes during the operational phase of the project because the potential exists to alter the balance extent and functionality of habitats and species. Therefore, the full list of 7 COs is set out below: ▪ Extent of the habitat on site; ▪ Distribution of the habitat within site; ▪ Structure and function of the habitat; ▪ Processes supporting the habitat; ▪ Distribution of typical species of the habitat; ▪ Viability of typical species as components of the habitat; and ▪ No significant disturbance of typical species of the habitat.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; • The generic nature of those 'standard' MMO mitigation measures that are available (see MMO Mitigation Measure 10 in Appendix B); and • The residual gaps that exist in these 'standard' mitigation measures. See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.
▪ Morphological Features encompassing a range of habitats ▪ Subtidal habitats with typically soft-sediment habitat ▪ Subtidal habitats with typically hard-substratum habitat (Reefs) ▪ Intertidal habitats (including saltmarshes) ▪ Supralittoral habitats	**Toxic Contamination** Spillage of fluids, fuels and/or construction materials (inc. from surface coatings/treatments) during installation or removal of structures (devices and cables), during survey/ maintenance or during aggregate extraction.	19	**Sensitivity Level(s)** maximum considered to be low (see Tables 3-6 for detail and colour code) **Commentary/Review** For all stages of work across all sectors (TIDE, CCS, AGG) from the construction to decommissioning and including operational/maintenance/extraction works, there is the potential for accidental discharges/spillages from machinery and vessels associated, although the likelihood is comparatively low. In particular, the probability of spillage is low because a range of standard navigational safety measures are employed in the marine environment. The consequence for subtidal and coastal benthic communities if a spillage was to occur is also likely limited in scale (due to small quantities of material and slight acute toxicity). **Relevant Conservation Objectives** (see Section 4.8.2) The COs are designed to avoid deterioration of the qualifying habitats, thus ensure that the integrity of the site is maintained. As they are broad-ranging and generic in their scope, most activities have the potential to lead to a failure of most, if not all, objectives. However, of the 7 COs listed, the following 3 are considered to be most relevant to impacts from toxic contamination/spillage events because they relate to the composition and distribution of the species present rather than the broader extent, distribution and functionality of habitats and the processes affecting them: ▪ Distribution of typical species of the habitat; ▪ Viability of typical species as components of the habitat; and ▪ No significant disturbance of typical species of the habitat.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; • The generic nature of those 'standard' MMO mitigation measures that are available (see MMO Mitigation Measure 6 in Appendix B); and • The residual gaps that exist in these 'standard' mitigation measures.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.

Sites at Which These Qualifying Features are Present and are Considered for the East Marine Plans are Reviewed in Tables A3, A4, A5 and A6 in Appendix A					
Qualifying and Supporting Feature (See also Section 4.4 and Screening Tables A3-A5 in Appendix A)	**Summary Impact Pathway** (See also Table 1 above and Table A1 in Appendix A)	**Pathway Ref. No.**	**Sensitivity Level(s) Commentary and Relevant Conservation Objective**	**Is There an Adverse Effect on Integrity With Initial Mitigation Measures?** (See also Table A7 in Appendix A)	**Is There an Adverse Effect on Integrity With Additional Mitigation Measures?**
				See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	
▪ Morphological Features encompassing a range of habitats ▪ Subtidal habitats with typically soft-sediment habitat ▪ Subtidal habitats with typically hard-substratum habitat (Reefs) ▪ Intertidal habitats (including saltmarshes) ▪ Supralittoral habitats	**Toxic Contamination** Release of contaminants associated with the dispersion of suspended sediments during installation or removal of structures (devices, pipelines and cables) or from the aggregate extraction process.	20	**Sensitivity Level(s)** maximum considered to be low (see Tables 3-6 for detail and colour code) **Commentary/Review** In general there is a low likelihood of contaminated sediments occurring across the locations associated with aggregate extraction, turbine deployment or the installation of CCS structures given the stronger flows (esp. where tidal energy generation could take place), the remote offshore locations and the low likelihood of such work being carried out in depositional conditions in proximity to industrial areas. The characteristically high-energy offshore environments are also likely to assist in the dispersion of any contamination releases, thus minimising any impacts unless contamination reaches the shoreline. **Relevant Conservation Objectives** (see Section 4.8.2) Of the 7 COs listed, the following 3 are considered to be most relevant to impacts from toxic contamination/spillage events because they relate to the composition and distribution of the species present rather than the broader extent, distribution and functionality of habitats and the processes affecting them: ▪ Distribution of typical species of the habitat; ▪ Viability of typical species as components of the habitat; and ▪ No significant disturbance of typical species of the habitat.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; • The generic nature of those 'standard' MMO mitigation measures that are available (see MMO Mitigation Measure 7 in Appendix B); and • The residual gaps that exist in these 'standard' mitigation measures. See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.
▪ Morphological Features encompassing a range of habitats ▪ Subtidal habitats with typically soft-sediment habitat ▪ Subtidal habitats with typically hard-substratum habitat (Reefs) ▪ Intertidal habitats (including saltmarshes)	**Toxic Contamination** Release of CO_2 into the water column and its acidification from the formation of carbonic acid.	21	**Sensitivity Level(s)** maximum considered to be low (see Tables 3-6 for detail and colour code) **Commentary/Review** The transport of captured CO_2 will be via pipeline or by ship with the former resulting in impacts to coastal and offshore habitats that are directly analogous to those that would arise from installation of natural gas transport routes (EC, 2008). Both during transport and storage there are the risks associated with leakage. The leaked CO_2 would dissolve in the water, forming carbonic acid (H2CO3). This would acidify the water, improving its ability to solubilise sources of calcium carbonate present in the form of coral and the carbonaceous shells of clams and other shellfish. However, impacts of an individual release are likely to be limited to the pelagic zone, and will disperse rapidly. As with the tidal energy generation, there are a number of uncertainties associated with the impacts that could occur in this emerging sector and, in particular, with respect to the alignment and landfall locations of carbon delivery pipelines (EC, 2008). Environment Agency guidance indicates that any such acidification effects would arise from 'abnormal' releases of CO_2 from offshore pipelines during operation or storage sites during operation or post closure (EA 2013). **Relevant Conservation Objectives** (see Section 4.8.2) Of the 7 COs listed, the following 3 are considered to be most relevant to impacts from toxic contamination/spillage events because they relate to the composition and distribution of the species present rather than the broader extent, distribution and functionality of habitats and the processes affecting them: ▪ Distribution of typical species of the habitat; ▪ Viability of typical species as components of the habitat; and ▪ No significant disturbance of typical species of the habitat.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; and • The absence even of any 'standard' MMO mitigation measures for the CCS sector specifically See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.
▪ Morphological Features encompassing a range of habitats ▪ Subtidal habitats with typically soft-sediment habitat ▪ Subtidal habitats with typically hard-substratum habitat (Reefs) ▪ Intertidal habitats (including saltmarshes) ▪ Supralittoral habitats	**Non Toxic Contamination** Increase in turbidity (and possibly reduced dissolved oxygen) associated with suspended sediments release during installation or removal of structures (devices, pipelines and cables) or from aggregate extraction.	22	**Sensitivity Level(s)** maximum considered to be low-medium (see Tables 3-6 for detail and colour code) **Commentary/Review** For aggregate extraction work there is a clear zone in which plumes form around the draghead. The extent of such plumes is well understood from past work. Any excavation work associated with the installation of turbines or cables also has the potential (depending on the *in situ* sediment type) to cause redistribution of sediment and potentially adverse effects on surrounding habitats. The extent of this effect has been defined within this HRA (based on precedent from past Plan-level HRA work) as the area that extends to one tidal excursion distance of the cable/device/extraction area. The greatest impacts will be at locations that have a lower energy condition or are on stable subtidal substrata. The disposal of construction material from installations and piled devices also has the potential to cause loss of or change to habitats. In some cases, the material can be re-used locally as scour protection around pile. The effects are generally likely to be temporary and localised. **Relevant Conservation Objectives** (see Section 4.8.2) Of the 7 COs listed, the following 3 are considered to be most relevant to impacts from toxic contamination/spillage events because they relate to the composition and distribution of the species present rather than the broader extent, distribution and functionality of habitats and the processes affecting them: ▪ Distribution of typical species of the habitat; ▪ Viability of typical species as components of the habitat; and ▪ No significant disturbance of typical species of the habitat.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; and • The absence even of any 'standard' MMO mitigation measures for dealing with turbidity specifically. See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.

Sites at Which These Qualifying Features are Present and are Considered for the East Marine Plans are Reviewed in Tables A3, A4, A5 and A6 in Appendix A					
Qualifying and Supporting Feature (See also Section 4.4 and Screening Tables A3-A5 in Appendix A)	**Summary Impact Pathway** (See also Table 1 above and Table A1 in Appendix A)	**Pathway Ref. No.**	**Sensitivity Level(s) Commentary and Relevant Conservation Objective**	**Is There an Adverse Effect on Integrity With Initial Mitigation Measures?** (See also Table A7 in Appendix A)	**Is There an Adverse Effect on Integrity With Additional Mitigation Measures?**
▪ Morphological Features encompassing a range of habitats ▪ Subtidal habitats with typically soft-sediment habitat ▪ Subtidal habitats with typically hard-substratum habitat (Reefs) ▪ Intertidal habitats (including saltmarshes)	**Biological Disturbance** Introduction of new structures (tidal devices or construction platforms) on the seabed providing new substratum that facilitates the colonisation and ingress of invasive non-native species.	24	**Sensitivity Level(s)** maximum considered to be low-medium (see Tables 3-6 for detail and colour code) **Commentary/Review** The placement of structures underwater (from TIDE of CCS activities) introduces new, and initially barren, surfaces which have the potential to facilitate the spread of invasive non-native species where, in the absence of competition from indigenous species, they are able to colonise. It is difficult to quantify the risk of introduction of invasive non-native species in this manner and the extent to which this occurs. The amount of new 'surface' will be comparatively small and, in turn, reflected by the subsequent colonisation. On the assumption that the current spread of such species is limited by the prevailing physical regime and the lack of new colonizing substrate, the options which cause the greatest change in physical processes and provide the greatest colonizing space would be expected to pose the greatest risk. **Relevant Conservation Objectives** (see Section 4.8.2) Of the 7 COs listed, the following 3 are considered to be most relevant to impacts from invasive species introductions because they have the potential to affect the balance of species within the habitats: ▪ Distribution of typical species of the habitat; ▪ Viability of typical species as components of the habitat; and ▪ No significant disturbance of typical species of the habitat.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; and • The absence even of any 'standard' MMO mitigation measures for dealing with invasive species specifically. See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.
▪ Morphological Features encompassing a range of habitats ▪ Subtidal habitats with typically soft-sediment habitat ▪ Subtidal habitats with typically hard-substratum habitat (Reefs) ▪ Intertidal habitats (including saltmarshes)	**Biological Disturbance** Introduction and ingress of invasive non-native species as biofouling species on the surfaces of vessels or construction plant.	25	**Sensitivity Level(s)** maximum considered to be low (see Tables 3-6 for detail and colour code) **Commentary/Review** The possibility also exists that invasive non-native species could be introduced on the vessels and equipment that are used to construct, maintain or decommission the devices. The likelihood of this occurrence are considered to be low because all such equipment is expected to be efficiently maintained and cleaned at regular intervals. However, it will be dependent upon this inspection regime being in place and on the provenance of the vessels and equipment being used. * **Relevant Conservation Objectives** (see Section 4.8.2) Of the 7 COs listed, the following 3 are considered to be most relevant to impacts from invasive species introductions because they have the potential to affect the balance of species within the habitats: ▪ Distribution of typical species of the habitat; ▪ Viability of typical species as components of the habitat; and ▪ No significant disturbance of typical species of the habitat.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; and • The absence even of any 'standard' MMO mitigation measures for dealing with this invasive species specifically. See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.

4.8.3 Potential Effects on Seabirds Features

The conservation objectives for the qualifying seabird interest features seek to avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring the integrity of the site. The conservation objectives are to ensure for the qualifying habitats that the following are maintained in the long term:

- Population of the species as a viable component of the site;
- Distribution of the species within site;
- Distribution and extent of habitats supporting the species;
- Structure, function and supporting processes of habitats supporting the species; and
- No significant disturbance of the species.

Taking account of these conservation objectives and the Plan-level activities to which the key interest features are sensitive, the effects of East Marine Plans on the integrity of the designated sites with seabird qualifying features is reviewed in Table 18.

Table 18: Assessment of the potential effects of the East Marine Plans on seabird features

Sites at Which These Qualifying Features are Present and are Considered for the East Marine Plans are Reviewed in Tables A3, A4, A5 and A6 in Appendix A					
Qualifying and Supporting Feature (See also Section 4.5 and Screening Tables in Appendix A)	**Summary Impact Pathway** (See also Table 1)	**Pathway Ref. No.**	**Sensitivity Level(s) Commentary and Relevant Conservation Objective**	**Is There an Adverse Effect on Integrity With Initial Mitigation Measures?** (See also Table A7 Appendix A)	**Is There an Adverse Effect on Integrity With Additional Mitigation Measures?**
▪ All seabird species	**Physical Loss/Gain of Habitat** Loss of onshore habitat (including bird breeding and roosting grounds, freshwater habitats, otter holts or shelters) under the footprint of power cables, CO_2 pipelines, cable/pipeline armouring and landside infrastructure due to the installation, operation and decommissioning of these structures.	2	**Sensitivity Level(s)** maximum considered to be high (see Table 8 for detail and colour code) **Commentary/Review** The effects arising from any onshore TIDE or CCS development will be highly dependent upon the locations selected and the scale of the work proposed. The impacts associated with any scheme may lead to a loss of breeding or roosting habitat, and seabirds are considered to be of high sensitivity to this risk. **Relevant Conservation Objectives** (see Section 4.8.3) All of the 5 COs listed are pertinent, although the following 2 are considered to be most relevant: ▪ Distribution and extent of habitats supporting the species; and ▪ Structure, function and supporting processes of habitats supporting the species.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; • The generic nature of those 'standard' MMO mitigation measures that are available (see MMO Measure 10 in Appendix B); and • The residual gaps that exist in these 'standard' mitigation measures. See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.
▪ All seabird species	**Physical Loss/Gain of Habitat** Loss of foraging areas from a reduction in coastal and offshore habitat due to installation of devices, power cables, CO_2 pipelines and/or cable/pipeline armouring both at the development footprint and outside from bed scour and indirectly from changes to the hydrodynamic (wave and tide) regime.	3	**Sensitivity Level(s)** maximum considered to be high (see Table 8 for detail and colour code) **Commentary/Risk Review** All species are considered to be of high sensitivity during surveying, construction, maintenance and decommissioning. However, the effect will depend on the quality and location of habitat that might be affected. For example: ▪ Loss of sandy sediments found within the East Marine Plan Areas may have the greatest effect on seabirds due to their importance for sandeels; and ▪ Loss of onshore habitat due to cable installation works could potentially affect breeding and/or wintering birds. **Relevant Conservation Objectives** (see Section 4.8.3) All of the 5 COs listed are pertinent, although the following 2 are considered to be most relevant: ▪ Distribution and extent of habitats supporting the species; and ▪ Structure, function and supporting processes of habitats supporting the species.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; and • The absence even of any 'standard' MMO mitigation measures for dealing with habitat foraging quality specifically. See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.
▪ Diving and surface feeding birds are most sensitive	**Physical Loss/Gain of Habitat** Presence of tidal generation (or other) structures on seabed for the duration of the project resulting in changes to prey and species behaviour (e.g. acting as FAD (Fish Aggregating Device), artificial reef or bird roost).	4	**Sensitivity Level(s)** considered to be low (see Table 8 for detail and colour code) **Commentary/Risk Review** Underwater structures may provide new foraging opportunities for diving species. Construction of above-surface arrays and structures above water that have a stable platform may serve as additional resting and/or breeding habitats, especially for gulls and terns. The extent of this (positive) effect and the degree to which it then has consequences for an increased risk of collision, etc is unknown, although sensitivity likely to be low. **Relevant Conservation Objectives** (see Section 4.8.3) All of the 5 COs listed are pertinent, although the following 2 are considered to be most relevant: ▪ Distribution and extent of habitats supporting the species; and ▪ Structure, function and supporting processes of habitats supporting the species.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; and • The absence even of any 'standard' MMO mitigation measures for dealing with FAD specifically See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.

Sites at Which These Qualifying Features are Present and are Considered for the East Marine Plans are Reviewed in Tables A3, A4, A5 and A6 in Appendix A				Is There an Adverse Effect on Integrity With Initial Mitigation Measures? (See also Table A7 Appendix A)	Is There an Adverse Effect on Integrity With Additional Mitigation Measures?
Qualifying and Supporting Feature (See also Section 4.5 and Screening Tables in Appendix A)	**Summary Impact Pathway** (See also Table 1)	**Pathway Ref. No.**	**Sensitivity Level(s) Commentary and Relevant Conservation Objective**		
▪ All seabird species	**Physical Damage to Habitat** Damage to onshore habitat (including bird breeding grounds, freshwater habitats, otter holts or shelters) by excavation, piling and construction work associated with the installation, operation and decommissioning of cables, CO_2 pipelines and landside infrastructure.	9	**Sensitivity Level(s)** considered to be low or medium (see Table 8 for detail and colour code) **Commentary/Risk Review** Onshore development associated with any scheme may lead to damage of intertidal or onshore habitat, and wintering species are considered to be of medium sensitivity to this situation. The greatest sensitivities occur during the construction or decommissioning phases when activities on site will be at their highest. **Relevant Conservation Objectives** (see Section 4.8.3) Of the 5 COs listed, the following 2 are considered to be most relevant: ▪ Distribution and extent of habitats supporting the species; and ▪ Structure, function and supporting processes of habitats supporting the species.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; • The generic nature of those 'standard' MMO mitigation measures that are available (see MMO Measure 10 in Appendix B); and • The residual gaps that exist in these 'standard' mitigation measures. See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.
▪ All seabird species	**Physical Damage to Habitat** Reduction in quality of foraging areas as result of damage to coastal and offshore habitat from baseline surveys (e.g. boreholes and trawls); from equipment use causing abrasion, damage or smothering during installation; from maintenance and removal of cables, pipeline, tidal/devices or from scour, sediment transport and hydrodynamic change during operation.	10	**Sensitivity Level(s)** considered to be low or medium (see Table 8 for detail and colour code) **Commentary/Review** All species are considered to be of low or medium sensitivity, with higher sensitivities occurring during the construction and decommissioning phases. However, the effect will depend on the quality and location of habitat that might be affected. For example: ▪ Loss of sandy sediments found within the East Marine Plan Areas may have the greatest effect on seabirds due to their importance for sandeels; and ▪ Loss of onshore habitat due to cable installation works could potentially affect breeding and/or wintering birds. **Relevant Conservation Objectives** (see Section 4.8.3) Of the 5 COs listed, the following 2 are considered to be most relevant: ▪ Distribution and extent of habitats supporting the species; and ▪ Structure, function and supporting processes of habitats supporting the species	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; and • The absence even of any 'standard' MMO mitigation measures for dealing with foraging habitat specifically See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.
▪ Diving and surface feeding birds are most sensitive	**Physical Damage to Habitat** Reduction in quality of foraging areas as result of damage to coastal and offshore habitat within and surrounding the aggregate sites during the extraction process.	11	**Sensitivity Level(s)** considered to be low or medium (see Table 8 for detail and colour code) **Commentary/Review** Diving species are sensitive to any direct or indirect damage to offshore foraging grounds arising from aggregate extraction work. It is known that species such as terns, Common Scoter or Red Throated Diver can forage in offshore locations that are used for aggregate extraction. However, once again, the effect will depend on the quality and location of habitat that might be affected. For example: the loss of sandy sediments found within the East Marine Plan Areas may have the greatest effect on seabirds due to their importance for sandeels. **Relevant Conservation Objectives** (see Section 4.8.3) Of the 5 COs listed, the following 2 are considered to be most relevant: ▪ Distribution and extent of habitats supporting the species; and ▪ Structure, function and supporting processes of habitats supporting the species	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; and • The absence even of any 'standard' MMO mitigation measures for dealing with foraging habitat specifically See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.

Sites at Which These Qualifying Features are Present and are Considered for the East Marine Plans are Reviewed in Tables A3, A4, A5 and A6 in Appendix A					
Qualifying and Supporting Feature (See also Section 4.5 and Screening Tables in Appendix A)	**Summary Impact Pathway** (See also Table 1)	**Pathway Ref. No.**	**Sensitivity Level(s) Commentary and Relevant Conservation Objective**	**Is There an Adverse Effect on Integrity With Initial Mitigation Measures?** (See also Table A7 Appendix A)	**Is There an Adverse Effect on Integrity With Additional Mitigation Measures?**
▪ Diving birds and nocturnal species	**Physical Damage to Species** Collision risk and possible mortality of species due to the presence of tidal devices or from vessels travelling to and from the site (including propeller collision risk).	13	**Sensitivity Level(s)** considered to be high (see Table 8 for detail and colour code) **Commentary/Review** Diving species have been assessed to be of high sensitivity to collisions with turbine blades during operation; other below sea-surface structures also represent a risk. Turbines with moving underwater structures pose a particular problem for diving species that use the whole water column, or are prone to foraging during periods of low light visibility (i.e. nocturnal foragers). There is currently insufficient evidence to quantify this risk, although theoretical calculations and initial observations from existing tidal stream developments suggest the risk is low. The wave devices which typically have more static underwater structures and are often in locations that are more distant from the shoreline are expected to pose relatively lower collision sensitivities. Above sea-surface structures and vessel traffic may also represent a collision risk during operation. Nocturnal species and those that forage during periods of low-light availability are assessed to be of medium sensitivity to this risk, whereas diurnal feeders are only of low sensitivity. Frid *et al.* (2012) stated that the risk of collision is expected to be minimal for most seabirds, with the predicted slow turbine speeds relative to the agility of diving bird species making the risk of mortality very low. Ultimately, the level of risk will be dependent upon exposure and that will only be fully understood at a project level. **Relevant Conservation Objectives** (see Section 4.8.3) For the purposes of this assessment, the overarching conservation objective for all the SPAs and Ramsar sites reviewed and all the impact pathways/activities assessed is to "maintain specific reference populations for feature species, as provided in the relevant citations". This has been applied because it covers impacts to both the species and the habitats that support them and it encompasses all of the five 5 COs that are common to all SPAs.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; • The generic nature of those 'standard' MMO mitigation measures that are available (see MMO Measure 12 in Appendix B); and • The residual gaps that exist in these 'standard' mitigation measures. See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.
▪ Nocturnal species	**Physical Damage to Species** Presence of above water structures, and any associated lighting, influencing migration/foraging of bird species.	14	**Sensitivity Level(s)** considered to be low or medium (see Table 8 for detail and colour code) **Commentary/Review** The use of lighting (on structures or vessels) could potentially increase collision risks and studies of different species have indicated that altering the type of lighting (e.g. flashing/strobing) and/or the light's colour spectrum can reduce the risk of attracting birds and therefore reduce such collision risks. Therefore it has the potential to either exacerbate or ameliorate an effect. The specific effects will only be understood at a project levels when details about the foraging behaviour and migratory pathways of particular species are understood. **Relevant Conservation Objectives** (see Section 4.8.3) For the purposes of this assessment, the overarching conservation objective for all the SPAs and Ramsar sites reviewed and all the impact pathways/activities assessed is to "maintain specific reference populations for feature species, as provided in the relevant citations". This has been applied because it covers impacts to both the species and the habitats that support them and it encompasses all of the five 5 COs that are common to all SPAs.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; and • The absence even of any 'standard' MMO mitigation measures for dealing with foraging habitat specifically See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.
▪ All seabird species	**Non-Physical Disturbance** Visual disturbance and exclusion from areas as a result of surveying; cable, pipeline or tidal device installation/operation and decommissioning activities (including movements of vessels).	16	**Sensitivity Level(s)** considered to be low or medium (see Table 8 for detail and colour code) **Commentary/Risk Review** There are potential effects during surveying and cable/device/pipeline installation and aggregate extraction. The greatest disturbance is likely to be caused by human presence and work on the foreshore. Survey work on the SeaGen Strangford Lough project showed that while some fine scale displacement of birds had been recorded in the immediate vicinity of a tidal device, the overall numbers in the Narrows at the mouth of the lough remained stable (Royal Haskoning, 2011). Nevertheless, there is potential for displacement of sea birds particularly for developments with significant surface infrastructure (Grecian *et al*., 2010). With respect to vessel movements, and especially aggregate extraction, the presence of the dredger may cause an increase in noise and vibration levels which could result in disturbance to / displacement of seabirds. Species such as Red-throated Divers and Sandwich Terns are potentially particularly sensitive. The value of the relevant area as a foraging sites and the extent of species habituation to existing traffic will be materials considerations when assessing the impacts at a project level. **Relevant Conservation Objectives** (see Section 4.8.3) Of the 5 COs listed, the following 2 are considered to be most relevant: ▪ Distribution of the species within site; and ▪ No significant disturbance of the species.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; • The generic nature of those 'standard' MMO mitigation measures that are available (see MMO Measure 11 in Appendix B); and • The residual gaps that exist in these 'standard' mitigation measures. See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.

Sites at Which These Qualifying Features are Present and are Considered for the East Marine Plans are Reviewed in Tables A3, A4, A5 and A6 in Appendix A					
Qualifying and Supporting Feature (See also Section 4.5 and Screening Tables in Appendix A)	**Summary Impact Pathway** (See also Table 1)	**Pathway Ref. No.**	**Sensitivity Level(s) Commentary and Relevant Conservation Objective**	**Is There an Adverse Effect on Integrity With Initial Mitigation Measures?** (See also Table A7 Appendix A)	**Is There an Adverse Effect on Integrity With Additional Mitigation Measures?**
▪ All seabird species	**Non-Physical Disturbance** Noise/vibration disturbance and exclusion from areas as a result of vessels and other activities during survey work (e.g. seismic exploration and geophysical surveys), construction (e.g. piling, drilling, cable laying), operation (e.g. device noise), maintenance or decommissioning. Also includes noise/vibration disturbance from vessels and draghead during aggregate extraction.	17	**Sensitivity Level(s)** considered to be low or medium (see Table 8 for detail and colour code) **Commentary/Risk Review** There are potential effects during surveying and cable/device/pipeline installation and aggregate extraction. The sensitivity of birds to airborne noise during construction is considered to be low given their ability to habituate to continual noises (e.g. piling). The sensitivity of species to underwater marine noise is difficult to know, but it is likely to be greater for diving species and sea-surface foragers. There is limited data on this issue although, as described under Impact Pathway 16 (which also addresses disturbance), survey work on the SeaGen Strangford Lough project has shown that while some fine scale displacement of birds in the immediate vicinity of the device, the overall numbers in the area have remained stable (Royal Haskoning, 2011). Nevertheless, there is potential for displacement of sea birds, particularly for developments with significant surface infrastructure (Grecian *et al*., 2010). **Relevant Conservation Objectives** (see Section 4.8.3) Of the 5 COs listed, the following 4 are considered to be most relevant: ▪ Population of the species as a viable component of the site; ▪ Distribution of the species within site; ▪ No significant disturbance of the species; and ▪ Structure, function and supporting processes of habitats supporting the species.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; • The generic nature of those 'standard' MMO mitigation measures that are available (see MMO Measure 11 in Appendix B); and • The residual gaps that exist in these 'standard' mitigation measures. See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.
▪ All seabird species (esp. diving species)	**Toxic Contamination** Spillage of fluids, fuels and/or construction materials (inc. from surface coatings/treatments) during installation or removal of structures (devices and cables), during survey/ maintenance or during aggregate extraction.	19	**Sensitivity Level(s)** considered to be low or medium (see Table 8 for detail and colour code) **Commentary/Review** For all stages of the work, from the construction to decommissioning and including operational/maintenance works, there is the potential for accidental discharges/spillages from machinery and vessels. All species, including seabirds and those using intertidal habitats, are considered of high sensitivity to this issue. Safety measures should be employed to mitigate against this risk. **Relevant Conservation Objectives** (see Section 4.8.3) Of the 5 COs listed, the following 3 are considered to be most relevant: ▪ Distribution of the species within site; ▪ No significant disturbance of the species; and ▪ Structure, function and supporting processes of habitats supporting the species.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; • The generic nature of those 'standard' MMO mitigation measures that are available (see MMO Mitigation Measure 6 in Appendix B); and • The residual gaps that exist in these 'standard' mitigation measures. See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.
▪ All seabird species (esp. diving species)	**Toxic Contamination** Release of contaminants associated with the dispersion of suspended sediments during installation or removal of structures (devices, pipelines and cables) or from the aggregate extraction process.	20	**Sensitivity Level(s)** considered to be low (see Table 8 for detail and colour code) **Commentary/Risk Review** There is a risk to seabirds from the mobilisation of sediment and changes in turbidity during surveying, aggregate extraction, cable/device installation and decommissioning activities; in particular, an increase of suspended sediment may disrupt foraging and predator-prey interactions. Changes in hydrodynamics may also affect seabirds. Diving species are considered of medium sensitivity to this risk, with other seabird species of low sensitivity. **Relevant Conservation Objectives** (see Section 4.8.3) Of the 5 COs listed, the following 3 are considered to be most relevant: ▪ Distribution of the species within site; ▪ No significant disturbance of the species; and ▪ Structure, function and supporting processes of habitats supporting the species.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; • The generic nature of those 'standard' MMO mitigation measures that are available (see MMO Mitigation Measure 7 in Appendix B); and • The residual gaps that exist in these 'standard' mitigation measures. See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.

Sites at Which These Qualifying Features are Present and are Considered for the East Marine Plans are Reviewed in Tables A3, A4, A5 and A6 in Appendix A					
Qualifying and Supporting Feature (See also Section 4.5 and Screening Tables in Appendix A)	**Summary Impact Pathway** (See also Table 1)	**Pathway Ref. No.**	**Sensitivity Level(s) Commentary and Relevant Conservation Objective**	**Is There an Adverse Effect on Integrity With Initial Mitigation Measures?** (See also Table A7 Appendix A)	**Is There an Adverse Effect on Integrity With Additional Mitigation Measures?**
▪ All seabird species (esp. diving species)	**Toxic Contamination** Release of CO_2 into the water column and its acidification from the formation of carbonic acid.	21	**Sensitivity Level(s)** considered to be low (see Table 8 for detail and colour code) **Commentary/Risk Review** In the event of any leak of carbon into coastal or offshore waters, then it is likely that any effects will be temporary and any effects will only arise from abnormal release events (EC 2008, EA 2013). There may be localised consequences for local benthic species and especially shellfish but the risk is low. The consequential, knock-on, effects of this to foraging birds (i.e. through adverse effects on prey species) is therefore considered to be very low. This is a new field of work and one in which ongoing research is being undertaken to understand these issues and the risk much better **Relevant Conservation Objectives** (see Section 4.8.3) Of the 5 COs listed, the following 3 are considered to be most relevant: ▪ Distribution of the species within site; ▪ No significant disturbance of the species; and ▪ Structure, function and supporting processes of habitats supporting the species.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; • The absence even of any 'standard' MMO mitigation measures for dealing with CCS sector effects specifically See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.
▪ All seabird species (esp. diving species)	**Non-Toxic Contamination** Increase in turbidity (and possibly reduced dissolved oxygen) associated with suspended sediments release during installation or removal of structures (devices, pipelines and cables) or from aggregate extraction.	22	**Sensitivity Level(s)** The risks are considered to be low (see Table 8 for detail and colour code) **Commentary/Review** Contamination effects on seabirds from sediments disturbed during surveying, cable/device installation and decommissioning are considered to be limited. **Relevant Conservation Objectives** (see Section 4.8.3) Of the 5 COs listed, the following 3 are considered to be most relevant: ▪ Distribution of the species within site; ▪ No significant disturbance of the species; and ▪ Structure, function and supporting processes of habitats supporting the species.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; and • The absence even of any 'standard' MMO mitigation measures for dealing with turbidity specifically. See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.
▪ Ground nesting species	**Biological Disturbance** Predation by introduced rats/mink through the positioning of static devices (turbines, rigs) close to breeding seabird sites.	23	**Sensitivity Level(s)** considered to be high (see Table 8 for detail and colour code) **Commentary/Risk Review** Breeding ground-or burrow-nesting seabirds are considered of high sensitivity to predation effects, whereas cliff-nesters are considered of medium sensitivity. While the sensitivity is high the exposure levels for the East Marine Plan Areas are low because it is open coastal waters with no islands. Any effects that could arise will be confined to inland estuaries and channels and the effects overall are expected to be negligible. **Relevant Conservation Objectives** (see Section 4.8.3) For the purposes of this assessment, the overarching conservation objective for all the SPAs and Ramsar sites reviewed and all the impact pathways/activities assessed is to "maintain specific reference populations for feature species, as provided in the relevant citations". This has been applied because it covers impacts to both the species and the habitats that support them and it encompasses all of the five 5 COs that are common to all SPAs.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; and • The absence even of any 'standard' MMO mitigation measures for dealing with rat/mink predation specifically. See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.

4.8.4 Potential Effects on Marine Mammal Features

In the UK the conservation objectives for the three qualifying features (grey seal, common seal, and bottlenose dolphin) are typically the same across different designated sites. The UK objectives seek to avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features. The conservation objectives are to ensure for the qualifying species that the following are maintained in the long term:

- Population of the species as a viable component of the site;
- Distribution of the species within site;
- Distribution and extent of habitats supporting the species;
- Structure, function and supporting processes of habitats supporting the species; and
- No significant disturbance of the species.

There is also is one designated site for which harbour porpoise is a qualifying interest feature species in the UK (Skerries and Causeway cSAC) and the conservation objectives for this site (NIEA, 2011) which are pertinent to its marine mammal interests are to:

"To ensure for the qualifying habitats that the following are maintained in the long term, subject to natural change:

- Distribution of typical species of the habitats;
- Viability of typical species as components of the habitat; and
- No disturbance of typical species of the habitat".

As another, non UK, example for the Roaringwater Bay and Island SAC in Southern Ireland, the following two conservation objective targets apply (National Parks and Wildlife Service (NPWS), 2011) for harbour porpoise:

- Species range within the site should not be restricted by artificial barriers to site use; and
- Human activities should occur at levels that do not adversely affect the harbour porpoise community at the site.

The conservation objective for the harbour porpoise at both the Cleaver Bank and the Dogger Bank (Van Hal *et al*., 2010) is to:

- Maintain the extent and quality of habitat in order to maintain the population.

Taking account of these conservation objectives and the Plan-level activities to which the key interest features are sensitive, the effects of East Marine Plans on the integrity of the designated sites with marine mammal qualifying features is reviewed in Table 19.

Table 19: Assessment of the potential effects of the East Marine Plans on marine mammal features

Sites at Which These Qualifying Features are Present and are Considered for the East Marine Plans are Reviewed in Tables A3, A4, A5 and A6 in Appendix A					
Qualifying and Supporting Feature (See also Section 4.6 and Screening Tables in Appendix A)	**Summary Impact Pathway** (See also Table 1)	**Pathway Ref. No.**	**Sensitivity Level(s) Commentary and Relevant Conservation Objective**	**Is There an Adverse Effect on Integrity With Initial Mitigation Measures?** (See also Table A7 Appendix A)	**Is There an Adverse Effect on Integrity With Additional Mitigation Measures?**
▪ Otter	**Physical Loss/Gain of Habitat** Loss of onshore habitat (including bird breeding and roosting grounds, freshwater habitats, otter holts or shelters) under the footprint of power cables, CO_2 pipelines, cable/pipeline armouring and landside infrastructure due to the installation, operation and decommissioning of these structures.	2	**Sensitivity Level(s)** maximum considered to be medium (see Table 14 for detail and colour code) **Commentary/Risk Review** Based on Scottish Natural Heritage (SNH) advice (during previous plan-level HRAs) about the impacts of development on otter (SNH, 2010; ABPmer 2013), as well as the relevant advice documents provided by SNH under Regulation 33(2) of the Conservation Regulations 1994 (as amended), it is evident that otter are vulnerable to the loss of their shelters (including those on the shoreline) and to the loss habitat which, in turn, can leave them more exposed to disturbance effects. Therefore, habitat damage and disturbance are interlinked factors. The effects arising from any onshore development will be highly dependent upon the locations selected and the scale of the work proposed. As the impacts associated with any scheme may lead to a loss of available habitat (holts), otter are therefore considered to be of medium sensitivity to this risk. **Relevant Conservation Objectives** (see Section 4.8.4) All of the 5 COs listed are pertinent, although the following 2 are considered to be most relevant: ▪ Distribution and extent of habitats supporting the species; and ▪ Structure, function and supporting processes of habitats supporting the species.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; and • The generic nature of those 'standard' MMO mitigation measures that are available (see MMO Measure 10 in Appendix B); and • The residual gaps that exist in these 'standard' mitigation measures. See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.
▪ Common seal ▪ Grey seal ▪ Bottlenose dolphin ▪ Harbour porpoise	**Physical Loss/Gain of Habitat** Loss of foraging areas from a reduction in coastal and offshore habitat due to installation of devices, power cables, CO_2 pipelines and/or cable/pipeline armouring both at the development footprint and outside from bed scour and indirectly from changes to the hydrodynamic (wave and tide) regime.	3	**Sensitivity Level(s)** maximum considered to be low (see Tables 12 and 13 for detail and colour code) **Commentary/Risk Review** Marine mammals are highly mobile and have large foraging ranges. Any loss of habitat from individual developments is likely to only constitute a very small fraction of the total area used by a species for foraging although this will depend on the specific details of the location. For example, Diederichs *et al*. (2008) found no significant influence of wind farms on the occurrence of harbour porpoises which were found to be recorded moving through and foraging in two wind farm areas (Horns Rev-North Sea and Nysted-Baltic Sea) almost daily. However, further understanding about the project-level effects is required and, as with all other pathways, a greater understanding about the in-combination effects is needed. To underpin this, a greater understanding of the behaviour and ecology of marine mammals is likely to be needed for future projects within the East Coast Plan areas. **Relevant Conservation Objectives** (see Section 4.8.4) Of the 5 COs listed, the following 2 are considered to be particularly relevant to impacts from physical loss/gain of habitat during the operational phase of the tidal energy plans: ▪ Distribution and extent of habitats supporting the species; and Structure, function and supporting processes of habitats supporting the species.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; and • The absence even of any 'standard' MMO mitigation measures for dealing with habitat foraging quality specifically. See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.
▪ Common seal ▪ Grey seal ▪ Bottlenose dolphin ▪ Harbour porpoise	**Physical Loss/Gain of Habitat** Presence of tidal generation (or other) structures on seabed for the duration of the project resulting in changes to prey and species behaviour (e.g. acting as FAD (Fish Aggregating Device), artificial reef or bird roost).	4	**Sensitivity Level(s)** considered to be low (see Tables 12 and 13 for detail and colour code) **Commentary/Review** Tidal turbines or CCS infrastructure placed on the seabed, which could potentially act both as artificial reefs and as FADs for prey species of marine mammals. Wilhelmsson *et al.* (2006) investigated this potential for wind turbines to function as artificial reefs and FADs. Fish abundance was found to be greater in the vicinity of the turbines than in surrounding areas, while species richness and Shannon-Wiener diversity (H′) were similar. A gill netting survey at the Svante Wind Farm, Sweden, found higher numbers of cod within two hundred metres of an operating turbine compared to the surrounding open waters, and higher still when the turbines were not operating (Westerberg, 1999). Diver held video surveys of the North Hoyle offshore wind farm piles found extremely high densities of juvenile whiting, apparently feeding on dense populations of amphipods amongst the fouling biota on the piles (Bunker, 2004). Both cod and whiting are prey items for marine mammals such as harbour porpoise and grey seal. Harbour porpoise have also been regularly recorded foraging around wind farm areas which could be because of an increase in prey species (Diederichs *et al*., 2008). The size of any structure/array will be a key consideration and devices with the highest FAD potential are, therefore, those with large elements (e.g. large mooring points or floating structures). The latter may be expected to attract pelagic fish by analogy to floating pontoons and pilings (Clynick., 2008) and vessels (Røstad *et al*., 2006). Devices with large moorings may provide additional shelter and food (habitat) for small demersal fish such as territorial blennies and gobies (Love *et al*., 2000). Increases in demersal fish have been observed around the piles of off-shore wind farms (Wilhelmsson *et al*., 2006; Linley *et al*., 2007). Commensurately, the FAD potential of devices with small footprints such as the buoy type structures and those with smaller device moorings (such as axis turbines) would be predicted to be low. Additionally, structures placed in areas with high flow rates would be predicted to attract and aggregate fewer fish. Tidal energy devices will also only have FAD potential out of the current on the sheltered lee of the device and, thus, this exposure to collision risk is much reduced. However, it is generally agreed that fish aggregation probably represents a very minor effect DECC (2009). Empirical data on the relationship between marine mammals and prey that might be aggregating around OWE areas is also limited.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; and • The absence even of any 'standard' MMO mitigation measures for dealing with FAD specifically See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further

Sites at Which These Qualifying Features are Present and are Considered for the East Marine Plans are Reviewed in Tables A3, A4, A5 and A6 in Appendix A				Is There an Adverse Effect on Integrity With Initial Mitigation Measures? (See also Table A7 Appendix A)	Is There an Adverse Effect on Integrity With Additional Mitigation Measures?
Qualifying and Supporting Feature (See also Section 4.6 and Screening Tables in Appendix A)	**Summary Impact Pathway** (See also Table 1)	**Pathway Ref. No.**	**Sensitivity Level(s) Commentary and Relevant Conservation Objective**		
			Relevant Conservation Objectives (see Section 4.8.4) Of the 5 COs listed, the following 3 are considered to be most relevant to impacts from non-physical disturbance as a result of an increase in prey species: ▪ Distribution of the species within site; ▪ Distribution and extent of habitats supporting the species; and ▪ Structure, function and supporting processes of habitats supporting the species.		details about these measures.
▪ Otter	**Physical Damage to Habitat** Damage to onshore habitat (including bird breeding grounds, freshwater habitats, otter holts or shelters) by excavation, piling and construction work associated with the installation, operation and decommissioning of cables, CO_2 pipelines and landside infrastructure.	9	**Sensitivity Level(s)** maximum considered to be low to medium (see Table 14 for detail and colour code) **Commentary/Risk Review** When assessing the impacts of construction work, the sensitivities of otter to habitat damage are gauged by the presence or absence of otter activity (e.g. spraints) and, in particular, by evidence of otter shelters, as it is usually these which ultimately constrain a development in terms of licensing. The scales of the developmental work, allied to the level of otter activity, dictate the potential risks that exist. However, even relatively small-scale developments such as bridge repairs or bank works have the potential to impact on otters, while larger developments spread over extensive areas pose a greater risk and require more detailed surveys and investigations into otter sensitivity. The extent to which habitat supporting otters will be damaged as a result of cable/pipeline installation activities is largely dependent on the proximity of the works to their holts and sheltering grounds. In advance of a full understanding about the exposure levels, the risk of this effect is considered to be low to medium. **Relevant Conservation Objectives** (see Section 4.8.4) Of the 5 COs listed, the following 2 are relevant to this impact pathway: ▪ Distribution and extent of habitats supporting the species; and ▪ Structure, function and supporting processes of habitats supporting the species.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; • The generic nature of those 'standard' MMO mitigation measures that are available (see MMO Measure 10 in Appendix B); and • The residual gaps that exist in these 'standard' mitigation measures. See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.
▪ Common seal ▪ Grey seal ▪ Bottlenose dolphin ▪ Harbour porpoise	**Physical Damage to Habitat** Reduction in quality of foraging areas as result of damage to coastal and offshore habitat from baseline surveys (e.g. boreholes and trawls); from equipment use causing abrasion, damage or smothering during installation; from maintenance and removal of cables, pipeline, tidal/devices or from scour, sediment transport and hydrodynamic change during operation.	10	**Sensitivity Level(s)** maximum considered to be low (see Tables 12 and 13 for detail and colour code) **Commentary/Review** As for Pathway 3, marine mammals are highly mobile and have large foraging ranges. Any loss of habitat from individual developments is likely to only constitute a very small fraction of the total area used by a species for foraging although this will depend on the specific details of the location. However, further understanding about the project-level effects will be required. **Relevant Conservation Objectives** (see Section 4.8.4) Of the 5 COs listed, the following 2 are considered to be particularly relevant to impacts from reduction in the quality of foraging habitat: ▪ Distribution and extent of habitats supporting the species; and ▪ Structure, function and supporting processes of habitats supporting the species.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; and • The absence even of any 'standard' MMO mitigation measures for dealing with foraging habitat specifically See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.
▪ Common seal ▪ Grey seal ▪ Bottlenose dolphin ▪ Harbour porpoise	**Physical Damage to Habitat** Reduction in quality of foraging areas as result of damage to coastal and offshore habitat within and surrounding the aggregate sites during the extraction process.	11	**Sensitivity Level(s)** maximum considered to be low (see Tables 12 and 13 for detail and colour code) **Commentary/Review** See also Pathways 3 and 10. The removal of seabed through aggregate extraction can affect prey availability for marine mammals. However, marine mammals have a varied diet and forage in a range of water depths across a large spatial area. Therefore, the extent of habitat that might be reduced in quality is likely to constitute a very small fraction of the total area used by a species for foraging, making any impact relatively low. However, the impacts will all depend upon whether the mammal species present are reliant on a particular habitat or prey species within a project area. **Relevant Conservation Objectives** (see Section 4.8.4) Of the 5 COs listed, the following 2 are considered to be particularly relevant to impacts from reduction in the quality of foraging habitat: ▪ Distribution and extent of habitats supporting the species; and ▪ Structure, function and supporting processes of habitats supporting the species.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; and • The absence even of any 'standard' MMO mitigation measures for dealing with foraging habitat specifically See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.

Sites at Which These Qualifying Features are Present and are Considered for the East Marine Plans are Reviewed in Tables A3, A4, A5 and A6 in Appendix A					
Qualifying and Supporting Feature (See also Section 4.6 and Screening Tables in Appendix A)	**Summary Impact Pathway** (See also Table 1)	**Pathway Ref. No.**	**Sensitivity Level(s) Commentary and Relevant Conservation Objective**	**Is There an Adverse Effect on Integrity With Initial Mitigation Measures?** (See also Table A7 Appendix A)	**Is There an Adverse Effect on Integrity With Additional Mitigation Measures?**
▪ Common seal ▪ Grey seal	**Physical Damage to Species** Damage to seal haul out locations during the installation, decommissioning and operation of the cables, pipeline and/or cable/pipeline armouring.	12	**Sensitivity Level(s)** maximum considered to be low (see Table 12 for detail and colour code) **Commentary/Review** Seals use haul-out sites for a range of purposes including breeding, resting and moulting (SCOS, 2009). Seals generally choose remote areas to haul-out and are generally highly sensitive to damage and disturbance (particularly in the breeding season). Cable/pipeline routes are most likely to come ashore where infrastructure already exists on the mainland. Most seals haul-out on relatively undisturbed sites, offshore sandbanks and rocky areas. Therefore, any damage to seal haul-outs is considered to be unlikely. **Relevant Conservation Objectives** (see Section 4.8.4) Of the 5 COs listed, the following 2 are considered to be particularly relevant to impacts from physical damage of haul-out habitat: ▪ Distribution and extent of habitats supporting the species; and ▪ Structure, function and supporting processes of habitats supporting the species.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; and • The absence even of any 'standard' MMO mitigation measures for dealing with seal haul outs specifically. See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.
▪ Common seal ▪ Grey seal ▪ Bottlenose dolphin ▪ Harbour porpoise ▪ Otter	**Physical Damage to Species** Collision risk and possible mortality of species due to the presence of tidal devices or from vessels travelling to and from the site (including propeller collision risk).	13	**Sensitivity Level(s)** maximum considered to be high (see Tables 12, 13 and 14 for detail and colour code) **Commentary/Review** Seals and cetaceans can potentially collide with construction vessel propellers and machinery, possibly leading to physical injury and, in worst case scenarios, fatality. Juvenile grey seal pups, which are inexperienced in the water, are likely to be particularly vulnerable to collision risk. Ships travelling at 14 knots (~7 m/s) or faster are most likely to cause lethal or serious injuries if there is a collision (Scottish Executive, 2007). Vessels involved in the construction phase of wet renewable devices are either likely to be stationary or travelling at much slower speeds than this; therefore, risk of injury by collision would be considerably lower. However, there could be impacts from vessel movements during all phases of the work and in recent years particular concerns have emerged in respect of the use of ducted propellers on vessels using dynamic positioning. The understanding of 'near field' interactions of wet renewable devices with marine mammals is limited as such technology is in its infancy. It is unlikely that small marine mammals will become trapped in the capture chambers associated with most wave devices. However, their behaviour in response to moving parts on tidal devices is less certain and a key area for further research (Scottish Executive, 2007). Carter (2007) investigated the collision risk to marine mammals from marine renewable tidal devices. The research focused on creating an acoustic device detection model to explore how much warning and avoidance time marine mammals swimming underwater would get of a device ahead of them. The study concluded that tidal stream devices are most likely to be first detected acoustically rather than visually by marine mammals. Therefore, it is possible that these species could show some long range avoidance of the device. Behavioural responses of marine mammals to perceived threats can be broadly categorized in two ways: avoidance and evasion. Hence, with respect to marine renewable devices, marine mammals may demonstrate two types of response: long range avoidance (i.e. avoiding the area within the vicinity of the device) or close range evasion (i.e. during a close encounter with a turbine blade), depending upon the distance at which the device is perceived and the subsequent behavioural response. Some devices will have features which have the potential to cause severe damage or mortality to a marine mammal, whereas other devices could be considered as having characteristics which are unlikely to cause harm to a marine mammals. Thus, collision risk can be seen as a function of the extent of exposure, avoidance response (both long range avoidance and close range evasion) and the potential physiological damage caused by a wet renewable device. The extent of any risk will also be dependant on device characteristics and modified by various environmental features. The good sensory capabilities and fast swimming speeds of marine mammals should help increase the chance of close range evasion with tidal stream devices. However, marine mammals do regularly collide with other anthropogenic structures (particularly when they have reduced perception levels while feeding or undertaking social interactions). The most comprehensive field based monitoring of marine mammals currently available is from the SeaGen tidal turbine device located in the Narrows of Strangford Lough, Northern Ireland from 2005 to 2010 (Royal Haskoning, 2011). This work has concluded that no major impacts on marine mammals had occurred across the 3 years of post-installation monitoring. While porpoises were recorded less frequently during installation, no long-term changes in abundance of either seals or porpoises were attributed to the presence or operation of the device. Observations found that seals and porpoises regularly transit past the operating turbine, demonstrating a lack of any barrier effect from this turbine. The seals which regularly transit the Narrows appeared to transit less frequently when the turbine was operating relative to when it was not operating. Small scale changes in the behaviour and distribution of seals and harbour porpoises were observed during operation. Seals generally transited at a relatively higher rate during periods of slack water, indicating avoidance. The report suggested that this avoidance reduces the risk of any direct interactions with the moving rotors and that both seals and porpoises have the capacity to adjust their distributions at local scales in response to a potential hazard. Monitoring of harbour porpoise has also been undertaken around the NSPI (OpenHydro) tidal turbine device deployed in the Minas Passage, Bay of Fundy (Nova Scotia) from August to November 2010. The monitoring used passive acoustic techniques and found that harbour porpoise were detected regularly through late summer and autumn, but did not appear to spend significant time periods around either the turbine or the control site (suggesting transit through Minas Passage or local foraging in areas out of detectable range). The study found no statistical evidence of the presence of the turbine attracting or repulsing porpoises, but when porpoises were present, behaviour appeared to differ between the two sites (Tollit *et al*., 2011). In the absence of a better understanding about the exposure levels (including device position in relating to main migration areas), the sensitivity of marine mammals to collision is considered to be high during the operational phases for the Tidal energy sector especially. Also, recent evidence indicates that movements of bottlenose dolphins (*Tursiops truncatus*) are greater than previously predicted (Robinson *et al*., 2012) and, therefore, impacts from anthropogenic activities should take these potentially wider ranging influences into account. **Relevant Conservation Objectives** (see Section 4.8.4) Of the 5 COs listed, the following 3 are considered to be particularly relevant to impacts from physical damage as a result of collision risk with vessels during all phases of projects and with tidal energy devices during the operational phases: ▪ Population of the species as a viable component of the site; ▪ Distribution of the species within site; and ▪ No significant disturbance of the species.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; and • The generic nature of those 'standard' MMO mitigation measures that are available (see MMO Measure 12 in Appendix B); and • The residual gaps that exist in these 'standard' mitigation measures. See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.

Sites at Which These Qualifying Features are Present and are Considered for the East Marine Plans are Reviewed in Tables A3, A4, A5 and A6 in Appendix A					
Qualifying and Supporting Feature (See also Section 4.6 and Screening Tables in Appendix A)	**Summary Impact Pathway** (See also Table 1)	**Pathway Ref. No.**	**Sensitivity Level(s) Commentary and Relevant Conservation Objective**	**Is There an Adverse Effect on Integrity With Initial Mitigation Measures?** (See also Table A7 Appendix A)	**Is There an Adverse Effect on Integrity With Additional Mitigation Measures?**
▪ Common seal ▪ Grey seal ▪ Bottlenose dolphin ▪ Harbour porpoise]	**Non-Physical Disturbance** Presence of sub-surface structures and disturbance (noise or visual) associated with tidal devices may present a barrier to movement and block migratory pathways or access to feeding grounds depending on array design.	15	**Sensitivity Level(s)** maximum considered to be medium (see Tables 12 and 13 for detail and colour code) **Commentary/Review** The potential for tidal energy devices/arrays to act as a barrier to movement will be dependant on the extent that noise and visual cues from the device(s) causes an avoidance response. It is also dependent on the ability of marine mammals to navigate around the devices and associated turbulence. The significance of any obstruction is also dependent on the spatial confines and size of the array (e.g. whether it spans across the entire mouth of an estuary). This is considered to be of minor to medium significance depending on the design of the array and location. **Relevant Conservation Objectives** (see Section 4.8.4) The COs are designed to avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained. Of the 5 COs listed, the following 4 are most relevant to spillage event effects in the long-term: ▪ Distribution of the species within site; ▪ Distribution and extent of habitats supporting the species; ▪ Structure, function and supporting processes of habitats supporting the species; and ▪ No significant disturbance of the species.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; and • The absence even of any 'standard' MMO mitigation measures for dealing with barrier effects specifically See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.
▪ Common seal ▪ Grey seal ▪ Bottlenose dolphin ▪ Harbour porpoise ▪ Otter	**Non-Physical Disturbance** Visual disturbance and exclusion from areas as a result of surveying; cable, pipeline or tidal device installation/operation and decommissioning activities (including movements of vessels).	16	**Sensitivity Level(s)** maximum considered to be low (see Tables 12, 13 and 14 for detail and colour code) **Commentary/Review** Visual disturbance from vessels in the different phases of developments will generally only be short term. However, the level of impact will be dependant the distance vessels are away from major seal haul out sites and major foraging areas for marine mammals. No evidence of disturbance was evident during installation, or a change in underlying relative grey seal abundance in the area was recorded in a shore based marine mammal survey undertaken for the SeaGen tidal energy device located in Strangford Lough (Royal Haskoning, 2011. Overall, sensitivities are considered to be low. **Relevant Conservation Objectives** (see Section 4.8.4) The COs are designed to avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained. Of the 5 COs listed, the following 2 are most relevant to spillage event effects in the long-term: ▪ Distribution of the species within site; ▪ No significant disturbance of the species.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; • The generic nature of those 'standard' MMO mitigation measures that are available (see MMO Measure 11 in Appendix B); and • The residual gaps that exist in these 'standard' mitigation measures. See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.
▪ Common seal ▪ Grey seal ▪ Bottlenose dolphin ▪ Harbour porpoise ▪ Otter	**Non-Physical Disturbance** Noise/vibration disturbance and exclusion from areas as a result of vessels and other activities during survey work (e.g. seismic exploration and geophysical surveys), construction (e.g. piling, drilling, cable laying), operation (e.g. device noise), maintenance or decommissioning. Also includes noise/vibration disturbance from vessels and draghead during aggregate extraction.	17	**Sensitivity Level(s)** maximum considered to be high (see Tables 12, 13 and 14 for detail and colour code) **Commentary/Review** The sensitivity of marine mammals is considered to be high during the construction phases of tidal and carbon storage works (especially where there is a need for piling), but low or medium during other periods. Geophysical surveys carried out for installations of marine renewable devices often involve side scan sonar that may cause acoustic disturbance of marine mammals. Available information on the magnitude impact from side scan sonar indicates that disturbance (for single or multiple devices) of marine mammals is low (ABPmer, 2007) in contrast to seismic surveys employed for oil and gas exploration which generate much greater source noise levels (Cummings, 2003; JNCC, 2008). The effect on marine mammals from vessel noise is not clear, with both attraction and avoidance reactions having been observed (Nedwell & Howell, 2004). Noise levels from the ship's echo-sounder or acoustic emissions from a dynamic positioning system would not be expected to cause widespread disturbance to marine mammals (Scottish Executive, 2007). For harbour porpoises, the zone of audibility of shipping noise ranges from 1-3km depending on the frequency of noise emitted by the ship (Thomsen *et al*., 2006). The Scottish Marine Wildlife Watching Code advises that the minimum approach distance for vessels to avoid visual and noise disturbance to dolphins and porpoises is 50m (200-400m for mothers and calves, or for animals that are clearly actively feeding or in transit). The key sources of noise related to construction and device installation are: ▪ Shipping and machinery; ▪ Dredging; and ▪ Pile driving or drilling. Additionally, cable/pipeline burial requires the use of trenching or jetting machinery in soft sediments, rock cutting machinery in hard sea-beds, or rock or concrete mattress laying may be used to protect cables in areas where they cannot be buried. Of all of the sources of noise noted above, the noise emitted during pile driving is understood to have the greatest potential effects on marine wildlife (Thomsen *et al*., 2006). This is due to the fact that pile driving generates very high sound pressure levels over a relatively broad frequency range (20Hz to >20kHz). A number of studies have investigated the distances at which marine mammals may be disturbed as a result of diameter piling noise, mainly associated with Offshore Wind Farms. Based on the findings from these studies it is apparent that, although hearing injuries from construction are only likely to occur within several hundred metres of pile driving activity, stronger avoidance responses could occur several kilometres from the piling with masking of vocalization and mild behavioural changes (e.g. change in swimming direction) occurring as far away as 20km or more from a wind farm development. Nedwell *et al*. (2007a) found that noise from	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; • The generic nature of those 'standard' MMO mitigation measures that are available (see MMO Measures 13 to 19 in Appendix B); and • The residual gaps that exist in these 'standard' mitigation measures. See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.

Sites at Which These Qualifying Features are Present and are Considered for the East Marine Plans are Reviewed in Tables A3, A4, A5 and A6 in Appendix A					
Qualifying and Supporting Feature (See also Section 4.6 and Screening Tables in Appendix A)	**Summary Impact Pathway** (See also Table 1)	**Pathway Ref. No.**	**Sensitivity Level(s) Commentary and Relevant Conservation Objective**	**Is There an Adverse Effect on Integrity With Initial Mitigation Measures?** (See also Table A7 Appendix A)	**Is There an Adverse Effect on Integrity With Additional Mitigation Measures?**
			pile driving operations can remain above the background underwater noise to ranges of 25km or more (Tougaard *et al*., 2003a; 2003b; David, 2006; Thomsen *et al*., 2006; Parvin *et al*., 2007; Nedwell *et al*., 2003a; Nedwell *et al*., 2007a). However, the levels of noise relates to pile size and most piles used for tidal or carbon storage work will be smaller than those used for windfarms. Studies undertaken as part of the Scottish Marine Renewables SEA (Scottish Executive, 2007) included undertaking a quantitative analysis of the PTS and TTS ranges of marine mammals for the operation of tidal current turbines. Permanent threshold shift occurs when there is a persistent high intensity noise that causes lasting damage, and TTS occurs when exposure to elevated high noise levels is for a few hours only and is followed by rapid recovery. The PTS assessment revealed that if the most sensitive receptor were to spend 30 minutes within a distance of 16m of the device, it might suffer permanent hearing damage. The 16m distance relates to a frequency of 19,953 Hz and source levels of 157.6 dB re 1µPa-1m, and is estimated to be the maximum distance over which PTS could occur for the most sensitive species. Evidence suggests that it is unlikely that an animal would choose to stay in close proximity to the source of a loud noise. The assessment of TTS revealed that if the most sensitive receptor were to spend 8 hours within 934m of the device, it might suffer temporary, recoverable hearing damage. The 934m distance relates to a frequency of 15,849 Hz and source levels of 157.2 dB re 1µPa-1m, and is estimated to be a maximum distance over which TTS could occur for the most sensitive species. The assessment was based on the assumption that the devices radiate omnidirectionally. A number of precautionary assumptions were also assumed to provide a worst-case scenario of potential effects to marine mammal species. For example, the seabed type that was applied to these calculations was a hard reflective seabed and the water depth was assumed to be relatively shallow. In deeper water, with a less reflective seabed (e.g. a muddy seabed), the range of TTS impact would be reduced (Scottish Executive, 2007). The same assumptions and methodology were used to assess the impacts of the wave device as the tidal device. It should be noted that there was no measurement data to base the noise emissions of the wave device on and, therefore, the sound levels had to be estimated based on available data for similar machinery types. The tonals due to the hydraulic power packs were scaled up to a 1 MW generator, again assuming that acoustic power scales linearly with generator power. However, the third octave levels representing the broadband wave noise spectrum have not been scaled up. Although it may be expected that a physically larger device might generate somewhat higher levels of wave noise, this is not expected to scale linearly with generator power. The estimated noise spectrum does not exceed the 30 minute PTS threshold at any frequency. Therefore, based on the limited data available, it is not expected that a wave energy device of this type would present any potential for causing PTS. The maximum predicted TTS range for an exposure of 8 hours is only 6m, so the risk of an animal experiencing TTS from a single 1 MW device of this type is insignificant. In addition to renewable energy devices, the increased noise and activity during dredging activities could lead to behavioural and stress related reactions (e.g. avoidance of migration route), especially due to marine mammals' acute hearing capabilities. A strong behavioural avoidance reaction could occur up to 500m from the source of dredger noise, and any potential disturbance might occur up to 7km away. Hearing damage is unlikely to occur at the sound frequencies and intensities associated with aggregate dredging (ABPmer 2012). The extant of the effects arising in the context of the baseline conditions and the distances covered by marine mammals will be key considerations as part of future project-level assessment work.			
			Relevant Conservation Objectives (see Section 4.8.4) Of the 5 COs listed, the following 2 are considered to be particularly relevant to impacts from non-physical noise and vibration disturbance: ▪ Distribution of the species within the site; and ▪ No significant disturbance of the species.		
▪ Bottlenose dolphin ▪ Harbour porpoise	**Non-Physical Disturbance** Impacts from Electromagnetic Fields (EMF) on electromagnetically sensitive fish and cetaceans interfering with prey location and mate detection in some species and creating barriers to migration.	18	**Sensitivity Level(s)** maximum considered to be low (see Table 13 for detail and colour code) **Commentary/Review** The generated magnetic fields that can be expected by wet renewable developments are expected to be perceived by cetaceans as a new localised addition to the heterogeneous pattern of geomagnetic anomalies already occurring naturally and anthropogenically in the sea. The expected magnetic field from cables (up to a few micro Telsa (µT)) is also very small, particularly relative to the Earth's own magnetic field (approximately 50 µT) (PMSS Ltd, 2007). The sensitivity of cetaceans to electromagnetic fields is considered to be low and it is only pertinent during the operational phases of tidal energy generation **Relevant Conservation Objectives** (see Section 4.8.4) Of the 5 COs listed, the following 2 are considered to be most relevant to impacts from non-physical EMF disturbance: ▪ Distribution of the species within site; and ▪ No significant disturbance of the species.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; • The generic nature of those 'standard' MMO mitigation measures that are available (see MMO Measure 13 to 19 in Appendix B); and • The residual gaps that exist in these 'standard' mitigation measures. See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.
▪ Common seal ▪ Grey seal ▪ Bottlenose dolphin ▪ Harbour porpoise	**Toxic Contamination** Spillage of fluids, fuels and/or construction materials (inc. from surface coatings/treatments) during installation or removal of structures (devices and cables), during survey/ maintenance or during aggregate extraction.	19	**Sensitivity Level(s)** maximum considered to be low (see Tables 12 and 13 for detail and colour code) **Commentary/Review** Tidal energy developments have essentially no planned discharges and are considered to have a negligible environmental effect (DECC, 2009). The marine renewables SEA (Scottish Executive, 2007) identifies a range of optional contamination sources, including anti-fouling paints and sacrificial anodes and the accidental leakage of fluids and/or spillage fuels or cargo from vessels. The quantities and toxicities associated with sacrificial anodes and antifouling coatings are generally expected to be extremely small, and it is therefore considered that this potential effect will be of negligible significance. It is not possible to make any realistic estimate of the geographical extent of this impact due to the large numbers of variables involved (quantities leaked, metocean conditions, etc) (Scottish Executive, 2007). Accidental leakage of hydraulic fluids may be more significant, should they occur through storm damage, device malfunction or collision with navigating vessels. However, probability of large amounts oil or hydraulic fluids entering the environment as a result of a major structural failure or spill is low. In the unlikely event of an incident, any oil entering the environment would be dispersed and degraded very quickly by the strong hydrodynamic conditions found in tidal device deployment locations, ensuring the exposure to marine mammals remains low.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of:	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures:

Sites at Which These Qualifying Features are Present and are Considered for the East Marine Plans are Reviewed in Tables A3, A4, A5 and A6 in Appendix A					
Qualifying and Supporting Feature (See also Section 4.6 and Screening Tables in Appendix A)	**Summary Impact Pathway** (See also Table 1)	**Pathway Ref. No.**	**Sensitivity Level(s) Commentary and Relevant Conservation Objective**	**Is There an Adverse Effect on Integrity With Initial Mitigation Measures?** (See also Table A7 Appendix A)	**Is There an Adverse Effect on Integrity With Additional Mitigation Measures?**
			Relevant Conservation Objectives (see Section 4.8.4) Of the 5 COs listed, the following 2 are considered to be most relevant to impacts from toxic contamination due to spillage incidents: ▪ Distribution of the species within site; and ▪ No significant disturbance of the species.	• The level of uncertainty associated with this effect; • The generic nature of those 'standard' MMO mitigation measures that are available (see MMO Mitigation Measure 6 in Appendix B); and • The residual gaps that exist in these 'standard' mitigation measures. See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	• The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.
▪ Common seal ▪ Grey seal ▪ Bottlenose dolphin ▪ Harbour porpoise	**Toxic Contamination** Release of contaminants associated with the dispersion of suspended sediments during installation or removal of structures (devices, pipelines and cables) or from the aggregate extraction process.	20	**Sensitivity Level(s)** maximum considered to be low (see Tables 12 and 13 for detail and colour code) **Commentary/Review** Sediments are likely to be low in contaminant levels within tidal areas, given the distance away from major coastal development and the inherently dispersive and often dynamic nature of the environment. The characteristically high-energy environments in which the devices will be located will also assist in the dispersion of any localised contamination, thus, minimising any impacts on water quality. **Relevant Conservation Objectives** (see Section 4.8.4) The COs are designed to avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus, ensuring that the integrity of the site is maintained. Of the 5 COs listed, the following 3 are most relevant to spillage/contamination event effects in the long-term: ▪ Population of the species as a viable component of the site; ▪ No significant disturbance of the species; and ▪ Distribution of the species within site.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; • The generic nature of those 'standard' MMO mitigation measures that are available (see MMO Mitigation Measure 7 in Appendix B); and • The residual gaps that exist in these 'standard' mitigation measures. See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.
▪ Common seal ▪ Grey seal ▪ Bottlenose dolphin ▪ Harbour porpoise	**Toxic Contamination** Release of CO_2 into the water column and its acidification from the formation of carbonic acid.	21	**Sensitivity Level(s)** maximum considered to be low (see Tables 12 and 13 for detail and colour code) **Commentary/Risk Review** In the event of any leak of carbon into coastal or offshore waters, then it is likely that any effects will be temporary and any effects will only arise from abnormal release events (EC 2008, EA 2013). There may be localised consequences for local benthic species and especially shellfish but the risk is low. The consequential, knock-on, effects of this on foraging/migrating mammals is likely therefore to be very low. This is a new field of work and one in which ongoing research is being undertaken to understand these issues and the risk much better The COs are designed to avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus, ensuring that the integrity of the site is maintained. Of the 5 COs listed, the following 3 are most relevant to spillage/contamination event effects in the long-term: ▪ Population of the species as a viable component of the site; ▪ No significant disturbance of the species; and ▪ Distribution of the species within site.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; and • The absence even of any 'standard' MMO mitigation measures for dealing with CCS sector effects specifically See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.
▪ Common seal ▪ Grey seal ▪ Bottlenose dolphin ▪ Harbour porpoise	**Non-Toxic Contamination** Increase in turbidity (and possibly reduced dissolved oxygen) associated with suspended sediments release during installation or removal of structures (devices, pipelines and	22	**Sensitivity Level(s)** maximum considered to be low (see Tables 12 and 13 for detail and colour code) **Commentary/Review** Local suspended sediment concentrations will increase as a result of aggregate extraction or from drilling of the seabed for the installation of the pile, burial of the power/carbon export cables/pipelines and disposal of drill cuttings. Increased turbidity could affect foraging, social interactions and predator/prey interactions of marine mammals, although marine mammals around the UK are regularly recorded foraging in turbid environments such as estuaries and tidal streams. Therefore, the risk of a significant impact is considered to be low.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of:	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures:

Sites at Which These Qualifying Features are Present and are Considered for the East Marine Plans are Reviewed in Tables A3, A4, A5 and A6 in Appendix A					
Qualifying and Supporting Feature (See also Section 4.6 and Screening Tables in Appendix A)	**Summary Impact Pathway** (See also Table 1)	**Pathway Ref. No.**	**Sensitivity Level(s) Commentary and Relevant Conservation Objective**	**Is There an Adverse Effect on Integrity With Initial Mitigation Measures?** (See also Table A7 Appendix A)	**Is There an Adverse Effect on Integrity With Additional Mitigation Measures?**
	cables) or from aggregate extraction.		**Relevant Conservation Objectives** (see Section 4.8.4) Of the 5 COs listed, the following 2 are considered to be particularly relevant to impacts from non-toxic contamination as a result of increased turbidity: ▪ Distribution of the species within the site; and ▪ No significant disturbance of the species.	• The level of uncertainty associated with this effect; and • The absence even of any 'standard' MMO mitigation measures for dealing with turbidity specifically. See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	• The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.

4.8.5 Potential Effects on Fish and Pearl Mussel Features

The conservation objectives for the qualifying fish interest features seek to avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features. The conservation objectives are to ensure for the qualifying species that the following are maintained in the long term:

- Population of the species, including range of genetic types for salmon, as a viable component of the site;
- Distribution of the species within site;
- Distribution and extent of habitats supporting the species;
- Structure, function and supporting processes of habitats supporting the species;
- No significant disturbance of the species;
- Distribution and viability of the species' host species (e.g. freshwater pearl mussel); and
- Structure, function and supporting processes of habitats supporting the species' host species.

Taking account of these conservation objectives and the Plan-level activities to which the key interest features are sensitive, the effects of East Marine Plans on the integrity of the designated sites with fish qualifying features is reviewed in Table 20.

Table 20: Assessment of the potential effects of the East Marine Plans on fish and pearl mussel features

Sites at Which These Qualifying Features are Present and are Considered for the East Marine Plans are Reviewed in Tables A3, A4, A5 and A6 in Appendix A					
Qualifying and Supporting Feature (See also Section 4.7 and Screening Tables in Appendix A)	**Summary Impact Pathway** (See also Table 1)	**Pathway Ref. No.**	**Sensitivity Level(s) Commentary and Relevant Conservation Objective**	**Is There an Adverse Effect on Integrity With Initial Mitigation Measures?** (See also Table A7 Appendix A)	**Is There an Adverse Effect on Integrity With Additional Mitigation Measures?**
▪ Atlantic salmon ▪ Sea lamprey ▪ River lamprey ▪ Allis shad ▪ Twaite shad ▪ Freshwater pearl mussel (indirectly)	**Physical Loss/Gain of Habitat** Loss of onshore habitat (including bird breeding and roosting grounds, freshwater habitats, otter holts or shelters) under the footprint of power cables, CO_2 pipelines, cable/pipeline armouring and landside infrastructure due to the installation, operation and decommissioning of these structures.	2	**Sensitivity Level(s)** maximum considered to be low (see Table 17 for detail and colour code) **Commentary/Risk Review** The effects arising from any onshore development will be highly dependent upon the locations selected and the scale of the work proposed. Clearly, the extent to which there is connectivity between the development sites and a key migratory watercourse will be a paramount consideration. However, it can be assumed that sensitivity of migratory fish will be low because no permanent losses of watercourses are likely to occur **Relevant Conservation Objectives** (see Section 4.8.5) The relevant COs seek to 'avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained'. Of the 7 COs listed, the following 4 are relevant objectives to maintain in the long term: ▪ Distribution and extent of habitats supporting the species; ▪ Structure, function and supporting processes of habitats supporting the species; ▪ No significant disturbance of the species; and ▪ Structure, function and supporting processes of habitats supporting freshwater pearl mussel host species.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; • The generic nature of those 'standard' MMO mitigation measures that are available (see MMO Measure 10 in Appendix B); and • The residual gaps that exist in these 'standard' mitigation measures. See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.
▪ Atlantic salmon ▪ Sea lamprey ▪ River lamprey ▪ Allis shad ▪ Twaite shad ▪ Freshwater pearl mussel (indirectly)	**Physical Loss/Gain of Habitat** Loss of foraging areas from a reduction in coastal and offshore habitat due to installation of devices, power cables, CO_2 pipelines and/or cable/pipeline armouring both at the development footprint and outside from bed scour and indirectly from changes to the hydrodynamic (wave and tide) regime.	3	**Sensitivity Level(s)** maximum considered to be low (see Table 17 for detail and colour code) **Commentary/Risk Review** Atlantic salmon and shad are highly mobile, migratory species undergoing large shifts in distribution during the marine phase of their lifecycle. Atlantic salmon and shad are also pelagic in lifestyle at sea, having very little association with the seabed. Unlike certain demersal fish species which could be considered 'resident' in the East Marine Plan Areas, any Atlantic salmon or shad passing through the area can be considered transient. Therefore, any potential damage to the seabed in deployment locations will be of negligible impact to these fish species. Sea lamprey which attach and then feed on a variety of pelagic and demersal fish species in the marine phase of their lifecycle are unusual in that they could be considered to have similar sensitivities to their host. However, as sea lamprey are a highly mobile, migratory species which are widely distributed at sea, any potential damage to the seabed in deployment locations will be of negligible impact to the sea lamprey. **Relevant Conservation Objectives** (see Section 4.8.5) Of the 7 COs listed, the following 2 are to some degree relevant to this impact pathway: ▪ Distribution and extent of habitats supporting the species; and ▪ Structure, function and supporting processes of habitats supporting the species.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; and • The absence even of any 'standard' MMO mitigation measures for dealing with habitat foraging quality specifically. See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.
▪ Atlantic salmon ▪ Sea lamprey ▪ River lamprey ▪ Allis shad ▪ Twaite shad ▪ Freshwater pearl mussel (indirectly)	**Physical Loss/Gain of Habitat** Presence of tidal generation (or other) structures on seabed for the duration of the project resulting in changes to prey and species behaviour (e.g. acting as FAD (Fish Aggregating Device), artificial reef or bird roost).	4	**Sensitivity Level(s)** maximum considered to be low (see Table 17 for detail and colour code) **Commentary/Risk Review** Seabed structures and especially tidal energy generating arrays could potentially act both as artificial reefs and as FADs (Wilhelmsson *et al*., 2006). However, there has been a lack of studies relevant which can be used to determine the degree to which species would aggregate, thought to be determined by a number of factors including size. Devices with the highest FAD potential are those with large elements (e.g. large mooring points or floating structures). The latter, such as wave attenuator devices and overtopping devices, may be expected to attract pelagic fish by analogy to floating pontoons and pilings (Clynick, 2008), as well as vessels (Røstad *et al*., 2006). Devices with large moorings may provide additional shelter and food (habitat) for small demersal fish such as territorial blennies and gobies (Love *et al*., 2000). Increases in demersal fish have been observed around the piles of off-shore wind farms (Wilhelmsson *et al*., 2006; Linley *et al*., 2007). Commensurately, the FAD potential of devices with small footprints such as the buoy type structures and those with smaller device moorings (such as axis turbines) would be predicted to be low. Additionally, structures placed in areas with high flow rates would be predicted to attract and aggregate fewer fish. Tidal energy devices will also only have FAD potential out of the current on the sheltered lee of the device and, thus, this exposure to collision risk is much reduced. Salmon and lamprey are highly mobile species undergoing large migrations and seasonal movements and are unlikely to be attracted to a tidal device. However, it is possible that sea lamprey could be recorded around devices if they are attached to host species that is using a wet renewable device as habitat. **Relevant Conservation Objectives** (see Section 4.8.5) The relevant COs seek to 'avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained'. All 7 COs listed are to some degree relevant to this impact pathway because both species viability and distribution rather than habitat composition are affected (although habitat composition is not altered within the boundaries of the relevant designated sites). These objectives are to maintain in the long term: ▪ Population of the species as a viable component of the site, including range of genetic types for salmon; ▪ Distribution of the species within site; ▪ Distribution and extent of habitats supporting the species; ▪ Structure, function and supporting processes of habitats supporting the species; ▪ No significant disturbance of the species; ▪ Distribution and viability of freshwater pearl mussel host species; and ▪ Structure, function and supporting processes of habitats supporting freshwater pearl mussel host species.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; and • The absence even of any 'standard' MMO mitigation measures for dealing with FAD specifically See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.

Sites at Which These Qualifying Features are Present and are Considered for the East Marine Plans are Reviewed in Tables A3, A4, A5 and A6 in Appendix A					
Qualifying and Supporting Feature (See also Section 4.7 and Screening Tables in Appendix A)	**Summary Impact Pathway** (See also Table 1)	**Pathway Ref. No.**	**Sensitivity Level(s) Commentary and Relevant Conservation Objective**	**Is There an Adverse Effect on Integrity With Initial Mitigation Measures?** (See also Table A7 Appendix A)	**Is There an Adverse Effect on Integrity With Additional Mitigation Measures?**
▪ Atlantic salmon ▪ Sea lamprey ▪ River lamprey ▪ Allis shad ▪ Twaite shad ▪ Freshwater pearl mussel (indirectly)	**Physical Damage to Habitat** Damage to onshore habitat (including bird breeding grounds, freshwater habitats, otter holts or shelters) by excavation, piling and construction work associated with the installation, operation and decommissioning of cables, CO_2 pipelines and landside infrastructure.	9	**Sensitivity Level(s)** maximum considered to be low (see Table 17 for detail and colour code) **Commentary/Risk Review** Atlantic salmon are highly mobile, migratory species undergoing large shifts in distribution when undertaking the marine phase of their lifecycle. Atlantic salmon are also pelagic in lifestyle at sea, having very little association with the seabed. Unlike certain demersal fish species which could be considered 'resident' in tidal deployment locations, any Atlantic salmon passing through the area can be considered transient. Therefore, any potential damage to the seabed in deployment locations will be of negligible impact to Atlantic salmon. Sea lamprey which attach and then feed on a variety of pelagic and demersal fish species in the marine phase of their lifecycle are unusual in that they could be considered to have similar sensitivities to their host. However, as sea lamprey are a highly mobile, migratory species which are widely distributed at sea, any potential damage to the seabed in deployment locations will be of negligible impact to the sea lamprey. Depending on the level of existing information available and the sensitivity of species and habitats present, pre-construction surveys might include collection of environmental baseline information. Preconstruction sampling and operational monitoring could involve beam trawls to assess fish populations. Fish surveys could also be effectively carried out using non-extractive means (e.g. diver surveys) or remote sensing (e.g. underwater video cameras). Impacts from monitoring are considered to be short term and of negligible significance for Atlantic salmon and sea lamprey. **Relevant Conservation Objectives** (see Section 4.8.5) The relevant COs seek to 'avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained'. Of the 7 COs listed, the following 2 are most relevant to this impact pathway because they focus of habitat composition and distribution rather than species viability. These objectives are to maintain in the long term: ▪ Distribution and extent of habitats supporting the species; and ▪ Structure, function and supporting processes of habitats supporting the species.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; • The generic nature of those 'standard' MMO mitigation measures that are available (see MMO Measure 10 in Appendix B); and • The residual gaps that exist in these 'standard' mitigation measures. See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.
▪ Atlantic salmon ▪ Sea lamprey ▪ River lamprey ▪ Allis shad ▪ Twaite shad ▪ Freshwater pearl mussel (indirectly)	**Physical Damage to Habitat** Reduction in quality of foraging areas as result of damage to coastal and offshore habitat from baseline surveys (e.g. boreholes and trawls); from equipment use causing abrasion, damage or smothering during installation; from maintenance and removal of cables, pipeline, tidal/devices or from scour, sediment transport and hydrodynamic change during operation.	10	**Sensitivity Level(s)** maximum considered to be low (see Table 17 for detail and colour code) **Commentary/Risk Review** When considering the impacts on foraging habitat quality, the issue are the same as for foraging habitat quality loss (see Impact pathway 3). Atlantic salmon and shad are highly mobile, migratory species undergoing large shifts in distribution during the marine phase of their lifecycle. Atlantic salmon and shad are also pelagic in lifestyle at sea, having very little association with the seabed. Unlike certain demersal fish species which could be considered 'resident' in the East Marine Plan Areas, any Atlantic salmon or shad passing through the area can be considered transient. Therefore, any potential damage to the seabed in deployment locations will be of negligible impact to these fish species. Sea lamprey which attach and then feed on a variety of pelagic and demersal fish species in the marine phase of their lifecycle are unusual in that they could be considered to have similar sensitivities to their host. However, as sea lamprey are a highly mobile, migratory species which are widely distributed at sea, any potential damage to the seabed in deployment locations will be of negligible impact to the sea lamprey. **Relevant Conservation Objectives** (see Section 4.8.5) Of the 7 COs listed, the following 2 are to some degree relevant to this impact pathway: ▪ Distribution and extent of habitats supporting the species; and ▪ Structure, function and supporting processes of habitats supporting the species.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; and • The absence even of any 'standard' MMO mitigation measures for dealing with foraging habitat specifically See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.
▪ Atlantic salmon ▪ Sea lamprey ▪ River lamprey ▪ Allis shad ▪ Twaite shad ▪ Freshwater pearl mussel (indirectly)	**Physical Damage to Habitat** Reduction in quality of foraging areas as result of damage to coastal and offshore habitat within and surrounding the aggregate sites during the extraction process.	11	**Sensitivity Level(s)** maximum considered to be high (see Table 17 for detail and colour code) As noted in previous sections of this impacts table, the migratory/transient and pelagic nature of salmonids and lamprey are key considerations and provide confidence that the risks to foraging quality are low from aggregate extraction . At the aggregate extraction sites, there are fish species which could also be affected through habitat change, and fish which are particularly sensitive to this (sandeel and spawning herring). In general the magnitude of change from individual projects would be expected to be low due to the local grounds being extensive and only very small areas being affected at any one time. More importantly however, no significant habitat change per se should take place due to marine aggregates because industry mitigation measures ensure that the seabed remains similar (ABPmer 2012) **Relevant Conservation Objectives** (see Section 4.8.5) Of the 7 COs listed, the following 2 are to some degree relevant to this impact pathway: ▪ Distribution and extent of habitats supporting the species; and Structure, function and supporting processes of habitats supporting the species.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; and • The absence even of any 'standard' MMO mitigation measures for dealing with foraging habitat specifically See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.
▪ Atlantic salmon ▪ Sea lamprey ▪ River lamprey ▪ Allis shad ▪ Twaite shad	**Physical Damage to Species** Collision risk and possible mortality of species due to the presence of tidal	13	**Sensitivity Level(s)** maximum considered to be high (see Table 17 for detail and colour code) **Commentary/Risk Review** The main collision risk is posed with tidal turbines and ABPmer (2009) undertook an evaluation of fish collision risk with tidal stream energy devices, including a review of existing impact prediction and monitoring data where available. As tidal stream energy converters are fledgling technologies, the study found very little direct evidence on fish collision impacts, either positive or negative. Behavioural responses of fish to perceived threats can be broadly categorized in two ways:	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated

Sites at Which These Qualifying Features are Present and are Considered for the East Marine Plans are Reviewed in Tables A3, A4, A5 and A6 in Appendix A					
Qualifying and Supporting Feature (See also Section 4.7 and Screening Tables in Appendix A)	**Summary Impact Pathway** (See also Table 1)	**Pathway Ref. No.**	**Sensitivity Level(s) Commentary and Relevant Conservation Objective**	**Is There an Adverse Effect on Integrity With Initial Mitigation Measures?** (See also Table A7 Appendix A)	**Is There an Adverse Effect on Integrity With Additional Mitigation Measures?**
▪ Freshwater pearl mussel (indirectly)	devices or from vessels travelling to and from the site (including propeller collision risk).		avoidance and evasion. Hence, with respect to marine renewable devices, fish may demonstrate two types of response: long range avoidance (i.e. avoiding the area within the vicinity of the device) or close range evasion (i.e. during a close encounter with a turbine blade), depending upon the distance at which the device is perceived and the subsequent behavioural response. Long range avoidance in the context of this report is considered to be avoidance at distances further away than where a visual response can be undertaken (i.e. through noise and vibration cues). Close range evasion is considered to be at distances where the primary stimulus for the response is triggered by a visual reaction to physical characteristics of the device. Some devices will have features which have the potential to cause severe damage or mortality to a fish, whereas other devices could be considered as having characteristics which are unlikely to cause harm to a fish. Collision risk can be seen as a function of the extent of exposure, avoidance response (both long range avoidance and close range evasion) and the potential physiological damage caused by a wet renewable device. The extent of any risk will also be dependant on device characteristics and modified by various environmental features. A conceptual model of fish collision risk has been developed and used to focus the review and consultation exercises. In general, it is considered likely that tidal energy devices would not provide sufficient cues for long range avoidance in most fish species. In other words, the devices are unlikely to result in any modification of a fish's long range behaviour, particularly elasmobranchs and demersal bony fish. This may mean that they would not be aware of the presence of the device before near field 'visual' cues are dominant, especially for hearing insensitive fish. It is possible that fish may be able to undertake close range evasion of most tidal stream devices. However, the speed of rotating blades in horizontal axis and venturi turbines combined with very fast flow rates in the surrounding tidal rapids means that strikes could be possible for fish with these devices. Little published data on the interactions between turbines and fish in the marine environment is currently available (ABPmer, 2010d). Research from the Roosevelt Island Tidal Energy Project on the East River in New York observed that the number of fish in and around the turbines was generally low (range of 16-1400 fish per day seen) and that the fish were predominantly small but still swam faster than the turbines rotated. Physiological damage would also be expected to be highest in horizontal axis and venturi turbines due to the rotating blades used. The extent of any injury is likely to be less in hydrofoil turbines due to the much slower movement of the blades. **Relevant Conservation Objectives** (see Section 4.8.5) The relevant COs seek to 'avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained'. Of the 7 COs listed, the following 5 are relevant to this impact pathway because they focus of species viability and distribution rather than habitat composition. These objectives are to maintain in the long term: ▪ Population of the species as a viable component of the site, including range of genetic types for salmon; ▪ Distribution of the species within site; ▪ No significant disturbance of the species; ▪ Distribution and viability of freshwater pearl mussel host species; and ▪ Structure, function and supporting processes of habitats supporting freshwater pearl mussel host species.	no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; • The generic nature of those 'standard' MMO mitigation measures that are available (see MMO Measure 12 in Appendix B); and • The residual gaps that exist in these 'standard' mitigation measures. See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.
▪ Atlantic salmon ▪ Sea lamprey ▪ River lamprey ▪ Allis shad ▪ Twaite shad ▪ Freshwater pearl mussel (indirectly)	**Non-Physical Disturbance** Presence of sub-surface structures and disturbance (noise or visual) associated with tidal devices may present a barrier to movement and block migratory pathways or access to feeding grounds depending on array design.	15	**Sensitivity Level(s)** maximum considered to be medium (see Table 17 for detail and colour code) **Commentary/Risk Review** Both Atlantic salmon and sea lamprey are migratory species which could be sensitive to any objects which could block migratory routes (the main barrier risk is posed with tidal arrays). Knowledge of the key migration routes and geographic distribution of post-smolts of Atlantic salmon in oceanic waters is sparse. Atlantic Salmon and Sea lamprey should be able to swim around or avoid deployment locations, but this will be dependant on the extent that noise and visual cues given off the device(s) causes an avoidance response. It is also dependent on the ability of fish to navigate around the devices and associated turbulence. Lampreys attach and then feed on a variety of pelagic and demersal fish species in the marine phase of their lifecycle and, thus, their movements and distribution at sea will largely be dictated by their host. Shad species are largely confined to migrating from rivers to estuaries and coastal areas (but have been occasionally recorded offshore). The significance of any obstruction is also dependent on the spatial confines and size of the devices and array (e.g. whether it spans across the entire mouth of an estuary) and the functional use of the area by fish. This is considered to be of minor to medium significance depending on the design of the array and location. **Relevant Conservation Objectives** (see Section 4.8.5) The relevant COs seek to 'avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained'. Of the 7 COs listed, the following 5 are relevant to this impact pathway because they focus of species viability and distribution rather than habitat composition. These objectives are to maintain in the long term: ▪ Population of the species as a viable component of the site, including range of genetic types for salmon; ▪ Distribution of the species within site; ▪ No significant disturbance of the species; ▪ Distribution and viability of freshwater pearl mussel host species; and ▪ Structure, function and supporting processes of habitats supporting freshwater pearl mussel host species.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; and • The absence even of any 'standard' MMO mitigation measures for dealing with barrier effects specifically See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.
▪ Atlantic salmon ▪ Sea lamprey ▪ River lamprey ▪ Allis shad ▪ Twaite shad ▪ Freshwater pearl mussel (indirectly)	**Non-Physical Disturbance** Noise/vibration disturbance and exclusion from areas as a result of vessels and other activities during survey work (e.g. seismic exploration and geophysical surveys), construction (e.g. piling, drilling, cable laying), operation (e.g. device noise), maintenance or decommissioning. Also includes noise/vibration disturbance from vessels and draghead during aggregate extraction.	17	**Sensitivity Level(s)** maximum considered to be high (see Table 17 for detail and colour code) **Commentary/Risk Review** Noise associated with installation activities might arise from vessel traffic, possible requirements for bed levelling, driving and drilling of piles, and installation of the power export cable (i.e. ploughing through sediment areas, rock cutting in hard sea beds, bolting to the sea bed and/or directional drilling). There is an increasing understanding of the source noise levels and frequencies associated with marine construction activities from various reports largely associated with offshore wind farms (Nedwell & Howell, 2004; Thomsen *et al*., 2006). The impacts from pile driving and the use of explosives are of most concern (e.g. IECS, 2007). Studies indicate that some exposures will result in changes or damage to sensory structures and hearing capabilities, impacts on other aspects of fish physiology and mortality (Hastings & Popper, 2005). Specifically, noise impacts from pile driving may result in permanent or temporary threshold shifts for species in close proximity to the activity (Thomsen *et al*., 2006). Piling in Southampton Waters, estimated as being approximately 194 dB re 1µPa-m (Nedwell *et al*., 2003b), are marginally in excess of the 170 dB re 1µPa-m threshold cited as representing a response threshold for salmon. The noise levels generated during this work resulted from piling of approximately 1m diameter circular piles. A mild reaction would be expected by salmon within ranges of 60 to 80m (Nedwell *et al*., 2003b). There is little available information on noise emissions from rock or mattress placement or cable trenching in similar environments, although the noise emissions for these activities are likely to be below those for pile driving (Nedwell & Howell, 2004). **Relevant Conservation Objectives** (see Section 4.8.5) The relevant COs seek to 'avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained'. Of the 7 COs listed, the following 5 are relevant to this impact pathway because they focus of species viability and distribution rather than habitat composition. These objectives are to maintain in the long term:	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; • The generic nature of those 'standard' MMO mitigation measures that are available (see MMO Measures 13 to 21 in Appendix B); and • The residual gaps that exist in these 'standard' mitigation measures.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans.

Sites at Which These Qualifying Features are Present and are Considered for the East Marine Plans are Reviewed in Tables A3, A4, A5 and A6 in Appendix A					
Qualifying and Supporting Feature (See also Section 4.7 and Screening Tables in Appendix A)	**Summary Impact Pathway** (See also Table 1)	**Pathway Ref. No.**	**Sensitivity Level(s) Commentary and Relevant Conservation Objective**	**Is There an Adverse Effect on Integrity With Initial Mitigation Measures?** (See also Table A7 Appendix A)	**Is There an Adverse Effect on Integrity With Additional Mitigation Measures?** See Section 5.3 for further details about these measures.
			▪ Population of the species as a viable component of the site, including range of genetic types for salmon; ▪ Distribution of the species within site; ▪ No significant disturbance of the species; ▪ Distribution and viability of freshwater pearl mussel host species; and ▪ Structure, function and supporting processes of habitats supporting freshwater pearl mussel host species.	See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	
▪ Atlantic salmon ▪ Sea lamprey ▪ River lamprey ▪ Allis shad ▪ Twaite shad ▪ Freshwater pearl mussel (indirectly)	**Non-Physical Disturbance** Impacts from Electromagnetic Fields (EMF) on electromagnetically sensitive fish and cetaceans interfering with prey location and mate detection in some species and creating barriers to migration.	18	**Sensitivity Level(s)** maximum considered to be low (see Table 17 for detail and colour code) **Commentary/Risk Review** The generated magnetic fields that can be expected by tidal energy power cables are expected to be perceived by Atlantic salmon as a new localised addition to the heterogeneous pattern of geomagnetic anomalies already occurring naturally and anthropogenically in the sea. The expected magnetic field from a cable (up to a few micro Telsa (μT)) is also very small, particularly relative to the Earth's own magnetic field (approximately 50 μT) (PMSS Ltd, 2007). The conclusion of most project-specific environmental impact assessments is that whilst there could be an interaction between these species and the sub-sea cables used, the result is unlikely to be of any significance at a population level (DECC, 2009). **Relevant Conservation Objectives** (see Section 4.8.5) The relevant COs seek to 'avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained. Of the 7 COs listed, the following 5 are relevant to this impact pathway because they focus of species viability and distribution rather than habitat composition. These objectives are to maintain in the long term: ▪ Population of the species as a viable component of the site, including range of genetic types for salmon; ▪ Distribution of the species within site; ▪ No significant disturbance of the species; ▪ Distribution and viability of freshwater pearl mussel host species; and ▪ Structure, function and supporting processes of habitats supporting freshwater pearl mussel host species.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; • The generic nature of those 'standard' MMO mitigation measures that are available (see MMO Measure 13 to 21 in Appendix B); and • The residual gaps that exist in these 'standard' mitigation measures. See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.
▪ Atlantic salmon ▪ Sea lamprey ▪ River lamprey ▪ Allis shad ▪ Twaite shad ▪ Freshwater pearl mussel (indirectly)	**Toxic Contamination** Spillage of fluids, fuels and/or construction materials (inc. from surface coatings/treatments) during installation or removal of structures (devices and cables), during survey/ maintenance or during aggregate extraction.	19	**Sensitivity Level(s)** maximum considered to be low (see Table 17 for detail and colour code) **Commentary/Risk Review** The quantities and toxicities associated with sacrificial anodes and antifouling coatings are generally expected to be extremely small and, therefore, it is considered that this potential effect will be of negligible significance. It is not possible to make any realistic estimate of the geographical extent of this impact due to the large numbers of variables involved (quantities leaked, metocean conditions, etc) (Scottish Executive, 2007). Accidental leakage of hydraulic fluids may be more significant, should they occur through storm damage or device malfunction of, or collision with, navigating vessels. However, probability of large amounts oil or hydraulic fluids entering the environment as a result of a major structural failure or spill is low. In the unlikely event of an incident, any oil entering the environment would be dispersed and degraded very quickly by the strong hydrodynamic conditions found in tidal and wave device deployment locations, ensuring the exposure to Atlantic salmon and sea lamprey remains low. **Relevant Conservation Objectives** (see Section 4.8.5) The relevant COs seek to 'avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained'. Of the 7 COs listed, the following 5 are relevant to this impact pathway because they focus of species viability and distribution rather than habitat composition. These objectives are to maintain in the long term: ▪ Population of the species as a viable component of the site, including range of genetic types for salmon; ▪ Distribution of the species within site; ▪ No significant disturbance of the species; ▪ Distribution and viability of freshwater pearl mussel host species; and ▪ Structure, function and supporting processes of habitats supporting freshwater pearl mussel host species.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; • The generic nature of those 'standard' MMO mitigation measures that are available (see MMO Mitigation Measure 6 in Appendix B); and • The residual gaps that exist in these 'standard' mitigation measures. See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.
▪ Atlantic salmon ▪ Sea lamprey ▪ River lamprey ▪ Allis shad ▪ Twaite shad ▪ Freshwater pearl mussel (indirectly)	**Toxic Contamination** Release of contaminants associated with the dispersion of suspended sediments during installation or removal of structures (devices, pipelines and cables) or from the aggregate extraction process.	20	**Sensitivity Level(s)** maximum considered to be low (see Table 17 for detail and colour code) **Commentary/Risk Review** Sediments are likely to be low in contaminant levels within the offshore East Marine Plan Areas, given the characteristically high-energy environments in which the devices will be located. This will assist in the dispersion of any localised contamination, thus minimising any impacts on water quality. **Relevant Conservation Objectives** (see Section 4.8.5) Of the 7 COs listed, the following 5 are to some degree relevant to this impact pathway: ▪ Population of the species as a viable component of the site, including range of genetic types for salmon; ▪ Distribution of the species within site; ▪ No significant disturbance of the species; ▪ Distribution and viability of freshwater pearl mussel host species; and ▪ Structure, function and supporting processes of habitats supporting freshwater pearl mussel host species.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; • The generic nature of those 'standard' MMO mitigation measures that are available (see MMO Mitigation Measure 7 in Appendix B); and	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans.

Sites at Which These Qualifying Features are Present and are Considered for the East Marine Plans are Reviewed in Tables A3, A4, A5 and A6 in Appendix A					
Qualifying and Supporting Feature (See also Section 4.7 and Screening Tables in Appendix A)	**Summary Impact Pathway** (See also Table 1)	**Pathway Ref. No.**	**Sensitivity Level(s) Commentary and Relevant Conservation Objective**	**Is There an Adverse Effect on Integrity With Initial Mitigation Measures?** (See also Table A7 Appendix A)	**Is There an Adverse Effect on Integrity With Additional Mitigation Measures?**
				• The residual gaps that exist in these 'standard' mitigation measures. See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	See Section 5.3 for further details about these measures.
▪ Atlantic salmon ▪ Sea lamprey ▪ River lamprey ▪ Allis shad ▪ Twaite shad ▪ Freshwater pearl mussel (indirectly)	**Toxic Contamination** Release of CO_2 into the water column and its acidification from the formation of carbonic acid.	21	**Sensitivity Level(s)** maximum considered to be low (see Table 17 for detail and colour code) In the event of any leak of carbon into coastal or offshore waters, then it is likely that any effects will be temporary and any effects will only arise from abnormal release events (EC 2008, EA 2013). There may be localised consequences for local benthic species and especially shellfish but the risk is low. The consequential, knock-on, effects of this on foraging/migrating fish is likely therefore to be very low. This is a new field of work and one in which ongoing research is being undertaken to understand these issues and the risk much better **Relevant Conservation Objectives** (see Section 4.8.5) Of the 7 COs listed, the following 5 are to some degree relevant to this impact pathway: ▪ Population of the species as a viable component of the site, including range of genetic types for salmon; ▪ Distribution of the species within site; ▪ No significant disturbance of the species; ▪ Distribution and viability of freshwater pearl mussel host species; and Structure, function and supporting processes of habitats supporting freshwater pearl mussel host species.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; and • The absence even of any 'standard' MMO mitigation measures for dealing with CCS sector effects specifically See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.
▪ Atlantic salmon ▪ Sea lamprey ▪ River lamprey ▪ Allis shad ▪ Twaite shad ▪ Freshwater pearl mussel (indirectly)	**Non-Toxic Contamination** Increase in turbidity (and possibly reduced dissolved oxygen) associated with suspended sediments release during installation or removal of structures (devices, pipelines and cables) or from aggregate extraction.	22	**Sensitivity Level(s)** maximum considered to be low (see Table 17 for detail and colour code) **Commentary/Risk Review** Atlantic salmon and sea lamprey successfully pass through estuaries with extremely high suspended sediments and, therefore, can be considered tolerant of turbid conditions. Sediments are likely to be low in contaminant levels within the offshore areas. The characteristically high-energy environments in which the devices will be located will assist in the dispersion of any localised contamination, thus minimising any impacts on water quality. **Relevant Conservation Objectives** (see Section 4.8.5) The relevant COs seek to 'avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained'. Of the 7 COs listed, the following 5 are relevant to this impact pathway because they focus of species viability and distribution rather than habitat composition. These objectives are to maintain in the long term: ▪ Population of the species as a viable component of the site, including range of genetic types for salmon; ▪ Distribution of the species within site; ▪ No significant disturbance of the species; ▪ Distribution and viability of freshwater pearl mussel host species; and ▪ Structure, function and supporting processes of habitats supporting freshwater pearl mussel host species.	**Possibility of an adverse effect on integrity** There is a need for additional plan-level mitigation measures to be assured that there will be no adverse effect on integrity of any designated site via this pathway. This is because of: • The level of uncertainty associated with this effect; and • The absence even of any 'standard' MMO mitigation measures for dealing with turbidity specifically. See Table A7 (Column 15) in Appendix A for further details about the mitigation gaps.	**No adverse effect on integrity** Assurance that the Plans will have NAEOI of any designated site are provided through the application of the following two key measures: • The need for an HRA process to be adopted for projects and plans affecting the East Marine Plan Areas; and • The adoption of an IPR process for the implementation of the East Marine Plans. See Section 5.3 for further details about these measures.

5 Conclusion

5.1 Marine Plan Impact Evaluation

This AAIR has reviewed the impacts arising from the relevant East Marine Plan policies according to the iterative processes identified in Section 3.2. Across all of the impact pathways that have been reviewed (see Table 1), the judgement reached is that it is not possible to be certain of no adverse effect on the integrity (NAEOI) of designated European/Ramsar sites without the application of mitigation measures. This is because of:

- **The high level of uncertainty associated with the Plan and the individual effects that will and might arise**. While in many cases the location of potential developments are known and identified within the Plan (see Figures 3-5) for the tidal energy, carbon storage and aggregate extraction sectors that have been reviewed, many uncertainties remain which include:

    - The baseline environmental conditions;

    - The project-level details such as the technologies that might be used;

    - The location of cable and pipeline alignments and landfall positions associated with the tidal energy and carbon capture and storage sectors;

    - The sensitivities of marine habitats and species to impacts via many of the various impact pathways (especially for the relatively immature/novel tidal energy and carbon storage sectors); and

    - The changes that will arise to project developments and to the number and location of designated sites in the future.

    Such uncertainties are an inherent characteristic of the marine planning process given the broad spatial extent and multi-sectoral nature of such planning.

- **The available 'standard' or 'typically-imposed' mitigation measures identified by the MMO are generic in nature and have gaps which mean that impact many pathways are incompletely addressed or not considered**. As also described in Appendix B, several mitigation measures are available that the MMO has identified as part of its licensing responsibilities. These are based on practical experience of implementing past projects and they are a useful initial list. However they are inherently generic in nature and while they focus on key areas of uncertainty such as the effects on marine mammals they have many gaps such that many impact pathways are not addressed at all. For instance they do not include the impacts arising from survey work or the carbon capture and storage sector. Table A7 (Column 15) in Appendix A presents further details about these mitigation gaps.

Therefore the available mitigation measures are not, of themselves, sufficient to ensure that there would be no LSE on any designated sites. This assessment also confirms that they will not ensure that there will be no adverse effect on the integrity of European/Ramsar sites especially in view of the many uncertainties associated with plan implementation.

A further, significant, consideration is that these issues also apply to the assessment of in-combination effects across sectors. The issues associated with understanding the in-combination effects are reviewed further in Section 5.2 and the mitigation that has been identified to address all the above consideration are reviewed in Section 5.3.

5.2 In-Combination Impacts

The Habitats Regulations require that, in determining whether a plan or project is likely to have a significant effect on a European/Ramsar site, the plan or project should be considered both alone and in-combination with other plans or projects. In this case, this applies not just to the in-combination effects arising from projects across the three sectors under review in this AAIR but to their effects in tandem with all other sectoral activities within the plan area[14]. This includes even those which, at this stage, are 'Criteria Based' Marine Plan Polices and as such have no specific spatially-definable implications for activities within the Marine Plan area. For some of these sectors, a SEA and Plan-level HRA already exists (e.g. Offshore Windfarms, Oil and Gas, Coastal Defence) and for some there are no such regional scale SEA/HRA although individual developments undertaken detailed assessments under the HRA process (e.g. Ports and Shipping, Navigation Dredging and Disposal, Tourism and Recreation). There is also one, i.e, Fisheries, for which our understanding of the policy and environmental implications impacts (alone and in-combination with others plans or projects) are only just being formally identified. Further details of the variations in approach across sectors are as follows:

- **Offshore Wind and Oil and Gas**: These sectors have been subject to statutory SEAs which have identified potentially significant environmental effects. HRAs have been conducted for potential developments associated with offshore oil and gas licensing rounds (DECC, 2011) and for the R3 offshore wind plan (R3OWF) (Entec, 2009a and 2009b).

- **Aggregates**: Has been subject to voluntary regional 'Marine Aggregate Regional Environmental Assessments' (MAREAs). The completed MAREAs encompass the East Anglian Coast (Emu 2012) and the Outer Thames Estuary (ERM, 2010). There is also a further regional assessment that is being finalised for the Humber Estuary and Coast (ERM in prep). This work encompass a large part but not all of the east coast plan areas. It does not for instance cover the more distant offshore areas identified for the AGG1 and AGG2 polices although individual EIAs/HRAs have been (will be) carried out for these areas. There are therefore gaps in the strategic coverage but also, because these are non-statutory assessments, no formal HRA has been undertaken at a plan-level scale for this sector (it is for this reason that the AGG1 and AGG2 were screened into this assessment).

- **Ports and Harbours, Navigation and Dredging**: There is no overarching strategic environmental assessment and plan-level HRA for these sectors. However, the projects that take place in the East Plan area (most notably in the Humber Estuary) have been subject to detailed review under the EIA and HRA processes and, in many cases, have required compensatory measure through managed realignment where they have been deemed to have an AEOI.

- **Coastal Protection**: The coastal protection requirements are subject to non-statutory Shoreline Management Plans (SMPs) which are accompanied by Plan-level HRAs. These identify, at a strategic level, the requirements for compensatory measures (through Managed Realignment) to offset the direct impacts or the losses to be incurred through future sea level rise (coastal squeeze). These compensatory requirements have been identified Coastal Habitat Management Plans (CHaMP). Following precedents that have been set throughout the UK the intertidal losses that are predicted

[14] Therefore, all the original 182 designated sites that were screened in (see Table 2) would be relevant to such and in-combination assessment.

as a result of coastal squeeze over the next 100 years would require replacement habitat to be created at a ratio of 1:1. Additional losses that arise as a result of the introduction of particular flood risk management measures may require replacement at a higher ratio. However, the policies surrounding these issues are under ongoing review.

- **Fishing**: This is a sector that has only recently been confirmed to be a plan or project under the Habitats Regulations and, work is ongoing relating to a review of current fishing activity and potential impacts on European Marine Sites. The work is due to report later in 2013 (MMO, 2013d). The scope of the work is currently unclear and therefore there remains major uncertainty in respect of any judgements that are made about project effects in-combination with fishing.

It is clear, therefore, that there are a range of different approaches that have been, and are being, taken forward in relation to the implementation of plans and projects across the East Marine Plan Areas. Many give assurances that individual projects will not have NAEOI of designated sites because of the thoroughness of the existing assessment process. However, a continued reliance of this extant process alone will not, on its own, guarantee that there will NAEOI on designated sites into the future. This is because there can be no definitive conclusion (with the requisite level of certainty that is needed under the Habitats Regulations) that no evidence/analysis gaps will arise between the different assessment processes and methods leading to an in-combination effect (even recognising that each assessment in its own right needs to consider the in-combination effects with other plans or projects).

More significantly, the fishing sector poses particular challenges both for any future assessments within this sector alone and for assessments of effects made for all other sectors in-combination with fishing. This is because of the uncertainties associated with the effects arising from fishing (as well as the uncertainties about how these will be dealt with in planning terms in the future).

In conclusion, therefore, there can be no guarantee that the Marine Plans will not have an adverse effect on the integrity of designated European/Ramsar sites in-combination with other plans or projects. Therefore, as noted in the preceding section, mitigation measures are required to be assured that there will be NAEOI. In particular, the process of plan implementation is important and it is recognised that the role of Marine Plan is to form a forward-looking, proactive new system for managing marine activities on the east coast and by its very nature it encompasses all activities affecting the Plan areas.

5.3 Mitigation Requirements

To address the issues highlighted in Sections 5.1 and 5.2, and ensure that the East Marine Plans will have NAEOI of European/Ramsar sites, additional mitigation measures/considerations were identified by the project team in consultation with NE and JNNC. These two measures are an iterative process for plan implementation and project-level HRA.

5.3.1 Iterative Plan Review

The central principle of these measures is that there needs to be a clear process for the implementation of the Plan. In particular, the process needs to involve a phased and iterative approach to implementation which is linked to ongoing project developments and their associated monitoring work and with the findings from such project-level work feeding back into the next phases of plan-implementation.

The pursuance of such an 'Iterative Plan Review' (IPR) process, in which the lessons learned from consented projects feed into subsequent development applications on an ongoing basis, will provide assurances that developments affecting the Marine Plan area are being managed to avoid adverse effects especially in-combination effects. Most importantly, this process will need to remain flexible enough to allow project-level decisions and revisions to be made in order to be assured that individual projects do not result in an adverse effect on integrity of any European/Ramsar site. The application of such a process is in-keeping with the approaches identified following previous plan-level HRA work where residual uncertainties exist about the impacts arising (e.g. ABPmer, 2010a; 2010b; 2011a; 2011b; 2013).

Part of this IPR process (which described in Figure 15) will include a review of the monitoring data that is collected as part of strategic initiatives (e.g. from MMO's Strategic Evidence Programme or Offshore Renewables Joint Energy Programme (ORJIP). Such work will ensure, either through the application of survey or providing guidance to separate initiatives, that sufficient strategic evidence is available to fill gaps in understanding that are not addressed by individual project-level monitoring programmes. Also, the mitigation measures that are applied for project developments will be regularly reviewed (building on the initial information collated in Appendix B) to determine their effectiveness and the role they play in offsetting impacts on an ongoing basis.

To ensure that the process is iterative and that the plans can be adaptive/responsive, these reviews of project-level assessment, monitoring and mitigation and the lessons that are learned will be linked to (and will inform) future reviews of the Plan. As part of this iterative sequence, the MMO will revisit the Marine Plan at 3 and 6 yearly intervals. Adaptability is a key facet of the process and it is recognised that if prescriptive measures are set out now they could be a hindrance to projects in the future (at which time we may know that certain requirements are less or more relevant) as projects are implemented and new lessons are learned, which has the potential to frustrate learning opportunities and the development of new, potentially more appropriate, mitigation measures. The process will also include regular consultation with other EU Member States to address issues relating to transnational sites to ensure no in-combination effects.

The Habitats Regulations, and the case-law that informs their implementation, place great emphasis on developers demonstrating 'no adverse effect' using best available scientific knowledge and beyond reasonable scientific doubt. The process of ongoing research and feeding the results of targeted monitoring back into the assessment process will address the relevant uncertainties, but it should be noted that there is a process to be followed (as described above) which may influence the rate and scale of project-level developments.

5.3.2 Project-level HRA Requirements

Further assurances that there will be NAEOI on designated sites is provided by the fact that each individual development that is undertaken within the East Marine Plan Areas will be required to undergo an HRA process in its own right and that a project-level AA will be required wherever the possibility of a LSE on a European/Ramsar site cannot be excluded on the basis of currently available information. Such project level HRA work will also need to have consideration to the potential effects of the individual project in-combination with all other extant projects within and outside the East Marine Plan Areas. This consideration, alongside clarity about the process of Plan-implementation (i.e. the IPR process), provides additional assurances that the Plan as a whole will not have an adverse effects on the integrity of designated sites[15].

[15] In some previous Plan-level HRAs such as those for the Pentland Firth and Orkney Waters Marine Renewable Energy Strategy (e.g. ABPmer, 2010a; 2010b) or the Round 3 Offshore Wind Farms (Entec 2009a; 2009b), the application of

Such project-level assessments and their associated monitoring review work will be linked to (and will inform) regular reviews of the Plan as part of the IPR sequence that will be pursued. Information that will need to be supplied within the project-level HRAs will include:

- Updates on the location and status of new European/Ramsar designations ;
- New information on interest feature sensitivities (in the context of the latest scientific understanding);
- Assessment of effects during survey, construction and operation phases of the project (including the in-combination effects with other extant proposals); and
- Proposed mitigation measures.

This future HRA work will need to be completed in the context of the latest scientific knowledge and evidence base that is available at the time of the assessment. It will also need to be done to the satisfaction of the consenting body (as competent authority at the project stage), taking account of advice from statutory nature conservation agencies and consultees where appropriate. It is recognised that pursuance of future plan or project-level HRAs (with reference to latest monitoring and scientific understanding) is a legal requirement in all case.

The current Marine Plan AAIR is designed to give direction to these future project level HRAs and, where required, AAs by identifying measures that should be required at that stage to avoid an adverse effect on the integrity of European/Ramsar sites. However, it does so only for the tidal energy, carbon storage and aggregate extractions sectors. The information provided on impact pathways, species sensitivities and impacts will be transferable in many cases to developments undertaken in other sectors but the information provided is not tailored specifically to such other projects.

Future developments across all sectors should re-visit the information presented in this HRA and ensure that they adhere to relevant mitigation measures at the project-level where they are necessary to avoid an adverse effect on the integrity of a European/Ramsar site. It follows that the manner in which these measures are applied and the detail of the individual initiatives required to achieve them will be subject to the findings of the project-level HRAs. Therefore, it is recognised that not all measures have to be applied in all cases, but only where the project requires it to ensure that there is no adverse effect on the integrity of any designated European/Ramsar sites.

In the same way, some developments are likely to pose a greater risk of impact on designated sites and features than others and are thus likely to present more challenges and require more mitigation work (at possibly a greater cost) than other locations in order to ensure no adverse effects on integrity. For instance were any future developments to extend into the boundaries of designated sites they would have a direct effect on the habitats within such sites. Other developments that are located outside, but close to, a European/Ramsar site could have an indirect effect as is indicated by the distances of the tidal excursion boundaries (as shown in the screening report). There is no presumption within this HRA or under the Habitats Regulations that designated sites will not or cannot be directly or indirectly affected in this manner although clearly the risks of impact and requirements for mitigation are likely to be greater where this is

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project-level HRA has been deemed to provide sufficient reassurance that the plans as a whole will not have an adverse effect. However, these examples relate to plans which cover smaller areas, refer to single sectors and where there are lower levels of uncertainty (especially in a broader strategic context) about the impacts arising than is the case for the Marine Plan.

the case. Therefore it is expected that developers will, in the first instance, seek to avoid designated sites.

5.4 Conclusion

On the basis of the application of these two key mitigation measures (IPR and Project-level HRA) it can be advised that it will be possible for the East Marine Plans not to have an adverse effect on the integrity of a European/Ramsar site either alone or in-combination with other plans or projects, subject to the application of appropriate mitigation measures.

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7 Abbreviations

µPa	Micro Pascal
(N)AEOI	(No) Adverse Effects On Integrity
AA	Appropriate Assessment
AAIR	Appropriate Assessment Information Report
ABPmer	ABP Marine Environmental Research Ltd
AC	Alternating Current
ACCOBAMS	Agreement on the Conservation of Cetaceans in the Black Sea, Mediterranean Sea and contiguous Atlantic Area
AGG	Aggregates Extraction Sector Policy
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas
B	Magnetic Field
BD	Biological Disturbance
BERR	Business, Enterprise and Regulatory Reform
BTO	British Trust for Ornithology
CCS	Carbon Capture and Storage Sector
CHaMP	Coastal Habitat Management Plans
CIS	Coastal Impact Statement
CMACS	Centre for Marine and Coastal Studies
CO_2	Carbon Dioxide
CO	Conservation Objective
COWRIE	Collaborative Offshore Wind Research Into The Environment
CRM	Collision Risk Modelling
cSAC	candidate Special Area of Conservation
dB	Decibel
dBht	Decibel Hearing Threshold
DC	Direct Current
DECC	Department of Energy & Climate Change
DECOMM	Decommissioning
Defra	Department for Environment Food and Rural Affairs
DO	Dissolved Oxygen
E	Electric Field
EA	Environment Agency
EC	European Commission
ECS	European Cetacean Society
EIA	Environmental Impact Assessment
EM	Electromagnetic
EMF	Electromagnetic Field
FAD	Fish Aggregation Device

FARL	European Inland Fisheries Advisory Commission
H_2CO_3	Carbonic Acid
HDD	Horizontal Directional Drilling
HRA	Habitats Regulations Appraisal
HVDC	High Voltage Direct Current
Hz	Hertz
iE	Induced Electric
IPPC	Integrated Pollution and Prevention and Control
IPR	Iterative Plan Review
JNCC	Joint Nature Conservation Committee
kHz	Kilo Hertz
km	Kilometre
LSE	Likely Significant Effect
MAREA	Marine Aggregate Regional Environmental Assessment
MarLIN	Marine Life Information Network
MCAA	Marine and Coastal Access Act 2009
MCZ	Marine Conservation Zone
mg/l	Milligram per litre
MMO	Marine Management Organisation
MPA	Marine Protected Area
MW	Mega Watt
NAEOI	no adverse effects on integrity
NE	Natural England
NIEA	Northern Ireland Environment Agency
NTS	Non-Technical Summary
nm	Nautical Mile
NPD	Non-Physical Disturbance
NTC	Non-Toxic Contamination
OSPAR	The Convention for the Protection of the Marine Environment of the North-East Atlantic
OWE	Offshore Wind Energy
PAH	Polyaromatic Hydrocarbons
PD	Physical Damage
PFSA	Pentland Firth Strategic Area (now more commonly referred to as Pentland Firth and Orkney Waters (PFOW)
PIZ	Primary Impact Zone
PLG	Physical Loss or Gain
POP	Persistent Organic Pollutant
PTS	Permanent Threshold Shift
pSAC	possible Special Area of Conservation
pSPA	potential Special Protection Area

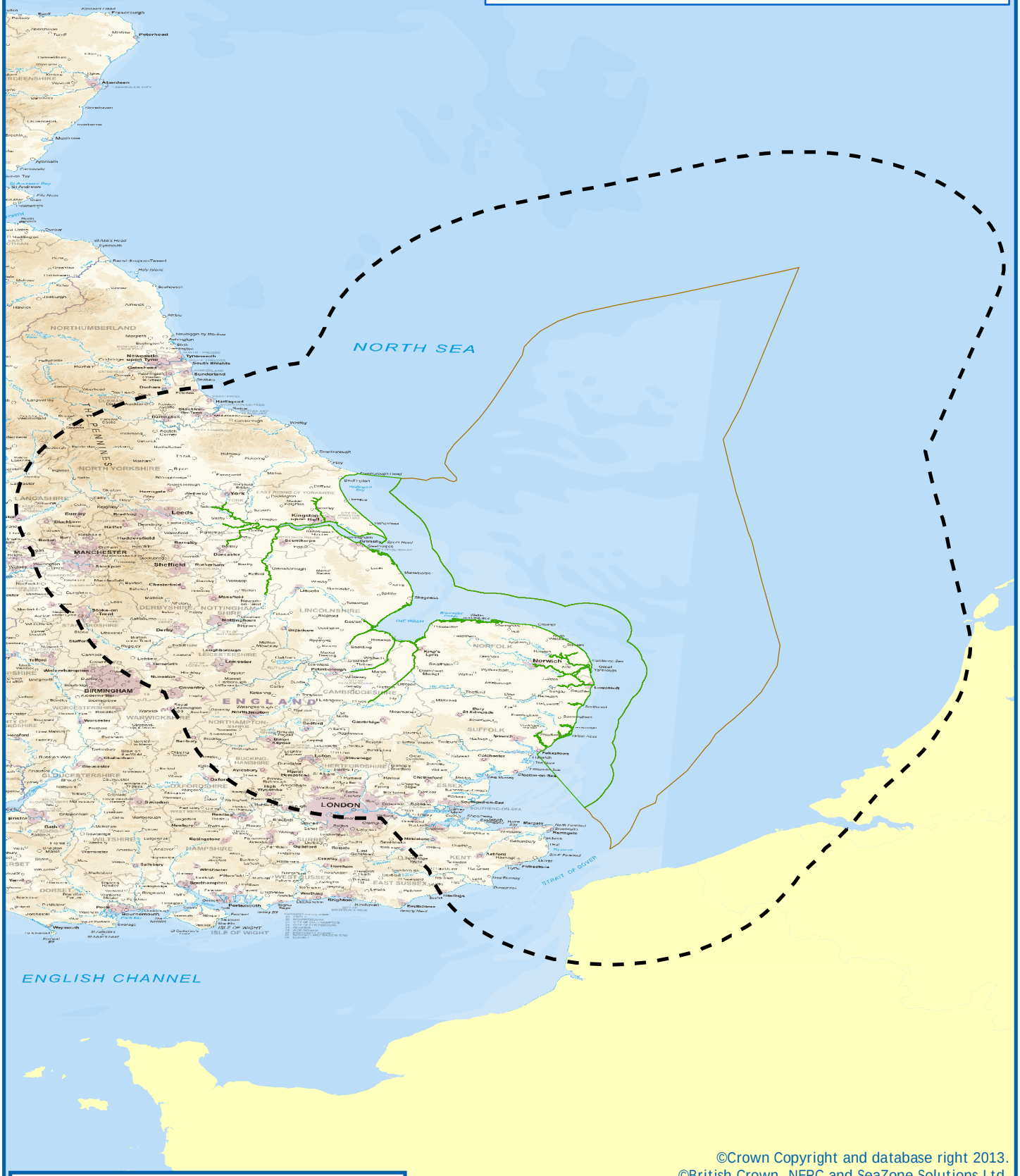
R3OWF	Round 3 Offshore Wind Plan
Ramsar	Wetland sites of international importance designated under the Ramsar Convention
SAC	Special Area of Conservation
SCI	Site of Community Importance
SCOS	Special Committee On Seals
SEA	Strategic Environmental Assessment
SIZ	Secondary Impact Zone
SNCB	Statutory Nature Conservation Body
SNH	Scottish Natural Heritage
SPA	Special Protection Area
SPL	Sound Pressure Level
spp.	Species (plural)
SSC	Suspended Sediment Concentration
TC	Toxic Contamination
TCE	The Crown Estate
TIDE	Tidal Energy Generation Sector Policy
TSHD	Trailer Suction Hopper Dredgers
TTS	Temporary Threshold Shift
UK	United Kingdom
WDCS	Whale and Dolphin Conservation Society

8 Figures

Figure 1: East Inshore and Offshore Marine Plan Areas Showing 100km Buffer Zone Used for Pre-Screening

marine management organisation

March 2013
This map has been produced using the ETRS89 Coordinate Reference System



100km HRA Screening Zone
East Inshore Marine Plan Area
East Offshore Marine Plan Area

Figure 2: Flow Diagram Describing the Policy Screening and Assessment process for the Marine Plan HRA

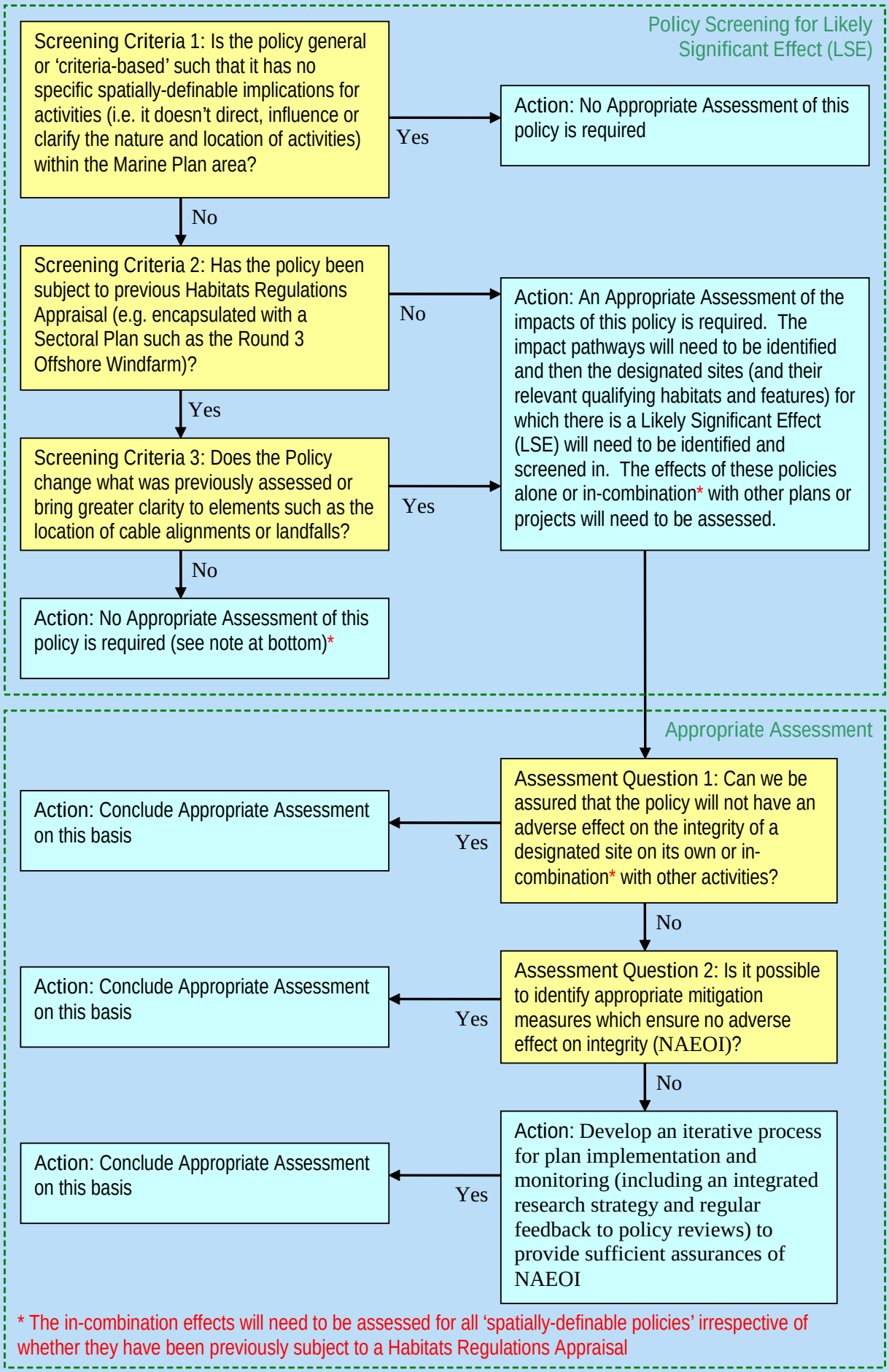


Figure 3: Location of Possible Tidal Energy (TIDE) Zones within the East Coast Marine Plan Areas

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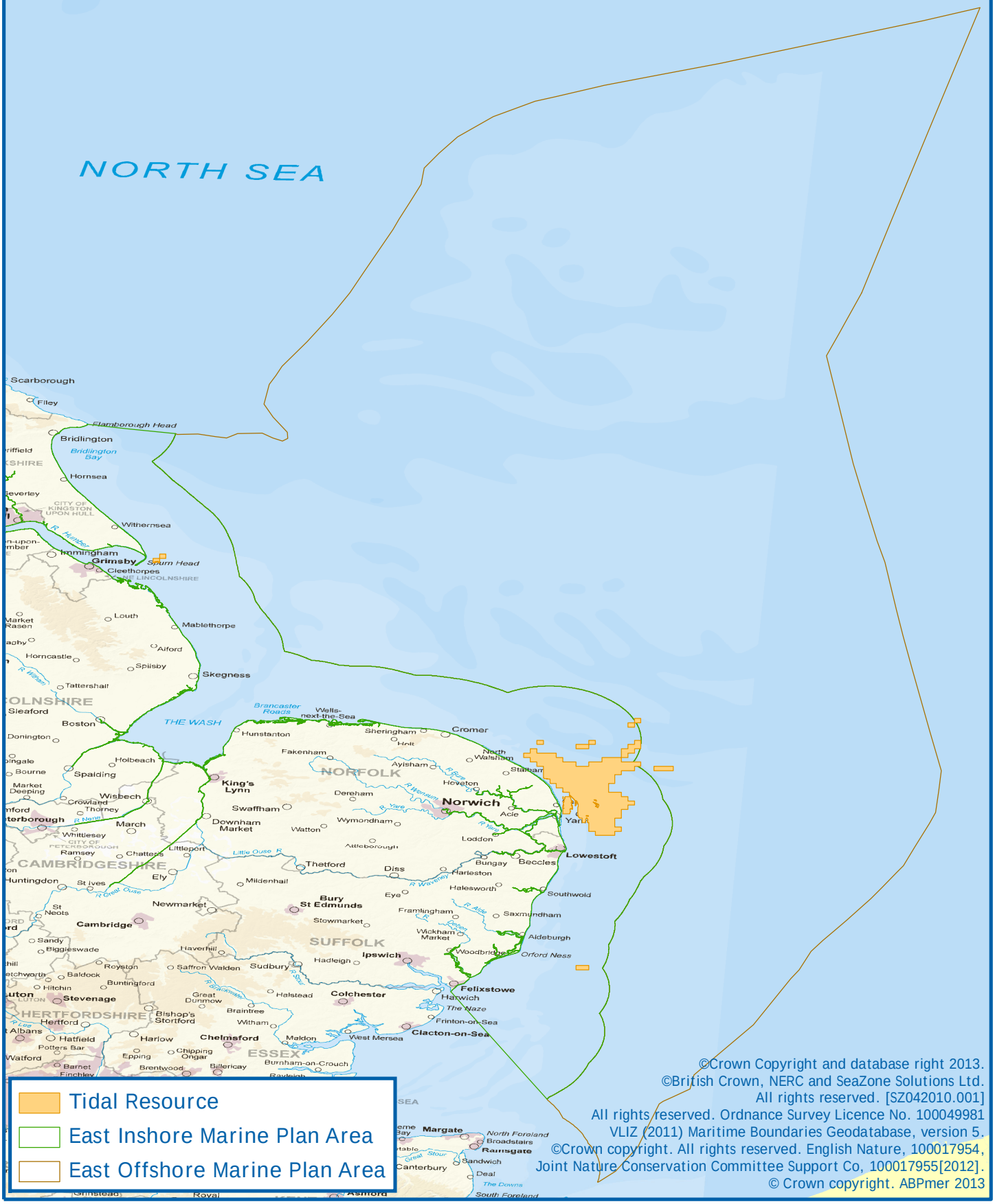

Figure 4: Location of Possible Carbon Storage (CCS) Zones within the East Coast Marine Plan Areas

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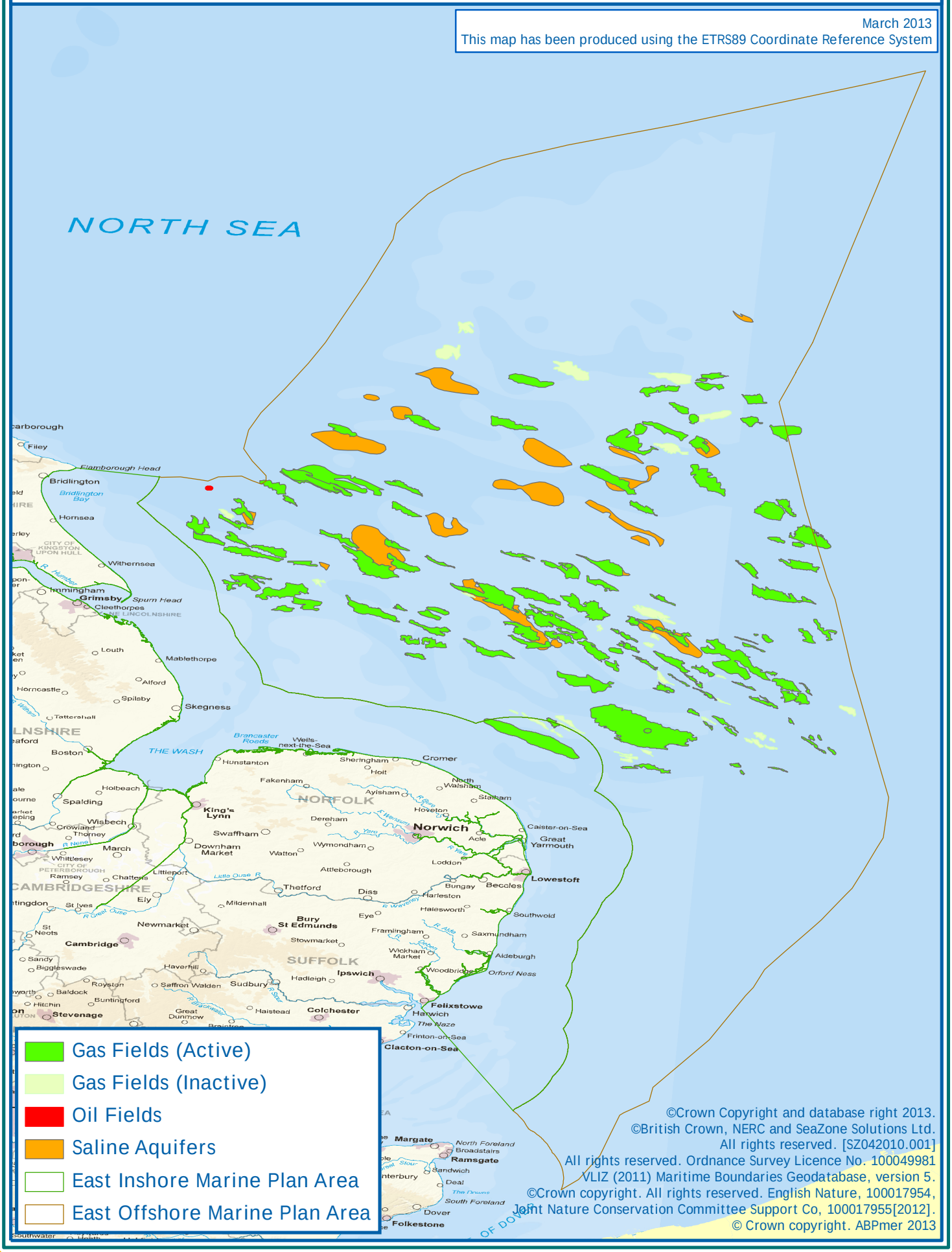

Figure 5: Location of Possible Aggregate Extraction (AGG1 and AGG2) Zones within the East Coast Marine Plan Areas

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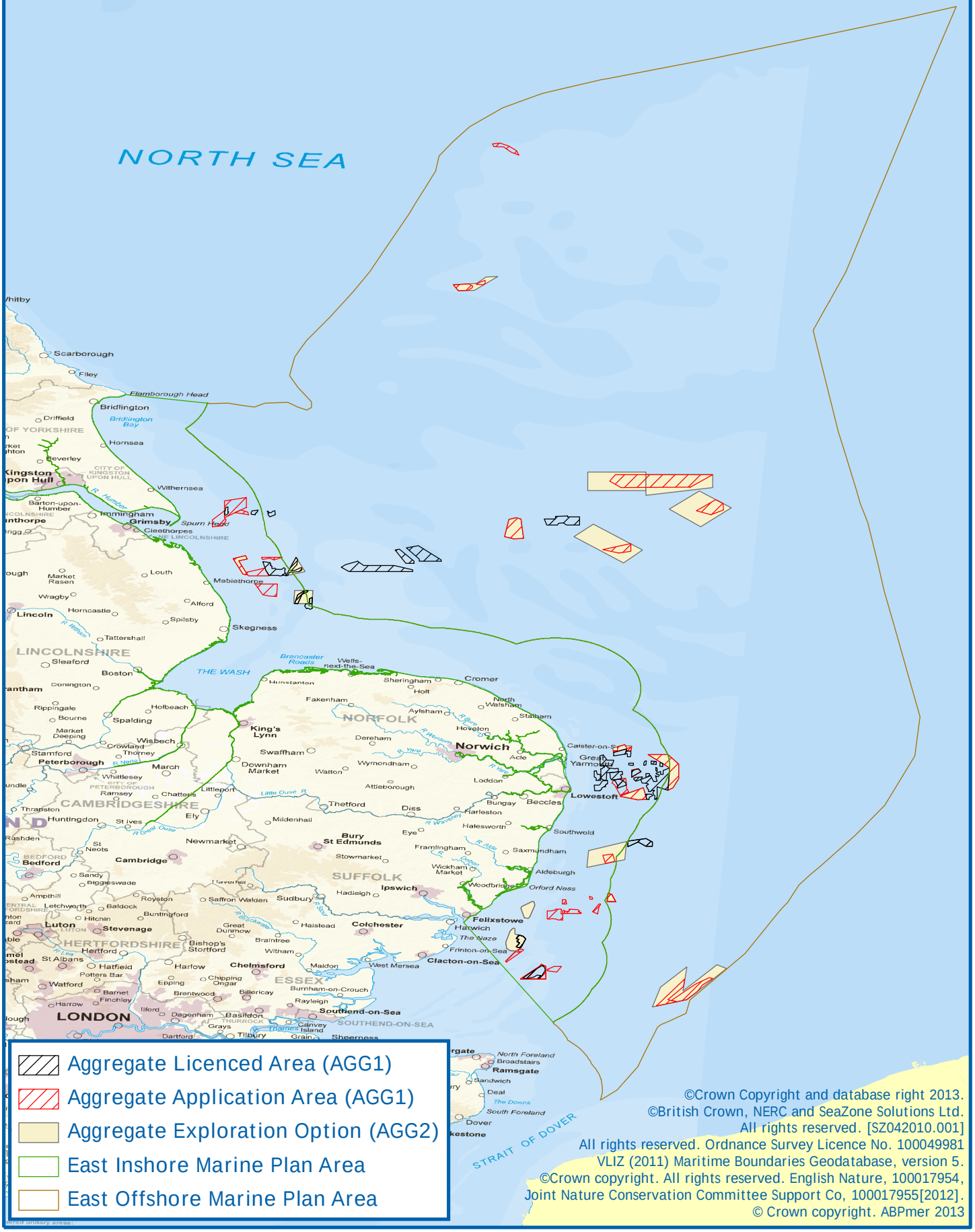

- Aggregate Licenced Area (AGG1)
- Aggregate Application Area (AGG1)
- Aggregate Exploration Option (AGG2)
- East Inshore Marine Plan Area
- East Offshore Marine Plan Area

Figure 6: Tidal Ellipse Distances Across the East Coast Marine Plan Areas

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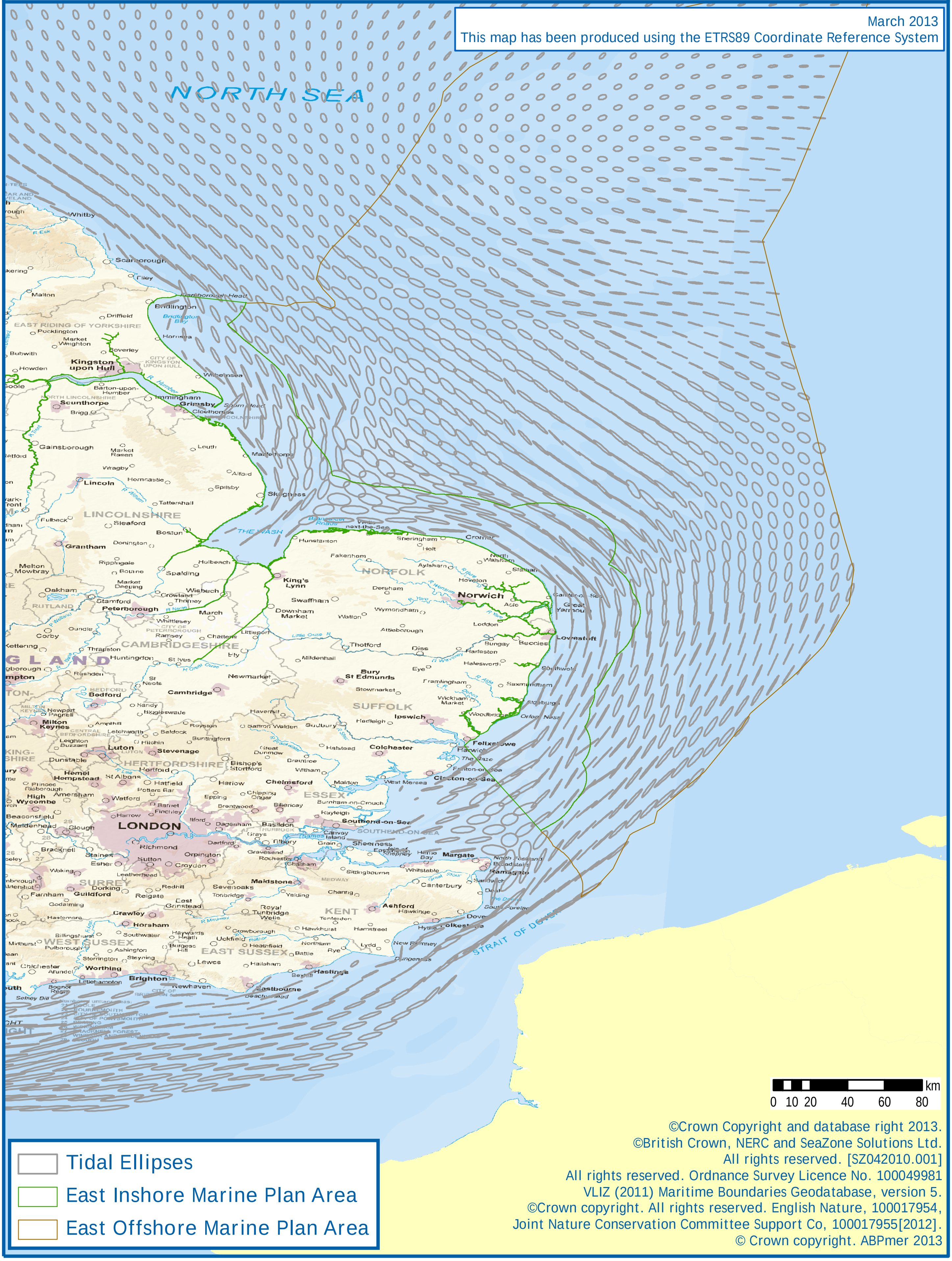

Tidal Ellipses
East Inshore Marine Plan Area
East Offshore Marine Plan Area

Figure 7: European/Ramsar Sites within the Plan Areas Screened into Assessment for Tidal Energy Activities

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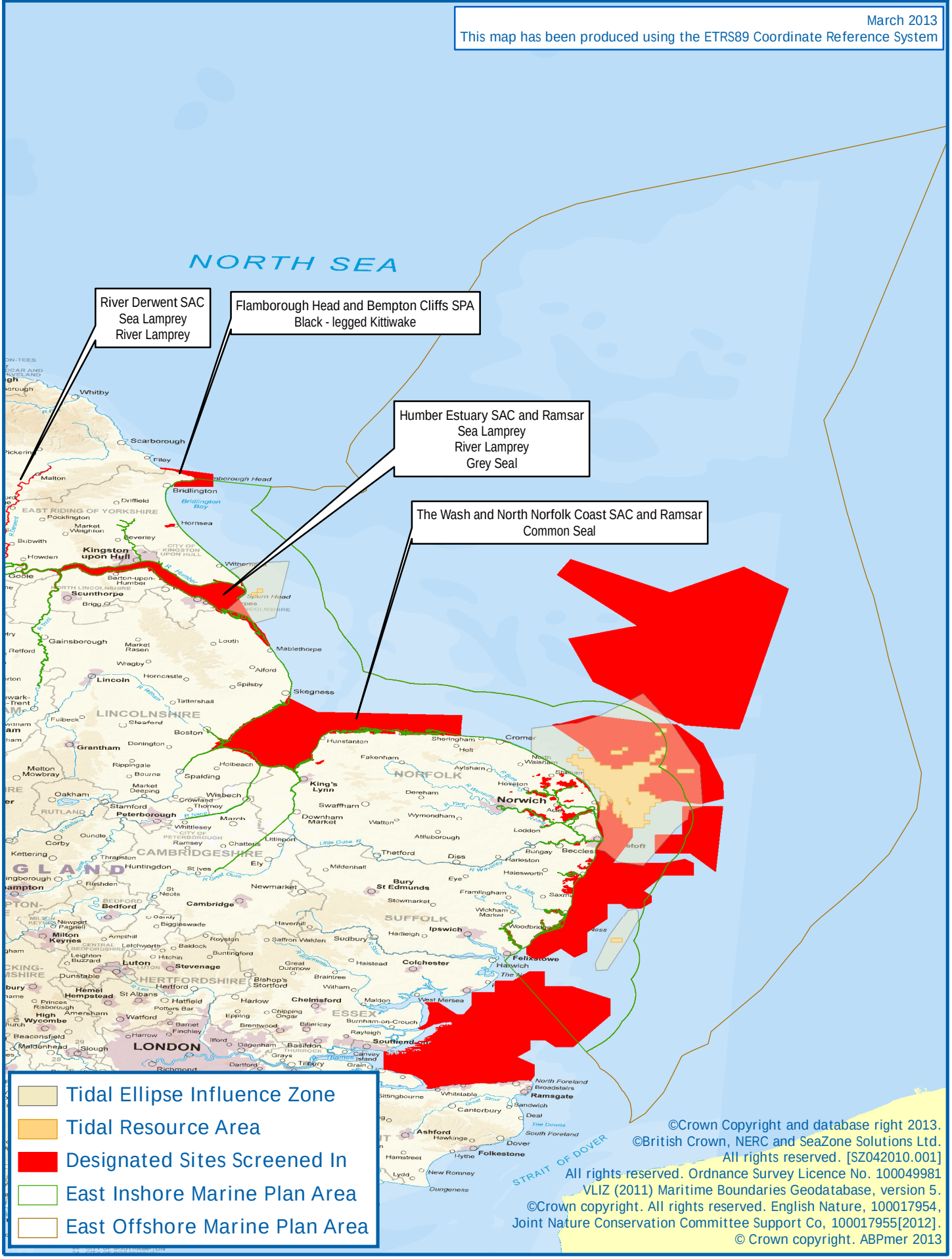

Figure 8: European/Ramsar Sites in UK Outside the Plan Areas Screened into Assessment for Tidal Energy Activities

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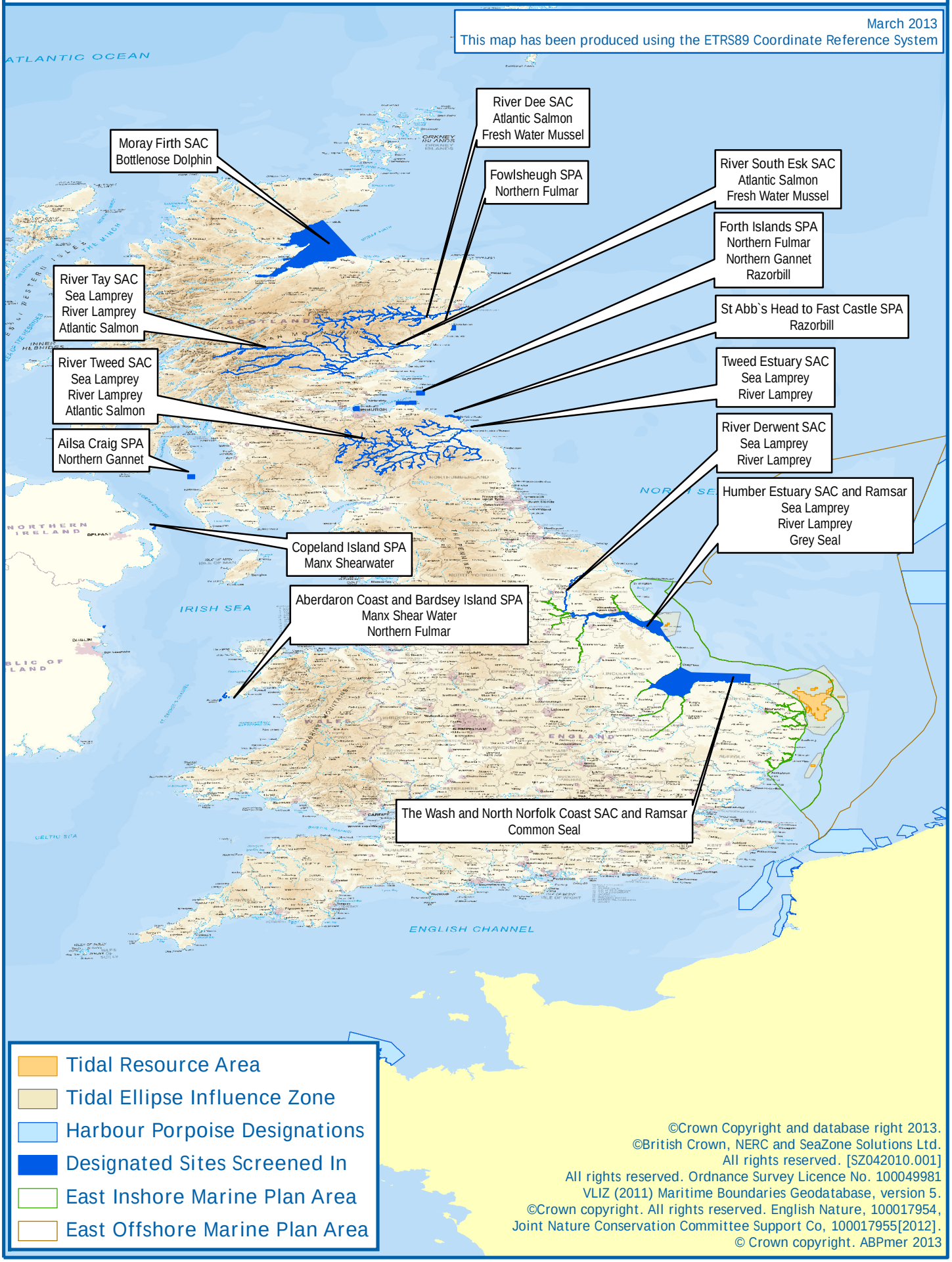

Figure 9: European/Ramsar Sites within the Plan Areas Screened into Assessment for Carbon Storage Activities

marine management organisation

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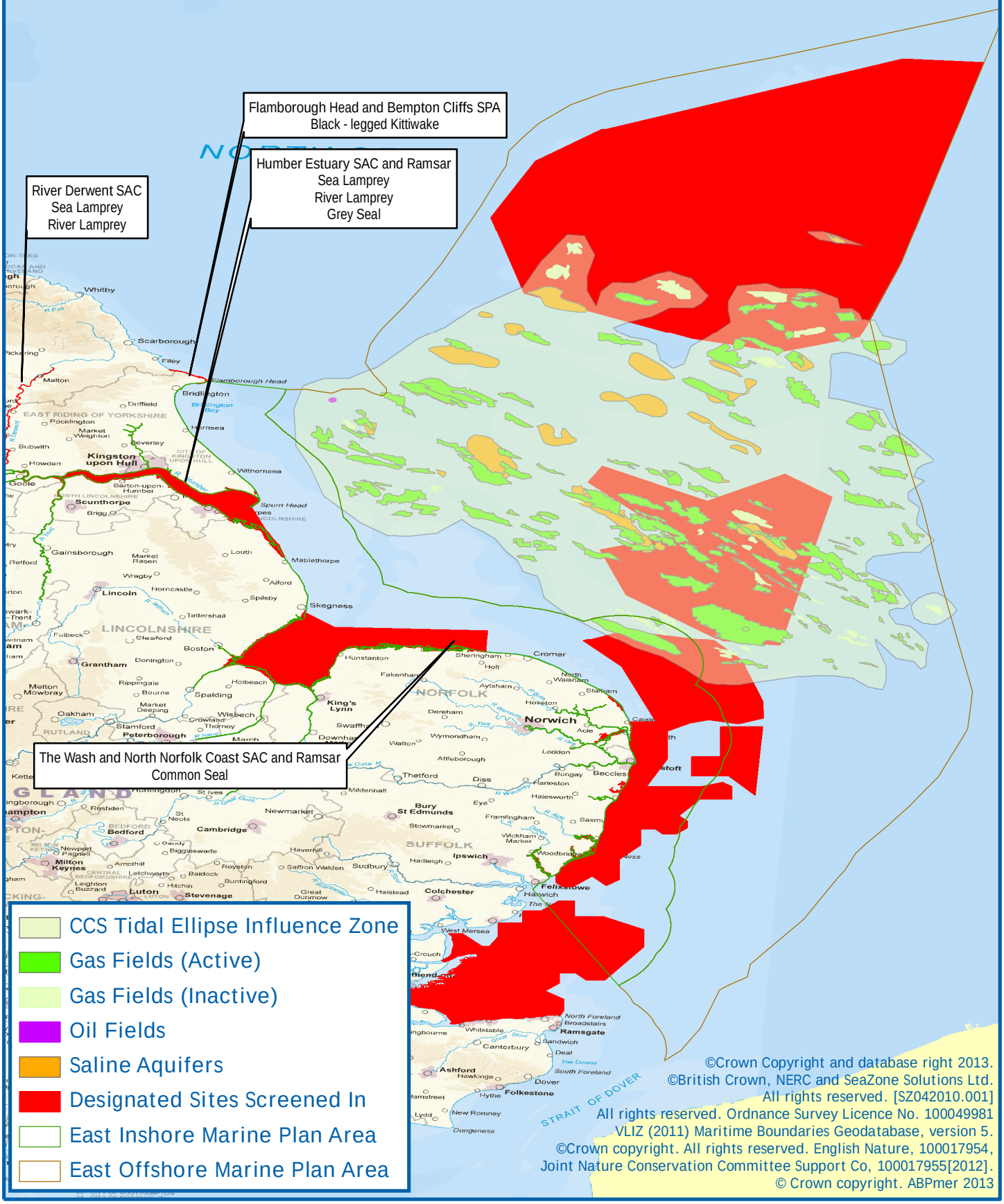

Figure 10: European/Ramsar Sites in UK Outside the Plan Screened into Assessment for Carbon Storage Activities

marine management organisation

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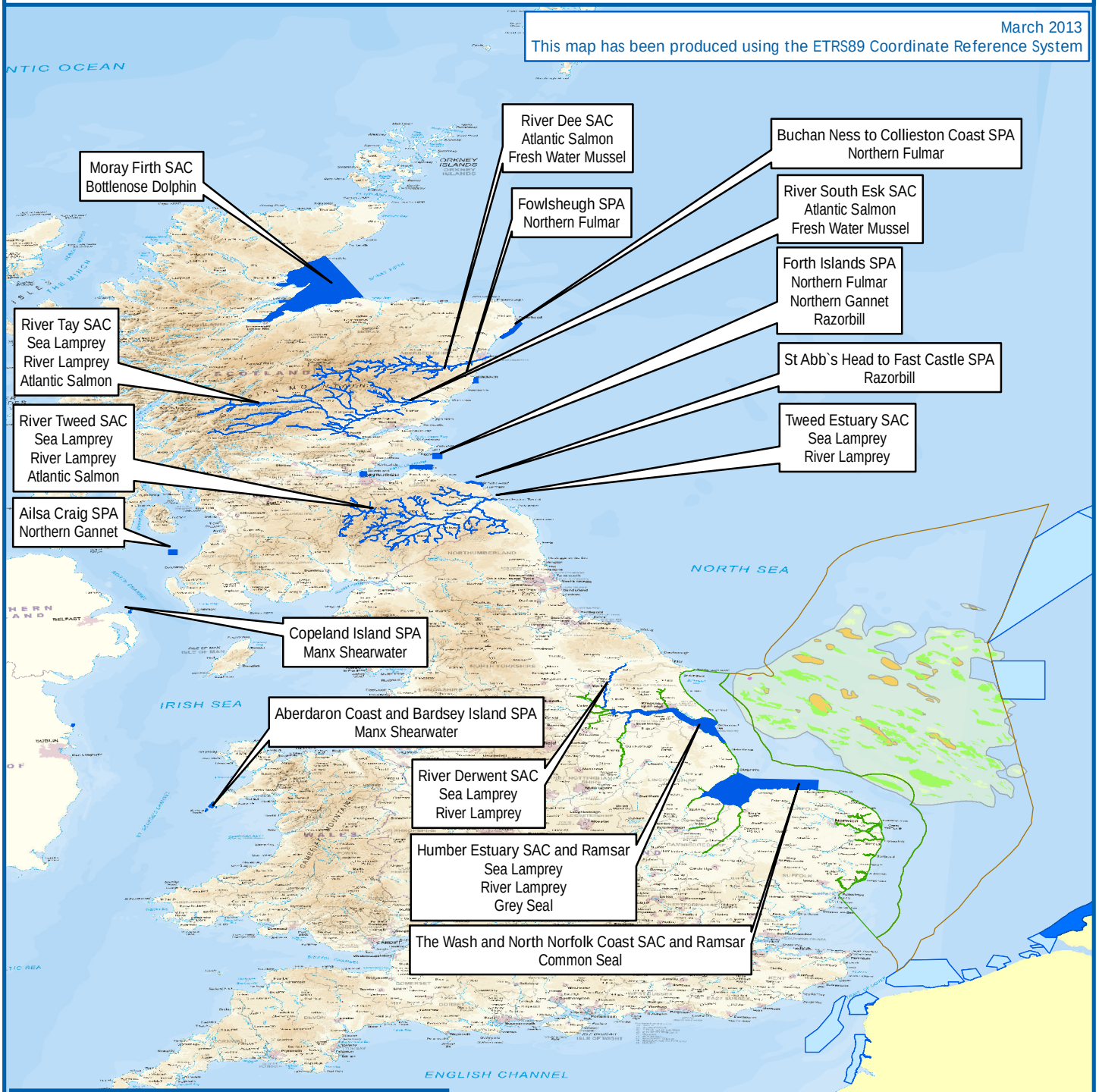

- CCS Tidal Ellipse Influence Zone
- Gas Fields (Active)
- Gas Fields (Inactive)
- Oil Fields
- Saline Aquifers
- Designated Sites Screened In
- Harbour Porpoise Designations
- East Inshore Marine Plan Area
- East Offshore Marine Plan Area

Figure 11: European/Ramsar Sites within the Plan Areas Screened into Assessment for Aggregate Activities

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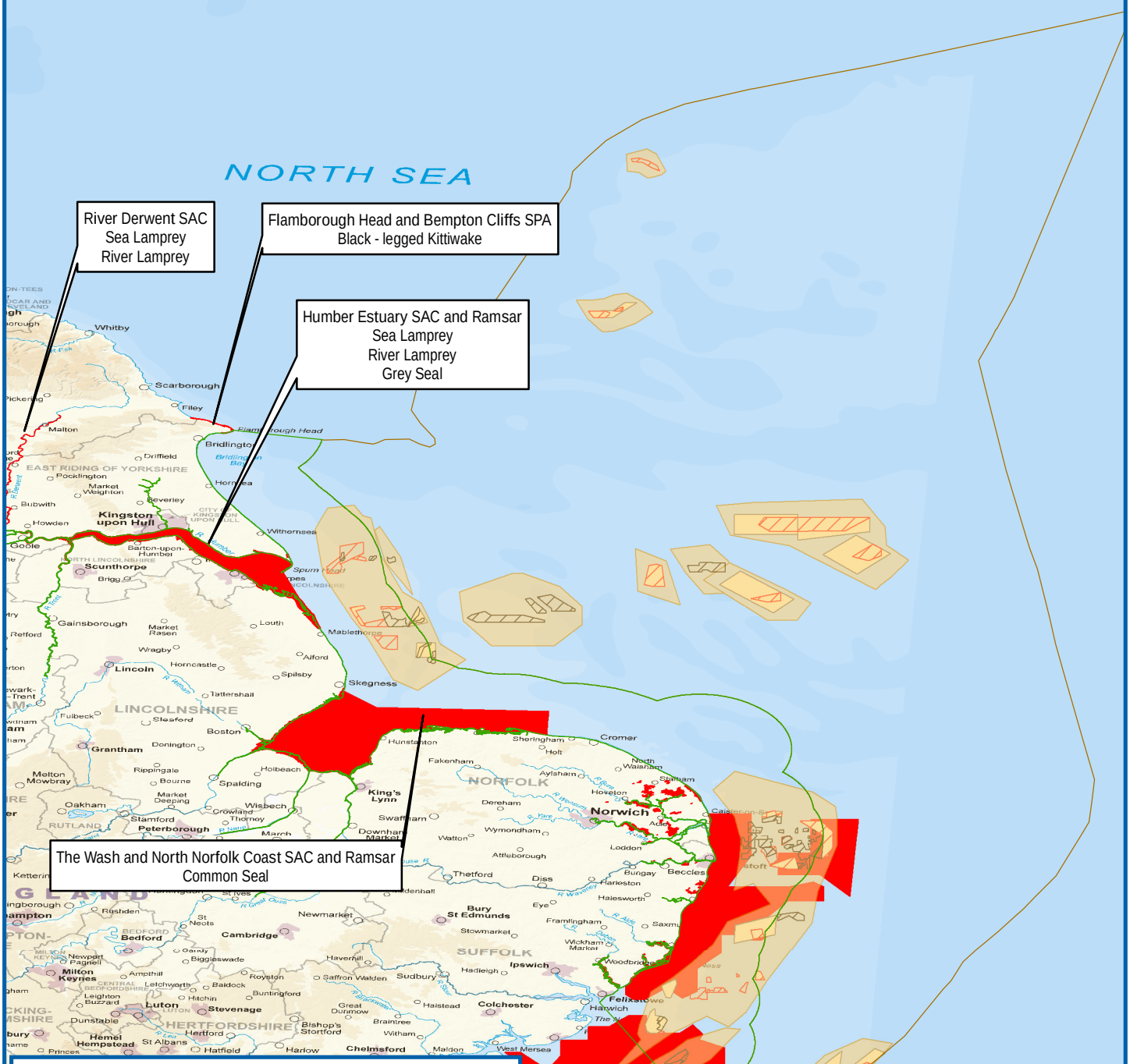

Figure 12: European/Ramsar Sites in UK Outside the Plan Areas Screened into Assessment for Aggregate Activities

marine management organisation

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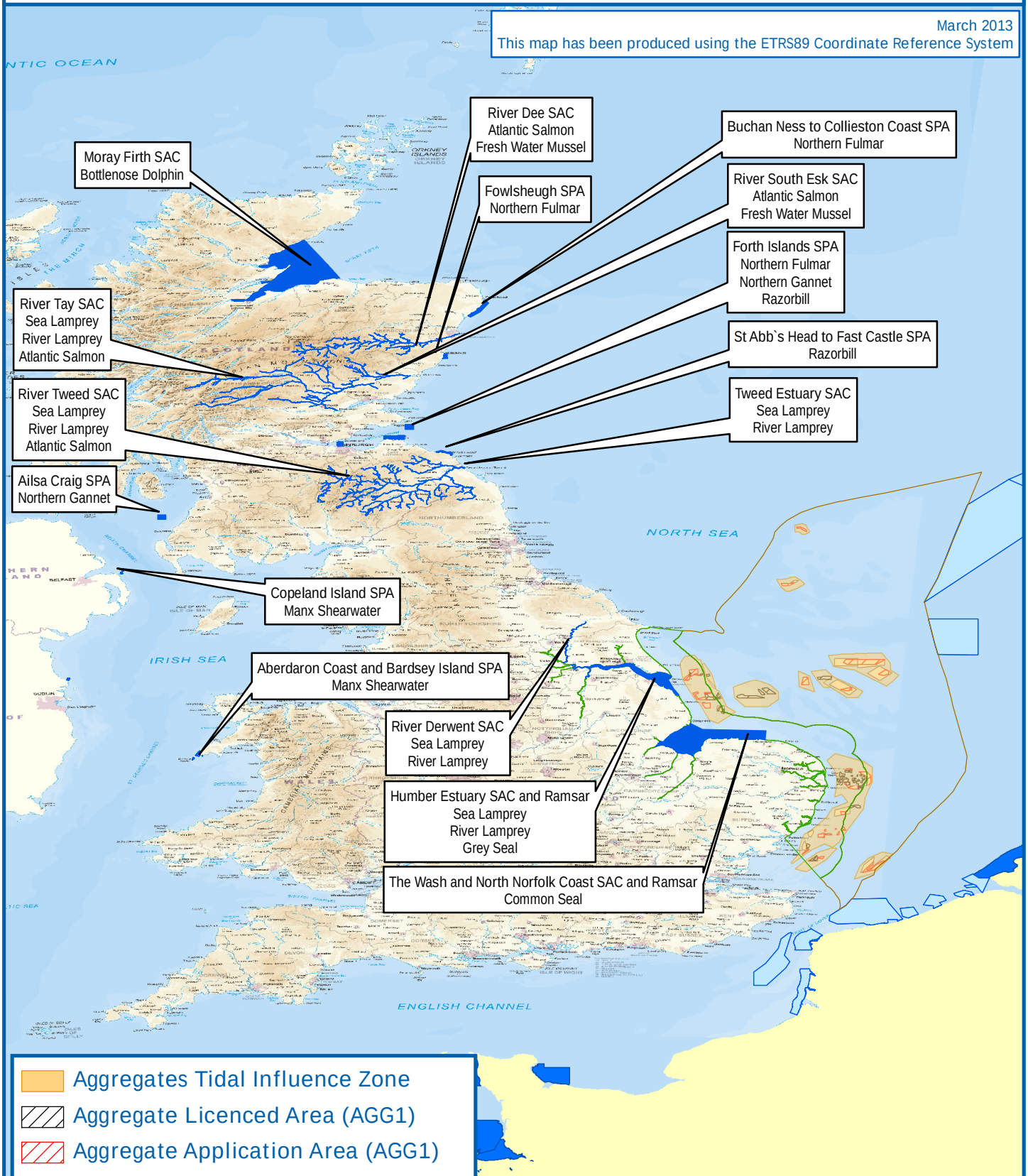

- Aggregates Tidal Influence Zone
- Aggregate Licenced Area (AGG1)
- Aggregate Application Area (AGG1)
- Aggregate Exploration Option (AGG2)
- Designated Sites Screened In
- Harbour Porpoise Designations
- East Inshore Marine Plan Area
- East Offshore Marine Plan Area

Figure 13: Transnational and UK SAC and Ramsar Sites Supporting Harbour Porpoise and Bottlenose Dolphins that have been Screened into Assessment

marine management organisation

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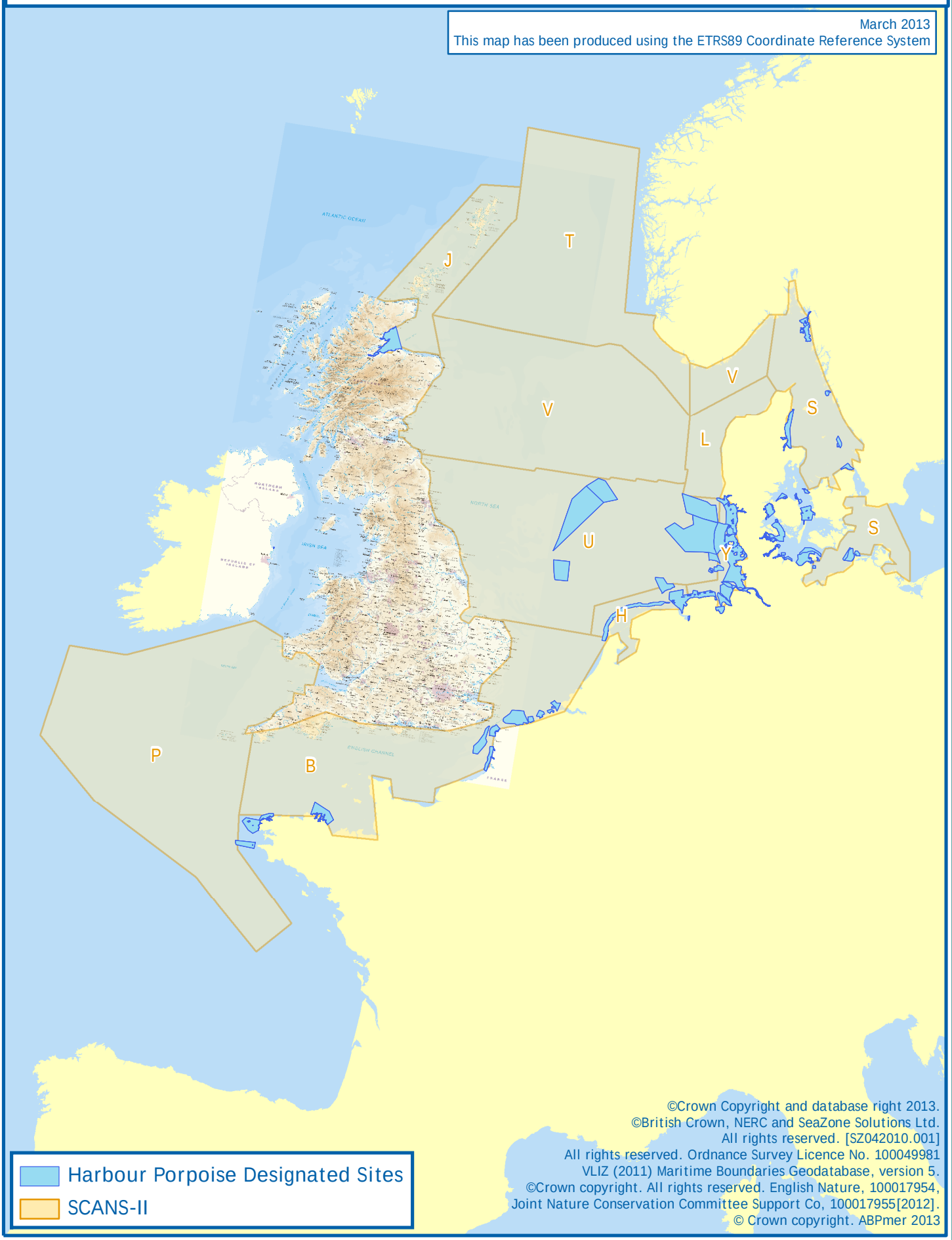

Harbour Porpoise Designated Sites
SCANS-II

Figure 14: Primary and Secondary Impact Zones and Tidal Ellipses for Areas 212, 328B, 328C and 240

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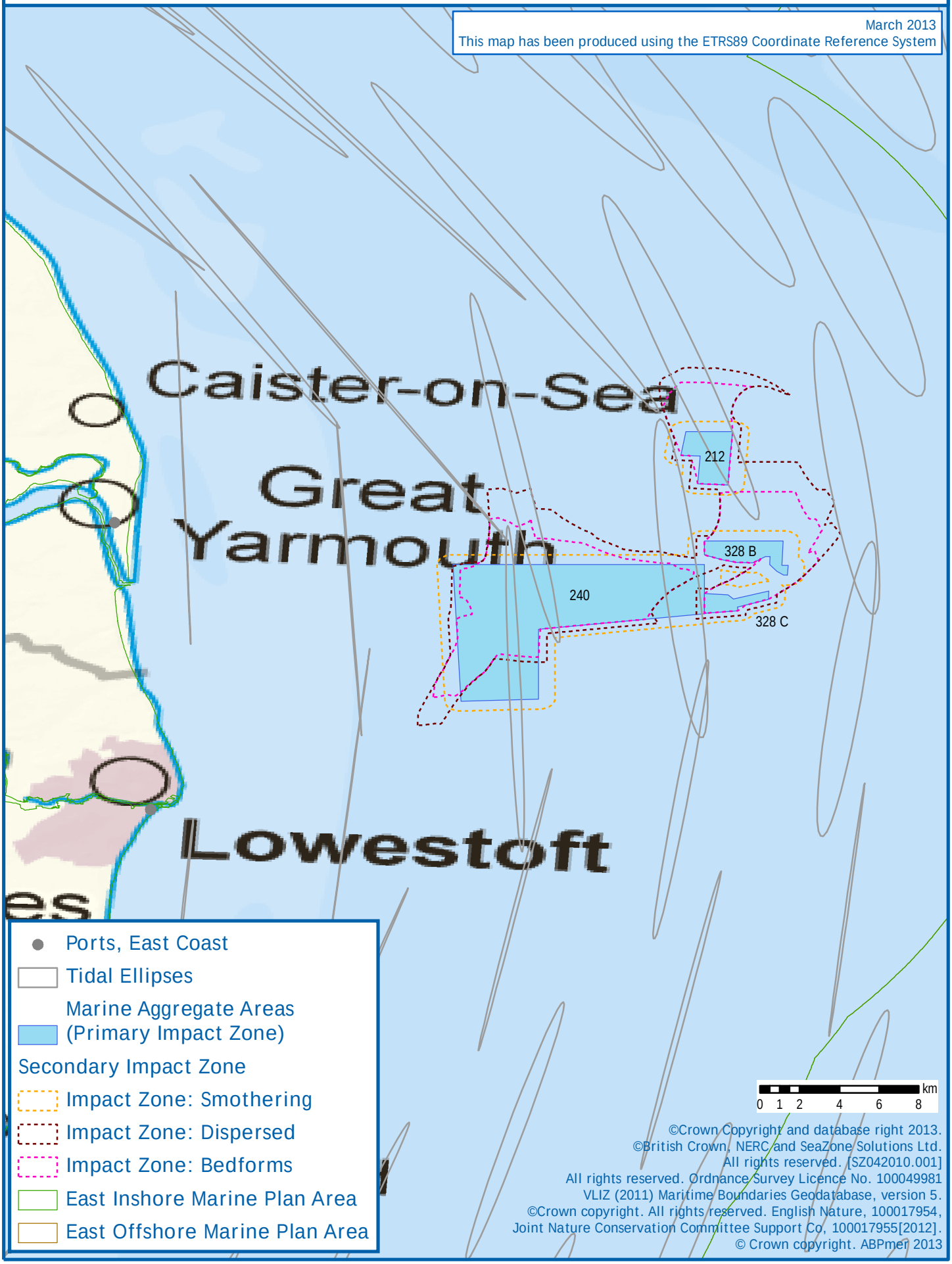
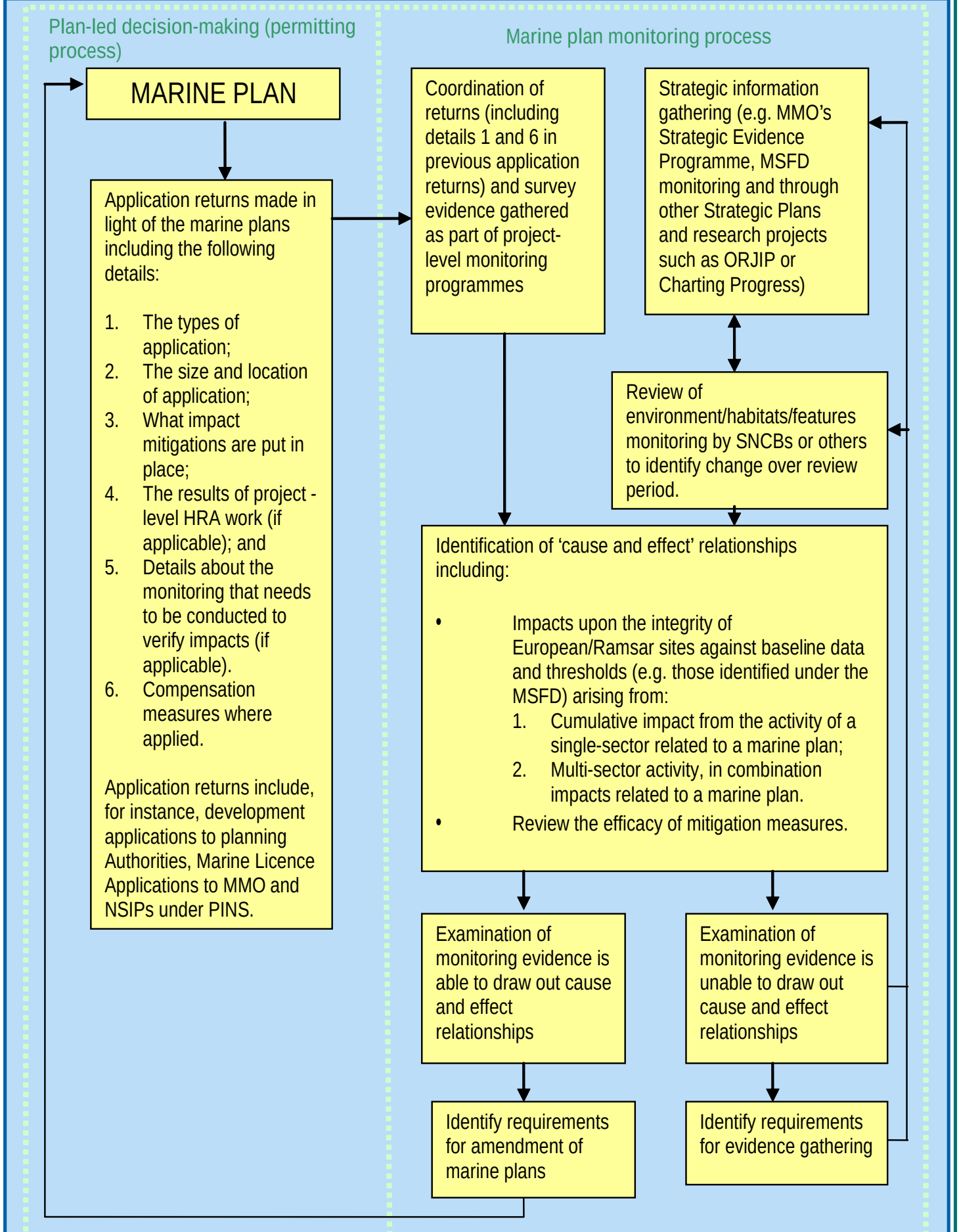


Figure 15: Flow Diagram Describing the Iterative Plan Review (IPR) Process for the East Marine Plan Areas HRA



9 Appendices

Appendix A: Screening, Impact Assessment and Mitigation Review Tables

Appendix B: Marine Management Organisation – ‘Standard’ Mitigation Measures

Appendix A: Screening, Impact Assessment and Mitigation Review Tables

The tables in this appendix summarise the results of the pre-screening, screening and Appropriate Assessment review work. They present the following details:

- **Table A1. Generic impact pathways associated with the East Marine Plans**. A list of 25 generic environmental impact pathways by which the screened in sites and their interest features could be affected by activities (i.e. tidal energy generation (TIDE), carbon capture and storage (CCS) and aggregate extraction (AGG)) which are directed by the East Marine Plans; with:

- **Table A2. Impact-Activity-Feature matrix for TIDE, CCS and AGG projects** An impact matrix showing the activities, changes, standard sensitivity categories and affected features for each environmental impact pathway that are relevant to the East Marine Plans;

- **Table A3. European/Ramsar sites in the UK (and their interest features) located within the Plan area and 100km Plan buffer area.** List of UK sites as reviewed during the Screening and Appropriate Assessment stages of the HRA;

- **Table A4. European/Ramsar sites outside UK territorial waters located within the 100km Plan buffer area (and designated for Harbour Porpoise and/or Bottlenose Dolphin).** List of transnational sites less than 100km from the East Marine Plans as reviewed during the Screening and Appropriate Assessment stages of the HRA;

- **Table A5. European/Ramsar sites within and outside UK territorial waters located outside the 100km Plan buffer area but 'screened in' for fish, seabirds and cetaceans that forage/migrate >100km**. List of UK and transnational sites more than 100km from the East Marine Plans that were reviewed during the Screening and Appropriate Assessment stages of the HRA;

- **Table A6 - Activity screening schedules for Tidal Energy, Carbon Capture and Storage and Aggregate Extraction sectors**. A table of European/Ramsar sites 'screened in' for the TIDE, CCS and AGG sectors based on the activities and impact pathways associated with these sectors.

- **Table A7. Impact-Mitigation matrix for TIDE, CCS and AGG projects**. An impact matrix linking the available standard MMO mitigation measures to the key impact pathways, and features and highlighting the gaps that exist where mitigation measures are not available for known pathways.

Note: These tables have been developed and, where required, updated throughout the HRA process and are all collated together within this appendix with their finalised content. This has been done to avoid repetition of tables and confusion as to which one represents the final product. Throughout the HRA process, no deletions have been made. This is to ensure that these tables express the fully auditable results of the entire pre-screening, screening and assessment processes.

Steps in the Appropriate Assessment Information Review (AAIR) Process(see Section 3.2.1 of AAIR Report)

- **Step 1 Impact Pathways Review:** Identification of the impact pathways that are relevant for each of the three relevant 'screened in' sectors (i.e. tidal energy generation, carbon capture storage, and aggregates extraction);
- **Step 2 Identify activities to which features are sensitive:** A review of the activities undertaken in each of the three sectors, and the environmental changes arising, which could have an impact of designated sites or interest features via the identified impact pathways;
- **Step 3 Activity-based screening of European/Ramsar Sites:** Identification (screening) of those European/Ramsar sites and their relevant interest features for which there is a LSE, or for which a LSE cannot be excluded, from the relevant sector activities and impact pathways;
- **Step 4 Detailed pathway-feature sensitivity review:** A review of the sensitivities of the relevant interest features to the identified impact pathways and sector activities;
- **Step 5 Assessment of the effects on European/Ramsar sites:** Assessment of impacts via each of the activities across the three sectors that are influenced by the 'screened in' Marine Plan policies followed by the identification of available mitigation measures for each identified impact pathway and the identification, where required, of additional mitigation measures which ensure that these activities have NAEOI.

Appropriate Assessment Information Review (AAIR) Matrix Output Links

Step 1 Output - Excel Spreadsheet (Table A1) in this Appendix summarising the 25 Impact Pathways identified for the three sector

Step 2 Output - Excel Spreadsheet (Table A2) in this Appendix showing activities to which features are sensitive for the 25 pathways

Step 3 Output - Four separate Excel Spreadsheets (Table A3, Table A4, Table A5 and Table A6) in this Appendix showing activity-based screening of European/Ramsar Sites

Step 4 Output - Eight separate tables in the text of the AAIR Report (see Tables 2, 3, 4, 5, 7, 11, 12, 13 and 15)

Step 5 Output - Four separate tables in the AAIR Report (see Tables 16, 17, 18 and 19) and Table A7 of this Appendix reviewing MMO mitigation measures

Table A1. Generic impact pathways associated with the East Coast Marine Plans

Pathway Ref No.	Potential Sensitivity Category		Generic Impacts Arising from Tidal Energy Generation (Impact Pathway Description)	Impact Summary	Sector to which Pathway applies		
	Categories of Deterioration or Disturbance*	Code			TIDE	CCS	AGG
1	Physical Loss/Gain of habitat (loss of habitat in development footprint)	PLG	Loss of coastal and offshore habitat under the footprint of devices, power cables, CO_2 pipelines and also cable/pipeline armouring arising from the installation, operation and decommissioning of these structures.	Loss of coastal/offshore seabed within development footprint	✓	✓	
2	Physical Loss/Gain of habitat (change to landward habitat in development footprint)	PLG	Loss of onshore habitat (including bird breeding and roosting grounds, freshwater habitats, otter holts or shelters) under the footprint of power cables, CO_2 pipelines, cable/pipeline armouring and landside infrastructure due to the installation, operation and decommissioning of these structures.	Loss of onshore habitat lost within development footprint	✓	✓	
3	Physical Loss/Gain of habitat (direct change to habitat around the development footprint)	PLG	Loss of foraging areas from a reduction in coastal and offshore habitat due to installation of devices, power cables, CO_2 pipelines and/or cable/pipeline armouring both at the development footprint and outside from bed scour and indirectly from changes to the hydrodynamic (wave and tide) regime.	Loss of coastal/offshore foraging areas within development footprint	✓	✓	
4	Physical Loss/Gain of habitat (direct change to habitat around the development footprint)	PLG	Presence of tidal generation (or other) structures on seabed for the duration of the project resulting in changes to prey and species behaviour (e.g. acting as FAD (Fish Aggregating Device), artificial reef or bird roost).	Loss or gain of habitat from introduced structures causing species change	✓	✓	
5	Physical Damage to habitat (indirect and temporary damage to habitat)	PD	Changes to coastal and offshore habitat as result of damage from baseline surveys (e.g. boreholes/trawls); from equipment use causing abrasion, damage or smothering during installation and from maintenance and removal of cables/pipelines/devices (e.g. jack-up legs, vessels, anchors, mooring chain).	Damage to coastal/offshore seabed during all project phases	✓	✓	✓
6	Physical Damage to habitat (direct and temporary damage to habitat)	PD	Damage to offshore seabed habitat at the site of extraction during the period of the works.	Damage to offshore seabed from aggregate extraction			✓
7	Physical Damage to habitat (indirect and temporary damage to habitat)	PD	Damage to the areas surrounding the site of extraction as a result of sediment redistribution and settlement.	Damage to offshore seabed from plume during aggregate extraction			✓
8	Physical Damage to habitat (indirect and longer-term damage to habitat)	PD	Changes to coastal and offshore habitat as a result of alterations to the wave climate or hydrodynamic (wave and tide) regime from the presence of tidal devices, CO_2 pipelines, power cables or cable/pipeline armouring causing physical changes (including alterations to sediment transport/scour) or from changes to seabed/sandbank morphology at the extraction site(s) (including alterations to sediment transport/scour).	Damage to coastal/offshore seabed from hydrodynamic changes	✓	✓	✓
9	Physical Damage to habitat (indirect and temporary damage to habitat)	PD	Damage to onshore habitat (including bird breeding grounds, freshwater habitats, otter holts or shelters) by excavation, piling and construction work associated with the installation, operation and decommissioning of cables, CO_2 pipelines and landside infrastructure.	Damage to onshore habitat during all project phases	✓	✓	
10	Physical Damage to habitat (indirect and temporary damage to habitat)	PD	Reduction in quality of foraging areas as result of damage to coastal and offshore habitat from baseline surveys (e.g. boreholes and trawls); from equipment use causing abrasion, damage or smothering during installation; from maintenance and removal of cables, pipeline, tidal/devices or from scour, sediment transport and hydrodynamic change during operation.	Damage to coastal/offshore foraging areas during all project phases	✓	✓	✓
11	Physical Damage to species (direct and temporary damage to habitat)	PD	Reduction in quality of foraging areas as result of damage to coastal and offshore habitat within and surrounding the aggregate sites during the extraction process.	Damage to coastal/offshore foraging areas from aggregate extraction			✓
12	Physical Damage to species (direct and temporary damage to habitat)	PD	Damage to seal haul out locations during the installation, decommissioning and operation of the cables, pipelines and/or cable/pipeline armouring.	Damage to seal haul out from cables or pipelines	✓	✓	
13	Physical Damage to species (direct damage to species from collision risk)	PD	Collision risk and possible mortality of species due to the presence of tidal devices or from vessels travelling to and from the site (including propeller collision risk).	Damage to species from underwater collision	✓	✓	✓
14	Physical Damage to species (direct damage to species from collision risk)	PD	Presence of above water structures, and any associated lighting, influencing migration/foraging of bird species	Damage to species from above-water collision or disorientation		✓	
15	Non-Physical disturbance (barrier to species movement)	NPD	Presence of sub-surface structures and disturbance (noise or visual) associated with tidal devices may present a barrier to movement and block migratory pathways or access to feeding grounds depending on array design	Disturbance from introduced structures causing barrier to mobile species movement	✓		
16	Non-Physical disturbance (disturbance to species)	NPD	Visual disturbance and exclusion from areas as a result of surveying; cable, pipeline or tidal device installation/operation and decommissioning activities (including movements of vessels).	Disturbance (visual) from activities during all project phases	✓	✓	✓
17	Non-Physical disturbance (disturbance to species)	NPD	Noise/vibration disturbance and exclusion from areas as a result of vessels and other activities during survey work (e.g. seismic exploration and geophysical surveys), construction (e.g. piling, drilling, cable laying), operation (e.g. device noise), maintenance or decommissioning. Also includes noise/vibration disturbance from vessels and draghead during aggregate extraction.	Disturbance (noise) from activities during all project phases	✓	✓	✓
18	Non-Physical disturbance (disturbance to species)	NPD	Impacts from Electromagnetic Fields (EMF) on electromagnetically sensitive fish and cetaceans interfering with prey location and mate detection in some species and creating barriers to migration.	Disturbance (EMF) from cables during operational phase	✓		
19	Toxic Contamination (reduction in water quality)	TC	Spillage of fluids, fuels and/or construction materials (inc. from surface coatings/treatments) during installation or removal of structures (devices and cables), during survey/maintenance or during aggregate extraction.	Contamination during surveys or maintenance activities	✓	✓	✓
20	Toxic Contamination (reduction in water quality)	TC	Release of contaminants associated with the dispersion of suspended sediments during installation or removal of structures (devices, pipelines and cables) or from the aggregate extraction process.	Contamination during installation/removal of structures or aggregate extraction	✓	✓	✓
21	Toxic Contamination (reduction in water quality)	TC	Release of CO_2 into the water column and its acidification from the formation of carbonic acid.	Contamination from carbon releases		✓	
22	Non-Toxic Contamination (elevated turbidity)	NTC	Increase in turbidity (and possibly reduced dissolved oxygen) associated with suspended sediments release during installation or removal of structures (devices, pipelines and cables) or from aggregate extraction.	Non-toxic Contamination from increases in turbidity	✓	✓	✓
23	Biological Disturbance (introduction of non-native species)	BD	Predation by introduced rats/mink through the positioning of static devices (turbines, rigs) close to breeding seabird sites.	Biological disturbance by increasing predation risk	✓	✓	✓
24	Biological Disturbance (introduction of non-native species)	BD	Introduction of new structures (tidal devices or construction platforms) on the seabed providing new substratum that facilitates the colonisation and ingress of invasive non-native species.	Biological disturbance from non-native species on substratum	✓	✓	
25	Biological Disturbance (introduction of non-native species)	BD	Introduction and ingress of invasive non-native species as biofouling species on the surfaces of vessels or construction plant.	Biological disturbance from non-native species on vessels	✓	✓	✓

* As derived from the standard 'categories of operations which may cause deterioration or disturbance' (UK Marine SAC project, 2001)

Table A2. Impact-Activity-Feature matrix for TIDE, CCS and AGG projects.

						Sector			Feature				
									Tables 3-5 of AAIR Report	Table 6 of AAIR report	Table 8 of AAIR report	Tables 12-14 of AAIR Report	Table 16 of AAIR Report
Project Phase	**Activity**	**Change**	**Sensitivity Category** (Using standard 'categories of operations which may cause deterioration or disturbance' (UK Marine SAC project, 2001))	**Impact Pathway Description** (see Note at the bottom of the table describing sources and HRA precedents - see also Table A1a for list)	**Pathway Ref. No.** (see Table A1a for list)	**TIDE**	**CCS**	**AGG**	Coastal, Intertidal and Subtidal Habitats and Associated Species	Supralittoral (Onshore) Habitats and Species	Bird Species	Marine Mammals (Seals, Cetaceans, Otter)	Migratory Fish and Freshwater Pearl Mussel
PREPARATORY SURVEY WORK (applies across all sectors where surveys are required to inform baseline environmental descriptions (all sectors), to investigate aggregate resources (AGG) or to prepare form installation of tidal devices, cables or pipelines (TIDE and CCS)	Trawling and borehole sampling during environmental baseline surveys	Temporary removal of, or change to, species or habitats features (e.g. biogenic reefs)	**Physical Damage** (indirect and temporary damage to marine habitat)	Changes to coastal and offshore habitat as result of damage from baseline surveys (e.g. boreholes/trawls); from equipment use causing abrasion, damage or smothering during installation and from maintenance and removal of cables/pipelines/devices (e.g. jack-up legs, vessels, anchors, mooring chain).	**5**	✓	✓	✓	✓				
	Trawling and borehole sampling during environmental baseline surveys	Temporary removal of, or change to, species or habitats features (e.g. biogenic reefs)	**Physical Damage** (indirect and temporary damage to marine habitat)	Reduction in quality of foraging areas as result of damage to coastal and offshore habitat from baseline surveys (e.g. boreholes and trawls); from equipment use causing abrasion, damage or smothering during installation; from maintenance and removal of cables, pipeline tidal/devices or from scour, sediment transport and hydrodynamic change during operation.	**10**	✓	✓	✓			✓	✓	✓
	Increased vessel activity during baseline surveys (including use of ducted propellers on vessels using dynamic positioning)	Elevated collision risk for marine species especially marine mammals	**Physical Damage** (direct damage to species from collision risk)	Collision risk and possible mortality of species due to the presence of tidal devices or from vessels travelling to and from the site (including propeller collision risk).	**13**	✓	✓	✓			✓	✓	✓
	Increased vessel activity during environmental baseline surveys	Visual disturbance of species	**Non-Physical disturbance** (disturbance to species)	Visual disturbance and exclusion from areas as a result of surveying; cable, pipeline or tidal device installation/operation and decommissioning activities (including movements of vessels).	**16**	✓	✓	✓			✓	✓	
	Seismic surveys; Increased vessel activity during environmental baseline surveys	Noise and vibration from seismic exploration and geophysical surveys creating underwater pressure waves that may affect/damage fish or marine mammals and or airborne noise that may affect bird species; Increased vessel activity causing elevated noise dist	**Non-Physical disturbance** (disturbance to species)	Noise/vibration disturbance and exclusion from areas as a result of vessels and other activities during survey work (e.g. seismic exploration and geophysical surveys), construction (e.g. piling, drilling, cable laying), operation (e.g. device noise), maintenance or decommissioning. Also includes noise/vibration disturbance from vessels and draghead during aggregate extraction	**17**	✓	✓	✓			✓	✓	✓
	Increased vessel activity during environmental baseline surveys	Elevated risk of spillages/releases of oil or other contaminants & toxic effects on marine species	**Toxic Contamination** (reduction in water quality)	Spillage of fluids, fuels and/or construction materials (inc. from surface coatings/treatments) during installation or removal of structures (devices and cables), during survey/maintenance or during aggregate extraction.	**19**	✓	✓	✓	✓		✓	✓	✓
	Increased vessel activity during environmental baseline surveys	Elevated risk of introducing non-native species as biofouling on the surfaces of vessels	**Biological Disturbance** (introduction of non-native species)	Introduction and ingress of invasive non-native species as biofouling species on the surfaces of vessels or construction plant.	**25**	✓	✓	✓	✓				
CONSTRUCTION AND DECOMMISSIONING (applies only to the TIDE and CCS sectors where devices, cable or pipelines would need to be installed and then, at the end of their operational life, removed. For the AGG sector there is no equivalent phase and it is only the impacts arising during the preparatory survey work or during the operational (dredging) phase that apply.	Use of jack-up legs and other activities for the installation and decommissioning of structures (including any future 'repowering'/upgrading activities), power cables or carbon pipleines.	Damage to vulnerable benthic habitats outside the developmental footprint from construction activities including abrasion from equipment and smothering of habitats where significant sediment is released.	**Physical Damage** (indirect and temporary damage to marine habitat)	Changes to coastal and offshore habitat as result of damage from baseline surveys (e.g. boreholes/trawls); from equipment use causing abrasion, damage or smothering during installation and from maintenance and removal of cables/pipelines/devices (e.g. jack-up legs, vessels, anchors, mooring chain).	**5**	✓	✓		✓				
	Activities associated with the Installation and decommissioning of power cables, carbon pipleines and landside structures.	Damage to vulnerable terrestrial and freshwater habitats outside the developmental footprint from construction activities.	**Physical Damage** (indirect and temporary damage to landward habitat in development footprint)	Damage to onshore habitat (including bird breeding grounds, freshwater habitats, otter holts or shelters) by excavation, piling and construction work associated with the installation, operation and decommissioning of cables, CO2 pipelines and landside infrastructure.	**9**	✓	✓			✓	✓	otter	✓
	Installation and decommissioning of structures (including any future 'repowering'/upgrading activities), power cables and carbon pipleines.	Where significant changes occur to intertidal or subtidal habitats (e.g. substratum) then they can lead to impacts to species' food resources	**Physical Damage** (indirect and temporary damage to habitat)	Reduction in quality of foraging areas as result of damage to coastal and offshore habitat from baseline surveys (e.g. boreholes and trawls); from equipment use causing abrasion, damage or smothering during installation; from maintenance and removal of cables, pipeline tidal/devices or from scour, sediment transport and hydrodynamic change during operation.	**10**	✓	✓				✓	✓	✓
	Installation and decommissioning of power cables or carbon pipleines that are aligned through intertidal habitats.	Temporary damage to seal haul out locations during the installation and decommissioning processes	**Physical Damage** (direct and temporary damage to habitat)	Damage to seal haul out locations during the installation, decommissioning and operation of the cables, pipeline and/or cable/pipeline armouring.	**12**	✓	✓					✓	
	Increased vessel activity during installation of devices and arrays (including use of ducted propellers on vessels using dynamic positioning).	Elevated collision risk for marine species especially marine mammals	**Physical Damage** (direct damage to species from collision risk)	Collision risk and possible mortality of species due to the presence of tidal devices or from vessels travelling to and from the site (including propeller collision risk).	**13**	✓	✓				✓	✓	✓
	Increased vessel activity during installation of devices and arrays.	Visual disturbance of species	**Non-Physical disturbance** (disturbance to species)	Visual disturbance and exclusion from areas as a result of surveying; cable, pipeline or tidal device installation/operation and decommissioning activities (including movements of vessels).	**16**	✓	✓				✓	✓	
	Noise and vibration generated by installation of structures, power cables or carbon pipleines (especially with percussive piling, percussive demolition or the use of explosives).	Underwater noise disturbance that may affect/damage/disturb fish or marine mammals and or airborne noise that may affect bird species	**Non-Physical disturbance** (disturbance to species)	Noise/vibration disturbance and exclusion from areas as a result of vessels and other activities during survey work (e.g. seismic exploration and geophysical surveys), construction (e.g. piling, drilling, cable laying), operation (e.g. device noise), maintenance or decommissioning. Also includes noise/vibration disturbance from vessels and draghead during aggregate extraction.	**17**	✓	✓				✓	✓	✓
	Increased vessel activity during installation and decommissioning of devices, arrays or pipleines.	Elevated risk of spillages/releases of oil or other contaminants & toxic effects on marine species	**Toxic Contamination** (reduction in water quality)	Spillage of fluids, fuels and/or construction materials (inc. from surface coatings/treatments) during installation or removal of structures (devices and cables), during survey/maintenance or during aggregate extraction.	**19**	✓	✓		✓	✓	✓	✓	✓
	Increase in suspended sediments with associated contaminant from construction work especially in environments with fine sediments (e.g. power cable or carbon pipeline trenching).	Toxic effects on marine species	**Toxic Contamination** (reduction in water quality)	Release of contaminants associated with the dispersion of suspended sediments during installation or removal of structures (devices, pipelines and cables) or from the aggregate extraction process.	**20**	✓	✓		✓	✓	✓	✓	✓
	Increase in suspended sediments from construction work especially in environments with fine sediments (e.g. power cable or carbon pipeline trenching).	Adverse effects on marine species	**Non-Toxic Contamination** (elevated turbidity)	Increase in turbidity (and possibly reduced dissolved oxygen) associated with suspended sediments release during installation or removal of structures (devices, pipelines and cables) or from aggregate extraction.	**22**	✓	✓		✓	✓	✓	✓	✓
	Introduction of fixed marine structures above the water surface.	Allowing introduction of rats/mink through the positioning of devices close to breeding seabird sites	**Biological Disturbance** (introduction of non-native species)	Predation by introduced rats/mink through the positioning of static devices (turbines, rigs) close to breeding seabird sites.	**23**	✓	✓				✓		
	Increased vessel activity during installation of devices, arrays or pipleines.	Introduction of invasive non-native species from biofouling on vessels and plant	**Biological Disturbance** (introduction of non-native species)	Introduction and ingress of invasive non-native species as biofouling species on the surfaces of vessels or construction plant.	**25**	✓	✓		✓				

Table A2. Impact-Activity-Feature matrix for TIDE, CCS and AGG projects.

						Sector			Feature				
									Tables 3-5 of AAIR Report	Table 6 of AAIR report	Table 8 of AAIR report	Tables 12-14 of AAIR Report	Table 16 of AAIR Report
Project Phase	**Activity**	**Change**	**Sensitivity Category** (Using standard 'categories of operations which may cause deterioration or disturbance' (UK Marine SAC project, 2001))	**Impact Pathway Description** (see Note at the bottom of the table describing sources and HRA precedents - see also Table A1a for list)	**Pathway Ref. No.** (see Table A1a for list)	**TIDE**	**CCS**	**AGG**	Coastal, Intertidal and Subtidal Habitats and Associated Species	Supralittoral (Onshore) Habitats and Species	Bird Species	Marine Mammals (Seals, Cetaceans, Otter)	Migratory Fish and Freshwater Pearl Mussel
OPERATIONAL PHASE (includes the process of aggregate extraction and the operation of a tidal energy device, the presences of power cables (TIDE) of carbon delivery pipelines (CCS)	Permanent (operational period) presence of structures on the seabed	Loss of seabed habitat and species from the placement of turbines, arrays, cables or pipleines.	**Physical Loss/Gain of habitat** (loss of habitat in development footprint)	Loss of coastal and offshore habitat under the footprint of devices, power cables, CO_2 pipelines and also cable/pipeline armouring arising from the installation, operation and decommissioning of these structures.	**1**	✓	✓		✓				
	Permanent (operational period) presence of structures, power cables, carbon pielines and infrastructure onshore	Loss of terrestrial or freshwater habitat and species from the placement of landside infrastructure (e.g. power cables and converter stations or carbon pipelines)	**Physical loss/gain of habitat** (direct change to habitat within development footprint)	Loss of onshore habitat (including bird breeding and roosting grounds, freshwater habitats, otter holts or shelters) under the footprint of power cables, CO_2 pipelines, cable/pipeline armouring and landside infrastructure due to the installation, operation and decommissioning of these structures.	**2**	✓	✓			✓	✓	otter	✓
	Permanent (operational period) presence of structures on the seabed	Where significant losses occur to intertidal or subtidal habitats (e.g. substratum) then they can lead to impacts to species' food resources	**Physical loss/gain of habitat** (direct change to habitat within development footprint)	Loss of foraging areas from a reduction in coastal and offshore habitat due to installation of devices, power cables, CO_2 pipelines and/or cable/pipeline armouring both at the development footprint and outside from bed scour and indirectly from changes to the hydrodynamic (wave and tide) regime.	**3**	✓	✓				✓	✓	✓
	Permanent (operational period) presence of structures on the seabed	Change to habitat composition (e.g. substratum) at developmental footprint and resulting changes to prey availability and species behaviour (e.g. fish aggregation, artificial reef or bird roosting)	**Physical loss/gain of habitat** (direct change to habitat around the development footprint)	Presence of tidal generation (or other) structures on seabed for the duration of the project resulting in changes to prey and species behaviour (e.g. acting as FAD (Fish Aggregating Device), artificial reef or bird roost).	**4**	✓	✓				✓	✓	✓
	Use of jack-up legs and other activities for the maintenance of marine structures, power cables and pipelines.	Regular disturbance to, or damage of, seabed habitat features	**Physical Damage** (direct and temporary damage to habitat)	Changes to coastal and offshore habitat as result of damage from baseline surveys (e.g. boreholes/trawls); from equipment use causing abrasion, damage or smothering during installation and from maintenance and removal of cables/pipelines/devices (e.g. jack-up legs, vessels, anchors, mooring chain).	**5**	✓	✓		✓				
	Extraction work within the licensed aggregate area.	The removal of surface substratum and associated seabed benthos leading to damage but followed by a process of re-colonisation and recovery.	**Physical Damage** to habitat (direct and temporary damage to habitat)	Damage to offshore seabed habitat at the site of extraction during the period of the works.	**6**			✓	✓				
	Plume dispersion over the areas adjacent to the licensed aggregate area.	The settlement of sediment causing changes to the seabed habitats	**Physical Damage** to habitat (indirect and temporary damage to habitat)	Damage to the areas surrounding the site of extraction as a result of sediment redistribution and settlement.	**7**			✓	✓				
	Presence and operation of sub-surface structures or changes to the seabed bathymetry	Changes to the hydrodynamics causing seabed disturbance through local scour and more distant erosion and smothering by re-deposition of mobilised sediment	**Physical Damage** (indirect and longer-term damage to habitat)	Changes to coastal and offshore habitat as a result of alterations to the wave climate or hydrodynamic (wave and tide) regime from the presence of tidal devices, CO2 pipelines, power cables or cable/pipeline armouring causing physical changes (including alterations to sediment transport/scour) or from changes to seabed/sandbank morphology at the extraction site(s) (including alterations to sediment transport/scour).	**8**	✓	✓	✓	✓				
	Activities for the maintenance of landside structures including power cables, converter stations or carbon pipelines.	Regular disturbance to, or damage of, habitat features (including onshore otter holts and shelters or seal haul outs)	**Physical Damage** (indirect and longer-term damage to landward habitat)	Damage to onshore habitat (including bird breeding grounds, freshwater habitats, otter holts or shelters) by excavation, piling and construction work associated with the installation, operation and decommissioning of cables, CO2 pipelines and landside infrastructure.	**9**	✓	✓			✓	✓	otter	✓
	Use of jack-up legs and other activities for the maintenance of marine structures, power cables or pipelines.	Where significant changes occur to intertidal or subtidal habitats (e.g. substratum) then they can lead to impacts to species' food resources	**Physical Damage** (indirect and longer-term damage to habitat)	Reduction in quality of foraging areas as result of damage to coastal and offshore habitat from baseline surveys (e.g. boreholes and trawls); from equipment use causing abrasion, damage or smothering during installation; from maintenance and removal of cables, pipeline tidal/devices or from scour, sediment transport and hydrodynamic change during operation.	**10**	✓	✓				✓	✓	✓
	Increase in suspended sediments and plume settlement during aggregate extraction	Where significant changes occur to intertidal or subtidal habitats (e.g. substratum) then they can lead to impacts to species' food resources	**Physical Damage** (direct and longer-term damage to habitat)	Reduction in quality of foraging areas as result of damage to coastal and offshore habitat within and surrounding the aggregate sites during the extraction process.	**11**			✓			✓	✓	✓
	Presence of power cables or pipelines and armouring on intertidal habitats	Impacts to seal haul out locations where any structures remain permanently present across intertidal areas (possibly also causing scour across adjacent areas)	**Physical Damage** (direct and longer-term damage to habitat)	Damage to seal haul out locations during the installation, decommissioning and operation of the cables and cable armouring	**12**	✓	✓					seal	
	Presence and operation of sub-surface structures and increased maintenance vessel activity (including use of ducted propellers on vessels using dynamic positioning)	Collision risk from subsurface turbines or maintenance vessel movements	**Physical Damage** (direct damage to species from collision risk)	Collision risk and possible mortality of species due to the presence of devices or from vessels travelling to and from the site (including propeller collision risk)	**13**	✓	✓	✓			✓	✓	✓
	Presence of above water structures, and any associated lighting	Changes to the behaviour of migrating or foraging birds	**Physical Damage** (direct damage to species from collision or disorientation)	Presence of above water structures, and any associated lighting, influencing migration/foraging of bird species.	**14**		✓				✓		
	Presence and operation of sub-surface moving turbines	Behavioural effects through the physical presence of devices/arrays that causes avoidance or creates barrier to movements	**Non-Physical disturbance** (exclusion of species)	Presence of sub-surface structures and disturbance (noise or visual) associated with tidal devices may present a barrier to movement and block migratory pathways or access to feeding grounds depending on array design..	**15**	✓						✓	✓
	Increased vessel movements and other activities during maintenance wotk or excavation	Visual disturbance of species	**Non-Physical disturbance** (disturbance to species)	Visual disturbance and exclusion from areas as a result of surveying, cable and device installation/operation and decommissioning activities and movements of vessels.	**16**	✓	✓	✓			✓	✓	
	Noise and vibration greater by operating equipment and vessels	Noise disturbance that may affect/damage/disturb fish or marine mammals	**Non-Physical disturbance** (disturbance to species)	Noise/vibration disturbance and exclusion from areas as a result of vessels and other activities during survey work (e.g. seismic exploration and geophysical surveys), construction (e.g. piling, drilling, cable laying), operation (e.g. device noise), maintenance or decommissioning. Also includes noise/vibration disturbance from vessels and draghead during aggregate extraction.	**17**	✓	✓	✓			✓	✓	✓
	Operation of subsea power cables	Electromagnetic fields around cables potentially affecting sensitive species and interfering with prey location and mate detection in some species	**Non-Physical disturbance** (disturbance to species)	Impacts from Electromagnetic Fields (EMF) on electromagnetically sensitive fish and cetaceans interfering with prey location and mate detection in some species and creating barriers to migration	**18**	✓						cetacean	✓

Table A2. Impact-Activity-Feature matrix for TIDE, CCS and AGG projects.

						Sector			Feature				
									Tables 3-5 of AAIR Report	Table 6 of AAIR report	Table 8 of AAIR report	Tables 12-14 of AAIR Report	Table 16 of AAIR Report
Project Phase	**Activity**	**Change**	**Sensitivity Category** (Using standard 'categories of operations which may cause deterioration or disturbance' (UK Marine SAC project, 2001))	**Impact Pathway Description** (see Note at the bottom of the table describing sources and HRA precedents - see also Table A1a for list)	**Pathway Ref. No.** (see Table A1a for list)	**TIDE**	**CCS**	**AGG**	Coastal, Intertidal and Subtidal Habitats and Associated Species	Supralittoral (Onshore) Habitats and Species	Bird Species	Marine Mammals (Seals, Cetaceans, Otter)	Migratory Fish and Freshwater Pearl Mussel
	Increased vessel activity during maintenance work or aggregate extraction.	Elevated risk of spillages/releases of oil or other contaminants & toxic effects on marine species	**Toxic Contamination** (reduction in water quality)	Spillage of fluids, fuels and/or construction materials (inc. from surface coatings/treatments) during installation or removal of structures (devices and cables), during survey/maintenance or during aggregate extraction.	**19**	✓	✓	✓	✓	✓	✓	✓	✓
	Increase in suspended sediments with associated contaminants during aggregate extraction	Toxic effects on marine species	**Toxic Contamination** (reduction in water quality)	Release of contaminants associated with the dispersion of suspended sediments during installation or removal of structures (devices, pipelines and cables) or from the aggregate extraction process.	**20**			✓	✓	✓	✓	✓	✓
	Release of CO_2 into the water column	Acidification of sea water with adverse effects of marine species (especially shellfish)	**Toxic Contamination** (reduction in water quality)	Release of CO_2 into the water column and its acidification from the formation of carbonic acid.	**21**		✓		✓		✓	✓	✓
	Increase in suspended sediments and plume settlement during aggregate extraction	Adverse effects on marine species	**Non-Toxic Contamination** (elevated turbidity)	Increase in turbidity (and possibly reduced dissolved oxygen) associated with suspended sediments release during installation or removal of structures (devices, pipelines and cables) or from aggregate extraction.	**22**			✓	✓	✓	✓	✓	✓
	Introduction of fixed marine structures above the water surface.	Allowing introduction of rats/mink through the positioning of structures close to breeding seabird sites	**Biological Disturbance** (introduction of non-native species)	Predation by introduced rats/mink through the positioning of static devices (turbines, rigs) close to breeding seabird sites.	**23**	✓	✓				✓		
	Presence and operation of sub-surface structures	Introduction and colonisation of invasive non-native species on introduced hard substrata	**Biological Disturbance** (introduction of non-native species)	Introduction of new structures (tidal devices or construction platforms) on the seabed providing new substratum that facilitates the colonisation and ingress of invasive non-native species.	**24**	✓	✓		✓				
	Presence and operation of vessels and construction plant	Introduction of invasive non-native species from biofouling on vessels and plant	**Biological Disturbance** (introduction of non-native species)	Introduction and ingress of invasive non-native species as biofouling species on the surfaces of vessels or construction plant.	**25**	✓	✓	✓	✓				

Note on how this list has been derived from precedents to ensure consistency across HRAs and other impacts assessments

This list of impact pathways and impacting activities set out in Tables 1 and 2 (Steps 1 and 2 of the AA review) are based on those developed during a series of previous Plan-level HRAs undertaken for marine renewable energy projects in Scotland (ABPmer 2010, 2011 and 2013) as well as by relevant strategic environmental impacts assessments and other guidance. The key references are listed below. Consultation with the key stakeholders and Statutory Nature Conservation Bodies has also been a key element in the development of these impact matrices.

References

ABPmer, 2013 Habitats Regulations Appraisal of Draft Plan for Wave and Tidal Energy in Scottish Waters Appropriate Assessment Information. Draft Report for Marine Scotland 2012; ABP Marine Environmental Research Ltd, April 2012 Report No. R.1863c

ABPmer, 2011. Habitats Regulations Appraisal of Draft Plan for Offshore Wind Energy in Scottish Territorial Waters: Information for Appropriate Assessment Report for the Scottish Government January 2011; ABP Marine Environmental Research Ltd. Report No. R. 1722 (overall summary) and R1772a -c (pre-screening, screening and assessment information reports)

ABPmer, 2010. Report to Inform Appropriate Assessment for the Pentland Firth Strategic Area (PFSA) Leasing Round. Report for The Crown Estate February 2010; ABP Marine Environmental Research Ltd, Report No. R.1602.

DECC, 2009. UK Offshore Energy Strategic Environmental Assessment: Future Leasing for Offshore Wind Farms and Licensing for Offshore Oil & Gas and Gas Storage

Entec UK Ltd, 2009. Habitats Regulations Assessment of the Round 3 Plan. Information to Inform an Appropriate Assessment, Report for The Crown Estate December 2009.

UK Marine SAC Project, 2001. Proposed list of categories of operations which may cause deterioration or disturbance to interest features. http://www.ukmarinesac.org.uk/activities/ports/ph2_2_4_1.htm

Table A3. European/Ramsar sites in the UK (and their interest features) located within the Plan area and 100km Plan buffer area.

Key:	
	No LSE - Screened out of assessment at HRA Plan-Level Screening Report
	LSE - Screened into assessment at HRA Plan-Level Screening Report
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T, C, A	LSE - Screened in during Appropriate Assessment because of activities associated with TIDE, CCS and/or AGG Sectors

Site Reference	Site Name	Designation	Interest Features for Which There is a Likely Significantly Effect (LSE)	Interest Features for Which There is No Likely Significantly Effect (LSE)	Sector having LSE: T= TIDE C = CCS A = AGG
Special Areas of Conservation					
UK0030076	Alde, Ore and Butley Estuaries	SAC	Estuaries, mudflats and sandflats not covered by seawater at low tide, Atlantic salt meadows		T,C,A
UK0030142	Arnecliff and Park Hole Woods	SAC		Old sessile oak woods with *Ilex* and *Blechnum* in the British Isles, Killarney fern *Trichomanes speciosum.*	
UK0014778	Asby Complex	SAC		Semi - natural dry grasslands and scrubland facies: on calcareous substrates (*Festuco-Brometalia*), *Molinia* meadows on calcareous, peaty or clayey silt-laden soils (*Molinion caeruleae*), Petrifying springs with tufa formation (*Cratoneurion*) , Alkaline fens, Limestone pavements , Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp., European dry heaths, Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*, Geyer`s whorl snail *Vertigo geyeri*, Slender green feather-moss *Drepanocladus* (*Hamatocaulis*) *vernicosus.*	
UK0030082	Aston Rowant	SAC		*Juniperus communis* formations on heaths or calcareous grasslands.	
UK0030031	Barnack Hills and Holes	SAC		Semi-natural dry grasslands and scrubland facies: on calcareous substrates (*Festuco-Brometalia*).	
UK0030085	Baston Fen	SAC		Spined loach *Cobitis taenia.*	
UK0030086	Beast Cliff – Whitby (Robin Hood's Bay)	SAC	Vegetated sea cliffs of the Atlantic and Baltic coasts.		X
UK0030087	Bee`s Nest and Green Clay Pits	SAC		Semi-natural dry grasslands and scrubland facies: on calcareous substrates (*Festuco-Brometalia*) and Great crested newt *Triturus cristatus* .	
UK0013104	Benacre to Easton Bavents Lagoons	SAC	Coastal lagoons.		T,C,A
UK0012740	Birklands and Bilhaugh	SAC		Old acidophilous oak woods with *Quercus robur* on sandy plains.	
UK0013697	Blean Complex	SAC		Sub-Atlantic and medio-European oak or oak-hornbeam forests of the *Carpinion betuli*.	
UK0019865	Breckland	SAC		Inland dunes with open *Corynephorus* and *Agrostis* grasslands, Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition* -type vegetation, European dry heaths, Semi-natural dry grasslands and scrubland facies: on calcareous substrates (*Festuco-Brometalia*), Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Alnion incanae*, *Salicion albae*), Great crested newt *Triturus cristatus* .	
UK0030034	Burnham Beeches	SAC		Atlantic acidophilous beech forests with Ilex and sometimes also Taxus in the shrublayer (Quercion robori-petraeae or Ilici-Fagenion)	
UK0030106	Calf Hill and Cragg Woods	SAC		Old sessile oak woods with *Ilex* and *Blechnum* in the British Isles and Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Alnion incanae*, *Salicion albae*).	
UK0030107	Cannock Chase	SAC		European dry heaths and Northern Atlantic wet heaths with *Erica tetralix.*	
UK0012672	Cannock Extension Canal	SAC		Floating water-plantain *Luronium natans.*	
UK0012768	Castle Eden Dene	SAC		*Taxus baccata* woods of the British Isles.	
UK0012724	Chilterns Beechwoods	SAC		*Asperulo-Fagetum* beech forests, Semi-natural dry grasslands and scrubland facies: on calcareous substrates (*Festuco-Brometalia*), Stag beetle *Lucanus cervus*.	
UK0014776	Craven Limestone Complex	SAC		Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp., Semi-natural dry grasslands and scrubland facies: on calcareous substrates (*Festuco-Brometalia*), *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*), Active raised bogs, Petrifying springs with tufa formation (*Cratoneurion*), Alkaline fens, Limestone pavements, Calaminarian grasslands of the *Violetalia calaminariae*, *Tilio-Acerion* forests of slopes, screes and ravines, White-clawed (or Atlantic stream) crayfish *Austropotamobius pallipes*, Bullhead *Cottus gobio*, Lady`s-slipper orchid *Cypripedium calceolus*.	
UK0030036	Denby Grange Colliery Ponds	SAC		Great crested newt *Triturus cristatus* .	
UK0030037	Devil`s Dyke	SAC		Semi-natural dry grasslands and scrubland facies: on calcareous substrates (*Festuco-Brometalia*).	
UK0030133	Dew's Ponds	SAC		Great crested newt *Triturus cristatus* .	
UK0030330	Dover to Kingsdown Cliffs	SAC	Vegetated sea cliffs of the Atlantic and Baltic coasts.	Semi-natural dry grasslands and scrubland facies: on calcareous substrates (*Festuco-Brometalia*).	X
UK0013059	Dungeness	SAC	Annual vegetation of drift lines, Perennial vegetation of stony banks.	Great crested newt *Triturus cristatus* .	X
UK0030140	Durham Coast	SAC	Vegetated sea cliffs of the Atlantic and Baltic coasts.		X
UK0030039	Eller's Wood and Sand Dale	SAC		Petrifying springs with tufa formation (*Cratoneurion*), Geyer's whorl snail *Vertigo geyeri*.	
UK0012646	Ensor's Pool	SAC		White Clawed crayfish.	
UK0012720	Epping Forest	SAC		Atlantic acidophilous beech forests with *Ilex* and sometimes also *Taxus* in the shrublayer (*Quercion robori-petraeae* or *Ilici-Fagenion*), Northern Atlantic wet heaths with *Erica tetralix*, European dry heaths, Stag beetle *Lucanus cervus*.	
UK0013690	Essex Estuaries	SAC	Estuaries, mudflats and sandflats not covered by seawater at low tide, Salicornia and other annuals colonising mud and sand, Spartina swards (Spartinion maritimae), Atlantic salt meadows, Mediterranean and thermo-Atlantic halophilous scrubs (Sarcocornetea fruticosi), Sandbanks which are slightly covered by sea water all the time.		X
UK0030331	Eversden and Wimpole Woods	SAC		Barbastelle *Barbastella barbastellus.*	
UK0030332	Fen Bog	SAC		Transition mires and quaking bogs.	
UK0014782	Fenland	SAC		*Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*), Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*, Spined loach *Cobitis taenia*, Great crested newt *Triturus cristatus* .	
UK0013036	Flamborough Head	SAC	Reefs, Vegetated sea cliffs of the Atlantic and Baltic coasts, Submerged or partially submerged sea caves.		T, C
UK0012835	Folkestone to Etchinghill Escarpment	SAC		Semi-natural dry grasslands and scrubland facies: on calcareous substrates (*Festuco-Brometalia*).	
UK0012817	Gang Mine	SAC		Calaminarian grasslands of the *Violetalia calaminariae*.	
UK0030043	Grimsthorpe	SAC		Semi-natural dry grasslands and scrubland facies: on calcareous substrates (*Festuco-Brometalia*), Early gentian *Gentianella anglica*.	
UK0030165	Hastings Cliffs	SAC	Vegetated sea cliffs of the Atlantic and Baltic coasts.		X
UK0030166	Hatfield Moor	SAC		Degraded raised bogs still capable of natural regeneration.	

Table A3. European/Ramsar sites in the UK (and their interest features) located within the Plan area and 100km Plan buffer area.

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Site Reference	Site Name	Designation	Interest Features for Which There is a Likely Significantly Effect (LSE)	Interest Features for Which There is No Likely Significantly Effect (LSE)	Sector having LSE: T= TIDE C = CCS A = AGG
UK0030170	Humber Estuary	SAC	Estuaries, mudflats and sandflats not covered by seawater at low tide, sandbanks which are slightly covered by seawater all the time, coastal lagoons, Salicornia and other annuals colonising mud and sand, Atlantic salt meadows, Embryonic shifting dunes, Shifting dunes along the shoreline with Ammophila arenaria (`white dunes'), fixed dunes with herbaceous vegetation (`grey dunes'), dunes with Hippophae rhamnoides, Sea lamprey Petromyzon marinus, River lamprey Lampetra fluviatilis, Grey seal Halichoerus grypus.		T, C, A
UK0012782	Ingleborough Complex	SAC		*Juniperus communis* formations on heaths or calcareous grasslands, Alkaline fens, Calcareous rocky slopes with chasmophytic vegetation, Limestone pavements, Semi-natural dry grasslands and scrubland facies: on calcareous substrates (*Festuco-Brometalia*), *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*), Blanket bogs, Petrifying springs with tufa formation (*Cratoneurion*), *Tilio-Acerion* forests of slopes, screes and ravines.	
UK0030178	Kirk Deighton	SAC		Great crested newt *Triturus cristatus*.	
UK0012844	Lower Derwent Valley	SAC		Lowland hay meadows (*Alopecurus pratensis*, *Sanguisorba officinalis*), Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Alnion incanae*, *Salicion albae*), Otter *Lutra lutra*.	
UK0012834	Lydden and Temple Ewell Downs	SAC		Semi-natural dry grasslands and scrubland facies: on calcareous substrates (*Festuco-Brometalia*).	
UK0030200	Manchester Mosses	SAC		Degraded raised bogs still capable of natural regeneration.	
UK0012809	Minsmere to Walberswick Heaths and Marshes	SAC	Annual vegetation of drift lines.	European dry heaths, Perennial vegetation of stony banks.	T, C
UK0030222	Nene Washes	SAC		Spined loach *Cobitis taenia*.	
UK0012892	Norfolk Valley Fens	SAC		Alkaline fens, Northern Atlantic wet heaths with *Erica tetralix*, European dry heaths, Semi-natural dry grasslands and scrubland facies: on calcareous substrates (*Festuco-Brometalia*), *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*), Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*, Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Alnion incanae*, *Salicion albae*), Narrow-mouthed whorl snail *Vertigo angustior*, Desmoulin's whorl snail *Vertigo moulinsiana*.	
UK0030225	North Downs Woodlands	SAC		*Asperulo-Fagetum* beech forests, *Taxus baccata* woods of the British Isles, Semi-natural dry grasslands and scrubland facies: on calcareous substrates (*Festuco-Brometalia*).	
UK0019838	North Norfolk Coast	SAC	Coastal lagoons, Perennial vegetation of stony banks, Mediterranean and thermo-Atlantic halophilous scrubs (Sarcocornetea fruticosi), Embryonic shifting dunes, Shifting dunes along the shoreline with Ammophila arenaria (`white dunes`), Fixed dunes with herbaceous vegetation (`grey dunes`), Humid dune slacks, Otter Lutra lutra	Petalwort *Petalophyllum ralfsii*.	T, C
UK0014775	North Pennine Dales Meadows	SAC		Mountain hay meadows, *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*).	
UK0030033	North Pennine Moors	SAC		European dry heaths, *Juniperus communis* formations on heaths or calcareous grasslands, Blanket bogs, Petrifying springs with tufa formation (*Cratoneurion*), Siliceous rocky slopes with chasmophytic vegetation, Old sessile oak woods with *Ilex* and *Blechnum* in the British Isles, Northern Atlantic wet heaths with *Erica tetralix*, Calaminarian grasslands of the *Violetalia calaminariae*, Siliceous alpine and boreal grasslands, Semi-natural dry grasslands and scrubland facies: on calcareous substrates (*Festuco-Brometalia*), Alkaline fens, Siliceous scree of the montane to snow levels (*Androsacetalia alpinae* and *Galeopsietalia ladani*), Calcareous rocky slopes with chasmophytic vegetation, Marsh saxifrage *Saxifraga hirculus*.	
UK0030228	North York Moors	SAC		Northern Atlantic wet heaths with Erica tetralix, European dry heaths, Blanket bogs.	
UK0014780	Orfordness – Shingle Street	SAC	Coastal lagoons, Annual vegetation of drift lines, Perennial vegetation of stony banks.		T, C, A
UK0030053	Orton Pit	SAC		Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp., Great crested newt *Triturus cristatus*.	
UK0013011	Ouse Washes	SAC		Spined loach *Cobitis taenia*.	
UK0030232	Overstrand Cliffs	SAC	Vegetated sea cliffs of the Atlantic and Baltic coasts.		T, C
UK0030234	Ox Close	SAC		Calaminarian grasslands of the *Violetalia calaminariae*, Semi-natural dry grasslands and scrubland facies: on calcareous substrates (*Festuco-Brometalia*) and *Tilio-Acerion* forests of slopes, screes and ravines.	
UK0030338	Parkgate Down	SAC		Semi-natural dry grasslands and scrubland facies: on calcareous substrates (*Festuco-Brometalia*).	
UK0030235	Paston Great Barn	SAC	Barbastelle Barbastella barbastellus.		×
UK0019859	Peak District Dales	SAC		Semi-natural dry grasslands and scrubland facies: on calcareous substrates (*Festuco-Brometalia*), *Tilio-Acerion* forests of slopes, screes and ravines, European dry heaths, Calaminarian grasslands of the *Violetalia calaminariae*, Alkaline fens, Calcareous and calcshist screes of the montane to alpine levels (*Thlaspietea rotundifolii*), Calcareous rocky slopes with chasmophytic vegetation, White-clawed (or Atlantic stream) crayfish *Austropotamobius pallipes* and Bullhead *Cottus gobio*. Brook lamprey *Lampetra planeri*.	
UK0012789	Pasturefields Saltmarsh	SAC		Inland salt meadows.	
UK0030237	Peter's Pit	SAC		Great crested newt *Triturus cristatus*.	
UK0030054	Portholme	SAC		Lowland hay meadows (*Alopecurus pratensis*, *Sanguisorba officinalis*).	
UK0012833	Queendown Warren	SAC		Semi-natural dry grasslands and scrubland facies: on calcareous substrates (*Festuco-Brometalia*).	
UK0019866	Rex Graham Reserve	SAC		Semi-natural dry grasslands and scrubland facies: on calcareous substrates (*Festuco-Brometalia*).	
UK0030246	Richmond Park	SAC		Stag beetle *Lucanus cervus*	
UK0030253	River Derwent	SAC	River lamprey Lampetra fluviatilis, Sea lamprey Petromyzon marinus.	Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation and Bullhead *Cottus gobio* and Otter *Lutra lutra*.	T, C, A
UK0012643	River Eden	SAC		River lamprey *Lampetra fluviatilis*, Sea lamprey *Petromyzon marinus*, Atlantic salmon *Salmo salar* and Otter *Lutra lutra*, Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or of the *Isoëto-Nanojuncetea*, Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation, Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Alnion incanae*, *Salicion albae*), White-clawed (or Atlantic stream) crayfish *Austropotamobius pallipes*. Bullhead *Cottus gobio* and Brook lamprey *Lampetra planeri*.	
UK0030258	River Mease	SAC		Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation, Spined loach *Cobitis taenia*, Bullhead *Cottus gobio*, White-clawed (or Atlantic stream) crayfish *Austropotamobius pallipes*, Otter *Lutra lutra*.	

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Site Reference	Site Name	Designation	Interest Features for Which There is a Likely Significantly Effect (LSE)	Interest Features for Which There is No Likely Significantly Effect (LSE)	Sector having LSE: T= TIDE C = CCS A = AGG
UK0012647	River Wensum	SAC		Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation, White-clawed (or Atlantic stream) crayfish *Austropotamobius pallipes*, Desmoulin's whorl snail *Vertigo moulinsiana*, Bullhead *Cottus gobio*, Brook lamprey *Lampetra planeri*.	
UK0030264	Rixton Clay Pits	SAC		Great crested newt *Triturus cristatus*.	
UK0030266	Rochdale Canal	SAC		Floating water-plantain *Luronium natans*.	
UK0012801	Roydon Common and Dersingham Bog	SAC		Northern Atlantic wet heaths with *Erica tetralix*, Depressions on peat substrates of the *Rhynchosporion*, European dry heaths.	
UK0030270	Saltfleetby–Theddlethorpe Dunes and Gibraltar Point	SAC	Shifting dunes along the shoreline with Ammophila arenaria (`white dunes`), Fixed dunes with herbaceous vegetation (`grey dunes`), Dunes with Hippophae rhamnoides, Humid dune slacks, Embryonic shifting dunes.		T, C, A
UK0013077	Sandwich Bay	SAC	Embryonic shifting dunes, Shifting dunes along the shoreline with Ammophila arenaria (`white dunes`), Fixed dunes with herbaceous vegetation (`grey dunes`), Dunes with Salix repens ssp. argentea (Salicion arenariae), Humid dune slacks.		X
UK0030276	Skipwith Common	SAC		Northern Atlantic wet heaths with *Erica tetralix*, European dry heaths.	
UK0030280	South Pennine Moors	SAC		European dry heaths, Blanket bogs, Old sessile oak woods with *Ilex* and *Blechnum* in the British Isles, Northern Atlantic wet heaths with *Erica tetralix*, Transition mires and quaking bogs.	
UK0012741	Staverton Park and The Thicks, Wantisden	SAC		Old acidophilous oak woods with *Quercus robur* on sandy plains.	
UK0030283	Stodmarsh	SAC		Desmoulin's whorl snail *Vertigo moulinsiana*.	
UK0030284	Strensall Common	SAC		Northern Atlantic wet heaths with *Erica tetralix*, European dry heaths.	
UK0013107	Thanet Coast	SAC	Reefs, Submerged or partially submerged sea caves.		
UK0013577	The Broads	SAC		Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp., Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition* -type vegetation, Transition mires and quaking bogs, Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*, Alkaline fens, Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Alnion incanae*, *Salicion albae*), *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*), Desmoulin's whorl snail *Vertigo moulinsiana*, Fen orchid *Liparis loeselii*, Ramshorn snail *Anisus vorticulus*, Otter *Lutra lutra*.	
UK0017075	The Wash and North Norfolk Coast	SAC	Sandbanks which are slightly covered by sea water all the time, Mudflats and sandflats not covered by seawater at low tide, Large shallow inlets and bays, Reefs, Salicornia and other annuals colonising mud and sand, Atlantic salt meadows (Glauco-Puccinellietalia maritimae), Mediterranean and thermo-Atlantic halophilous scrubs (Sarcocornetea fruticosi), Coastal lagoons, Common seal Phoca vitulina, Otter Lutra lutra.		T, C, A
UK0012915	Thorne Moor	SAC		Degraded raised bogs still capable of natural regeneration.	
UK0012838	Thrislington	SAC		Semi-natural dry grasslands and scrubland facies: on calcareous substrates (*Festuco-Brometalia*).	
UK0012882	Waveney and Little Ouse Valley Fens	SAC		*Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*), Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*, Desmoulin's whorl snail *Vertigo moulinsiana*.	
UK0013595	West midland Mosses	SAC		Natural dystrophic lakes and ponds and transition mires and quaking bogs.	
UK0013043	Winterton – Horsey Dunes	SAC	Atlantic decalcified fixed dunes (Calluno-Ulicetea), Humid dune slacks, Embryonic shifting dunes, Shifting dunes along the shoreline with Ammophila arenaria (`white dunes`).		T, C, A
UK0013696	Wormley Hoddesdonpark Woods	SAC		Sub-Atlantic and medio-European oak or oak-hornbeam forests of the *Carpinion betuli*.	
UK0012831	Wye and Crundale Downs	SAC		Semi-natural dry grasslands and scrubland facies: on calcareous substrates (*Festuco-Brometalia*).	
UK0030352	Dogger Bank	cSAC	Sandbanks which are slightly covered by sea water all the time.		C, A
UK0030358	North Norfolk Sandbanks and Saturn Reef	cSAC	Sandbanks which are slightly covered by sea water all the time, Reefs.		T, C, A
UK0030369	Haisborough, Hammond and Winterton	SCI	Sandbanks which are slightly covered by sea water all the time, Reefs.		T, C, A
UK0030370	Inner Dowsing, Race Bank and North Ridge	SCI	Sandbanks which are slightly covered by sea water all the time, Reefs.		A
UK0030371	Margate and Long Sands	SCI	Sandbanks which are slightly covered by sea water all the time.		A
Special Protected Areas					
UK9009141	Abberton Reservoir	SPA	Wintering populations of Northen Shoveler, Eurasian Teal, Eurasian Wigeon, Gadwall, Pochard, Tufted Duck, Common Goldeneye, Mute Swan, Coot and Great Crested Grebe, supports 39763 waterfowl. Breeding population of Great Cormorant.		X
UK9009112	Alde-Ore Estuary	SPA	Breeding populations of Pied Avocet, Little Tern, Sandwich Tern and Lesser Black-backed Gull. Wintering populations of Ruff, Pied Avocet and Redshank.	Breeding Marsh Harrier.	T, C, A
UK9009291	Benacre to Easton Bavents	SPA	Breeding populations of Bittern and Little Tern.	Breeding Marsh Harrier.	T,C,A
UK9009171	Benfleet and Southend Marshes	SPA	Wintering populations of Dark-bellied Brent Goose, Dunlin, Knot, Ringed Plover and Grey Plover, supports 34789 waterfowl.		X
UK9009245	Blackwater Estuary (Mid-Essex Coast	SPA	Breeding populations of Common Pochard, Ringed Plover and Little Tern. Wintering populations of Dark-bellied Brent Goose, Ringed Plover, Dunlin, Black-tailed Godwit and Grey Plover, supports 109964 waterfowl. Wintering populations of Hen Harrier		X
UK9005151	Bowland Fells	SPA	Breeding populations of Lesser black-backed gull	Breeding populations of Hen Harrier and Marlin.	X
UK9009201	Breckland	SPA		Breeding populations of Stone Curlew, European Nightjar and Woodlark.	
UK9009181	Breydon Water	SPA	Wintering populations of Bewick's Swan, Golden Plover, Pied Avocet and Northen Lapwing, supports 43225 waterfowl. Breeding population of Common Tern. Populations of Ruff on passage.		T, C ,A
UK9009253	Broadland	SPA	Wintering populations of Bewick's Swan, Whooper Swan, Hen harrier and Gadwall. Breeding populations of Eurasian Bittern.	Breeding populations of Marsh Harrier.	T, C ,A

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UK9009243	Colne Estuary (Mid-Essex Coast Phase	SPA	Breeding population of Common Pochard, Ringed Plover and Little Tern. Wintering population of Dark-bellied Brent Goose, hen harrier and Redshank, supports 38600 waterfowl.		X
UK9009244	Crouch & Roach Estuaries (Mid-Essex Coast Phase 3)	SPA	Wintering populations of Dark-bellied Brent Goose and Hen Harrier, supports 18607 waterfowl.		X
UK9009261	Deben Estuary	SPA	Wintering populations of Dark-bellied Brent Goose and Pied Avocet.		T, C, A
UK9009242	Dengie (Mid-Essex Coast Phase 1)	SPA	Wintering populations of Dark-bellied Brent Goose, Grey Plover, Hen Harrier and Knot, supports 31454 waterfowl.		X
UK9012091	Dungeness to Pett Level	SPA	Wintering population of Northern Shoveler and Bewick's Swan. Breeding population of Mediterranean Gull, Little Tern and Common Tern.		X
UK9006101	Flamborough Head & Bempton Cliffs	SPA	Breeding population of Black Legged Kittiwake.		T, C
UK9009246	Foulness (Mid-Essex Coast Phase 5)	SPA	Wintering populations of Bar-tailed Godwit, Pied Avocet, Dark-bellied Brent Goose, Knot, Eurasian Oystercatcher, Grey Plover, Hen Harrier and Redshank, supports 107999 waterfowl. Breeding populations of Ringed Plover, Pied Avocet, Little Tern, Common Tern and Sandwich Tern.		X
UK9008022	Gibraltar Point	SPA	Wintering population of Sanderling, Bar-tailed Godwit and Grey Plover. Breeding population of Little Tern.		T,C
UK9009271	Great Yarmouth North Denes	SPA	Breeding population of Little Tern.		T, C, A
UK9009131	Hamford Water	SPA	Wintering populations of Eurasian Teal, Dark-bellied Brent Goose, Ringed Plover, Black-tailed Godwit, Grey Plover, Pied Avocet, Redshank and Common Shelduck. Breeding population of Little Tern.		X
UK9006171	Hornsea Mere	SPA	Wintering population of Gadwall. Breeding population of Mute Swan.		T, C
UK9006111	Humber Estuary	SPA	Wintering populations of Eurasian Bittern, Hen Harrier, Bar-tailed Godwit, Golden Plover, Pied Avocet, Dunlin, Black-tailed Godwit, Shelduck, and Redshank. Breeding populations of Eurasian Bittern, Pied Avocet and Little Tern. Migrating populations of Ruff, Dunlin, Knot, Black-tailed Godwit, and Redshank. Non-breeding assemblage of 153934 waterfowl.	Breeding populations of Marsh Harrier.	T, C, A
UK9012111	Lee Valley	SPA	Wintering populations of Eurasian Bittern, Northern Shoveler and Gadwell.		X
UK9006092	Lower Derwent Valley	SPA	Wintering populations of Bewick's Swan, Ruff, Eurasian Teal, Eurasian Wigeon and Golden Plover, supports 40616 waterfowl. Breeding population of Northern Shoveler.		X
UK9012031	Medway Estuary & Marshes	SPA	Breeding populations of Pied Avocet, Little Tern and Common Tern, and an internationally important assemblage of breeding waterfowl.Wintering populations of Bewick's Swan, Pied Avocet, Northern Pintail, Northern Shoveler, Eurasian Teal, Eurasian Wigeon, Ruddy Turnstone, Dark-bellied Brent Goose, Dunlin, Knot, Ringed Plover, Eurasian Oystercatcher, Black-tailed Godwit, Curlew, Grey Plover, Common Shelduck, Redshank and Common Greenshank, supprts 65496 waterfowl.		X
UK9009101	Minsmere-Walberswick	SPA	Breeding populations of Eurasian Bittern, Pied Avocet, Little Tern, Northern Shoveler, Eurasian Teal, and Gadwall.Wintering populations of Northern Shoveler, Gadwall, Hen Harrier and Greater White-fronted Goose.	Breeding populations of European Nightjar and Marsh Harrier.	T, C
UK9008031	Nene Washes	SPA	Wintering populations of Bewick's Swan, Northern Pintail, Northern Shoveler, Eurasian Teal, Eurasian Wigeon and Gadwall.Breeding populations of Northern Shoveler, Garganey, Gadwall, and Black-tailed Godwit.		X
UK9009031	North Norfolk Coast	SPA	Breeding populations of Eurasian Bittern, Pied Avocet, Little Tern, Common tern and Sandwich Tern. Wintering populations of Pied Avocet, Eurasian Wigeon, Pink-footed Goose, Dark-bellied Brent Goose, Knot, supports 91536 waterfowl.	Breeding populations of Marsh Harrier.	T, C
UK9006272	North Pennine Moors	SPA	Breeding population of European Golden Plover	Breeding populations of Northern Harrier, Merlin and Peregrine Falcon.	X
UK9006161	North York Moors	SPA	Breeding population of European Golden Plover	Breeding populations of Merlin.	X
UK9006131	Northumbria Coast	SPA	Wintering populations of Ruddy Turnstone and Purple Sandpiper. Breeding populations of Little Tern.		X
UK9008041	Ouse Washes	SPA	Wintering populations of Bewick's Swan, Whooper Swan, Ruff, Northern Pintail, Northern Shoveler, Eurasian Teal, Eurasian Wigeon, Gadwall, Common Pochard, Tufted Duck, Mute Swan, Hen Harrier, Coot, Great Cormorant, supports 64428 waterfowl. Breeding populations of Northern Shoveler, Mallard, Garganey, Gadwall and Black-tailed Godwit, and an internationally important assemblage of breeding waterfowl.		X
UK9020309	Outer Thames Estuary	SPA	Wintering population of Red-throated Diver.		T,C ,A
UK9007021	Peak District Moors (South Pennine Moors Phase 1)	SPA	Breeding population of European Golden Plover	Breeding populations of Short-eared Owl and Merlin.	X
UK9008051	Rutland Water	SPA	Wintering populations of Northern Shoveller, Eurasian Teal, Eurasian Wigeon, Gadwell, Tufted Duck, Common Goldeneye, Mute Swan, Eurasian Coot, Goosander and Great Crested Grebe, supports 25037 waterfowl.		X
UK9020286	Sandlings	SPA		Breeding populations of European Nightjar and Woodlark.	
UK9007022	South Pennine Moors Phase 2	SPA	Supports an internationally important overwintering assemblage of waterfowl. Breeding population of European Golden Plover	Breeding populations of Short-eared Owl and Merlin.	X
UK9012121	Stodmarsh	SPA	Wintering populations of Eurasian Bittern, Northern Shoveler, Hen Harrier and Gadwall.Breeding populations of Gadwall, and an internationally important assemblage of breeding waterfowl.		X
UK9009121	Stour and Orwell Estuaries	SPA	Breeding population of Pied Avocet. Wintering populations of Northern Pintail, Dark-bellied Brent Goose, Dunlin, Knot, Black-tailed Godwit, Grey Plover, Redshank, supports 63017 waterfowl.Population of Redshank on passage.		X
UK9006061	Teesmouth & Cleveland Coast	SPA	Breeding population of Little Tern.Populations of Sandwich Tern and Redshank on passage. Wintering population of Knot, supports 21312 waterfowl.		X
UK9012021	Thames Estuary & Marshes	SPA	Wintering populations of Pied Avocet, Dunlin, Knot, Black-tailed Godwit, Grey Plover, Redshank and Hen Harrier, supports 75019 waterfowl. Population of Ringed Plover on passage.		X
UK9012071	Thanet Coast & Sandwich Bay	SPA	Breeding population of Little Tern. Wintering populations of Ruddy Turnstone. Wintering populations of Golden Plover		X
UK9012011	The Swale	SPA	Wintering populations of Dark-bellied Brent Goose, Dunlin, Redshank, supports 65588 waterfowl. Internationally important assemblage of breeding waterfowl.		X

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UK9008021	The Wash	SPA	Breeding populations of Little Tern and Common Tern. Wintering populations of Bewick's Swan, Bar-tailed Godwit, Northern Pintail, Eurasian Wigeon, Gadwall, Pink-footed Goose, Ruddy Turnstone, Dark-bellied Brent Goose, Common Goldeneye, Sanderling, Dunlin, Knot, Oystercatcher, Black-tailed Godwit, Common Scoter, Eurasian Curlew, Grey Plover, Common Shelduck, Redshank, supports 400367 waterfowl.		T
UK9005171	Thorne & Hatfield Moors	SPA		Breeding population of European Nightjar.	
UK9020296	Upper Nene Valley Gravel Pits	SPA	Breeding populations of Eurasian Bittern, Gadwell and Golden Plover, supports 23821 waterfowl.		X
Ramsar					
UK11001	Abberton Reservoir	Ramsar	Ramsar Criterion 6 - Spring/autumn populations of Gadwall and Northern Shoveler and wintering population of Eurasian Wigeon. Species/populations identified subsequent to designation for possible future consideration under Criterion 6 include; overwintering populations of Mute Swan and Common Pochard. Ramsar Criterion 5 - site supports a winter population of 23787 waterfowl.		X
UK11002	Alde-Ore Estuary	Ramsar	Ramsar Criterion 3 - Site supports a notable assemblage of breeding and wintering wetland birds. Ramsar Criterion 6 - Site supports a breeding population of Lesser Black-backed Gull and wintering populations of Pied Avocet and Common Redshank.	Ramsar Criterion 2 - Site supports nationally scare plants and invertebrates.	T, C A
UK11006	Benfleet and Southend Marshes	Ramsar	Ramsar Criterion 5 - Site supports a winter population of 32867 waterfowl. Ramsar Criterion 6 - Site supports a spring/autumn population of Dark-bellied Brent Goose and overwintering populations of Grey Plover and Knot. Species/populations identified subsequent to designation for possible future consideration under Criterion 6 include; overwintering population of Dunlin.		X
UK11007	Blackwater Estuary (Mid-Essex Coast Phase 4)	Ramsar	Ramsar Criterion 1 - Qualifies by virtue of the extent and diversity of saltmarsh habitat present. Ramsar Criterion 3 - This site supports a full and representative sequence of saltmarsh plant communities covering the range of variation in Britain. Ramsar Criterion 5 - Site supports a winter population of 105061 waterfowl. Ramsar criterion 6 – Site supports overwintering populations of Dark-bellied Brent Goose, Grey Plover, Dunlin and Black-tailed Godwit. Species/populations identified subsequent to designation for possible future consideration under Criterion 6 include; overwintering populations of Common Shelduck, European Golden Plover, and Common Redshank.	Ramsar Criterion 2 - The invertebrate fauna is well represented and includes at least 16 British Red Data Book species.	X
UK11008	Breydon Water	Ramsar	Ramsar Criterion 5 - Site supports a winter population of 68175 waterfowl. Ramsar Criterion 6 – Site supports overwintering populations of Tundra Swan and Northern Lapwing. Species/populations identified subsequent to designation for possible future consideration under Criterion 6 include; overwintering populations of Pink-footed Goose, Eurasian Wigeon, Northern Shoveler and Black-tailed Godwit. Winerting populations of Golden Plover		T, C, A
UK11010	Broadland	Ramsar	Ramsar Criterion 2 - The site supports a number of rare species and habitats within the biogeographical zone context, including the following Habitats Directive Annex I features: Otter Lutra lutra. Ramsar Criterion 6 – Site supports overwintering populations of Tundra Swan, Eurasian Wigeon, Gadwall and Northern Shoveler. Species/populations identified subsequent to designation for possible future consideration under Criterion 6 include; overwintering populations of Pink-footed Goose and Greylag Goose.	Ramsar Criterion 2 - The site supports a number of rare species and habitats within the biogeographical zone context, including the following Habitats Directive Annex I features: Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*, Alkaline fens, Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Alnion incanae*, *Salicion albae*), Desmoulin's whorl snail *Vertigo moulinsiana* and Fen Orchid *Liparis loeselii*. The site supports an outstanding assemblage of rare plants and invertebrates including nine British Red Data Book plants and 136 British Red Data Book invertebrates.	T, C
UK11014	Chippenham Fen	Ramsar		Ramsar criterion 1 - Site supports a spring-fed calcareous basin mire, with diverse flora. Ramsar Criterion 2 – Site supports a rich invertebrate fauna, including many rare and scarce invertebrates characteristic of ancient fenland sites in Britain. Ramsar Criterion 3 - Site supports diverse vegetation types, rare and scarce plants. The site is the stronghold of Cambridge milk parsley *Selinum carvifolia*.	
UK11015	Colne Estuary (Mid-Essex Coast Phase 2)	Ramsar	Ramsar Criterion 1 - The site is important due to the extent and diversity of saltmarsh present. Ramsar Criterion 3 - This site supports a full and representative sequence of saltmarsh plant communities covering the range of variation in Britain. Ramsar Criterion 5 - Site supports a winter population of 32041 waterfowl. Ramsar Criterion 6 - Site supports overwintering populations of Dark-bellied Brent Goose and Common Redshank. Species/populations identified subsequent to designation for possible future consideration under Criterion 6 include; overwintering population of Black-tailed Godwit.	Ramsar Criterion 2 - Site supports 12 species of natioanlly scare plants and at least 38 British Red Data Book invertebrates species.	X
UK11058	Crouch & Roach Estuaries (Mid-Essex Coast Phase 3)	Ramsar	Ramsar Criterion 5 - Site supports a winter population of 16970 waterfowl.Ramsar Criterion 6 - Site supports an overwintering population of Dark-bellied Brent Goose.	Ramsar Criterion 2 - Site supports an appreciable assemblage of rare, vulnerable or endangered species or subspecies of plants and animals includ 13 natioanlly scare plant species and several important invertebrate species.	X
UK11017	Deben Estuary	Ramsar	Ramsar Criterion 6 - Site supports an overwintering population of Dark-bellied Brent Goose.	Ramsar Criterion 2 - Site supports a population of the mollusc *Vertigo angustior*.	T, C, A
UK11018	Dengie (Mid-Essex Coast Phase 1)	Ramsar	Ramsar Criterion 1 - Qualifies by virtue of the extent and diversity of saltmarsh habitat present. Ramsar Criterion 2 - Site supports a number of rare plant and animal species including 11 species of nationally scarce plants (including the eelgrass Zostera angustifolia, Z. marina and Z. noltei). Ramsar Criterion 3 - This site supports a full and representative sequence of saltmarsh plant communities covering the range of variation in Britain. Ramsar Criterion 5 – Site supports a winter population of 43828 waterfowl. Ramsar Criterion 6 - Site supports overwintering populations of Dark-bellied Brent Goose, Grey Plover and Knot. Species/populations identified subsequent to designation for possible future consideration under Criterion 6 include; overwintering populations of Bar-tailed Godwit.	Ramsar Criterion 2 - Site supports a number of rare plant and animal species including 11 species of nationally scarce plants and Red Data Book invertebrate species.	X
UK11019	Dersingham Bog	Ramsar		Ramsar Criterion 2 – Site supports an important assemblage of invertebrates, including nine British Red Data Book species.	
UK11026	Foulness (Mid-Essex Coast Phase 5)	Ramsar	Ramsar Criterion 1 - This site qualifies by virtue of the extent and diversity of saltmarsh habitat present. Ramsar Criterion 3 - The site contains extensive saltmarsh habitat, with areas supporting full and representative sequences of saltmarsh plant communities covering the range of variation in Britain. Ramsar Criterion 5 - Site supports a winter population of 82148 waterfowl. Ramsar criterion 6 - Site supports a spring/autumn population of Common Redshank and winter populations of Dark-bellied Brent Goose, Eurasian Oystercatcher, Grey Plover, Knot and Bar-tailed Godwit.	Ramsar Criterion 2 - The site supports a number of nationally-rare and nationally-scarce plant species, and British Red Data Book invertebrates.	X
UK11027	Gibraltar Point	Ramsar	Ramsar Criterion 1 - The dune and saltmarsh habitats present on the site are representative of all the stages of colonisation and stabilisation. Also most northerly example of nationally rare saltmarsh/dune communities containing sea heath Frankenia laevis, rock sea lavender Limonium binervosum and shrubby seablite Suaeda vera. Ramsar Criterion 2 – Site supports a diverse assemblage of wetland invertebrate species of which eight species are listed as rare in the British Red Data Book and a further four species listed as vulnerable. Ramsar Criterion 5 - Site supports a winter population of 53072 waterfowl. Ramsar Criterion 6 - Site supports spring/autumn populations of Grey Plover, Sanderling and Bar-tailed Godwit and an overwintering population of Dark-bellied Brent Goose. Species/populations identified subsequent to designation for possible future consideration under Criterion 6 include; a spring/autumn population of Knot.	Ramsar Criterion 1 - There is a fine example of freshwater marsh containing sedges *Carex* spp., rushes *Juncus* spp., and ferns, including adder's-tongue fern *Ophioglossum vulgatum.*	T, C
UK11028	Hamford Water	Ramsar	Ramsar Criterion 6 - Site supports spring/autumn populations of Red Plover and Common Redshank and overwintering populations of Dark-bellied Brent Goose and Black-tailed Godwit. Species/populations identified subsequent to designation for possible future consideration under Criterion 6 include; an overwintering population of Grey Plover.		X

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UK11031	Humber Estuary	Ramsar	Ramsar Criterion 1 - The site is a representative example of a near-natural estuary with the following component habitats: dune systems and humid dune slacks, estuarine waters, intertidal mud and sand flats, saltmarshes, and coastal brackish/saline lagoons. Ramsar Criterion 3 - The Humber Estuary Ramsar site supports a breeding colony of grey seals Halichoerus grypus at Donna Nook. Ramsar Criterion 5 – Site supports a winter population of 153,934 waterfowl. Ramsar Criterion 6 - Site supports passage populations of Knot, Dunlin, Black-tailed Godwit and Common Redshank, wintering populations of Common Shelduck, Knot, Dunlin, Black-tailed Godwit, Bar-tailed Godwit and Common Redshank. Ramsar Criterion 8 - The Humber Estuary acts as an important migration route for both river lamprey Lampetra fluviatilis and sea lamprey Petromyzon marinus between coastal waters and their spawning areas. Ramsar Criertion 6 - Site supports a wintering and passage population of Golden Plover.	Ramsar Criterion 1 - The dune slacks at Saltfleetby-Theddlethorpe are the most north-easterly breeding site in Great Britain of the natterjack toad *Bufo calamita*.	T, C ,A
UK11034	Lee Valley	Ramsar	Ramsar Criterion 6 - Site supports spring/autumn populations of Northern shoveler and Gadwell.	Ramsar Criterion 2 - Site supports the nationally scarce plant species whorled water-milfoil *Myriophyllum verticillatum* and the rare or vulnerable invertebrate *Micronecta minutissima* (a water-boatman).	X
UK11037	Lower Derwent Valley	Ramsar	Ramsar Criterion 4 - The site qualifies as a staging post for passage birds in spring. Of particular note are the nationally important numbers of Ruff a Whimbrel. Ramsar Criterion 5 - Site supports a winter population of 31942 waterfowl. Ramsar Criterion 6 - Site supports wintering populations of Eurasian Wigeon and Eurasian Teal.	Ramsar Criterion 1 - The site represents one of the most important examples of traditionally managed species-rich alluvial flood meadow habitat remaining in the UK. The river and flood meadows play a substantial role in the hydrological and ecological functioning of the Humber Basin. Ramsar Criterion 2 - The site has a rich assemblage of wetland invertebrates including 16 species of dragonfly and damselfly, 15 British Red Data Book wetland invertebrates as well as a leafhopper *Cicadula ornata* for which Lower Derwent Valley is the only known site in Great Britain.	X
UK11040	Medway Estuary & Marshes	Ramsar	Ramsar Criterion 5 - Site supports a winter population of 47637 waterfowl. Ramsar Criterion 6 - Site supports spring/autumn populations of Grey Plover and Common Redshank and wintering populations of Dark-bellied Brent Goose, Common Shelduck, Northern Pintail, Ringed Plover, Knot and Dunlin. Species/populations identified subsequent to designation for possible future consideration under Criterion 6 include; a spring/autumn popula of Black-tailed Godwit.	Ramsar Criterion 2 - The site supports a number of species of rare plants and animals, including at least twelve British Red Data Book species of wetland invertebrates. A significant number of non-wetland British Red Data Book species also occur.	X
UK11044	Minsmere-Walberswick	Ramsar	Ramsar Criterion 1 - The site contains a mosaic of marine, freshwater, marshland and associated habitats, complete with transition areas in between Contains the largest continuous stand of reedbeds in England and Wales and rare transition in grazing marsh ditch plants from brackish to fresh water. Ramsar Criterion 2 - This site supports nine nationally scarce plants and at least 26 red data book invertebrates. An important assemblage of rare breeding birds associated with marshland and reedbeds including: Eurasian Bittern, Gadwell, Eurasian Teal, Northern Shoveller, Avocet and Bearded Tit. An important assemblage of Marsh Harrier	Ramsar Criterion 2 - Supports a population of the mollusc *Vertigo angustior*.	T, C
UK11046	Nene Washes	Ramsar	Ramsar Criterion 2 - The site supports an important assemblage of nationally rare breeding birds. In addition, a wide range of raptors occur through the year. The site also supports several nationally scarce plants, and two vulnerable and two rare British Red Data Book invertebrate species have been recorded.Ramsar Criterion 6 - Site supports an overwintering population of Bewick's Swan. Species/populations identified subsequent to designation for possible future consideration under Criterion 6 include; a spring/autumn population of Black-tailed Godwit and a winter population of Northern Pintail.		X
UK11048	North Norfolk Coast	Ramsar	Ramsar Criterion 1 - The site is one of the largest expanses of undeveloped coastal habitat of its type in Europe. It is a particularly good example of a marshland coast with intertidal sand and mud, saltmarshes, shingle banks and sand dunes. There are a series of brackish-water lagoons and extensive areas of freshwater grazing marsh and reed beds. Ramsar Criterion 5 – Site supports a winter population of 98462 waterfowl. Ramsar Criterion 6 - Site supports breeding populations of Sandwich Tern, Common Tern and Little Tern, spring/autumn populations of Knot, overwintering populations of Pink-footed Goose, Dark-bellied Brent Goose, Eurasian Wigeon and Northern Pintail. Species/populations identified subsequent to designation for possible future consideration under Criterion 6 include; spring/autumn populations of Ringed Plover, Sanderling, and Bar-tailed Godwit.	Ramsar Criterion 2 - Supports at least three British Red Data Book and nine nationally scarce vascular plants, one British Red Data Book lichen and 38 British Red Data Book invertebrates.	T, C
UK11049	Northumbria Coast	Ramsar	Ramsar Criterion 6 - Site supports breeding populatins of Litter Tern, Purple Sandpiper and Ruddy Turnstone.		X
UK11051	Ouse Washes	Ramsar	Ramsar Criterion 1 - The site is one of the most extensive areas of seasonally-flooding washland of its type in Britain. Ramsar Criterion 2 - The site supports several nationally scarce plants and invertebrates. The site also supports a diverse assemblage of nationally rare breeding waterfowl associated with seasonally-flooding wet grassland. Ramsar Criterion 5 – Site supports a winter population of 59133 waterfowl. Ramsar Criterion 6 - Site supports overwintering populations of Bewick's Swan, Whooper Swan, Eurasian Wigeon, Gadwall, Eurasian Teal, Northern Pintail and Northern Shoveler. Species/populations identified subsequent to designation for possible future consideration under Criterion 6 include; overwintering populations of Mute Swan, Common Pochard and Black-tailed Godwit.		X
UK11056	Redgrave & South Lopham Fens	Ramsar		Ramsar Criterion 1 - The site is an extensive example of spring-fed lowland base-rich valley, remarkable for its lack of fragmentation. Ramsar Criterion 2 and 3 - The site supports many rare and scarce invertebrates, including a population of the fen raft spider *Dolomedes plantarius*.	
UK11061	Roydon Common	Ramsar		Ramsar Criterion 1 - The site is the most extensive example of valley mire-heathland biotope within East Anglia; it is a mixed valley mire holding vegetation communities which reflect the influence of both base-poor and base-rich water. Ramsar Criterion 3 - The vegetation communities have a restricted distribution within Britain - it also supports a number of acidophilic invertebrates outside their normal geographic range and six British Red Data Book invertebrates.	
UK11062	Rutland Water	Ramsar	Ramsar Criterion 5 – Site supports an international important assemblage of waterfowl species. Ramsar Criterion 6 - Site supports spring/autumn populatins of Gadwell and Northern shoveler. Species/populations identified subsequent to designation for possible future consideration under Criterion 6 include; a spring/autumn population of Mute Swan.		X
UK11066	Stodmarsh	Ramsar	Ramsar Criterion 2 – A diverse assemblage of rare wetland birds including breeding population of Gadwall, spring/autumn populations of Gadwall and overwintering populations of Great Bittern Hen Harrier and Northern Shoveler.	Ramsar Criterion 2 – Site supports six British Red Data Book wetland invertebrates, two nationally rare plants, and five nationally scarce species.	X
UK11067	Stour and Orwell Estuaries	Ramsar	Ramsar Criterion 2 – Site contains seven nationally scarce plants: stiff saltmarsh-grass Puccinellia rupestris; small cord-grass Spartina maritima; perennial glasswort Sarcocornia perennis; lax-flowered sea lavender Limonium humile; and the eelgrasses Zostera angustifolia, Z. marina and Z. nc Ramsar Criterion 5 – Site supports a winter population of 63017 waterfowl. Ramsar Criterion 6 - Site supports a spring/autumn population of Common Redshank and overwintering populations of Dark-bellied Brent Goose, Northern Pintail, Grey Plover, Knot, Dunlin, Black-tailed Godwit and Common Redshank.	Ramsar Criterion 2 - Contains five British Red Data Book invertebrates: the muscid fly *Phaonia fusca*; the horsefly *Haematopota grandis*; two spiders, *Arctosa fulvolineata* and *Baryphema duffeyi*; and the Endangered swollen spire snail *Mercuria confusa*.	X
UK11068	Teesmouth & Cleveland Coast	Ramsar	Ramsar Criterion 5 – Site supports an internationally important assemblage fo waterfowl species during the winter. Ramsar Criterion 6 - Site support a spring/autumn population of Common Redshank and an overwintering population of Knot.		X
UK11069	Thames Estuary & Marshes	Ramsar	Ramsar Criterion 5 – Site supports a winter population of 45118 waterfowl. Ramsar Criterion 6 - Site supports spring/autumn populations of Ringed Plover and Black-tailed Godwit and overwintering populations of Grey Plover, Knot, Dunlin and Common Redshank.	Ramsar Criterion 2 - The site supports one endangered plant species and at least 14 nationally scarce plants of wetland habitats. The site also supports more than 20 British Red Data Book invertebrates.	X
UK11070	Thanet Coast & Sandwich Bay	Ramsar	Ramsar Criterion 6 - Site supports an overwintering population of Ruddy Turnstone.	Ramsar Criterion 2 - Site supports 15 British Red Data Book wetland invertebrates.	X

Table A3. European/Ramsar sites in the UK (and their interest features) located within the Plan area and 100km Plan buffer area.

Key:	
	No LSE - Screened out of assessment at HRA Plan-Level Screening Report
	LSE - Screened into assessment at HRA Plan-Level Screening Report
×	No LSE - Screened out during the Appropriate Assessment as unaffected by activities associated with TIDE, CCS and/or AGG Sectors
T, C, A	LSE - Screened in during Appropriate Assessment because of activities associated with TIDE, CCS and/or AGG Sectors

Site Reference	Site Name	Designation	Interest Features for Which There is a Likely Significantly Effect (LSE)	Interest Features for Which There is No Likely Significantly Effect (LSE)	Sector having LSE: T= TIDE C = CCS A = AGG
UK11071	The Swale	Ramsar	Ramsar Criterion 5 – Site supports a winter population of 77501 waterfowl. Ramsar Criterion 6 - Site supports a spring/autumn population of Common Redshank and overwintering populations of Dark-bellied Brent Goose and Grey Plover. Species/populations identified subsequent to designation for possible future consideration under Criterion 6 include; a spring/autumn population of Ringed Plover and overwintering populations of Eurasian Wigeon, Northern Pintail, Northern Shoveler and Black-tailed Godwit.	Ramsar Criterion 2 - The site supports nationally scarce plants and at least seven British Red data book invertebrates.	X
UK11072	The Wash	Ramsar	Ramsar Criterion 1 - The Wash is a large shallow bay comprising very extensive saltmarshes, major intertidal banks of sand and mud, shallow water and deep channels. Ramsar Criterion 3 - Qualifies because of the inter-relationship between its various components including saltmarshes, intertidal sand and mud flats and the estuarine waters. Ramsar Criterion 5 - Site supports a winter population of 292541 waterfowl. Ramsar Criterion 6 – Site supports spring/autumn populations of Eurasian Oystercatcher, Grey Plover, Knot, Sanderling, Eurasian Curlew, Common Redshank, and Ruddy Turnstone and overwintering populations of Pink-footed Goose, Dark-bellied Brent Goose, Common Shelduck, Northern Pintail, Dunlin and Bar-tailed Godwit. Species/populations identified subsequent to designation for possible future consideration under Criterion 6 include; spring/autumn populati of Ringed Plover and Black-tailed Godwit and overwintering populations of European Golden Plover and Northern Lapwing.		T,C
UK11077	Wicken Fen	Ramsar		Ramsar Criterion 1 - Site contains one of the most outstanding remnants of the East Anglian peat fens. Ramsar Criterion 2 – The site supports one species of British Red Data Book plant, fen violet *Viola persicifolia* , which survives at only two other sites in Britain. It also contains eight nationally scarce plants and 121 British Red Data Book invertebrates.	
UK11078	Woodwalton Fen	Ramsar		Ramsar Criterion 1 - The site is within an area that is one of the remaining parts of East Anglia which has not been drained. The fen is near natural supports several types of open fen and swamp communities. Ramsar Criterion 2 – The site supports two species of British Red Data Book plants, fen violet *Viola persicifolia* and fen wood-rush *Luzula pallidula* . Woodwalton also supports a large number of wetland invertebrates including 20 British Red Data Book species. Aquatic beetles, flies and moths are particularly well represented.	
UK11083	Upper Nene Valley Gravel Pits	Ramsar	Ramsar Criterion 5: Regularly supports over 20,000 waterbirds. Ramsar Criterion 6: Wintering population of Mute Swan and Gadwall.		X

Table A4. European/Ramsar sites outside UK territorial waters located within the 100km Plan buffer area (and designated for Harbour Porpoise and/or Bottlenose Dolphin)

Key:	
	No LSE - Screened out of assessment at HRA Plan-Level Screening Report
	LSE - Screened into assessment at HRA Plan-Level Screening Report (By virtue of having harbour porpoise and or bottlenose dolphin as a qualifying feature)
×	No LSE - Screened out during the Appropriate Assessment as unaffected by activities associated with TIDE, CCS and/or AGG Sectors
T, C, A	LSE - Screened in during Appropriate Assessment because of activities associated with TIDE, CCS and/or AGG Sectors
NB all sites screened in within the screening report have been retained in at the Appropriate Assessment level because of uncertainties associated with the migration and foraging behaviour	

Site Reference	Site Name	Country	Type	Natura 2000 Site	Sector having LSE: T= TIDE C = CCS A = AGG
BE2500831	Ijzervallei	Belgium	A	SPA	
BEMNZ0004	Sbz 3 / Zps 3	Belgium	A	SPA	
BE2300005	Bossen En Heiden Van Zandig Vlaanderen: Oostelijk Deel	Belgium	B	SAC	
BE2500004	Bossen, Heiden En Valleigebieden Van Zandig Vlaanderen: Westelijk Deel	Belgium	B	SAC	
BEMNZ0005	Vlakte Van De Raan	Belgium	B	SAC	T, C. A
BE2500003	Westvlaams Heuvelland	Belgium	B	SAC	
BE32001A0	Vallée De La Lys (Comines-Warneton)	Belgium	H	SPA	
BE32001B0	Vallée De La Lys (Comines-Warneton)	Belgium	I	SAC	
BE2501033	Het Zwin	Belgium	J	SPA	
BE2301134	Krekengebied	Belgium	J	SPA	
BE2524317	Kustbroedvogels Te Zeebrugge-Heist	Belgium	J	SPA	
BE2500932	Poldercomplex	Belgium	J	SPA	
BEMNZ0002	Sbz 1 / Zps 1	Belgium	J	SPA	
BEMNZ0003	Sbz 2 / Zps 2	Belgium	J	SPA	
BE2500121	Westkust	Belgium	J	SPA	
BE2500001	Duingebieden Inclusief Ijzermonding En Zwin.	Belgium	K	SAC	
BE2500002	Polders	Belgium	K	SAC	
BEMNZ0001	Uitbreiding Trapegeer-Stroombank	Belgium	K	SAC	
DE1003301	Doggerbank	Germany	B	SAC	T, C. A
FR3110038	Estuaire De La Canche	France	A	SPA	
FR3110083	Marais De Balançon	France	A	SPA	
FR3110039	Platier D'oye	France	A	SPA	
FR3100483	Coteau De Dannes Et De Camiers	France	B	SAC	
FR3100488	Coteau De La Montagne D'acquin Et Pelouses Du Val De Lumbres	France	B	SAC	
FR3100474	Dunes De La Plaine Maritime Flamande	France	B	SAC	
FR3100482	Dunes De L'authie Et Mollieres De Berck	France	B	SAC	
FR3100481	Dunes Et Marais Arriere-Littoraux De La Plaine Maritime Picarde	France	B	SAC	
FR3100475	Dunes Flandriennes Decalcifiees De Ghyvelde	France	B	SAC	
FR3100479	Falaises Et Dunes De Wimereux, Estuaire De La Slack, Garennes Et Communaux D'ambleteuse-Audresselles	France	B	SAC	
FR3100477	Falaises Et Pelouses Du Cap Blanc Nez, Du Mont D'hubert, Des Noires Mottes, Du Fond De La Forge Et Du Mont De Couple	France	B	SAC	
FR3100498	Foret De Tournehem Et Pelouses De La Cuesta Du Pays De Licques	France	B	SAC	
FR3100499	Forets De Desvres Et De Boulogne Et Bocage Prairial Humide Du Bas-Boulonnais	France	B	SAC	
FR3100491	Landes, Mares Et Bois Acides Du Plateau De Sorrus Saint Josse, Prairies Alluviales Et Bois Tourbeux En Aval De Montreuil	France	B	SAC	
FR2200347	Marais Arriere-Littoraux Picards	France	B	SAC	
FR3102001	Marais De La Grenouillère	France	B	SAC	
FR3100484	Pelouses Et Bois Neutrocalcicoles De La Cuesta Sud Du Boulonnais	France	B	SAC	
FR3100485	Pelouses Et Bois Neutrocalcicoles Des Cuestas Du Boulonnais Et Du Pays De Licques Et Foret De Guines	France	B	SAC	
FR3100487	Pelouses, Bois Acides A Neutrocalcicoles, Landes Nord-Atlantiques Du Plateau D'helfaut Et Systeme Alluvial De La Moyenne Vallee De L'aa	France	B	SAC	
FR3100489	Pelouses, Bois, Forets Neutrocalcicoles Et Systeme Alluvial De La Moyenne Vallee De L'authie	France	B	SAC	
FR3100494	Prairies Et Marais Tourbeux De Guines	France	B	SAC	
FR3100492	Prairies Et Marais Tourbeux De La Basse Vallee De L'authie	France	B	SAC	
FR3102004	Ridens Et Dunes Hydrauliques Du Detroit Du Pas-De-Calais	France	B	SAC	T, C. A
FR3112006	Bancs Des Flandres*	France	F	SPA	
FR3110085	Cap Gris-Nez	France	F	SPA	
FR3102002	Bancs Des Flandres*	France	G	SAC	T, C. A
FR3100495	Prairies, Marais Tourbeux, Forets Et Bois De La Cuvette Audomaroise Et De Ses Versants	France	G	SAC	
FR3102003	Recifs Gris-Nez Blanc-Nez	France	G	SAC	T, C. A
FR3112004	Dunes De Merlimont	France	J	SPA	
FR2210068	Estuaires Picards : Baie De Somme Et D'authie	France	J	SPA	
FR2212003	Marais Arrière-Littoraux Picards	France	J	SPA	
FR3112003	Marais Audomarois	France	J	SPA	
FR3102005	Baie De Canche Et Couloir Des Trois Estuaires	France	K	SAC	T, C. A
FR3100480	Estuaire De La Canche, Dunes Picardes Plaquees Sur L'ancienne Falaise, Foret D'hardelot Et Falaise D'equihen	France	K	SAC	
FR2200346	Estuaires Et Littoral Picards (Baies De Somme Et D'authie)	France	K	SAC	
FR3100478	Falaises Du Cran Aux Oeufs Et Du Cap Gris-Nez, Dunes Du Chatelet, Marais De Tardinghen Et Dunes De Wissant	France	K	SAC	T, C. A
FR2200348	Vallee De L'authie	France	K	SAC	
NL2009162	Abtskolk & De Putten	Netherlands	A	SPA	
NL1000030	Coepelduynen	Netherlands	B	SAC	
NL2008001	Doggersbank	Netherlands	B	SAC	T, C. A
NL2003019	Groote Gat	Netherlands	B	SAC	
NL1000012	Kennemerland-Zuid	Netherlands	B	SAC	
NL2008002	Klaverbank	Netherlands	B	SAC	T, C. A
NL1000013	Meijendel En Berkheide	Netherlands	B	SAC	
NL9802025	Veerse Meer	Netherlands	D	SAC & Ramsar	
NL1000009	Duinen Den Helder - Callantsoog	Netherlands	E	SAC	
NL1000010	Duinen Schoorl	Netherlands	E	SAC	
NL9801080	Noordhollands Duinreservaat	Netherlands	E	SAC	
NL1000016	Solleveld	Netherlands	E	SAC	
NL2008003	Vlakte Van De Raan	Netherlands	E	SAC	T, C. A
NL1000014	Westduinpark En Wapendal	Netherlands	E	SAC	
NL3009018	Zwin	Netherlands	F	SPA	
NL2003062	Noordzeekustzone	Netherlands	G	SAC	T, C. A
NL3000027	Zwin	Netherlands	G	SAC	
NL9802021	Grevelingen	Netherlands	H	SPA & Ramsar	
NL9802018	Haringvliet	Netherlands	H	SPA & Ramsar	
NL3009016	Oosterschelde	Netherlands	H	SPA & Ramsar	
NL9802017	Voordelta	Netherlands	H	SPA & Ramsar	
NL2002017	Voornes Duin	Netherlands	H	SPA & Ramsar	
NL9802026	Westerschelde & Saeftinghe	Netherlands	H	SPA & Ramsar	
NL9910002	Zwanenwater	Netherlands	H	SPA & Ramsar	
NL3000016	Duinen Zwanenwater En Pettemerduinen	Netherlands	I	SAC	
NL4000021	Grevelingen	Netherlands	I	SAC	
NL1000015	Haringvliet	Netherlands	I	SAC	
NL1000018	Oosterschelde	Netherlands	I	SAC	
NL4000017	Voordelta	Netherlands	I	SAC	
NL9803077	Voornes Duin	Netherlands	I	SAC	
NL9803061	Westerschelde	Netherlands	I	SAC	
NL2000006	Kwade Hoek	Netherlands	J	SPA	
NL9802001	Noordzeekustzone	Netherlands	J	SPA	
NL9801079	Duinen Goeree	Netherlands	K	SAC	
NL1000017	Kop Van Schouwen	Netherlands	K	SAC	
NL1000020	Manteling Van Walcheren	Netherlands	K	SAC	
NL2008004	Noordzeekustzone Ii	Netherlands	K	SAC	
*	These sites were not found on the Natura 2000 website (http://www.eea.europa.eu/) but we have assumed the designated conservation sites using the type codes.				

Table A5. European/Ramsar sites within and outside UK territorial waters located outside the 100km Plan buffer area but 'screened in' for fish, seabirds and cetaceans that forage/migrate >100km

Key:	
	LSE - Screened into assessment at HRA Plan-Level Screening Report (By virtue of having harbour porpoise and or bottlenose dolphin as a qualifying feature)
×	No LSE - Screened out during the Appropriate Assessment as unaffected by activities associated with TIDE, CCS and/or AGG Sectors
T, C, A	LSE - Screened in during Appropriate Assessment because of activities associated with TIDE, CCS and/or AGG Sectors

Site Reference	Site	Species					
		Anadromous Fish	Manx Shearwater	Northern Fulmar	Northern Gannet	Razorbill	Harbour Porpoise
	Aberdaron Coast and Bardsey Island SPA		T, C, A				
	Abers - Côtes Des Legendes SAC (French)						T, C, A
	Ærø, Havet Syd For Og Nærå SAC (Danish)						T, C, A
	Ailsa Craig SPA				T, C, A		
	Anse de Vauville SAC (French)						
	Baie de Lancieux, Baie de L'arguenon, Archipel de Saint Malo et Dinard SAC (French)						
	Baie de Seine occidentale SAC (French)						
	Baie Du Mont Saint-Michel SAC (French)						
	Banc et rucifs de Surtainville SAC (French)						
	Borkum-Riffgrund SAC (German)						T, C, A
	Buchan Ness to Collieston Coast SPA			T, C, A			
	Cap d'Erquy-Cap Frúhel SAC (French)						
	Centrale Storebælt Og Vresen SAC (Danish)						T, C, A
	Chausey SAC (French)						
	Chaussée De Sein SAC (French)						T, C, A
	Copeland Island SPA		T, C, A				
	Cote De Cancale A Parame SAC (French)						
	Darßer Schwelle SAC (German)						T, C, A
	Fehmarnbelt SAC (German)						T, C, A
	Flensborg Fjord, Bredgrund Og Farvandet Omkring Als SAC (Danish)						T, C, A
	Forth Islands SPA			T, C, A	T, C, A	C, A	
	Fowlsheugh SPA			T, C, A			
	Fyns Hoved, Lillegrund Og Lillestrand SAC (Danish)						T, C, A
	Gilleleje Flak Og Tragten SAC (Danish)						T, C, A
	Grassholm SPA				T, C, A		
	Hamburgisches Wattenmeer SAC (German)						T, C, A
	Havet Mellem Romsø Og Hindsholm Samt Romsø SAC (Danish)						T, C, A
	Helgoland Mit Helgoländer Felssockel SAC (German)						T, C, A
	Howth Head Coast SPA			T, C, A			
	Irelands Eye SPA			T, C, A		T, C, A	
	Kadetrinne SAC (German)						T, C, A
	Kosterfjorden-Väderöfjorden SAC (German)						T, C, A
	Küstenbereiche Flensburger Förde Von Flensburg Bis Geltinger Birk SAC (German)						T, C, A
	Küstenlandschaft Bottsand - Marzkamp U. Vorgelagerte Flachgründe SAC (German)						T, C, A
	Küstenlandschaft Vor Großenbrode Und Vorgelagerte Meeresbereiche SAC (German)						T, C, A
	Lambay Island SPA		T, C, A	T, C, A		T, C, A	
	Lillebælt SAC (Danish)						T, C, A
	Maden På Helnæs Og Havet Vest For SAC (Danish)						T, C, A
	Meeresgebiet Der Östlichen Kieler Bucht SAC (German)						T, C, A
	Moray Firth SAC (UK)						
	Nationalpark Niedersächsisches Wattenmeer SAC (German)						T, C, A
	NTP S-H Wattenmeer Und Angrenzende Küstengebiete SAC (German)						T, C, A
	River Dee SAC	T, C, A					
	River South Esk SAC	T, C, A					
	River Tay SAC	T, C, A					
	River Tweed SAC	T, C, A					
	Røsnæs, Røsnæs Rev Og Kalundborg Fjord SAC (Danish)						T, C, A
	Sagas-Bank SAC (German)						T, C, A
	Saltee Island SPA					T, C, A	
	Schlei Incl. Schleimünde Und Vorgelagerter Flachgründe SAC (German)						T, C, A
	Skagens Gren Og Skagerrak SAC (Danish)						T, C, A
	Skokholm and Skomer SPA		T, C, A			T, C, A	
	Spa Östliche Deutsche Bucht SAC (German)						T, C, A
	St Abb's Head to Fast Castle SPA					T, C, A	
	Staberhuk SAC (German)						T, C, A
	Steingrund SAC (German)						T, C, A
	Stora Middelgrund Och Röde Bank SAC (Swedish)						T, C, A
	Store Middelgrund SAC (Danish)						T, C, A
	Südküste Der Eckernförder Bucht Und Vorgelagerte Flachgründe SAC (German)						T, C, A
	Sydlige Nordsø SAC (Danish)						T, C, A
	Sylter Außenriff SAC (Danish)						T, C, A
	Tregor Goëlo SAC (French)						T, C, A
	Tweed Estuary SAC	T, C, A					T, C, A
	Unterelbe SAC (German)						T, C, A
	Vadehavet Med Ribe Å, Tved Å Og Varde Å Vest For Varde SAC (Danish)						T, C, A
	Voordelta SAC (Dutch)						
	Vrångöskärgården SAC (Swedish)						T, C, A
	Waddenzee SAC (Dutch)						
	Wicklow Head SPA			T, C, A		T, C, A	

Table A6 - Activity screening schedules for Tidal Energy, Carbon Capture and Storage and Aggregate Extraction sectors

Key for interest features that have been screened **into** the plan-level Appropriate Assessment

Key	Meaning	Key	Meaning	Key	Meaning	Key	Meaning
4.1	Article 4.1 of Birds Directive	4.2	Article 4.2 of Birds Directive	Cri 6	Ramsar Criterion No.	30,000	Number of birds regulary occuring
A1 (P)	Annex I Habitat (primary reason)	A2 (P)	Annex II Species (primary reason)	A1 (Q)	Annex I Habitat (qualifying)	A2 (Q)	Annex II Species (qualifying)
(yellow)	Interest features and European/Ramsar sites that have been screened out of the Appropriate Assessment						
P	Inland habitats and species (terrestrial and riverine)	P	Intertidal and Coastal habitats and species	P	Marine/Offshore habitats and species	P	Screening criteria

NB Transnational sites for harbour porpoise and bottlenose dolphin also relevant see Tables A4 and A5

European/Ramsar Site	Landward/Riverine	Intertidal/Coastal	Marine/Offshore	Outer Thames Estuary	Humber Estuary	Alde-Ore Estuary	Breydon Water	Broadland	Deben Estuary	Great Yarmouth North Denes	Benacre to Easton Bavents	Flamborough Head and Bempton Cliffs	Gibraltar Point	Hornsea Mere	Minsmere - Walberswick	North Norfolk Coast	St Abbs Head to Fast Castle	Buchan Ness to Collieston Coast	Forth Islands	Fowlsheugh	Alisa Craig	Aberdaron Coast and Bardsey Island	Copeland Island	The Wash	Grassholm	Howth Head Coast	Irelands Eye	Lambay Island	Saltee Island	Skokholm and Skomer	Wicklow Head	Inner Dowsing, Race Bank and North Ridge	Margate and Long Sands	Dogger Bank	North Norfolk Sandbanks and Saturn Reef	Haisborough, Hammond and Winterton	The wash and North Norfolk Coast	Winterton and Horse Dunes	River Derwent	Humber Estuary	Beanacre to Easton Bavents Lagoons	Orfordness-Shingle Street	Alde, ore and Butley Estuaries	Saltfleetby-Theddlethorpe Dunes and Gibraltar Point	Minsmere to Walberswick Heaths and Marshes	Flamborough Head	Overstrand Cliffs	North Norfolk Coast	Tweed Estuary	River Tweed	Moray Firth	River Dee	River South Esk	River Tay	Breydon Water	Deben Estuary	Humber Estuary	Alde-Ore Estuary	Broadland	Gibraltar Point	Minsmere-Walberswick	North Norfolk Coast	The Wash
Sector	CCS			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	TIDE			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	AGG			✓	✓	✓	✓	✓	✓	✓	✓						✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓					
Screening Criteria (Location Relative to Marine Plan Areas)	> 100km																✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓																		✓	✓	✓	✓	✓	✓									
	< 100km				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓								✓													✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓	✓	✓	✓	✓
	Within ellipse																																																														
	Footprint			✓	✓					✓																						✓	✓	✓	✓	✓	✓																				✓						
(back to contents page)	Distribution			Special Protection Area																												Special Area of Conservation																							Ramsar								
Designation				SPA	SPA	SPA	SPA	SPA	SPA	SPA	SPA	SPA	SPA	SPA	SPA	SPA	SPA	SPA	SPA	SPA	SPA	SPA	SPA	SPA	SPA	SPA	SPA	SPA	SPA	SPA	SPA	SCI	SCI	cSAC	cSAC	SCI	SAC	SAC	SAC	SAC	SAC	SAC	SAC	SAC	SAC	SAC	SAC	SAC	SAC	SAC	SAC	SAC	SAC	SAC	Ram	Ram	Ram	Ram	Ram	Ram	Ram	Ram	Ram
Interest Features (grouped in some cases e.g. dunes) **Site Code**				UK9020309	UK9006111	UK9009112	UK9009181	UK9009253	UK9009261	UK9009271	UK9009291	UK9006101	UK9008022	UK9006171	UK9009101	UK9009031	UK9004271	UK9002491	UK9004171	UK9002271	UK9003091	UK9013121	UK9020291	UK9008021	UK9014041	IE004113	IE004113	IE004069	IE004002	UK9014051	IE004127	UK0030370	UK0030371	UK0030352	UK0030358	UK0030369	UK0017075	UK0013043	UK0030253	UK0030170	UK0012741	UK0014780	UK0030076	UK0030270	UK0012809	UK0013036	UK0030232	UK0019838	UK0030292	UK0012691	UK0019808	UK0030251	UK0030262	UK0030312	UK11008	UK11017	UK11031	UK11002	UK11010	UK11027	UK11044	UK11048	UK11072
Mammals																																																															
Grey Seal		✓	✓																																					A2 (Q)																		Cri 3						
Common Seal		✓	✓																																	A2 (P)																										
Bottlenose dolphin			✓																																																A2 (P)													
Otter	✓	✓																																	A2 (Q)		A2 (Q)									A2 (Q)												Cri 2				
Fish and other species																																																															
Salmon	✓	✓	✓																																															A2 (P)		A2 (P)	A2 (P)	A2 (P)									
Allis shad	✓	✓	✓																																																												
Twaite shad	✓	✓	✓																																																												
Sea Lamprey	✓	✓	✓																																			A2 (Q)	A2 (Q)											A2 (Q)	A2 (Q)				A2 (Q)			Cri 8						
River Lamprey	✓	✓	✓																																			A2 (P)	A2 (Q)											A2 (Q)	A2 (Q)				A2 (Q)			Cri 8						
Freshwater Pearl Mussel	✓																																																			A2 (P)	A2 (P)										
Coastal Habitats																																																															
Sandbanks slightly covered by seawater all the time		✓	✓																													A1 (P)	A1 (P)	A1 (P)	A1 (P)	A1 (P)	A1 (P)			A1 (Q)																									
Estuaries		✓																																						A1 (P)			A1 (P)															Cri 1						
Mudflats and sandflats not covered by seawater at low tide		✓																																			A1 (P)			A1 (P)			A1 (Q)															Cri 1					Cri 1	Cri 1
Coastal lagoons		✓																																			A1 (Q)			A1 (Q)	A1 (P)	A1 (P)						A1 (P)									Cri 1					Cri 1	
Large shallow inlets and bays		✓																																			A1 (P)																										
Reefs		✓	✓																													A1 (P)			A1 (P)	A1 (P)	A1 (P)										A1 (P)																	
Submarine structures made by leaking gases			✓																																																													
Submerged or partially submerged sea caves		✓	✓																																												A1 (P)																	
Annual vegetation of drift lines		✓																																								A1 (P)			A1 (P)																		
Salicornia and other annuals colonising mud and sand		✓																																			A1 (P)			A1 (Q)																								
Spartina swards		✓																																																														
Atlantic salt meadows		✓																																			A1 (P)			A1 (Q)			A1 (Q)																					
Mediterranean and thermo-Atlantic halophilous scrut		✓																																			A1 (P)											A1 (P)																Cri 1
Saltmarsh (type not specified)		✓																																																								Cri 1			Cri 1	Cri 1	Cri 1	
Atlantic decalcified fixed dunes (Calluno-Ulicetea)		✓																																				A1 (P)																										
Humid Dune Slacks		✓																																				A1 (P)						A1 (P)				A1 (P)									Cri 1						
Shifting dunes along the shoreline with Ammophila arenaria		✓																																				A1 (Q)		A1 (Q)				A1 (P)				A1 (P)															
Embryonic shifting dunes		✓																																				A1 (Q)		A1 (Q)				A1 (Q)				A1 (P)															
Perennial vegetation of stony bank:	✓	✓																																								A1 (P)						A1 (P)															
Fixed dunes with herbaceous vegetatio		✓																																						A1 (Q)				A1 (P)				A1 (P)															
Dunes with Hippophae rhamnoide:		✓																																						A1 (Q)				A1 (P)																			
Vegetated sea cliffs	✓	✓																																												A1 (P)	A1 (P)																
Machair	✓																																																															
Dune systems		✓																																																								Cri 1						
Sand dunes		✓																																																													Cri 1	
Rare Saltmarsh and dune communities		✓																																																											Cri 1			
Shingle Banks		✓																																																													Cri 1	
Reed Bed																																																														Cri 1	Cri 1	
Birds-Breeding Season																																																															
Breeding Seabird Assemblage	✓	✓																																																									Cri 3					
Golden Eagle	✓																																																															
Osprey	✓																																																															
Wood Sandpiper	✓	✓																																																														
Northern Ganne	✓	✓	✓																4.2		4.2				4.2																																						
Lesser Black-backed Gu	✓	✓	✓			4.2																																																				Cri 6					
Herring Gul	✓	✓	✓																																																												
Black-legged Kittiwake	✓	✓	✓									4.2																																																			
Common Guillemot	✓	✓	✓																																																													
Corn Crake	✓																																																															
Merlin	✓	✓																																																														
Black-throated Diver	✓	✓																																																														
European Storm Petre	✓	✓	✓																																																													
Arctic Tern	✓	✓																																																														
Eurasian Dottere	✓																																																															
Northern Fulma	✓	✓	✓																4.2	4.2	4.2							4.2	4.2	4.2			4.2																																
European Shag	✓	✓	✓																																																													
Red-throated Diver	✓	✓	✓																																																														
European Golden Plover	✓	✓																																																															
Short-Eared owl	✓																																																															
Dunlin	✓	✓																																																														
Great Cormorant	✓	✓	✓																																																														
Great Black-backed Gu	✓	✓	✓																																																														
Atlantic Puffin	✓	✓	✓																																																														
Razorbill	✓	✓	✓														4.2		4.2	4.2								4.2	4.2	4.2	4.2	4.2																																
Sandwich Terr	✓	✓	✓			4.1										4.1																																															Cri 6	
Common Tern	✓	✓	✓													4.1								4.1																																							Cri 6	
Little Tern	✓	✓	✓		4.1	4.1				4.1	4.1		4.1		4.1	4.1								4.1																																							Cri 6	
Manx Shearwate	✓	✓	✓																				4.2	4.2					4.2		4.2																																	
Roseate Tern	✓	✓	✓																																																														
Peregrine Falcor	✓																																																															
Arctic Skua	✓	✓																																																														
Whimbrel	✓	✓																																																														
Red-necked phalarope	✓	✓																																																														
Great Skua	✓	✓	✓																																																														
Great Crested Grebe	✓	✓																																																															
Leach's Storm Petre	✓	✓	✓																																																														
Great Bittern	✓	✓			4.1			4.1			4.1				4.1	4.1																																													Cri 2		
Common Redshank	✓	✓																																																															
Common Snipe	✓	✓																																																															
Pochard	✓	✓																																																															
Gadwal	✓	✓													4.2																																														Cri 2		
Slavonian Grebe	✓	✓																																																															
Tufted Duck	✓	✓																																																															
Shoveler	✓	✓													4.2																																														Cri 2		
Shelduck	✓	✓																																																															
Ringed Plover	✓	✓																																																															
Goosander	✓	✓																																																															
Common Eider	✓	✓																																																															
Greenshank	✓	✓																																																															
Eurasian Curlew	✓	✓																																																															
Common Scoter	✓	✓	✓																																																														
Northern Lapwing	✓	✓																																																															
Eurasian Tea	✓	✓													4.2																																														Cri 2		
Eurasian Wigeon	✓	✓																																																															
Common Goldeneye	✓	✓																																																															
Black Guillemot	✓	✓																																																															
Eurasian Oystercatcher	✓	✓																																																															
Common (Mew) Gul	✓	✓	✓																																																													
Black-headed Gul	✓	✓																																																																
Spotted Crake	✓	✓																																																															
Pied Avocet	✓	✓			4.1	4.1									4.1	4.1																																													Cri 2		
Mute Swan	✓	✓												4																																																	
Greylag Goose	✓	✓																																																															
Bearded Tit																																																														Cri 2		
Birds Overwintering/Passage																																																															
Wintering Waterfowl Assemblage	✓	✓	✓													91,536								400,367																															68,175		153,934	Cri 3		53,072		989,462	292,541
Common Redshank	✓	✓			4.2	4.2																		4.2																																	Cri 6	Cri 6					Cri 6
Great Crested Grebe	✓	✓																																																														
Whooper Swan	✓	✓						4.1																																																								
Barnacle Goose	✓	✓																																																															
Greylag Goose	✓	✓																																																										Cri 6				
Greenland White-fronted Goose	✓	✓													4.2																																																
Pink-footed Goose	✓	✓														4.2								4.2																																			Cri 6			Cri 6	Cri 6
Light-bellied Brent Goose	✓	✓																																																															
Dark-bellied Brent Goose	✓	✓						4.1								4.1								4.1																																Cri 6				Cri 6		Cri 6	Cri 6
Ruff	✓	✓			4.1	4.1																																																										
Bar-tailed Godwit	✓	✓			4.1								4.1											4.1																																	Cri 6			Cri 6		Cri 6	Cri 6
Eurasian Wigeon	✓	✓														4.2								4.2																																			Cri 6			Cri 6	
Northen Pintai	✓	✓																						4.2																																						Cri 6	Cri 6
Red Knot	✓	✓			4.2											4.2								4.2																																	Cri 6			Cri 6			Cri 6
Purple Sandpiper	✓	✓																																																															
Ruddy Turnstone	✓	✓																						4.2																																							Cri 6
Slavonian Grebe	✓	✓																																																															
Red-throated Diver	✓	✓		4.1																																																												
Common Eider	✓	✓																																																															
Common Shelduck	✓	✓			4.2																			4.2																																	Cri 6						Cri 6
Great Cormorant	✓	✓																																																														
Mallard	✓	✓																																																															
Greater Scaup	✓	✓																																																															
Long-tailed Duck	✓	✓																																																															
Black (Common) Scoter	✓	✓	✓																					4.2																																							
Velet Scoter	✓	✓	✓																																																														
Common Goldeneye	✓	✓																						4.2																																							
Red-breasted Merganser	✓	✓																																																															
Eurasian Curlew	✓	✓																						4.2																																							Cri 6
Eurasian Oystercatcher	✓	✓																						4.2																																							Cri 6
Ringed Plover	✓	✓																																																												Cri 6	Cri 6
European Golden Plover	✓	✓			4.1																																																				Cri 6						Cri 6
Grey Plover	✓	✓											4.2											4.2																																					Cri 6			Cri 6
Northern Lapwing	✓	✓																																																					Cri 6								Cri 6
Dunlin	✓	✓			4.2																			4.2																																	Cri 6						Cri 6
Sandwich Terr	✓	✓																																																														
Sanderling	✓	✓											4.2											4.2																																					Cri 6		Cri 6	Cri 6
Black-tailed Godwit	✓	✓			4.2																			4.2																																	Cri 6						Cri 6
Goosander	✓	✓																																																														
Eurasian Tea	✓	✓																																																															
Gadwal	✓	✓						4.2						4.2	4.2									4.2																																			Cri 6				
Common Greenshank	✓	✓																																																															
Black-headed Gul	✓	✓																																																															
Common Terr	✓	✓	✓																																																														
Common Gull (Mew)	✓	✓	✓																																																														
Northern Shoveler	✓	✓													4.2																																											Cri 6				
Bewick Swar	✓	✓						4.1																4.1																																							
Common Pochard	✓	✓																																																															
Tufted Duck	✓	✓																																																															
Bittern	✓	✓			4.1																																																											
Pied Avocet	✓	✓			4.1	4.1			4.1							4.1																																										Cri 6					
Lesser Black-back Gul	✓	✓																																																															
Tundra Swar	✓	✓																																																					Cri 6				Cri 6				
Taiga Bean Goose	✓	✓																																																															

Step 4: Not available as excel spreadsheet matrix but presented in tabular format in AAIR Report (see Tables 2, 3, 4, 5, 7, 11, 12, 13 and 15)

Step 5: Not available as excel spreadsheet matrix but presented in tabular format in AAIR Report (see Tables 16, 17, 18 and 19)

Table A7. Impact-Mitigation matrix for TIDE, CCS and AGG projects

						Sector Mitigation Measure Availability (see Appendix B for List of MMO Standard Mitigation)			**Feature Mitigation Summary**					**Mitigation Status Review** (identification of gaps)
Project Phase	**Activity**	**Change**	**Sensitivity Category** (Using standard 'categories of operations which may cause deterioration or disturbance' (UK Marine SAC project, 2001))	**Impact Pathway Description** (see Note at the bottom of the table describing sources and HRA precedents - see also Table A1a for list)	**Pathway Ref. No.** (see Table A1a for list)	**TIDE**	**CCS**	**AGG**	Coastal, Intertidal and Subtidal Habitats and Associated Species	Supralittoral (Onshore) Habitats and Species	Bird Species	Marine Mammals (Seals, Cetaceans, Otter)	Migratory Fish and Freshwater Pearl Mussel	**Status of Standard MMO Measures** (NB in all cases there are no statutory measures and no measures specially for the CCS sector)
PREPARATORY SURVEY WORK (applies across all sectors where surveys are required to inform baseline environmental descriptions (all sectors), to investigate aggregate resources (AGG) or to prepare form installation of tidal devices, cables or pipelines (TIDE and CCS)	Trawling and borehole sampling during environmental baseline surveys	Temporary removal of, or change to, species or habitats features (e.g. biogenic reefs)	**Physical Damage** (indirect and temporary damage to marine habitat)	Changes to coastal and offshore habitat as result of damage from baseline surveys (e.g. boreholes/trawls); from equipment use causing abrasion, damage or smothering during installation and from maintenance and removal of cables/pipelines/devices (e.g. jack-up legs, vessels, anchors, mooring chain).	**5**	None available for baseline surveys specifically	None available for CSS Sector	None available for baseline surveys specifically	No mitigation measures available					No measures available which deal with the survey period specifically
	Trawling and borehole sampling during environmental baseline surveys	Temporary removal of, or change to, species or habitats features (e.g. biogenic reefs)	**Physical Damage** (indirect and temporary damage to marine habitat)	Reduction in quality of foraging areas as result of damage to coastal and offshore habitat from baseline surveys (e.g. boreholes and trawls); from equipment use causing abrasion, damage or smothering during installation; from maintenance and removal of cables, pipeline, tidal/devices or from scour, sediment transport and hydrodynamic change during operation.	**10**	None available for baseline surveys specifically	None available for CSS Sector	None available for baseline surveys specifically			No mitigation measures avaialable	No mitigation measures avaialable	No mitigation measures avaialable	
	Increased vessel activity during baseline surveys (including use of ducted propellers on vessels using dynamic positioning)	Elevated collision risk for marine species especially marine mammals	**Physical Damage** (direct damage to species from collision risk)	Collision risk and possible mortality of species due to the presence of tidal devices or from vessels travelling to and from the site (including propeller collision risk).	**13**	None available for baseline surveys specifically	None available for CSS Sector	None available for baseline surveys specifically			No mitigation measures avaialable	No mitigation measures avaialable	No mitigation measures avaialable	
	Increased vessel activity during environmental baseline surveys	Visual disturbance of species	**Non-Physical disturbance** (disturbance to species)	Visual disturbance and exclusion from areas as a result of surveying; cable, pipeline or tidal device installation/operation and decommissioning activities (including movements of vessels.	**16**	None available for baseline surveys specifically	None available for CSS Sector	None available for baseline surveys specifically			No mitigation measures avaialable	No mitigation measures avaialable		
	Seismic surveys; Increased vessel activity during environmental baseline surveys	Noise and vibration from seismic exploration and geophysical surveys creating underwater pressure waves that may affect/damage fish or marine mammals and or airborne noise that may affect bird species; Increased vessel activity causing elevated noise disturbance to marine mammals, birds and possibly shoreline mammals (otter)	**Non-Physical disturbance** (disturbance to species)	Noise/vibration disturbance and exclusion from areas as a result of vessels and other activities during survey work (e.g. seismic exploration and geophysical surveys), construction (e.g. piling, drilling, cable laying), operation (e.g. device noise), maintenance or decommisioning. Also includes noise/vibration disturbance from vessels and draghead during extraction.	**17**	None available for baseline surveys specifically	None available for CSS Sector	None available for baseline surveys specifically			No mitigation measures avaialable	No mitigation measures avaialable	No mitigation measures avaialable	
	Increased vessel activity during environmental baseline surveys	Elevated risk of spillages/releases of oil or other contaminants & toxic effects on marine species	**Toxic Contamination** (reduction in water quality)	Spillage of fluids, fuels and/or construction materials (inc. from surface coatings/treatments) during installation or removal of structures (devices and cables), during survey/maintenance or during aggregate extraction.	**19**	None available for baseline surveys specifically	None available for CSS Sector	None available for baseline surveys specifically	No mitigation measures available	No mitigation measures available	No mitigation measures available	No mitigation measures available	No mitigation measures available	
	Introduction of fixed marine structures	Allowing introduction of rats/mink through the positioning of devices close to breeding seabird sites	**Biological Disturbance** (introduction of non-native species)	Predation by introduced rats/mink through the positioning of static devices (turbines, rigs) close to breeding seabird sites.	**23**	None available for baseline surveys specifically	None available for CSS Sector				No mitigation measures available			
	Increased vessel activity during environmental baseline surveys	Elevated risk of introducing non-native species as biofouling on the surfaces of vessels	**Biological Disturbance** (introduction of non-native species)	Introduction and ingress of invasive non-native species as biofouling species on the surfaces of vessels or construction plant.	**25**	None available for baseline surveys specifically	None available for CSS Sector	None available for baseline surveys specifically	No mitigation measures available					
CONSTRUCTION AND DECOMMISSIONING (applies only to the TIDE and CCS sectors where devices, cable or pipelines would need to be installed and then, at the end of their operational life, removed. For the AGG sector there is no equivalent phase and it is only the impacts arising during the preparatory survey work or during the operational (dredging) phase that apply.	Use of jack-up legs and other activities for the installation and decommissioning of structures (including any future 'repowering'/upgrading activities), power cables or carbon pipelines.	Damage to vulnerable benthic habitats outside the developmental footprint from construction activities including abrasion from equipment and smothering of habitats where significant sediment is released.	**Physical Damage** (indirect and temporary damage to marine habitat)	Changes to coastal and offshore habitat as result of damage from baseline surveys (e.g. boreholes/trawls); from equipment use causing abrasion, damage or smothering during installation and from maintenance and removal of cables/pipelines/devices (e.g. jack-up legs, vessels, anchors, mooring chain).	**5**	2, 3, 8	None available for CSS Sector		Surveys, micro-siting of devices, site remediation					No measures to address decommissioning or repowering; No measures for habitat smothering
	Activities associated with the Installation and decommissioning of power cables, carbon pipelines and landside structures.	Damage to vulnerable terrestrial and freshwater habitats outside the developmental footprint from construction activities.	**Physical Damage** (indirect and temporary damage to landward habitat in development footprint)	Damage to onshore habitat (including bird breeding grounds, freshwater habitats, otter holts or shelters) by excavation, piling and construction work associated with the installation, operation and decommissioning of cables, CQ pipelines and landside infrastructure.	**9**	10	None available for CSS Sector			Horizontal Directional Drilling (HDD)	Horizontal Directional Drilling (HDD)	Horizontal Directional Drilling (HDD)	Horizontal Directional Drilling (HDD)	Measures only available to deal with cabling effects; No measures for wider effects on onshore habitats
	Installation and decommissioning of structures (including any future 'repowering'/upgrading activities), power cables and carbon pipelines.	Where significant changes occur to intertidal or subtidal habitats (e.g. substratum) then they can lead to impacts to species' food resources	**Physical Damage** (indirect and temporary damage to habitat)	Reduction in quality of foraging areas as result of damage to coastal and offshore habitat from baseline surveys (e.g. boreholes and trawls); from equipment use causing abrasion, damage or smothering during installation; from maintenance and removal of cables, pipeline, tidal/devices or from scour, sediment transport and hydrodynamic change during operation.	**10**	2, 3	None available for CSS Sector				Surveys, micro-siting of devices	Surveys, micro-siting of devices	Surveys, micro-siting of devices	No measures specifically dealing with foraging but captured generically under the effects of habitat damage on "Associated Species"
	Installation and decommissioning of power cables or carbon pipelines that are aligned through intertidal habitats.	Temporary damage to seal haul out locations during the installation and decommissioning processes	**Physical Damage** (direct and temporary damage to habitat)	Damage to seal haul out locations during the installation, decommissioning and operation of the cables, pipeline and/or cable/pipeline armouring.	**12**	2, 3	None available for CSS Sector					Surveys, micro-siting of devices		No measures specifically dealing with haul outs but captured generically under the effects of habitat damage on "Associated Species"
	Increased vessel activity during installation of devices and arrays (including use of ducted propellers on vessels using dynamic positioning).	Elevated collision risk for marine species especially marine mammals	**Physical Damage** (direct damage to species from collision risk)	Collision risk and possible mortality of species due to the presence of tidal devices or from vessels travelling to and from the site (including propeller collision risk).	**13**	None for non-operation phases	None available for CSS Sector				No mitigation measures available	No mitigation measures available	No mitigation measures available	No measures specifically dealing with effects of vessels during construction and decommissioning
	Increased vessel activity during installation of devices and arrays.	Visual disturbance of species	**Non-Physical disturbance** (disturbance to species)	Visual disturbance and exclusion from areas as a result of surveying; cable, pipeline or tidal device installation/operation and decommissioning activities (including movements of vessels.	**16**	11	None available for CSS Sector				Restricted temporal operations	Restricted temporal operations		No measures specifically dealing with visual effects although the general 'displacement of mobile species' is addressed
	Noise and vibration generated by installation of structures, power cables or carbon pipelines (especially with percussive piling, percussive demolition or the use of explosives).	Underwater noise disturbance that may affect/damage/disturb fish or marine mammals and or airborne noise that may affect bird species	**Non-Physical disturbance** (disturbance to species)	Noise/vibration disturbance and exclusion from areas as a result of vessels and other activities during survey work (e.g. seismic exploration and geophysical surveys), construction (e.g. piling, drilling, cable laying), operation (e.g. device noise), maintenance or decommissioning. Also includes noise/vibration disturbance from vessels and draghead during aggregate extraction.	**17**	13 to 19	None available for CSS Sector				Soft start, restrict operation period/activity	Soft start, restrict operation period/activity	Soft start, restrict operation period/activity	A range of measures available to address disturbance (especially from piling) on mobile species.
	Increased vessel activity during installation and decommissioning of devices, arrays or pipelines.	Elevated risk of spillages/releases of oil or other contaminants & toxic effects on marine species	**Toxic Contamination** (reduction in water quality)	Spillage of fluids, fuels and/or construction materials (inc. from surface coatings/treatments) during installation or removal of structures (devices and cables), during survey/maintenance or during aggregate extraction.	**19**	6, 7	None available for CSS Sector		Coating treatments, provision of bunding & storage	Coating treatments, provision of bunding & storage	Coating treatments, provision of bunding & storage	Coating treatments, provision of bunding & storage	Coating treatments, provision of bunding & storage	Effects on "Associated Species" from paints/coatings is addressed but not the wider risks from spillages etc
	Increase in suspended sediments with associated contaminant from construction work especially in environments with fine sediments (e.g. power cable or carbon pipeline trenching).	Toxic effects on marine species	**Toxic Contamination** (reduction in water quality)	Release of contaminants associated with the dispersion of suspended sediments during installation or removal of structures (devices, pipelines and cables) or from the aggregate extraction process.	**20**	None specifically dealing with sediment contaminants	None available for CSS Sector		No mitigation measures available	No mitigation measures available	No mitigation measures available	No mitigation measures available	No mitigation measures available	No measures specifically dealing with contaminant release from sediments
	Increase in suspended sediments from construction work especially in environments with fine sediments (e.g. power cable or carbon pipeline trenching).	Adverse effects on marine species	**Non-Toxic Contamination** (elevated turbidity)	Increase in turbidity (and possibly reduced dissolved oxygen) associated with suspended sediments release during installation or removal of structures (devices, pipelines and cables) or from aggregate extraction.	**22**	None specifically dealing with plumes	None available for CSS Sector		No mitigation measures available	No mitigation measures available	No mitigation measures available	No mitigation measures available	No mitigation measures available	No measures specifically dealing with turbidity plume effects during TIDE project construction or decommissioning
	Introduction of fixed marine structures above the water surface.	Allowing introduction of rats/mink through the positioning of devices close to breeding seabird sites	**Biological Disturbance** (introduction of non-native species)	Predation by introduced rats/mink through the positioning of static devices (turbines, rigs) close to breeding seabird sites.	**23**	None available for TIDE Sector	None available for CSS Sector				No mitigation measures available			No mitigation measures available
	Increased vessel activity during installation of devices, arrays or pipelines.	Introduction of invasive non-native species from biofouling on vessels and plant	**Biological Disturbance** (introduction of non-native species)	Introduction and ingress of invasive non-native species as biofouling species on the surfaces of vessels or construction plant.	**25**	None available for TIDE Sector	None available for CSS Sector		No mitigation measures available					No mitigation measures available
OPERATIONAL PHASE (includes the process of aggregate extraction and the operation of a tidal energy device, the presences of power cables (TIDE) of carbon delivery pipelines (CCS)	Permanent (operational period) presence of structures on the seabed	Loss of seabed habitat and species from the placement of turbines, arrays, cables or pipelines.	**Physical Loss/Gain of habitat** (loss of habitat in development footprint)	Loss of coastal and offshore habitat under the footprint of devices, power cables, CQ pipelines and also cable/pipeline armouring arising from the installation, operation and decommissioning of these structures.	**1**	1, 2			Surveys and micro-siting of tidal devices					No measures to address macro-siting such as avoiding designated sites where possible
	Permanent (operational period) presence of structures, power cables, carbon pipelines and infrastructure onshore	Loss of terrestrial or freshwater habitat and species from the placement of landside infrastructure (e.g. power cables and converter stations or carbon pipelines)	**Physical loss/gain of habitat** (direct change to habitat within development footprint)	Loss of onshore habitat (including bird breeding and roosting grounds, freshwater habitats, otter holts or shelters) under the footprint of power cables, CO2 pipelines, cable/pipeline armouring and landside infrastructure due to the installation, operation and decommissioning of these structures.	**2**	10	None available for CSS Sector			Horizontal Directional Drilling (HDD)	Horizontal Directional Drilling (HDD)	Horizontal Directional Drilling (HDD)	Horizontal Directional Drilling (HDD)	Only deals with cabling effects through HDD option; No measures for impacts via other activities

Table A7. Impact-Mitigation matrix for TIDE, CCS and AGG projects

						Sector Mitigation Measure Availability (see Appendix B for List of MMO Standard Mitigation)			**Feature Mitigation Summary**					**Mitigation Status Review** (identification of gaps)
Project Phase	**Activity**	**Change**	**Sensitivity Category** (Using standard 'categories of operations which may cause deterioration or disturbance' (UK Marine SAC project, 2001))	**Impact Pathway Description** (see Note at the bottom of the table describing sources and HRA precedents - see also Table A1a for list)	**Pathway Ref. No.** (see Table A1a for list)	**TIDE**	**CCS**	**AGG**	Coastal, Intertidal and Subtidal Habitats and Associated Species	Supralittoral (Onshore) Habitats and Species	Bird Species	Marine Mammals (Seals, Cetaceans, Otter)	Migratory Fish and Freshwater Pearl Mussel	**Status of Standard MMO Measures** (NB in all cases there are no statutory measures and no measures specially for the CCS sector)
	Permanent (operational period) presence of structures on the seabed	Where significant losses occur to intertidal or subtidal habitats (e.g. substratum) then they can lead to impacts to species' food resources	**Physical loss/gain of habitat** (direct change to habitat within development footprint)	Loss of foraging areas from a reduction in coastal and offshore habitat due to installation of devices, power cables, CO2 pipelines and/or cable/pipeline armouring both at the development footprint and outside from bed scour and indirectly from changes to the hydrodynamic (wave and tide) regime.	**3**	2, 3	None available for CSS Sector				Surveys and micro-siting of tidal devices	Surveys and micro-siting of tidal devices	Surveys and micro-siting of tidal devices	No measures specifically dealing with foraging (outwith prey displacement through noise effects - see MMO pathways 13-15)
	Permanent (operational period) presence of structures on the seabed	Change to habitat composition (e.g. substratum) at developmental footprint and resulting changes to prey availability and species behaviour (e.g. fish aggregation, artificial reef or bird roosting)	**Physical loss/gain of habitat** (direct change to habitat around the development footprint)	Presence of tidal generation (or other) structures on seabed for the duration of the project resulting in changes to prey and species behaviour (e.g. acting as FAD (Fish Aggregating Device), artificial reef or bird roost).	**4**	None specifically dealing with FAD	None specifically dealing with FAD				No mitigation measures available	No mitigation measures available	No mitigation measures available	No measures specifically dealing with FAD behaviours
	Use of jack-up legs and other activities for the maintenance of marine structures, power cables and pipelines.	Regular disturbance to, or damage of, seabed habitat features	**Physical Damage** (direct and temporary damage to habitat)	Changes to coastal and offshore habitat as result of damage from baseline surveys (e.g. boreholes/trawls); from equipment use causing abrasion, damage or smothering during installation and from maintenance and removal of cables/pipelines/devices (e.g. jack-up legs, vessels, anchors, mooring chain).	**5**	None specifically dealing with Operational Phase	None available for CSS Sector		No mitigation measures available					No measures dealing with operational (maintenance) phase of TIDE projects (only MMO pathways 2, 3 & 8 dealing with construction)
	Extraction work within the licensed aggregate area.	The removal of surface substratum and associated seabed benthos leading to damage but followed by a process of re-colonisation and recovery.	**Physical Damage** to habitat (direct and temporary damage to habitat)	Damage to offshore seabed habitat at the site of extraction during the period of the works.	**6**			4, 5	Surveys; exclusion zone					Measures don't address effects to wider associated species such as bird foraging
	Plume dispersion over the areas adjacent to the licensed aggregate area.	The settlement of sediment causing changes to the seabed habitats	**Physical Damage** to habitat (indirect and temporary damage to habitat)	Damage to the areas surrounding the site of extraction as a result of sediment redistribution and settlement.	**7**			4, 5	Surveys; exclusion zone					No measures specifically dealing with 'plume settlement' effects around extraction area but assumed to be encompassed by measures 4 and 5 (NB these refer to "construction phase")
	Presence and operation of sub-surface structures or changes to the seabed bathymetry	Changes to the hydrodynamics causing seabed disturbance through local scour and more distant erosion and smothering by re-deposition of mobilised sediment	**Physical Damage** (indirect and longer-term damage to habitat)	Changes to coastal and offshore habitat as a result of alterations to the wave climate or hydrodynamic (wave and tide) regime from the presence of tidal devices, CO2 pipelines, power cables or cable/pipeline armouring causing physical changes (including alterations to sediment transport/scour) or from changes to seabed/sandbank morphology at the extraction site(s) (including alterations to sediment transport/scour).	**8**	9	None available for CSS Sector	None available for AGG Sector	Cable effects					For TIDE sector measures deal with cables not devices and there are no equivalent measures for the AGG sector
	Activities for the maintenance of landside structures including power cables, converter stations or carbon pipelines.	Regular disturbance to, or damage of, habitat features (including onshore otter holts and shelters or seal haul outs)	**Physical Damage** (indirect and longer-term damage to landward habitat)	Damage to onshore habitat (including bird breeding grounds, freshwater habitats, otter holts or shelters) by excavation, piling and construction work associated with the installation, operation and decommissioning of cables, CQ pipelines and landside infrastructure.	**9**	None available for TIDE Sector	None available for CSS Sector			No mitigation measures available	No mitigation measures available	No mitigation measures available	No mitigation measures available	Any onshore habitat issues only addressed through cabling mitigation; No measures for wider effects on onshore habitats from maintenance work
	Use of jack-up legs and other activities for the maintenance of marine structures, power cables or pipelines.	Where significant changes occur to intertidal or subtidal habitats (e.g. substratum) then they can lead to impacts to species' food resources	**Physical Damage** (indirect and longer-term damage to habitat)	Reduction in quality of foraging areas as result of damage to coastal and offshore habitat from baseline surveys (e.g. boreholes and trawls); from equipment use causing abrasion, damage or smothering during installation; from maintenance and removal of cables, pipeline, tidal/devices or from scour, sediment transport and hydrodynamic change during operation.	**10**	2, 3	None available for CSS Sector				No mitigation measures available	No mitigation measures available	No mitigation measures available	No measures specifically dealing with foraging but captured generically under the effects of habitat damage on "Associated Species"
	Increase in suspended sediments and plume settlement during aggregate extraction	Where significant changes occur to intertidal or subtidal habitats (e.g. substratum) then they can lead to impacts to species' food resources	**Physical Damage** (direct and longer-term damage to habitat)	Reduction in quality of foraging areas as result of damage to coastal and offshore habitat within and surrounding the aggregate sites during the extraction process.	**11**			11			Restricted temporal operations	Restricted temporal operations	Restricted temporal operations	Displacement effects mitigation from AGG sector exist but are generic without reference to specific impacting activities
	Presence of power cables or pipelines and armouring on intertidal habitats	Impacts to seal haul out locations where any structures remain permanently present across intertidal areas (possibly also causing scour across adjacent areas)	**Physical Damage** (direct and longer-term damage to habitat)	Damage to seal haul out locations during the installation, decommissioning and operation of the cables and cable armouring	**12**	None specifically dealing with Operational Phase	None available for CSS Sector					No mitigation measures available		No measures specifically dealing with haul outs during operational phase
	Presence and operation of sub-surface structures and increased maintenance vessel activity (including use of ducted propellers on vessels using dynamic positioning)	Collision risk from subsurface turbines or maintenance vessel movements	**Physical Damage** (direct damage to species from collision risk)	Collision risk and possible mortality of species due to the presence of devices or from vessels travelling to and from the site (including propeller collision risk)	**13**	12	None available for CSS Sector	None available for AGG Sector			Automatic proximity shutdown	Automatic proximity shutdown	Automatic proximity shutdown	No measures for AGG sector and No measures dealing with vessels effects in TIDE sector
	Presence of above water structures, and any associated lighting	Changes to the behaviour of migrating or foraging birds	**Physical Damage** (direct damage to species from collision or disorientation)	Presence of above water structures, and any associated lighting, influencing migration/foraging of bird species.	**14**		None available for CSS Sector				No mitigation measures available			No mitigation measures available
	Presence and operation of sub-surface moving turbines	Behavioural effects through the physical presence of devices/arrays that causes avoidance or creates barrier to movements	**Non-Physical disturbance** (exclusion of species)	Presence of sub-surface structures and disturbance (noise or visual) associated with tidal devices may present a barrier to movement and block migratory pathways or access to feeding grounds depending on array design.	**15**	None specifically dealing with barrier effects						No mitigation measures available	No mitigation measures available	No measures dealing with barrier effects
	Increased vessel movements and other activities during maintenance work or excavation	Visual disturbance of species	**Non-Physical disturbance** (disturbance to species)	Visual disturbance and exclusion from areas as a result of surveying, cable and device installation/operation and decommissioning activities and movements of vessels.	**16**	None specifically dealing with visual effects	None available for CSS Sector	11			Restricted temporal operations	Restricted temporal operations		No measures specifically dealing with visual effects in TIDE sector although the general 'displacement of mobile species' in AGG sector is addressed
	Noise and vibration greater by operating equipment and vessels	Noise disturbance that may affect/damage/disturb fish or marine mammals	**Non-Physical disturbance** (disturbance to species)	Noise/vibration disturbance and exclusion from areas as a result of vessels and other activities during survey work (e.g. seismic exploration and geophysical surveys), construction (e.g. piling, drilling, cable laying), operation (e.g. device noise), maintenance or decommissioning. Also includes noise/vibration disturbance from vessels and draghead during aggregate extraction.	**17**	None specifically dealing with vessel effects	None available for CSS Sector	11			Restricted temporal operations	Restricted temporal operations	Restricted temporal operations	No measures specifically dealing with vessel effects in TIDE sector although the general 'displacement of mobile species' in AGG sector is addressed
	Operation of subsea power cables	Electromagnetic fields around cables potentially affecting sensitive species and interfering with prey location and mate detection in some species	**Non-Physical disturbance** (disturbance to species)	Impacts from Electromagnetic Fields (EMF) on electromagnetically sensitive fish and cetaceans interfering with prey location and mate detection in some species and creating barriers to migration.	**18**	20, 21						No mitigation measures available for cetaceans	Shielding, burial depth, cable separation	Mitigation measures available for fish species but not cetaceans
	Increased vessel activity during maintenance work or aggregate extraction.	Elevated risk of spillages/releases of oil or other contaminants & toxic effects on marine species	**Toxic Contamination** (reduction in water quality)	Spillage of fluids, fuels and/or construction materials (inc. from surface coatings/treatments) during installation or removal of structures (devices and cables), during survey/maintenance or during aggregate extraction.	**19**	6, 7	None available for CSS Sector	None available for AGG Sector	Coating treatments, provision of bunding & storage	Coating treatments, provision of bunding & storage	Coating treatments, provision of bunding & storage	Coating treatments, provision of bunding & storage	Coating treatments, provision of bunding & storage	Effects on "Associated Species" from paints/coatings is addressed but not the wider risks from spillages etc. and AGG sector not addressed
	Increase in suspended sediments with associated contaminants during aggregate extraction	Toxic effects on marine species	**Toxic Contamination** (reduction in water quality)	Release of contaminants associated with the dispersion of suspended sediments during installation or removal of structures (devices, pipelines and cables) or from the aggregate extraction process.	**20**			None specifically dealing with sediment contaminants	No mitigation measures available	No mitigation measures available	No mitigation measures available	No mitigation measures available	No mitigation measures available	No measures specifically dealing with contaminant release from sediments
	Release of CO_2 into the water column	Acidification of sea water with adverse effects of marine species (especially shellfish)	**Toxic Contamination** (reduction in water quality)	Release of CO_2 into the water column and its acidification from the formation of carbonic acid	**21**		None available for CSS Sector		No mitigation measures available		No mitigation measures available	No mitigation measures available	No mitigation measures available	No mitigation measures available
	Increase in suspended sediments and plume settlement during aggregate extraction	Adverse effects on marine species	**Non-Toxic Contamination** (elevated turbidity)	Increase in turbidity (and possibly reduced dissolved oxygen) associated with suspended sediments release during installation or removal of structures (devices, pipelines and cables) or from aggregate extraction.	**22**			None specifically dealing with plumes	No mitigation measures available	No mitigation measures available	No mitigation measures available	No mitigation measures available	No mitigation measures available	No measures specifically dealing with turbidity plume effects during aggregate extraction
	Introduction of fixed marine structures above the water surface.	Allowing introduction of rats/mink through the positioning of structures close to breeding seabird sites	**Biological Disturbance** (introduction of non-native species)	Predation by introduced rats/mink through the positioning of static devices (turbines, rigs) close to breeding seabird sites.	**23**	None available for TIDE Sector	None available for CSS Sector				No mitigation measures available			No mitigation measures available
	Presence and operation of sub-surface structures	Introduction and colonisation of invasive non-native species on introduced hard substrata	**Biological Disturbance** (introduction of non-native species)	Introduction of new structures (tidal devices or construction platforms) on the seabed providing new substratum that facilitates the colonisation and ingress of invasive non-native species.	**24**	None available for TIDE Sector	None available for CSS Sector		No mitigation measures available					No mitigation measures available
	Presence and operation of vessels and construction plant	Introduction of invasive non-native species from biofouling on vessels and plant	**Biological Disturbance** (introduction of non-native species)	Introduction and ingress of invasive non-native species as biofouling species on the surfaces of vessels or construction plant.	**25**	None available for TIDE Sector	None available for CSS Sector	None available for AGG Sector	No mitigation measures available					No mitigation measures available

Appendix B: Marine Management Organisation – 'Standard' Mitigation Measures

This appendix presents a review of possible measures that could be applied at a project level to mitigate for possible, or known, adverse effects. These are derived from regularly used or previously proposed mitigation measures that the Marine Management Organisation (MMO) may draw upon as part of their consents and licensing responsibilities taking into account recommendations from SNCBs. These measures are listed in Table B1 and compared against the identified HRA impact pathways (as separately listed in Table A1 in Appendix A).

These mitigation measures are drawn from the experience of the MMO in relation to applications that have been made to date and they have not been framed within any formal Strategic Environmental Assessment (SEA). Therefore, as presented here, they do not carry statutory weight beyond being options for the MMO to consider. This means that, for the purposes of this HRA of the East Marine Plans, it is not possible to rely on these regularly used or previously proposed mitigation measures to be pursued and there is definitely the need to consider further mitigation.

With respect to each of the three sectors under review the background to these measures is as follows:

- **Tidal Energy Generation (TIDE)**: The measures listed for tidal energy generation are derived from the consenting requirements that were applied to the wind power generation life cycle. The impacts from generic infrastructure, cabling and land fall hazards will be the same for tidal energy. Any additional tidal energy impacts will be technology and project specific. Regularly used or previously proposed mitigation measures for Tidal Energy generation technologies are likely to develop as the sector matures.

- **Carbon Capture & Storage (CSS)**: No regularly used or previously proposed mitigation measures have been identified that specifically relate to Carbon Capture & Storage because this sector is in its infancy and there have not been any projects pursued to date. It is recognised that the Offshore Oil and Gas Sectors is deemed to be an appropriate surrogate sector (in the same way that some common wind energy impacts can be allocated to the tidal energy generation sector) but there is no clear strategic list of mitigation measures to draw upon that is specific to the CCS sector .

- **Aggregates (AGG)**: Aggregate dredging has only been a licensable activity for the MMO since 6 April 2011 and so regularly used or previously proposed mitigation measure are emerging on a case by case basis. These are likely to build over time to a more recognised set of measures. In lieu of being able to identify regularly used or previously proposed mitigation measures, there are those that have been identified for the licensed sites as identified for AGG1 sites such as in the Licence Renewal Environmental Statement for Areas 212, 328B, 328C and 240 as listed in Table B2 (ABPmer, 2012).

Table B1: Review of MMO Mitigation Measures against identified HRA impact pathways

MMO Mitigation Ref N°	MMO Interest Feature Category	HRA Interest Feature Category	MMO-defined Hazard	MMO Mitigation Description	HRA Pathway Ref N° **	Sector
1	Listed Features	Coastal, intertidal and subtidal habitats and associated species.	Habitat loss through permanent structure placement.	Annex I survey followed by micro site planning around any features.	**1**	TIDE
2	Listed Features	Coastal, intertidal and subtidal habitats and associated species.	Habitat loss or damage through cable routing and or general construction.	Annex I survey followed by micro site planning around any features.	**1, 5**	TIDE
3	Listed Features	Coastal, intertidal and subtidal habitats and associated species.	Physical change to seabed or habitat type during construction.	Annex I survey followed by micro site planning around any features.	**5**	TIDE
4	Annex 1 Habitat (e.g. *Sabelleria spinulosa* reef)	Coastal, intertidal and subtidal habitats and associated species.	Physical change to seabed or habitat type during construction (e.g. *Sabelleria spinulosa* reef).	Activity exclusion zone e.g. 50m (distance dependant on reason for the exclusion zone) buffer beyond the boundary of a listed feature.	**6**	AGG
5	Annex 1 Habitat (e.g. Long Sands Head subtidal sandbank)	Coastal, intertidal and subtidal habitats and associated species.	Physical change to seabed or habitat type during construction (e.g. Long Sands Head subtidal sandbank).	Annual appropriate survey (SSS, sub-bottom profiler & multibeam bathymetry) to provide data for the revision of licences conditions; potential redesign of an activity exclusion zone in line with the mobile features new surveyed position e.g. buffer beyond the current feature boundary of a distance dictated by need to protect the feature and the confidence in delineation of the feature by the detail and quality of the associated survey.	**6**	AGG
6	Listed Features	Coastal, intertidal and subtidal habitats and associated species.	Release of hazardous chemicals that may be toxic, persistent or bioaccumulative into the marine environment.	Any coatings/treatments are suitable for use in the marine environment and are used in accordance with best environmental practice, (e.g. approved by HSE, EA Pollution Prevention Control Guidelines).	**19**	TIDE
7	Listed Features	Coastal, intertidal and subtidal habitats and associated species.	Release of hazardous chemicals that may be toxic, persistent or bioaccumulative into the marine environment.	Install bunding and/or storage facilities to contain and prevent the release of fuel, oils, and chemicals associated with plant, refuelling and construction equipment, into the marine environment. i.e. secondary containment should be used with a capacity of not less than 110% of the containers storage capacity.	**20**	TIDE
8	Listed Features	Coastal, intertidal and subtidal habitats and associated species.	Damage associated with the accumulation of unlicensed debris materials and debris.	Any equipment, temporary structures, waste and/or debris associated with the works are removed within a designated period (e.g. 6 weeks) of the completion of the works.	**5**	TIDE
9	Listed Features	Coastal, intertidal and subtidal habitats and associated species.	Hydrodynamic changes caused by cables affecting exposure to energy and water borne particulates (e.g. food and nutrients).	Burying of cables though trenching should be backfilled in such a way that the original sediment profile and hydrology is maintained.	**8**	TIDE

MMO Mitigation Ref N°	MMO Interest Feature Category	HRA Interest Feature Category	MMO-defined Hazard	MMO Mitigation Description	HRA Pathway Ref N° **	Sector
N/A	Habitats and sessile species	Coastal, intertidal and subtidal habitats and associated species.	Small scale smothering and water clarity from construction vessels or levelling of seabed.	No standard mitigation.	**5**	TIDE
N/A	Habitats and sessile species, hydrodynamics	Coastal, intertidal and subtidal habitats and associated species.	Cables on surface causing abrasion, penetration and/or disturbance of substrate below the seabed surface.	No standard mitigation.	**8**	TIDE
10	Terrestrial and supra-tidal features	Coastal, intertidal and subtidal habitats and associated species (onshore habitats).	Feature damage or loss due to land based infrastructure.	Horizontal directional drilling beneath to bypass features.	**2, 9**	TIDE
11	Mobile Species e.g. Red Throated Diver	Seabirds, Marine Mammals and Fish.	Species Displacement (e.g. Red throated diver).	Restricted operations within an temporal and spatial envelope e.g. nocturnal (nautical twilight as described by the U.S. Naval Observatory) operations only during the overwinter period (Dec-Mar).	**16, 17**	AGG
N/A	Mobile Species	Seabirds, Marine Mammals and Fish.	Tidal barrages and other infrastructure posing a barrier to birds, mammals and fish movement.	No standard mitigation.	**15**	TIDE
12	Highly Mobile Species	Seabirds, Marine Mammals and Fish.	Death or injury to highly mobile species by collision with infrastructure (Technology specific) (e.g. marine mammal collision).	Automatic shutdown of rotary mechanism by proximity sensor.	**13**	TIDE
13	Mobile Species	Marine Mammals and Fish.	Displacement of protected species or protected species prey by underwater noise caused by infrastructure installation (piling).	Restrict piling to low species activity periods within annual and diurnal cycles as appropriate.	**17**	TIDE
14	Mobile Species	Marine Mammals and Fish.	Displacement of protected species or protected species prey by underwater noise caused by infrastructure installation (piling).	Where appropriate to the local species ensuring that piling commences using an agreed soft start procedure; the gradual increase of piling power, incrementally over a set time period, until full operational power is achieved. The soft-start duration should be a period of not less than 20 minutes. The soft-start procedure will vary according to hammer and pile design and other factors.	**17**	TIDE
15	Mobile Species	Seabirds, Marine Mammals and Fish.	Displacement of protected species or protected species prey by underwater noise caused by operation of power generating equipment.	Restrict power generation operations to low species activity periods within annual and diurnal cycles as appropriate e.g. to reduce the risk of injury and disturbance to herring during the spawning period (Oct-Nov).	**17**	TIDE

MMO Mitigation Ref N°	MMO Interest Feature Category	HRA Interest Feature Category	MMO-defined Hazard	MMO Mitigation Description	HRA Pathway Ref N° **	Sector
16	Marine mammals	Marine mammals.	Disturbance or injury to marine mammals.	Ensuring that piling activities do not commence until half an hour has elapsed during which marine mammals have not been detected in or around the site. The detection should be undertaken both visually (by Marine Mammal Observer) and acoustically using appropriate Passive Acoustic Monitoring equipment. Both the observers and equipment must be deployed at a reasonable time before piling is due to commence.	**17**	TIDE
17	Marine mammals	Marine mammals.	Disturbance or injury to marine mammals.	Ensuring that at times of poor visibility e.g. night-time, foggy conditions and sea state greater than that associated with force 2 winds, enhanced acoustic monitoring of the zone is carried out prior to commencement of relevant construction activity.	**17**	TIDE
18	Marine mammals	Marine mammals.	Disturbance or injury to marine mammals.	Ensuring that piling commences using an agreed soft start procedure; the gradual increase of piling power, incrementally over a set time period, until full operational power is achieved. The soft-start duration should be a period of not less than 20 minutes. The soft-start procedure will vary according to hammer and pile design and other factors.	**17**	TIDE
19	Marine mammals	Marine mammals.	Disturbance or injury to marine mammals.	Ensuring an efficient communication and reporting methodology exists between the Marine Mammal Observers and the skipper of the piling vessel.	**17**	TIDE
20	Mobile Species e.g. Atlantic salmon, sea trout and European eel	Fish and Pearl Mussel.	Impacts (such as disorientation during migration and attraction/aggregation) of EMF on electro-sensitive receptors.	Apply appropriate shielding and cable burial depth to reduce EMF strength to an acceptable level.	**18**	TIDE
21	Mobile Species e.g. Atlantic salmon, sea trout and European eel	Fish and Pearl Mussel.	Impacts (such as disorientation during migration and attraction/aggregation) of EMF on electro-sensitive receptors.	Consider cable separation and out -of-phase cancellation approaches to negate the potential field magnification cause by multiple close-by 'in-phase' cables.	**18**	TIDE
N/A		All Features.	In combination effects.	No standard mitigation.	**N/A**	ALL
** see Table A1 in Appendix A for full list of HRA-defined impact pathways.						

Table B2: Summary of Potential Ecological Impacts and Mitigation Measures for Aggregate Areas 212, 328 B, 328 C and 240 (ABPmer, 2012)

Receptor	Potential Impact	Impact Significance	Mitigation	Residual Impact
Physical Processes	Changes in wave conditions at the coastline, caused by changes in the pattern of wave refraction as the waves travel over the dredged areas (Section 5.2.1)	Insignificant	None Required	-
	Changes in wave conditions at the coastline, caused by the removal of sandbanks or other similar features within the dredging areas, which may alter the way in which wave energy is dissipated (Section 5.2.2)	Insignificant	None Required	-
	Altered tidal currents both in the vicinity of the dredging areas and close to the coastline, thus disrupting sediment transport pathways (Sections 5.2.3 and 5.2.4)	Insignificant	None Required	-
	Altered/interrupted natural sediment supply to the coast and, or sedimentary features as a result of being trapped in the dredged areas and (Section 5.2.5)	Insignificant	None Required	-
	Beach 'draw down' into the dredged areas by storm waves, i.e. by erosion of material from the foreshore and its deposition within the nearshore zone (Section 5.2.6)	Insignificant	None Required	-
	Changes in SSCs and sedimentation brought about by the plume dispersion during dredging (Section 5.2.6)	Insignificant	None Required	-
Water and Sediment Quality	Potential hydromorphological changes to WFD waterbodies (Section 6.2.1)	Insignificant	None Required	
	Potential Changes to Suspended Sediment Concentrations (Section 6.3.2)	Insignificant	None Required	-
	Potential Changes to Dissolved Oxygen (Section 6.3.3)	Insignificant	None Required	-
	Potential Changes to Levels of Contaminants in Water (Section 6.3.4)	Insignificant	None Required	-
	Potential Impacts from Redistribution of Sediment-Bound Chemical Contaminants (Section 6.3.5)	Insignificant	None Required	-
Nature Conservation and Ecology	Potential Effect of Seabed Removal and Bathymetric Changes on sandbank features of the Haisborough, Hammond and Winterton cSAC (Section 7.2.1)	Insignificant	None Required	-
	Potential Indirect Effect of a Suspended Sediment Plume on sandbank features of the Haisborough, Hammond and Winterton cSAC (Section 7.2.2)	Insignificant	None Required	-
	Potential Indirect Effect of Fine Sand Dispersion on sandbank features of the Haisborough, Hammond and Winterton cSAC (Section 7.2.3)	Insignificant	None Required	-
	Potential Effects of Sediment Flux on sandbank features of the Haisborough, Hammond and Winterton cSAC (Section 7.2.4)	Insignificant	None Required	-
Benthic Species and Habitats	Potential impacts to benthic habitat and species receptors from seabed removal (Section 8.2.1)	Insignificant to minor (general benthic habitat and species)	Best practice measures (Section 3.7)	-
		Insignificant (UK BAP habitat 'subtidal sands and gravels')	Best practice measures (Section 3.7)	-
		Moderate Adverse (*Sabellaria spinulosa*)	Detailed sidescan surveys (and interpretation) at the pre-dredge stage	Insignificant to Minor Adverse

Receptor	Potential Impact	Impact Significance	Mitigation	Residual Impact
			(within the PIZ and the 500m 'smothering' SIZ); more detailed investigations undertaken where necessary. Implementation of exclusion zones if appropriate.	
	Potential impacts to benthic habitat and species receptors due to the suspended sediment plume (Section 8.2.2)	Insignificant (general benthic habitat	None Required	-
		Insignificant (UK BAP priority habitat subtidal sands and gravels)	None Required	-
		Insignificant (*Sabellaria spinulosa*)	None Required	-
	Potential impacts to benthic habitat and species receptors due to fine sand dispersion (incl. bedform) (Section 8.2.3)	Insignificant (general benthic habitat)	None Required	-
		Insignificant (UK BAP priority habitat subtidal sands and gravels)	None Required	-
		Minor Adverse (*Sabellaria spinulosa*)	Not required *per se*, but would benefit from mitigation outlined above for Section 8.2.1.	Insignificant to Minor Adverse
	Potential impacts to benthic habitat and species receptors due to bathymetric changes (incl. sediment flux) (Section 8.2.4)	Insignificant	None Required	-
	Potential disturbance of benthic invertebrate receptors due to noise (Section 8.2.5)	Insignificant	None Required	-
Fish and Shellfish Ecology	Potential impacts of seabed removal on spawning, nursery and overwintering grounds Section 9.21)	Insignificant (fish, general assemblage; indirect effects – food chain)	None Required	-
		Insignificant (fish, general assemblage; indirect effects – habitat change)	Best Practice (Section 3.7)	-
		Insignificant (fish, general assemblage; direct effects – uptake,)	None Required	-
		Minor adverse (fish, sandeel; direct fish uptake); Insignificant (fish, sandeel - egg uptake); Minor adverse (sandeel habitat change)	None Required & Best Practice (Section 3.7)	-
		Insignificant (fish, herring; egg uptake and spawning habitat change)	None Required & Best Practice (Section 3.7.4)	-
		Minor adverse (shellfish), Insignificant (brooding crustacean)	None Required & Best Practice (Section 3.7)	-
	Potential impacts on fish and shellfish due to changes in water quality (due to fine sediment plume and fine sand dispersion) (Section 9.2.2)	Insignificant ((fish, general assemblage)	None Required	-
		Insignificant ((fish, herring eggs and larvae)	None Required	-
		Insignificant (shellfish)	None Required	-
	Potential impacts to fish and shellfish due to noise effects (Section 9.2.3)	Insignificant	None Required	-

Receptor	Potential Impact	Impact Significance	Mitigation	Residual Impact
Marine and Coastal Ornithology	Potential indirect effects on seabirds as a result of seabed removal (incl. prey availability) (Section 10.2.1)	Insignificant (including Terns and Red-throated Divers)	None Required	-
	Potential impacts on the foraging of seabirds features due to suspended sediment plumes (Section 10.2.2)	Insignificant (including Terns and Red-throated Divers)	None Required	-
	Potential impact of disturbance generated by vessel presence on seabirds including noise and vibration (Section 10.2.3)	Insignificant	None Required	-
Marine Mammals	Potential impacts to marine mammals due to seabed removal (Section 11.2.1)	Insignificant	None Required	-
	Potential impacts to marine mammals from reduced water clarity due to the suspended sediment plume (Section 11.2.2)	Insignificant	None Required	-
	Potential disturbance to marine mammals due to the noise and vibration effects (Section 11.2.3)	Insignificant	None Required	-
	Potential collision risk to marine mammals due to vessel movements (Section 11.2.4)	Insignificant	None Required	-
Cumulative Effects and In-combination Impacts	See Table 17.6	Insignificant	None Required	-