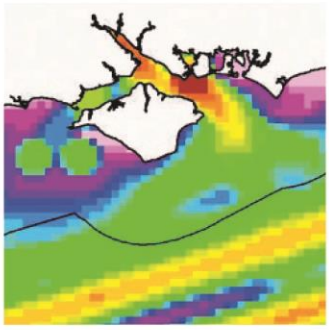
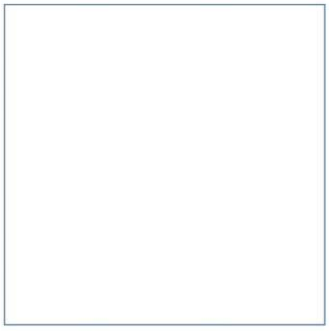
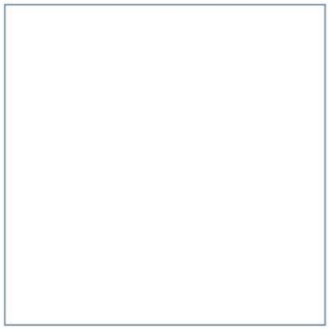
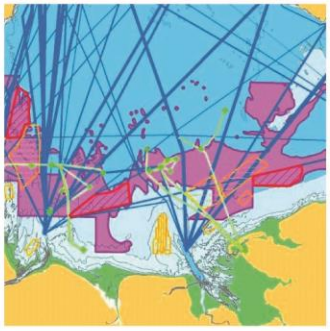
Welsh Government

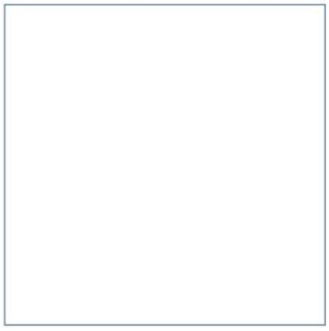
Mitigation and Compensation Opportunity in Marine Consenting

March 2020







Innovative Thinking - Sustainable Solutions

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Document Information

Document History and Authorisation		
Title	Mitigation and Compensation Opportunity in Marine Consenting	
Commissioned by	Welsh Government	
Issue date	March 2020	
Document ref	R.3385	
Project no	R/4844/1	
Date	**Version**	**Revision Details**
09/03/2020	1	Issued for client review
25/03/2020	2	Issued for client use

Prepared	Approved	Authorised
Susanne Armstrong	Natalie Frost	Stephen Hull

Suggested Citation

ABPmer, (2020). Mitigation and Compensation Opportunity in Marine Consenting, ABPmer Report No. R.3385. A report produced by ABPmer for Welsh Government, March 2020.

Notice

ABPmer
Quayside Suite, Medina Chambers, Town Quay, Southampton, Hampshire SO14 2AQ
T: +44 (0) 2380 711844 W: http://www.abpmer.co.uk/

Preface

When consenting marine developments there is a statutory requirement, including as part of the Welsh National Marine Plan, to consider and manage potential impacts upon marine biodiversity, particularly within Marine Protected Areas (MPA). Wales has a number of such sites reflecting the high quality natural environment.

In some cases, where adverse impacts upon an MPA cannot be adequately avoided or mitigated, compensation may be required in order for a project to proceed.

This report reviews MPA related compensation requirements and presents current knowledge and approaches to securing marine compensation.

It is intended that it will aid our understanding of opportunities for the practical application of MPA related compensation requirements particularly with regard to marine renewable energy development.

It is a report to Welsh Government, it does not represent the views of Welsh Government, and should be considered accordingly.

Summary

The main objectives of this study were to:

- Review the range of marine mitigation and compensation measures which are practical and have been secured (or considered), along with any good practice, with a view to delivering effective measures to maintain (or even improve) numbers of birds, fish and mammals and quality of the marine habitats on which they depend within the boundaries of Welsh seas; and
- Consider, at a high level, any limitations associated with the application of novel mitigation and compensation measures and their associated application in marine consenting.

The project was informed by desk top reviews, stakeholder engagement and wider project team experience.

A wide range of mitigation measures have been employed to date for the four key marine ecology receptor groups (marine habitats, birds, fish and mammals). These have been undertaken (or considered) to ensure compliance with a wide range of policy and legislative drivers, as well as to support sustainable development in Welsh waters. An overview of such measures, along with an understanding of their relative effectiveness is provided as part of the deliverables of this project. This provides a useful resource to inform environmental assessments and ultimately the consenting process.

The mitigation hierarchy defines a sequential process that should be adopted to avoid, mitigate and compensate negative ecological impacts, with compensation very much interpreted as a measure of last resort. In this context, mitigation measures should be considered from the very outset of a potential development and may be employed throughout all stages of the project lifecycle.

The specific understanding of compensatory requirements is very much driven by the underlying legislative or policy driver. The whole process of securing and agreeing compensation measures takes into consideration a large number of factors, and there is considerable guidance, case law and precedents that can be drawn upon to inform these requirements. Specific examples in relation to the provision of compensation in the marine environment have to date been largely limited to intertidal habitats, birds and fish. Greater consideration is, however, being given to more novel compensation measures both for these receptors and marine mammals.

There are a number of complexities in defining and securing mitigation and compensation packages. These include, for example, reaching agreement on compensation packages, delivering like for like, certainty of effectiveness, timing issues and costs. There are also a number of key practical elements which potentially influence the effective delivery of compensatory measures. These include, for example, the requirement to obtain separate consents to implement the measures, overlap with both the terrestrial and marine planning regimes and the alignment of timings of the potential impacts and the ability to deliver the required compensatory measures. It is also not uncommon for such schemes to encounter objections from local stakeholders, and for numerous site specific issues to slow implementation. The delivery of a number of compensatory measures has also been dependent on the availability of suitable land (for which there can be considerable competition).

The extent to which compensation objectives are being met is generally regularly reviewed through monitoring, with more formally defined review periods typically in the region of 5 to 10 years. For most UK compensatory sites with specific compensation objectives, it is also uncertain how these sites will be 'signed off' and the habitat deemed acceptable compensation for that which was lost. The duration of these types of agreements also introduces uncertainty as a developer may become insolvent over such a time period. A mechanism to ensure delivery is fulfilled into the longer term (as required by a number of legislative drivers) is therefore important.

Overall, it was suggested by stakeholders that there is a requirement for greater guidance and clarity on the whole process of agreeing mitigation and compensation requirements for individual projects. This would ideally capture all stages in the process from understanding the initial adverse impacts, identifying and agreeing the respective measures, setting objectives and ultimately how compliance will be demonstrated. In practice any new guidance would need to build on existing guidance and might prove difficult to achieve given the complexities of site and project specific issues. Such guidance would also need to be designed to meet the needs of developers, regulators and wider stakeholders.

As highlighted above, there are a number of possible mitigation, compensation and enhancement measures that can be applied for marine ecological receptors. It is important that the associated evidence base is maintained and developed to better understand the levels of certainty that can be assumed in terms of the likelihood of successful application. Similarly, it is important to understand the environmental effects of new and emerging technologies as well as increasing project scales.

There is an ongoing requirement to understand the full breadth of mitigation and compensation opportunities that may be relevant to, and can be factored into, the marine consenting process. There is also a requirement for greater research, and ultimately policy decisions, in relation to the overall acceptability, legal compliance and practical application of mitigation/compensation options and any alternative solutions. Consideration should also be given to a more strategic, holistic approach to the provision of mitigation, compensation and environmental enhancements.

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1 Introduction

The Welsh National Marine Plan (WNMP) sets out the long term vision for the sustainable development of Welsh waters. This recognises the importance of the marine environment in supporting a wide range of habitats, species and important heritage features that are protected through international, national and local designations, as well as in contributing to people's wellbeing. In addition, a diverse array of activities which are vital to the Welsh economy are located and operate within this space.

The WNMP sets out a series of both general cross-cutting and sector-specific policies. General policies seek to promote sustainable development and include those with specific reference to the protection and enhancement of the marine environment as well as the decision-making process. Sector policies include supporting and safeguarding policy for activities such as Aggregates, Aquaculture, Defence, Dredging and Disposal, Energy – Low Carbon, Energy – Oil and Gas, Fisheries, Ports and Shipping, Subsea Cabling, Surface Water and Wastewater Treatment and Disposal (SWW) and Tourism and Recreation. Sector objectives articulate the desired future state for that sector and provide the associated rationale for the policies. In the specific context of this project this includes aspirations to promote Marine Renewable Energy (MRE) activities (wave, tidal stream, tidal range and offshore wind) in Welsh waters and recognises other sectors are also likely to grow and use marine resources.

To implement sustainable development, the consenting of projects and activities needs to be informed by a proportionate and sound evidence base, underpinned by robust environmental assessments. The exact nature of the assessments depends on the type and scale of the activity proposed, as well as site specific parameters such as the potential to affect protected features. Furthermore, the assessment process determines the potential for environmental effects and ultimately the identification of required mitigation, compensation and enhancement measures to meet the respective legislative and policy drivers.

The specific definitions of mitigation and compensation, and how they are applied, vary across the different underpinning legislation. Natural Resources Wales (NRW) has defined mitigation and compensation as follows[1], and it is these definitions that have been assumed within this project:

- **Mitigation**: A measure to avoid, reduce, minimise or cancel out one or more adverse impacts.
- **Compensation**: A measure to make up for the negative effects of a plan or project. The term should only be used appropriately in the context of the different legislation requirements when referring to specific measures.

A wide range of mitigation and compensation measures have been employed to date for the four key receptor groups which have been the focus of this project: habitats, fish, marine mammals and birds. An overview of such measures, along with an understanding of their relative effectiveness, provides a useful resource to inform environmental assessments. In addition, with the development of new and emerging technologies, and the expansion into new areas and increasing project scales, the requirement for additional measures to secure the network of protected ecological features in Welsh waters is becoming more apparent. This has resulted in a need to understand the breadth of mitigation and compensation opportunities that may be relevant to, and can be factored into, the marine consenting process.

[1] In its 'guidance on terminology relating to environmental measures in the context of marine developments' (NRW, 2018).

1.1 Objectives

The main objective of this project was to identify the legislative requirements applying to marine consenting decisions in Wales that give rise to mitigation and/or compensation considerations. More specifically this included:

- To review the range of marine mitigation and compensation measures which are practical and have been secured (or considered), along with any good practice, with a view to delivering effective measures to maintain (or even improve) numbers of birds, fish and mammals and quality of the marine habitats on which they depend within the boundaries of Welsh seas; and
- To consider, at a high level, any limitations associated with the application of novel mitigation and compensation measures and their associated application in marine consenting.

The main focus of the project has been the potential effects arising from MRE developments on marine habitats, fish, marine mammals and birds. However, lessons learnt from other sectors and the wider applicability of the findings has also been considered. Similarly, while the main focus of the project was in relation to the provision of effective mitigation and compensation, wider requirements for environmental enhancements have also been captured where applicable.

The project was informed by desk top reviews, stakeholder engagement and wider project team experience.

1.2 Report structure

To provide this information the report is structured as follows:

Section 2: Outlines the approach taken to identify current and potential mitigation and compensation requirements;
Section 3: Highlights policy and legislative drivers for mitigation and compensation requirements as well as enhancement opportunities;
Section 4: Provides background context with respect to protected habitats and species in Wales;
Section 5: Provides a review of possible mitigation measures;
Section 6: Outlines potential compensation measures; and
Section 7: Presents an over-arching summary and conclusions.

In addition, the report includes the following appendices:

Appendix A: Online survey – a copy of the questionnaire exported from SurveyMonkey;
Appendix B: A list of organisations contacted with respect to the questionnaire;
Appendix C: Stakeholder responses – all responses received to the online survey (anonymous); and
Appendix D: **(Environment (Wales) Act)** Section 7 habitats and species.

This report is also supported by an accompanying Microsoft Excel spreadsheet: (Mitigation_Summary_25Mar2020.xlsx).

2 Approach

To achieve the objectives of this project, a combination of desk-based review, stakeholder engagement and project team experience were used. The methodology applied to each of the project tasks is outlined below.

2.1 Policy and legislative drivers

A review of all legislative drivers that give rise to mitigation and/or compensation requirements was undertaken. The review is provided in Section 3, and is structured according to the driver hierarchy, with European Directives and their transposing legislation discussed first in Section 3.1, UK legislation and policy in Section 3.2, and Welsh legislation, policy and plans in Section 3.3. A synthesis bringing it all together, demonstrating the hierarchy, interlinkages and synergies is also provided in Section 3.4.

2.2 Ecological features

A review of protected sites and features in Welsh waters was undertaken based on the current status of the Welsh Marine Protected Area (MPA) network (https://naturalresources.wales/guidance-and-advice/environmental-topics/wildlife-and-biodiversity/protected-areas-of-land-and-seas/marine-protected-areas/?lang=en). This included consideration of the international (Special Protection Area (SPA), Special Area of Conservation (SAC) and Ramsar sites) and national (Site of Special Scientific Interest (SSSI) and Marine Conservation Zones (MCZs)) designations in Welsh waters. Similarly, protected habitats and species such as those listed under Section 7 of the Environment (Wales) Act were also captured.

2.3 Possible mitigation and compensation measures

A review of possible mitigation and compensations measures has been undertaken to identify those that have successfully been applied or proposed for application to date, as well as more novel concepts that could be considered going forward. In this context, examples of wider enhancement measures that have been employed to date and which could also be applied as mitigation or compensation measures have also been captured.

This work included a review of plan level Habitats Regulations Assessments (HRAs), the supporting assessments for recent marine licence and Nationally Significant Infrastructure Projects (NSIP) application/authorisations, as well as direct project team experience. Previous reports that have synthesised effective mitigation and compensation measures were also reviewed. The main focus of the review was on MRE projects; however, experience from other sectors for which evidence is transferable was also captured.

2.3.1 Possible mitigation measures

A matrix was developed to outline currently employed mitigation measures, or those that have been proposed as part of MRE applications, where there is a relatively high degree of certainty in their success. This was set in the context of key impact pathways for each of the receptors being considered within this project (marine habitats, birds, fish and mammals). It was based on the principles of the activities-pressures-sensitivity relationships which have been developed by the Statutory Nature Conservation Bodies (SNCBs). This enabled possible mitigation measures to be captured according to pathways/pressures regardless of the over-arching project or activity type, as

well as individual project stages (e.g. design and planning; construction; operation and maintenance; and decommissioning).

The information captured for each mitigation measure is illustrated in Table 1. Mitigation measures have been described for each of the identified high-level impact pathways. Where it has been possible to provide an indication of the types of activities resulting in these pathways, this has also been included alongside the likely impact to the receptor. Similarly, identification of the point in the project life-cycle at which the mitigation first needs to be considered; whether it is a proven or novel technique; and key considerations for their use have also been identified where possible. The matrix has been provided separately in an excel spreadsheet format (Mitigation_Summary_25Mar2020.xlsx). More generic text on the principles of the mitigation hierarchy and overarching considerations on the use and application of mitigation measures has been provided in the accompanying text (see Section 5).

The spreadsheet is structured in accordance with each of the receptor groups and has an accompanying set of "readme" information. The terminology applied within the spreadsheet has been standardised as far as possible to ensure consistency across the different categories of information.

Table 1. Parameters recorded within the mitigation matrix

Parameter	Description
Pathway	Describes the potential pathway which leads to an impact requiring mitigation. These will be specific to each receptor type.
Life-cycle phase of impact	This is the lifecycle phase(s) in which the impact is realised. The lifecycle phase(s) will be selected from the following: ▪ Planning/Design ▪ Construction ▪ Operation/Maintenance ▪ Decommissioning
Example activity and impact	This includes an example of an activity which leads to the pathway, and a description of the impact which requires mitigation. These will be specific to each receptor type.
Mitigation Measure	This describes the mitigation measures that could be implemented. These will be specific to each receptor type/impact pathway. However, the measures are grouped into the following three categories: ▪ Consideration of location, footprint and scale of scheme/activities ▪ Design of scheme/activities ▪ Construction and operational working practices.
Mitigation Hierarchy	This column describes where in the mitigation hierarchy that the measures sits. The mitigation hierarchy is broken down into these four options: ▪ Avoid ▪ Minimise ▪ Compensate ▪ Restore
Mitigation implemented at which life-cycle phase	This column is selected from the same life-cycle phases as above. It describes at what point in the life-cycle the mitigation should be incorporated into the scheme and implemented.
Proven technique?	In order to address whether the technique is considered successful, this column identifies the regularity that it has been implemented as a mitigation measure, and is selected from the following five options:

Parameter	Description
	▪ **Industry standard in UK** - Used as a matter of course and considered best practice for the pathway in the UK. ▪ **Regularly applied** - Known to be applied across industry worldwide, however not always required for industry within the UK ▪ **Has demonstrated success, but not regularly used** - Examples of use, either in the UK or abroad, with proven success. However, not applied regularly within the UK or abroad. ▪ **Novel** - Identified as a potential mitigation, or posed in literature, but not applied in industry and as such has limited evidence for efficacy. ▪ **Effectiveness uncertain** - The mitigation measure has been referred to in literature and may have been applied in industry but its effectiveness has been questioned either in literature or as a result of monitoring
Key Considerations	These detail the key considerations which need to be considered as part of the implementation of the mitigation measure. These are wide ranging but will be developed from the following list: ▪ Sensitivity of receptor ▪ Legislative requirement ▪ Sediment quality ▪ Magnitude of impact ▪ Value of receptor - (relative or absolute) ▪ Balance of impacts ▪ Site history ▪ Data availability ▪ Site suitability ▪ Local species characteristics ▪ Site characteristics ▪ Suitability of infrastructure ▪ Key species present

2.3.2 Possible compensation measures

Various types of compensatory measures have been implemented to date, primarily for intertidal habitats and birds. More limited examples are known for fish and there are no known instances where they have been applied for marine mammals. Examples of such measures and the underlying principles on which they were agreed is provided in Section 6. These examples have largely been derived from the OMReg database of habitat creation schemes maintained by ABPmer (https://www.omreg.net/), as well as wider project experience and lessons learnt from across marine activities.

This was supplemented from the outputs of strategic and ongoing research into the success of and the potential use of compensation measures in the marine environment. This included, for example, the 2016 Defra review of the Effectiveness of Natura 2000 Sites Compensation Measures in England (Defra, 2016); Humber Estuary Managed Realignments - Lessons for the Future (Environment Agency, 2013; Creating and Sustaining Compensatory Mudflat (Natural England, 2015a); Severn Tidal Power SEA (Severn Tidal Power, 2010); UK Offshore Wind Expansion - Meeting the challenges of Article 6(4) of the Habitats Directive (ABPmer, 2020), the RenewableUK in partnership with The Crown Estate: Article 6(4) Workshop (January 2020) and MPA management measures.

The development of new and emerging technologies, and the expansion into new areas and increasing project scales, is generating the requirement for the consideration and development of additional measures to secure the network of protected ecological features in Welsh waters. A high-level review of potential innovative compensation measures has therefore also been undertaken. This has been based on an understanding of current measures (and the likelihood of success) as well as the types of pressures that will arise as increasing numbers (and scale) of MRE projects are proposed. A series of case studies have been developed (one for each of the receptor types) to illustrate how the implementation of such measures might work in practice. This has also captured key considerations with respect to how they might be applied in practice. The review of potential measures was further informed though a process of stakeholder engagement (as outlined below).

2.4 Stakeholder engagement

The Welsh Government is committed to working in partnership with stakeholders through continued positive engagement, with a view to promoting sustainable development and proportionate decision making in Wales. Therefore, as a key element of this project, a range of stakeholders with experience of the application of mitigation and compensation measures in marine consenting were consulted to canvass their views.

The main focus of the questionnaire was on compensation measures where there is the greatest uncertainty with respect to the application of novel techniques to ensure compliance with legislative and policy drivers (and associated guidance). ABPmer therefore prepared a series of questions to garner the views of marine practitioners on marine compensation options, techniques and innovations. The online questionnaire was approved by the Welsh Government prior to posting on SurveyMonkey in both English and Welsh (see Appendix A).

The questions required a range of stakeholder responses, including multiple choice answers (select one option only), check-boxes (tick all options that are relevant) and 'free text' to provide further detail if desired. This approach provided stakeholders with the flexibility to offer as much (or as little) information as they wanted. The introductory text suggested the online survey would take less than 10 minutes to complete, although it is noted that this could have been influenced by a range of factors. For example, the level of detail provided by a respondent could have related to familiarity with marine consenting and the provision of compensatory measures, among many other possible variables.

Stakeholders were invited to participate in the online survey by email. A list of organisations invited to complete the online questionnaire can be found at Appendix B. The online survey was open for just over two weeks (19/02/20 to 06/03/20. As noted in Appendix C, which summarises the survey results in detail, in total, 21 fully completed questionnaires were received. A questionnaire was assumed to be completed if the respondent pressed the final 'Submit' button at the end of the online survey, and answered at least one of the content questions.

The initial questions of the online survey (see Appendix A) aimed to understand the range of role(s) undertaken by stakeholders and the sectors in which respondents had an interest in relation to marine consenting and the application of compensatory measures. An appreciation of stakeholder roles was considered a useful way to reflect different perspectives of marine consenting in Wales, while remaining anonymous. As noted in Appendix C, employees from government bodies were the most numerous respondents, with nine responses, followed by consultancies (n=4), Non-Governmental Organisations (NGOs) (n=2), industry bodies (n=2), developers (n=2) and a 'wider stakeholders' (n=1). Six participants did not specify who they worked for/what their role was.

With regard to government bodies, responses were received not only from Welsh, but also English and Scottish agencies, with roles ranging from those involved in licensing to regulatory advice as well as a programme lead/implementer.

Subsequent questions were designed to understand stakeholder views with respect to the main challenges when identifying and securing compensatory measures. This was followed by gathering thoughts on the types of compensatory measures that could be provided for marine ecological receptors – habitats, birds, fish and marine mammals. One of the final questions related to the wider principles of ensuring that there is no future decline in marine biodiversity and mechanisms to achieve better environmental outcomes, whilst another gave respondents with an opportunity to provide further comments.

2.5 Synthesis

A synthesis of each of the project elements outlined above was undertaken to produce an overarching summary and conclusions of the findings. This also included a series of recommendations for further research and consideration.

3 Policy and Legislation

A literature review of all of the legislative drivers that give rise to mitigation and/or compensation requirements has been undertaken. This section is structured according to the driver hierarchy, with European Directives and their transposing legislation discussed first in Section 3.1, UK legislation and policy in Section 3.2, and Welsh legislation, policy and plans in Section 3.3. A synthesis highlighting the hierarchy, interlinkages and synergies is also provided in Section 3.4.

3.1 European Directives

3.1.1 Introduction

European Union (EU) legislation is implemented through common implementation strategies or rules which are developed by joint working of the European Commission (EC) and EU Member States, providing a level of coordination at a regional level. The UK then implements the legislation through national legislative instruments and associated 'directions' or guidance to the relevant departments or agencies. This section discusses the directives listed in Table 2, and outlines how mitigation and/or compensation are interpreted by these, and/or UK legislation.

Table 2. Key EU directives and transposing UK/Welsh legislation

EU Directive (Where Applicable)	Legislation Relevant to Welsh Marine Consenting	Purpose
Environmental Impact Assessment (EIA) Directives (85/337/EEC as amended; 2014/52/EU)	Marine Works (EIA) Regulations 2007 (as amended) (re. marine licensing). Town and Country Planning (EIA) (Wales) Regulations 2017 (as amended) (re. coastal/intertidal aspects). Transport and Works Act 1992 (as amended) (for Developments of National Significance (DNS)). Planning Act 2008 (as amended) (for Nationally Significant Infrastructure Projects (NSIPs)).	Sets out what developments require EIA, and how this should be undertaken.
The Birds and Habitats Directives (2009/147/EC; 92/43/EEC)	Conservation of Habitats and Species Regulations 2017 (the "Habitats Regulations") (as amended).	Establish a network of sites (the 'Natura 2000' network) to protect habitats and species of European importance.
Water Framework Directive (WFD) (2000/60/EC)	Water Environment (WFD) (England and Wales) Regulations 2017	Establishes a legislative framework for the protection of surface waters and groundwater throughout the EU.
Marine Strategy Framework Directive (MSFD) (2008/56/EC)	Marine Strategy Regulations 2010	More effective protection of the marine environment across Europe.

The UK left the European Union (EU) on 31 January 2020, and the European Union (Withdrawal Agreement) Act 2020 received Royal Assent on 23 January. Existing EU law and regulation will continue to apply in the UK throughout 2020, as a result of various amendments to existing regulations implementing European Directives. The UK government has signalled its commitment to 'non-regression' of environmental protection, but the retention of EU law/directives will be decided on a case by case basis. For some, such as the Habits Regulations, new regulations have already been introduced to ensure the continued applicability. However, the UK will no longer be subject to the jurisdiction of the European Court of Justice or the Commission's opinion, and under the terms of the European Union (Withdrawal Agreement) Bill, Ministers/decision-makers have discretion concerning the extent to which EU case law is followed. For the purposes of this report, it is assumed that the requirements of the above Directives will continue to apply, although there is potential scope for some level of divergence in relation to interpretation in the future.

3.1.2 The Environmental Impact Assessment (EIA) Directive

Background

The Environmental Impact Assessment (EIA) Directive (2011/92/EU EIA), as amended by the EIA Directive (2014/52/EU), sets out the procedure that must be followed before approval is granted for a range of plans and projects, defined in Annexes I and II of the Directive. The EIA Directive is transposed into UK law through a series of regulations, notably the Marine Works (Environmental Impact Assessment) Regulations 2007 (as amended) for marine projects. Terrestrial planning extends to the low water mark, and land-based developments can have a direct impact upon the marine area (e.g. development along the coast can require extensive sea defences). As noted in Table 1, different pieces of legislation furthermore apply to Developments of National Significance (DNS)) and Nationally Significant Infrastructure Projects (NSIPs).

The EIA process requires a number of steps to be undertaken to assess the potentially significant effects associated with a particular project, and the effects that might occur cumulatively with other plans and projects. These steps include screening, scoping and the preparation of an environmental statement (ES). In England and Wales, for NSIPs granted permission under the Planning Act 2008, there is an additional step: the preparation of preliminary environmental information prior to the submission of the formal ES. For DNS projects, a pre-application process is furthermore included, a step which is discretionary with marine licence applications through NRW.

In Wales, a developer wishing to apply for a marine licence for a new EIA development at sea or on the coast must provide the Welsh marine licensing authority, NRW, with an assessment of the potential environmental impacts of the new development.

Mitigation and compensation context

Within the EIA Directive, the terms 'mitigation and compensation' are not directly mentioned. Article 5(1) of the Directive states that:

> *'(…) the developer shall include at least: (…) a description of the features of the project and/or measures envisaged in order to avoid, prevent or reduce and, if possible, offset likely significant adverse effects on the environment'.*

Annex IV (Point 7) further elaborates that this should be done for both construction and operational phases of a development. The 2014 amendments added the actions 'prevent' and 'offset' to Article 5. Furthermore, Annex IV now also includes a provision to provide monitoring measures. Image 1 below,

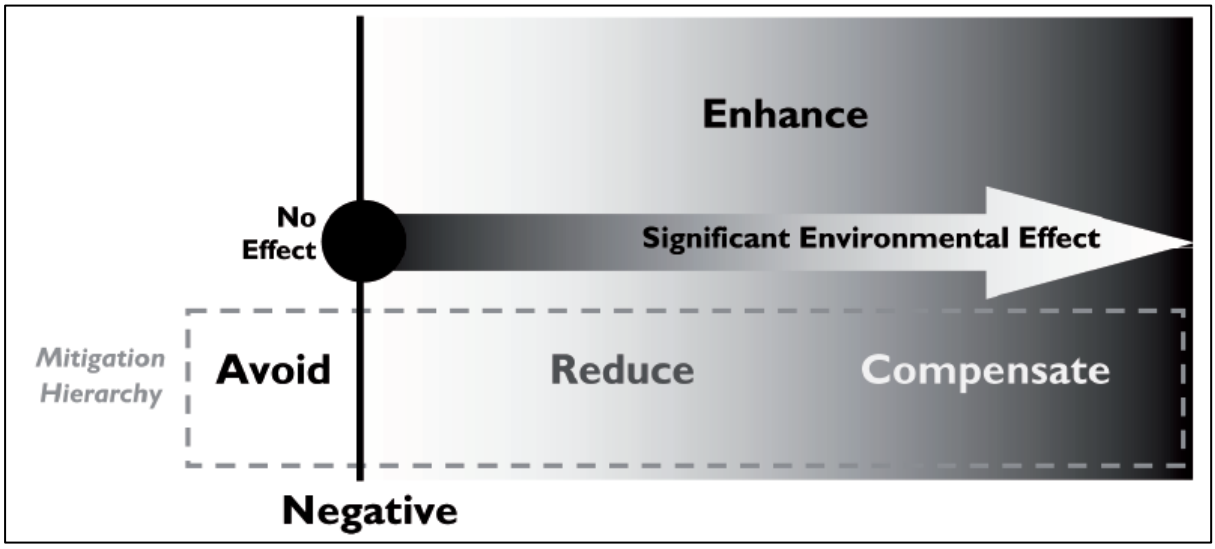
taken from European Commission (EC) (2017a) guidance, shows how mitigation (and compensation/offsetting) are interpreted under the Directive.

Types of Mitigation Measures	
Type of measure	**How it works**
Measures to prevent	Impact avoidance by: ■ Changing means or techniques, not undertaking certain Projects or components that could result in adverse impacts. ■ Changing the site, avoiding areas that are environmentally sensitive. ■ Putting in place preventative measures to stop adverse effects from occurring.
Measures to reduce	Impact minimisation by: ■ Scaling down or relocating the Project. ■ Redesign elements of the Project. ■ Using a different technology. ■ Taking supplementary measures to reduce the impacts either at the source or at the receptor (such as noise barriers, waste gas treatment, type of road surface).
Measures to offset	Offset or compensate for residual adverse impacts that cannot be avoided or further reduced in one area with improvements elsewhere with: ■ Site remediation / rehabilitation / restoration. ■ Resettlement. ■ Monetary compensation.

Source: EC, 2017a

Image 1. Types of mitigation measures as defined by the European Commission

These measures are often referred to as the 'mitigation hierarchy' (see Image 2); reflecting the fact that, in EIA, a sequential process should be adopted to avoid, mitigate and compensate negative ecological impacts, with compensation very much interpreted as a measure of last resort (as noted by Chartered Institute of Ecology and Environmental Management (CIEEM), 2019).



Source: IEMA, 2011

Image 2. The mitigation hierarchy in EIA

The 2017 EC guidance does not provide much detail on how mitigation should be pursued, beyond stating that '*best available techniques can provide a very reliable starting place for Developers*', and that the ES '*should clearly describe the adverse impact each measure is intended to avoid, mitigate or compensate when implemented*'. Furthermore, details on the effectiveness, reliability, certainty and monitoring arrangements should be provided.

UK guidance notes that mitigation should be practiced throughout an EIA and indeed a development's design process. Three categories of mitigation are identified by practitioners (Institute of Environmental Management and Assessment (IEMA), 2011):

1. Actions undertaken by the EIA that influence the design stage;
2. Standard construction practices for avoiding and minimising environmental effects; and
3. Specified follow-up action to be implemented post-consent.

Compensation in EIA terms can be provided either within or outside a project site. CIEEM (2018) guidelines note that, '*as a general rule, compensation should be focused on the same type of ecological features as those affected and equivalent levels of ecological 'functionality' sought*'. However, it is acknowledged that there could be cases when it might not possible to achieve ecological equivalence through compensation.

There can be confusion in EIA practice as to the difference between environmental enhancement measures and mitigation or compensation measures. Enhancement measures are actions that are specifically designed to achieve net environmental gain i.e. to move the environment from its baseline state to an improved state as a result of implementing the development. Mitigation or compensation measures are actions that aim to reduce, remedy or compensate for the negative environmental consequences of a development. The confusion tends to arise where a mitigation measure is predicted to be so effective that not only will it reduce the development's negative environmental effects, but it may also lead to an improvement in the environment. This often occurs in terrestrial developments in relation to landscaping and planting regimes around sites. Confusion between enhancement and compensation is also common in habitat replacement, where habitat is replaced at a ratio greater than one perhaps a ratio of 2:1 (as is often the case with regard to Birds and Habitats Directive compensation; see next section). EIA practitioners can on occasion present this as environmental gain, rather than recognising it as the action required to adequately compensate for negative effects elsewhere (IEMA, 2011).

3.1.3 The Birds and Habitats Directives (Natura 2000 Sites)

Background

The Birds and Habitats Directives seek to establish a network of sites (the 'Natura 2000' network) to protect habitats and species of European importance. The network comprises sites classified under the Birds Directive to protect key bird species and their habitats (SPAs) and sites designated under the Habitats Directive to protect habitats and non-avian species (SACs). This has been transposed into UK law via the Conservation of Habitats and Species Regulations 2017 (SI 2017/1012) (as amended) (the "Habitats Regulations"). Post Brexit, the provisions of the existing Habitats Regulations have been replaced by The Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019, which mirror existing provisions.

The Directives, and associated case law and guidance, establish strict procedures that must be followed by competent authorities when taking decisions on plans and projects potentially affecting features protected by site designations.

As a matter of policy, Ramsar sites are also considered to be subject to the same strict legal protection as European designated nature conservation sites (JNCC, 2019). In the UK, Ramsar site boundaries generally overlap with SPA boundaries. Ramsar sites are designated under the Ramsar Convention, which the UK signed in 1973, and which was aimed at identifying and protecting the most significant wetlands for wildlife, especially waterfowl.

European Protected Species (EPS) are species of plants and animals (other than birds) protected by law throughout the European Union. They are listed in Annexes II and IV of the European Habitats Directive. The lists include several hundred species of plants and animals. This includes many coastal and marine species; for example, all species of cetacean are protected under Annex IV.

Mitigation and compensation context

In relation to European protected sites, guidance produced by the European Commission (EC, in 2018) defines mitigation and compensation as follows:

- *'Mitigation measures in the broader sense, are those measures that aim to minimise, or even eliminate, the negative impacts likely to arise from the implementation of a plan or project so that the site's integrity is not adversely affected. These measures are considered in the context of Article 6(3) and are an integral part of the specifications of a plan or project or conditional to its authorisation;*
- *Compensatory measures are independent of the project (including any associated mitigation measures). They are intended to offset the residual negative effects of the plan or project so that the overall ecological coherence of the Natura 2000 network is maintained. They can only be considered in the context of Article 6(4)*'.

Mitigating measures would be set out as part of the so-called Habitats Regulations Assessment (HRA) process, as specified in the UK's Habitats Regulations. An HRA is required where a plan or project, is located close to, or within, an area designated or proposed under the Birds and Habitats Directives (European Sites) and/or the Ramsar Convention. In essence, this requires the lead Competent Authority (e.g. NRW in the case of marine licensing in Wales) to determine whether the proposed works are likely to have a significant effect on a European Site and, if so, to undertake an Appropriate Assessment of the implications of the proposals in light of the site's conservation objectives.

In carrying out Appropriate Assessments, Competent Authorities must consider whether they can satisfactorily conclude that such mitigating measures incorporated into a plan or project, or secured through conditions, will enable it to be concluded that the plan or project will not have an adverse effect on the integrity of a Natura 2000 site. If this cannot be concluded, then compensatory measures may need to be considered in accordance with the strict test of Article 6(4) of the Habitats Directive.

'Compensatory measures' is a key term used in Article 6(4) of the Habitats Directive and in the Conservation of Habitats and Species Regulations (2017) (as amended). It describes measures taken to ensure that the overall coherence of the Natura 2000 network is protected. Compensatory measures are required once a competent authority has concluded that adverse effects on a Natura 2000 site cannot be ruled out, and where the 'Imperative Reasons of Overriding Public Interest' (IROPI) and 'no alternative solutions' tests have been met (see Image 3 for a flowchart on these tests).

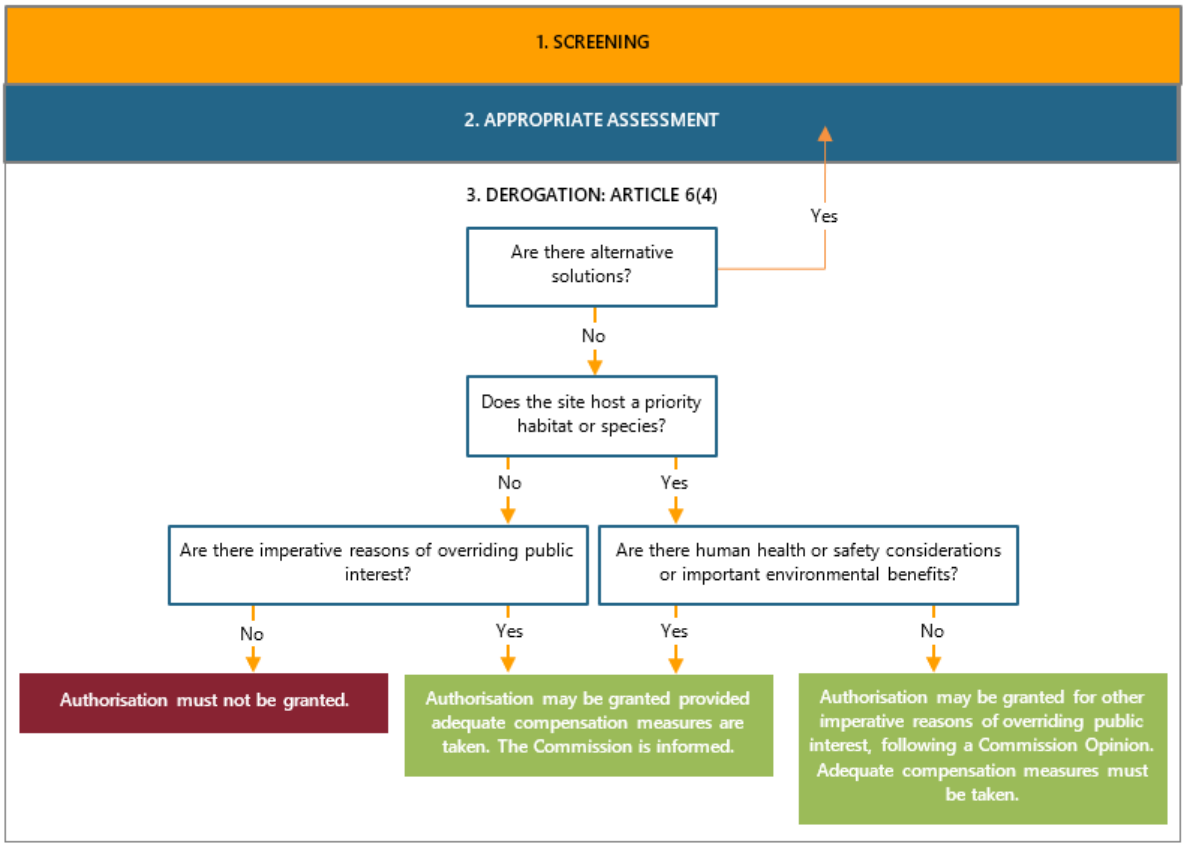


Image 3. Article 6(4) tests

With regard to European protected species, Articles 12 and 16 of Directive 92/43/EEC establish a system of strict protection for the species listed but allow for derogation from these provisions under defined conditions. Sections 43 and 45 of the Habitats Regulations provide protection to the animal and plant EPS respectively, and Section 53 specifies licence requirements (and derogation tests).

A so-called 'mitigation licence' is required if a development will have impacts on EPS that would otherwise be illegal. Any such licence application must pass three legal tests (NRW, 2020a):

- The purpose of the work is for preserving public health or public safety or other imperative reasons of over-riding public interest including those of a social or economic nature and beneficial consequences of primary importance for the environment;
- There is no satisfactory alternative; and
- The action authorised will not be detrimental to the maintenance of the population of the species concerned at a favourable conservation status (FCS) in their natural range.

Compensatory measures – guidance

With the Habitats Directive having been in place for more than a quarter century, a large amount of guidance, case-law and examples are available which detail the principles and practices for delivering compensation where proposed projects meet the alternatives and IROPI tests.

One of the key guidance documents addressing the scope of compensatory measures to maintain the coherence of the *Natura 2000* Network is the 'Managing *Natura 2000* Sites' document (EC, 2000, updated in 2018). This was followed by a further document on Article 6(4) of the 'Habitats Directive'

(EC, 2007), which clarified the concepts of alternatives, IROPI and compensatory measures. This document states that:

> *'to ensure the overall coherence of Natura 2000, the compensatory measures proposed for a project should address, in comparable proportions, the habitats and species negatively affected; concern the same biogeographical region in the same Member State; and provide functions comparable to those which had justified the selection criteria of the original site'.*

The EC's 2018 guidance indicates that appropriate measures could include new habitat creation or '*work to improve the biological value*' of an existing site, or one which is to be classified, '*so that the carrying capacity or the food potential are increased by a quantity corresponding to the loss on the site affected by the project*'. It further specifies that, in terms of the Habitats Directive, the compensation could similarly '*consist of the re-creation of a comparable habitat or the biological improvement of a substandard habitat of the same type within an existing designated site, or even the addition to the Natura 2000 network of a new site of comparable quality to the original site*'.

The 2018 guidance lists the following range of compensatory or accompanying measures which have been implemented 'in current practice in the EU under the Habitats Directive', including those listed/mentioned in the previous paragraph:

- *'Habitat improvement in existing sites: improving the remaining habitat on the site concerned or restoring the habitat on another Natura 2000 site, in proportion to the loss due to the plan or project;*
- *Habitat re-creation: creating a habitat on a new or enlarged site, to be incorporated into Natura 2000;*
- *In association with other works, proposing a new site of sufficient quality under the Habitats or Birds Directive and establishing/implementing conservation measures for this new site;*
- *Species reintroduction;*
- *Species recovery and reinforcement, including reinforcement of prey species;*
- *Land purchase;*
- *Rights acquisition;*
- *Reserve creation (including strong restrictions in land use);*
- *Incentives for certain economic activities that sustain key ecological functions; and*
- *Reduction in (other) threats, usually to species, either through action on a single source or through co-ordinated action on all threat factors (e.g. factors stemming from space-crowded effects).'*

Strong links to a site's conservation objectives and those aspects of structure and function that affect biological integrity are made by both guidance documents, e.g. EC (2007) stated that:

> *'Compensatory measures under the Habitats Directive must be established according to reference conditions that are defined after the characterisation of the biological integrity of the site likely to be lost or deteriorated, and according to the likely significant negative effects that would remain after mitigation. Biological integrity can be defined as all those factors that contribute to the maintenance of the ecosystem including structural and functional assets. In the framework of the Habitats Directive, the biological integrity of a site is linked to the conservation objectives for which the site was designated as part of the Natura 2000 network.'*

It is furthermore stressed that '*compensatory measures must necessarily consist of ecological measures*', meaning that, under the Habitats Directive '*payments to individuals or towards special funds, regardless of whether or not these are ultimately allocated to nature conservation projects are not suitable*' (EC, 2018).

Both the 2007 and 2018 guidance documents also note that:

> *'Compensatory measures should be additional to the actions that are normal practice under the Habitats and Birds Directives or obligations laid down in EC law. For example, the implementation of a management plan, or the proposal/designation of a new area, already inventoried as of Community importance, constitute "normal" measures for a Member State. Thus, compensatory measures should go beyond the normal/standard measures required for the protection and management of Natura 2000 sites'.*

The above documents also provide detailed guidance on location, extent and timing of compensatory measures; this is not reiterated here, as these aspects are not the focus of this report.

3.1.4 The Water Framework Directive

Background

The Water Framework Directive (WFD) establishes a legislative framework for the protection of surface waters and groundwater throughout the EU. It is transposed into law in England and Wales by The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017 (as amended).

Mitigation and compensation context

'Mitigation' has two meanings with respect to the WFD:

1. Measures identified to help heavily modified waterbodies achieve good ecological potential. These aim to enhance and restore the quality of the waterbody and could be, and have been, employed by developers when unavoidable impacts are expected. WFD mitigation examples include realigning flood defences, enhancing ecology and improving fish passage (e.g. NRW, 2015).); and
2. Measures used by developers to mitigate impacts of a project or plan.

Where an activity or project carries a risk of affecting a waterbody, a WFD compliance assessment has to be undertaken. This would, amongst other things identify mitigating measures aimed at avoiding or minimising impacts. Where a WFD compliance assessment for a proposed development determines that it is not possible to mitigate the impacts to a level where deterioration of a waterbody can be avoided, the project would need to be assessed in the context of Article 4.7 of the Directive. Where derogation is deemed necessary, then an 'Article 4.7 derogation case' would need to be submitted by applicants, and the proposal subjected to four derogation tests (which would all need to be passed) (The Planning Inspectorate, 2017):

1. All practicable steps are to be taken to mitigate the adverse impacts on the water body concerned;
2. The reasons for modifications or alterations are specifically set out and explained in the River basin management plan;
3. There is an overriding public interest in the Proposed Development and/or its benefits outweigh the benefits of the WFD objectives; and
4. The benefits of the project cannot be achieved by a significantly better environmental option.

The WFD does not specifically require compensatory measures to be undertaken. Rather the WFD accepts that – if it can be demonstrated that the requirements of the Article 4(7) tests are met – there will be a residual adverse effect on the status of the waterbody in question (EC, 2017b). It is however noteworthy that compensation-type measures can be requested by the relevant authority, as was for example the case in relation to Associated British Port's (ABP's) Green Port Hull development (see Section 5.2.2).

3.1.5 Marine Strategy Framework Directive (MSFD)

Background

The aim of the EU Marine Strategy Framework Directive (MSFD) is to protect more effectively the marine environment across Europe, and for marine waters to achieve 'good environmental status' (GES) of marine waters by 2020, whilst protecting the resource base upon which marine-related economic and social activities depend. It enshrines in law the ecosystem approach to the management of human activities having an impact on the marine environment, integrating the concepts of environmental protection and sustainable use. The Directive came into force in 2008 and was transposed into UK law by the Marine Strategy Regulations 2010.

The MSFD establishes European Marine Regions on the basis of geographical and environmental criteria. The UK's marine waters are in the 'North East Atlantic Ocean' marine region, with waters to the west of the UK, including Welsh waters, comprising part of the Celtic Seas subregion. Each Member State is required to develop marine strategies for their marine waters. The UK has one marine strategy covering the whole of its marine waters, and published its programme of measures in 2015 (Defra, 2015).

The MSFD does not state a specific programme of measures that Member States should adopt to achieve GES, except for the establishment of MPAs. The MSFD does, however, outline 11 high-level descriptors of GES in Annex I of the Directive; including seafloor integrity, biological diversity and introduction of energy (e.g. noise).

Mitigation and compensation context

The UK government considers that the current regulatory regime is sufficiently robust to ensure GES can be achieved. This means that '*there is no need for additional licensing, monitoring, or assessment burdens for Government, marine licensing authorities or developers*' (Defra, 2014). It is considered that '*marine plans will contribute to meeting the objectives of the MSFD, particularly in relation to any measures which have a spatial dimension*' (Defra, 2015).

It is however noteworthy that project specific MSFD assessments are known to have been produced by a few developments, for example, Swansea Tidal Lagoon and (in draft) to support the Wylfa Newydd application.

Indeed, the WNMP references all the descriptors of the 'Marine Strategy', which relates to the MSFD, and has at least one policy against each. Thus, developers are required to give due regard to the MSFD with its requirements for adopting an ecosystem approach (and for some descriptors, provide assessments) through the WNMP (see Section 3.3.9 for more detail).

3.2 UK Legislation and Policy

3.2.1 Introduction

In addition to EU directives discussed in the previous section, there is a range of UK legislation not directly related to the key European Directives which can trigger the requirement for mitigation and/or compensation. Furthermore, various policy or guidance documents are also of note.

3.2.2 The Marine and Coastal Access Act 2009 (Marine Conservation Zones (MCZs))

Background

The 2009 Marine and Coastal Access Act (MCAA) (amongst others) provides for the designation of MCZs to protect marine features of national importance. There is currently only one MCZ designated in Welsh waters (Skomer Marine Conservation Zone; see also Section 4.2.1) and therefore currently no detailed Welsh guidance. However, Welsh Government has initiated work to designate further MCZs.

Mitigation and compensation context

Section 126 of the Act, specifically Subsection 7c specifies that, where there is a significant risk that the achievement of the conservation objectives of an MCZ may be 'hindered', then

> *'the person seeking the authorisation will undertake, or make arrangements for the undertaking of, measures of equivalent environmental benefit to the damage which the act will or is likely to have in or on the MCZ'.*

The only mention of mitigation in the Act is in Section 127, which encourages nature conservation bodies to given advice and guidance as to how '*the effect of any activity or activities on an MCZ or MCZs may be mitigated*'.

In England, the Marine Management Organisation (MMO, 2013) considered that '*types of compensatory measures that might be considered under the Habitats Directive would also be appropriate to put forward here, although consideration will not be confined to those*'.

3.2.3 Wildlife and Countryside Act 1981 (as amended) (Sites of Special Scientific Interest; nationally protected species)

Background

The Wildlife and Countryside Act 1981 (as amended) provides the national framework for nature conservation in the UK. It underpins Sites of Special Scientific Interest (SSSI) designations and the protection of nationally protected species.

With regard to protected species, the Act affords national protection to birds, animals and plants which are listed in its Schedules 1, 5 and 8 respectively. Nationally protected species frequently affected by marine and coastal developments include wild birds, water vole (*Arvicola terrestris*), all cetaceans (whales and dolphins), as well as many shellfish, reptiles and otter (*Lutra lutra*).

Mitigation and compensation context

Each SSSI has a list of activities that are likely to damage the site's special interest. These damaging operations are allowed to occur if an appropriate licence, consent or permission has been issued by the relevant authority (NRW in Wales).

The Wildlife and Countryside Act itself does not make provisions for mitigation or compensation. In practice, where an application requires planning permission or a marine licence, and there is a potential for a SSSI to be affected, then the nature conservation body would tend to advise on the level of compensation required, and the effectiveness of any mitigation proposed.

With regard to nationally protected species, similar to EPS, a licence would be required to permit acts that would otherwise be illegal. However, NRW are not able to issue a licence for 'development' under the Wildlife and Countryside Act in a similar way to some of the licences issued under the Habitats Regulations (NRW, 2020b). Instead, where developers are not able to mitigate the action to such an extent that an offence is unlikely, then 'the proposed works should be amended to, where possible, reduce or remedy the adverse effects'. Such actions should be documented in a method statement. If after such remedies are incorporated, offence issues still cannot be reasonably avoided then the developer will need to rely on the 'incidental result defence'. This relates to Section 10(3)(c) of the Wildlife and Countryside Act, which allows the carrying out of lawful operations from which some harm to the species would arise in terms of the listed offences as an incidental result of actions that could not reasonably have been avoided. According to NRW (2020b), '*such a defence is only sustained if, as far as is reasonable, appropriate action is taken to safeguard the animals and their places used for shelter and protection. Ultimately only a court can decide what is reasonable*'.

3.2.4 Wider UK Policy and Guidance

UK Marine Policy Statement 2011

With regard to the marine context, the UK Marine Policy Statement 2011, which is applicable in Wales, is also worth noting. This stated as one of its high-level marine objectives that biodiversity should be '*protected, conserved and where appropriate recovered and loss [...] halted*'. It furthermore elaborates that:

> *'Marine plan authorities should be mindful that, consistent with the high-level marine objectives, the UK aims to ensure:*
>
> - *A halting and, if possible, a reversal of biodiversity loss with species and habitats operating as a part of healthy, functioning ecosystems; and*
> - *The general acceptance of biodiversity's essential role in enhancing the quality of life, with its conservation becoming a natural consideration in all relevant public, private and non-governmental decisions and policies.'*

Furthermore, under 'economic considerations', it is noted that

> *'as a general principle, development should aim to avoid harm to marine ecology, biodiversity and geological conservation interests (including geological and morphological features), including through location, mitigation and consideration of reasonable alternatives. Where significant harm cannot be avoided, then appropriate compensatory measures should be sought. Additional requirements apply in relation to developments affecting Natura 2000 sites.*'

Net Gain as set out in the English 25-Year Environment Plan and Environment Bill

In 2018, the UK Government published a 25 Year Environment Plan for England (HM Government, 2018); amongst others, this contained a commitment to embed environment net gain for development in England 'to deliver environmental improvements locally and nationally'[2]. It further specified that '*in future, we want to expand the net gain approaches used for biodiversity to include wider natural capital benefits, such as flood protection, recreation and improved water and air quality. Those approaches will sit alongside existing regulations that protect our most threatened or valuable habitats and species'*. Marine commitments were also included in the 25 Year Plan, though these did not mention 'net gain', instead pledging to '*reverse the loss of marine biodiversity and, where practicable, restoring it*'.

[2] Please note that, whilst the 25 Year Plan was prepared by HM Government, as the environment is a devolved matter, it does not apply to Wales.

The 25 Year Environment Plan was at least in part prompted by the Natural Capital Committee's (NCC's) annual reports. Specifically, the 2015 Annual Report urged the UK Government to develop a 25-year plan for improving the natural environment and restoring its capital. In its 2017 Annual Report, the NCC emphasised the importance of rapid progress in developing and delivering this plan if the Government's aims of this being the first generation to leave the environment in a better state than the one it inherited were to be met against a backdrop of falling stocks of national natural capital (NCC, 2018).

The 'Environment Bill 2019-21', which is currently progressing through Parliament, includes a commitment to make 'biodiversity gain' a condition of planning permission in England. This means that in England, coastal and intertidal habitats will have to be considered, down to the mean low water mark, to account for the whole regime of the Town and Country Planning Act in England.

In preparation for the Bill, Natural England has developed a biodiversity metric ('Biodiversity Metric 2.0'), which facilitates the calculation of biodiversity losses and gains, including for intertidal habitats (Natural England *et al.*, 2020).

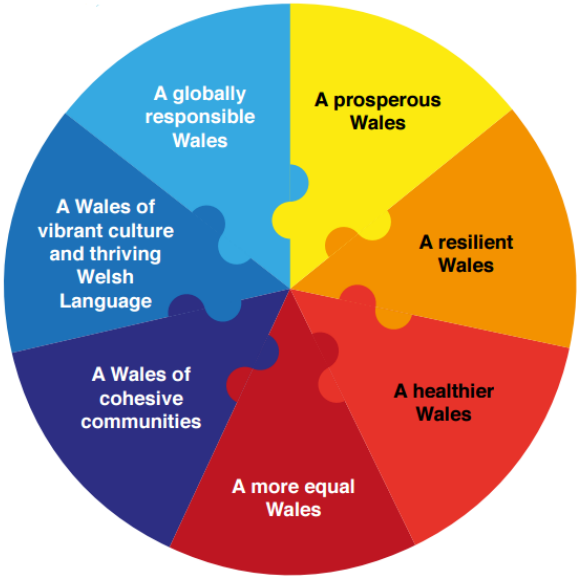
3.3 Welsh Legislation, Policy and Plans

3.3.1 Introduction

Legislation, policy and guidelines specific to Wales are outlined in this section. This includes consideration of a number of Acts of relevance to environmental provision in Wales as well as policies and policies/objectives stated within the WNMP.

3.3.2 Well-being of Future Generations (Wales) Act 2015

The Well-being of Future Generations (Wales) Act 2015 seeks to improve the social, economic, environmental and cultural well-being of Wales. This Act put in place seven well-being goals which are outlined in Image 4. Under the 'Resilient Wales' goal, it aims to create 'a nation which maintains and enhances a biodiverse natural environment with healthy functioning ecosystems that support social, economic and ecological resilience and the capacity to adapt to change (for example climate change).'



Welsh Government, 2016

Image 4. Seven wellbeing goals of the Well Being of Future Generations (Wales) Act 2015

3.3.3 The 2015 Nature Recovery Action Plan for Wales

Welsh Government published the national biodiversity strategy 'The Nature Recovery Action Plan for Wales' in 2015, with the ambition to 'halt the decline in biodiversity by 2020 and then reverse the decline, for its intrinsic value, and to ensure lasting benefits to society. The Plan sets out how Wales will deliver the commitments of the United Nations (UN) convention on biological diversity, the strategic plan for biodiversity 2011-2020 and the 20 associated Aichi targets (a short term framework for action), as well as the EU biodiversity strategy. The Plan focusses on six objectives for nature recovery in Wales, and actions to reverse the decline of biodiversity are set out under each objective. The objectives are as follows:

- Objective 1: Engage and support participation and understanding to embed biodiversity throughout decision making at all levels.
- Objective 2: Safeguard species and habitats of principal importance and improve their management.
- Objective 3: Increase the resilience of our natural environment by restoring degraded habitats and habitat creation.
- Objective 4: Tackle key pressures on species and habitats.
- Objective 5: Improve our evidence, understanding and monitoring.
- Objective 6: Put in place a framework of governance and support for delivery.

Under Objective 4, it is noted that '*it is vital to anticipate, prevent and mitigate the causes of biodiversity loss at source, using both our legislation, and innovative and holistic nature-based solutions*' (NB: 'compensation' is not mentioned by the Plan).

The actions are allocated to specific partners, including public bodies and local nature partnerships. Public bodies are required to consider using the Plan as a basis on which to base a 'biodiversity and ecosystem resilience duty forward plan'.

3.3.4 Planning (Wales) Act 2015

The Planning (Wales) Act 2015 provides a high-level framework for achieving sustainable development and land use in Wales. It amends the Town and Country Planning Act in various ways, as set out in Schedule 2 of the Act; though there is no specific mention of 'mitigation' or 'compensation' within the Act. It should be noted that The Town and Country Planning Act 1990 and the Planning and Compulsory Purchase Act 2004, as amended, are the principal statutory controls over land use in Wales, although both were amended through the Planning (Wales) Act. The Planning (Wales) Act does however make provision for 'Developments of National Significance' (DNS) to be consented by Welsh Ministers[3].

Local and strategic development plans

The Planning (Wales) Act contains provisions to designate a strategic planning area, and for local planning authorities to develop strategic development plans (SDPs). These are intended to address matters transcending local authority boundaries and priorities/policies set out in local development plans (LDPs). SDPs are still under development, with those for the Cardiff and South East Wales regions being amongst the first to take shape (Welsh Government, 2019).

[3] The Developments of National Significance (Specified Criteria and Prescribed Secondary Consents) (Wales) Regulations 2016 (as amended) specify the thresholds and criteria for the types of development which qualify as DNS and consent for which must be applied for directly to the Welsh Ministers under Section 62D of the Town and Country Planning Act 1990.

3.3.5 Environment (Wales) Act 2016

The Environment (Wales) Act 2016 provides the legislative framework for the sustainable management of natural resources. It does not specifically mention mitigation or compensation (as interpreted in the context of this report), but contains several commitments to enhance the environment. Section 3 on the 'Sustainable management of natural resources' notes that the objective is to

'maintain and enhance the resilience of ecosystems and the benefits they provide and, in so doing—

(a) meet the needs of present generations of people without compromising the ability of future generations to meet their needs, and
(b) contribute to the achievement of the well-being goals in Section 4 of the Well-being of Future Generations (Wales) Act 2015.'

Section 4 of the Act sets out principles for the sustainable management of natural resources. Section 6 of the Act requires public authorities to seek to '*maintain and enhance biodiversity […] in the exercise of their functions*'.

Section 7 additionally requires Welsh Ministers to publish a list of living organisms and habitats in Wales, which are considered of key significance to sustain and improve biodiversity in relation to Wales (see Section 4.3 and Appendix D). The Act also notes that the Welsh Ministers must '*take all reasonable steps to maintain and enhance the living organisms and types of habitat included in any list published under this section and encourage others to take such steps*'.

2020 Area Statements

The Environment Act made it a duty for NRW to produce Area Statements; these are being published in March 2020. For this purpose, Wales has been divided into six areas, and a statement is also being prepared for the marine area. The Statements will set out:

- The natural resources in each area and the benefits they provide;
- Address the key challenges and opportunities at a local level; and
- Common evidence base with information, data and evidence.

3.3.6 Planning Policy Wales (Edition 10, December 2018)

Welsh terrestrial planning policy is outlined in the Planning Policy Wales (PPW), which was first published in 2016. The primary objective of PPW is 'to ensure that the planning system contributes towards the delivery of sustainable development and improves the social, economic, environmental and cultural wellbeing of Wales, as required by the Planning (Wales) Act 2015, the Well-being of Future Generations (Wales) Act 2015 and other key legislation' (Welsh Government, 2018).

PPW includes specific policies on conserving and enhancing the natural environment through planning. It states that the planning system should contribute to the delivery of sustainable development and improve the social, economic, environmental and cultural well-being of Wales. The PPW and the associated National Development Framework (NDF) concentrate on development and land use issues of national significance, indicating areas of major opportunities and change, highlighting areas that need protecting and enhancing and helping to co-ordinate the delivery of Welsh Government.

With regard to mitigation and compensation, the PPW notes that:

'Planning authorities must follow a stepwise approach to maintain and enhance biodiversity and build resilient ecological networks by ensuring that any adverse environmental effects are firstly avoided, then minimized, mitigated, and as a last resort compensated for; enhancement must be secured wherever possible.'

It is also of note that the Chief Planner of the Planning Directorate wrote to planning officers in October 2019 emphasising the importance of securing biodiversity enhancement/gain. The letter stated that:

'where biodiversity enhancement is not proposed as part of an application, significant weight will be given to its absence, and unless other significant material considerations indicate otherwise it will be necessary to refuse permission.'

For SSSIs, there is 'a presumption against development likely to damage a SSSI'. For European sites, the Article 6(4) tests highlighted in Section 3.1.3 above are noted, and it is stressed that '*any necessary compensatory measures to protect the overall coherence of the network of SACs and SPAs must be secured*'.

3.3.7 2018 Natura 2000 Action Plan

Whilst not directly related to mitigation or compensation, it is worth noting that the management of Natura 2000 sites is the responsibility of the devolved administrations, whose respective authorities would tend to put in place management plans for individual or sets of designated sites. These would amongst others include plans/suggestions for specific management and enhancement activities (though issues of additionality may arise if used for compensation/mitigation in the same site, see Section 3.1.3).

The Welsh 2018 Action Plan for the country's marine Natura 2000 sites (MPA Management Steering Group, 2018), focuses on priority network level actions, but also includes some current local level actions. The latter incorporate some measures such as the reduction of disturbance to marine mammals or birds.

3.3.8 2017 Natural Resources Policy

The focus of the 2017 Natural Resources Policy is the sustainable management of Wales' natural resources, to maximise their contribution to achieving goals within the Well-being of Future Generations Act. The three national priorities for managing Wales' natural resources are identified as follows:

- Delivering nature-based solutions;
- Increasing renewable energy and resource efficiency; and,
- Taking a place-based approach

Whilst compensation or mitigation for development are not specifically mentioned, references are made to domestic and planning, as well as the requirement for a 'coordinated approach' to 'remove preventable impacts'.

3.3.9 The Welsh National Marine Plan (WNMP) (November 2019)

The WNMP was prepared and adopted under the Marine and Coastal Access Act 2009 and in conformity with the UK Marine Policy Statement. It represents the start of a process of shaping Welsh seas to support economic, social, cultural and environmental objectives. Its overarching objective is to

'Support the sustainable development of the Welsh marine area by contributing across Wales' well-being goals, supporting the Sustainable Management of Natural Resources (SMNR) through decision making and by taking account of the cumulative effects of all uses of the marine environment'.

Under the topic 'living within environmental limits', the following key objectives of note to this report are as follows:

- *'Support the achievement and maintenance of Good Environmental Status (GES) and Good Ecological Status (GeS).*
- *Protect, conserve, restore and enhance marine biodiversity to halt and reverse its decline including supporting the development and functioning of a well-managed and ecologically coherent network of Marine Protected Areas (MPAs) and resilient populations of representative, rare and vulnerable species.*
- *Maintain and enhance the resilience of marine ecosystems and the benefits they provide in order to meet the needs of present and future generations.'*

Furthermore, many of the policies essentially require the observation of the mitigation hierarchy as introduced above in Image 2. Notably, Policy ENV_01 on 'Resilient marine ecosystems' states:

'Proposals should demonstrate how potential impacts on marine ecosystems have been taken into consideration and should, in order of preference:

a. avoid adverse impacts; and/or
b. minimise impacts where they cannot be avoided; and/or
c. mitigate impacts where they cannot be minimised.

If significant adverse impacts cannot be avoided, minimised or mitigated, proposals must present a clear and convincing case for proceeding. Proposals that contribute to the protection, restoration and/or enhancement of marine ecosystems are encouraged.'

Also particularly noteworthy is policy ENV_02 on MPAs, which states:

'Proposals should demonstrate how they:

a. avoid adverse impacts on individual Marine Protected Areas (MPAs) and the coherence of the network as a whole;
b. have regard to the measures to manage MPAs; and
c. avoid adverse impacts on designated sites that are not part of the MPA network.'

There is also a table in the WNMP detailing the Plan policies that support the achievement of Good Environmental Status under the MSFD, and the achievement of WFD goals are referenced in connection with Policy ENV_06 on 'Air and water quality'.

When applying for marine licences, NRW now asks marine licence applicants (for Bands 2 and 3) to demonstrate that they have taken account of the WNMP by filling in a signposting document, detailing how the proposed project complies with each of the policies, where applicable (NRW, 2020c).

Neighbouring marine plans

In England, 11 marine plan areas have been declared by the MMO, with marine plans for most of these areas being in various stages of preparation, though four are finished/final. Those neighbouring

the Welsh marine area are the North West inshore and offshore areas, and the South West inshore and offshore areas. For all four plan areas, plans have yet to be finalised, with draft plans currently being consulted upon.

In Ireland, a Draft National Marine Planning Framework (NMPF) has been published for public consultation. It is anticipated that the final NMPF and associated environmental reports will be prepared for submission to the Irish Government and adoption by the Oireachtas in late 2020.

3.4 Synthesis

This section has reviewed legislation, policy and plans as they pertain to mitigation and compensation in marine consenting. As noted, the type, nature, scale and location of a proposed activity will influence the regulatory regime under which the permissions for a project are determined. In the context of marine consenting, this could be through several of the following:

- Marine licensing – from NRW,
- Terrestrial planning permission, where there is an intertidal element – from a Local Planning Authority,
- A DNS consent or Transport and Works Act Order (for harbour works) – from Welsh Ministers, or
- A Development Consent Order for NSIPs - from the Secretary of State (handled by the Planning Inspectorate).

The specific definitions of mitigation and compensation, and how they are applied, vary across the different legislation. The principles are, however, similar across the varying drivers. In its 'guidance on terminology relating to environmental measures in the context of marine developments' (NRW, 2018), NRW has defined mitigation and compensation as follows:

- **Mitigation**: *A measure to avoid, reduce, minimise or cancel out one or more adverse impacts*.
- **Compensation**: *A measure to make up for the negative effects of a plan or project. The term should only be used appropriately in the context of the different legislation requirements when referring to specific measures*.

In making decisions on marine licences, NRW has to ensure that a myriad of legislative requirements have been taken account of, and many plans and policies given due regard. This shows that there is a certain hierarchy to mitigation and compensation, depending on the location of a proposed development or project. It further highlights the need for co-ordination with the terrestrial planning regime and cross border authorities, where applicable.

Again, dependent on the type, nature, scale and location of a proposed activity/development, applications for the types of permissions identified above will need to be supported by a series of environmental assessments. From an environmental perspective this could include, for example, EIA, HRA, WFD and MCZ assessments. In all instances, the level of detail required to demonstrate compliance with these assessments should be proportionate to a project's scale, potential impacts and risk.

Where an EIA is required, then mitigation is considered throughout all stages of the process. As outlined in Section 3.1.2, all practicable mitigation measures should have already have been applied/considered during all preceding steps of a project, prior to any application being submitted (including any feasibility or optioneering phases). In practice, this is likely to be undertaken in an iterative manner throughout the entire EIA process. Mitigation can also take the form of post-consent actions such as impact verification monitoring and adaptive management. During an EIA,

compensation measures would be identified as a measure of last resort if, despite all efforts to mitigate impacts, offsetting is still required. Should the affected receptor not be designated or protected, then offsetting matrices such as those being developed in the context of biodiversity net gain in England (see Section 3.2.4) could be relevant.

Net gain is a concept that is receiving a lot of attention at present, and is currently being written into English law in relation to biodiversity net gain within the terrestrial planning system. In Wales, whilst not currently specifically noted in legislation or policy, it is worth noting that NRW would typically interpret 'enhancement' as specified in policy ENV_01 of the WNMP (see Section 3.3.9) as 'an environmental improvement that may intensify or increase the quality, value or extent of a resource', and one which goes over and above mitigation and compensation measures (NRW, 2019a). This interpretation of 'enhancement' is closely related to the concept of net gain.

For projects or developments which are located in, or adjacent to, a European designated or Ramsar site, then an HRA is generally required. Should the latter determine that there is an adverse effect on the integrity of a site, then a development can only go ahead if it passes the strict tests of Article 6(4) of the Habitats Directive (see Image 3). Furthermore, developers would need to prove that all practicable mitigation options have been applied and adequate compensation is provided. Compensatory requirements related to European designated sites are strict and build on detailed EC guidance as well as case law, as outlined in Section 3.1.3. Where a project has passed all the tests, an iterative process of engagement would typically take place between the developer, regulators and their advisors before a compensation measure or package is agreed.

Where a development has the potential to impact a site which is subject to national designations such as MCZs or SSSIs, permission or consents would be required from NRW, whereby reassurances would again be required that all mitigation avenues had been exhausted. Compensation for nationally designated sites could in theory be more flexible than that for European designated sites, with MCZ related legislation for example referencing measures of 'equal environmental benefit'. However, it is noteworthy that, for MCZs, the English licensing body (the MMO) has taken the view that the types of measures considered for European designated sites would also be appropriate for MCZs (though not confined to them) (see Section 3.2.2). Various species and habitats are also protected from being killed, injured or disturbed under provisions of the Habitats Regulations and the Wildlife and Countryside Act 1981 (as amended). Biodiversity provisions are also made under Section 7 of the Environment (Wales) Act.

WFD assessments are also typically required where a development is in, or close to, a WFD waterbody. Again, all possible mitigating measures need to be taken to reduce impacts on a water body, but compensation is not typically requested where a derogation is granted (once all four derogation tests outlined in Section 3.1.4 are passed).

When proposing developments in the marine environment, developers need to also ensure that their proposals are consistent with the relevant local and regional plans, policies and statements. For coastal and intertidal developments which have a terrestrial planning element, this would include terrestrial plans such as LDPs and SDPs (see Section 3.3.4). As noted in Section 3.3.9, NRW now asks marine licence applicants (for project Bands 2 and 3) to fill in a signposting document detailing how the proposed project complies with relevant WNMP policies (NRW, 2020c). Both terrestrial and marine plans would typically include policies requiring the observation of environmental legislation as well as the mitigation hierarchy. The WNMP contains numerous such policies, notably overarching policies 'ENV_01' on 'Resilient marine ecosystems' and ENV_02 on MPAs (see Section 3.3.9).

Proposals in Wales also need to demonstrate consistency with various policies and legislation, notably through the implementation of the Wellbeing of Future Generations (Wales) Act (2015) and the Environment (Wales) Act (2016) (see Sections 3.3.2 and 3.3.5 respectively).

Once a developer and the consenting body have undertaken all, or some, of these forms of assessments to inform the consenting process, and undertaken effective stakeholder consultation, then a thorough understanding of impact prediction and associated compensation, mitigation and enhancement measures would have been gained for a given project. Such a suite of measures would then typically be captured in a dedicated agreed method statement, and the resulting agreed measures would form part of the respective consent through conditions placed on the applicant. For complex projects, these can be incorporated within legal agreements. Developers are typically required to demonstrate compliance with these measures to satisfy the consenting requirements. The information can also be important in helping to learn lessons for future projects.

4 Protected Habitats and Species in Welsh Waters

Wales has a rich marine environment which is home to a variety of habitats and species (Welsh Government, 2018). Many of these features are afforded protection as a matter of policy as well as through international and national legislation.

The MPA network constitutes numerous sites of European and international importance which include SPAs, SACs and Ramsar Sites. The nationally designated sites within the MPA network include MCZs and SSSIs with coastal or marine features.

The MPA network in Wales (as defined by Welsh Government in 2018) consists of approximately 140 sites (107 SSSI, 15 SAC, 13 SPA, four Ramsar sites and one MCZ) (Welsh Government, 2018)[4] (Figure 1). Within the 140 sites, there are approximately 118 unique features with are both supported by underlying sub-features and processes as well as being characterised by important ecological assemblages.

Further details of each of the designated sites are provided below followed by a brief overview of the four receptor groups which are included within this report (habitats, fish, marine mammals and fish). The legislative background on these designations, and further detail on the implication of this level of protection, is provided in Section 3.

[4] It should be noted that the number of sites within the MPA network is reported differently (133 and 128) at NRW's MPA page (link) This is assumed to be a function of the SSSI features that are considered to be coastal/marine within the respective counts. Furthermore, the MPA network is subject to ongoing review and the latest details with respect to designations should be obtained from Lle – A Geo-Portal for Wales (inshore and coastal), or JNCC's Protected Area Datasets (offshore).

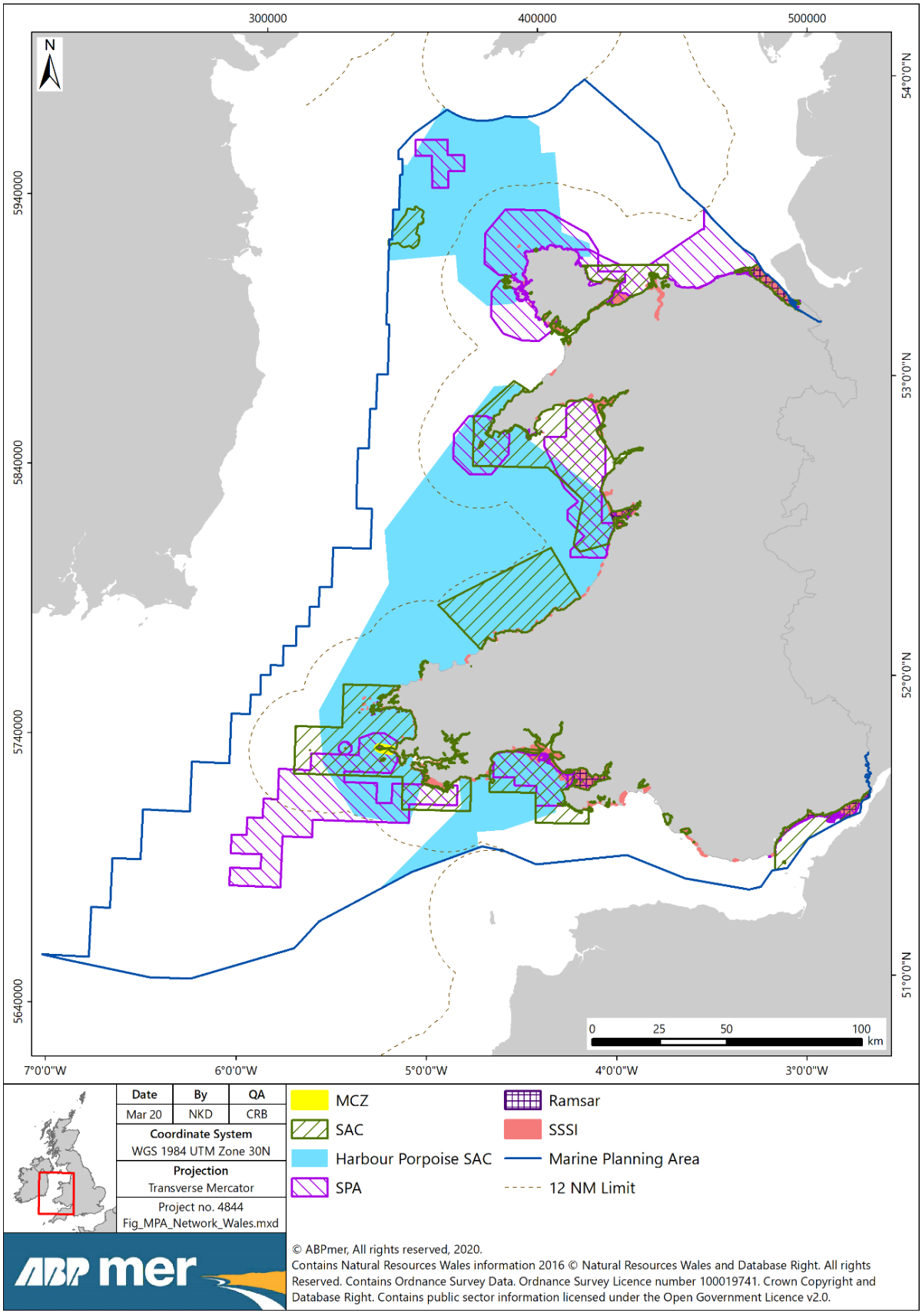


Figure 1. Welsh MPA network

4.1 Sites of European and International Importance

4.1.1 Special Area of Conservation

Marine SACs are designated for the protection of internationally important benthic habitats and species, marine mammals and fish which are listed in Annex II and/or Annex IV of the European Commission's Habitat Directive (Council Directive 92/43/EEC) (see Section 3.1.3). Within Wales, there are 15 SACs which have been designated for protecting 20 unique marine features (12 habitats, five fish species and three marine mammals). There are also several riverine SACs which are designated for migratory fish and/or freshwater pearl mussel.

4.1.2 Special Protection Area

SPAs are designated for the protection of internationally important bird species which are listed on Annex I of the EU's Birds Directive (Council Directive 2009/147/EC) (see Section 3.1.3). Within Wales, there are 13 SPAs which have been designated for protecting 32 different coastal and marine bird species. Birds are protected during breeding, migration and overwintering periods, with each site's designation stating which period the features are afforded additional protection.

4.1.3 Ramsar Sites

Ramsar sites are wetlands of international importance. They are designated under the Ramsar Convention, an intergovernmental treaty that aims to stop the loss of wetlands. Within Wales, there are four Ramsar sites which have been designated for protecting 23 species and habitats of importance (16 bird species, five benthic habitats and one fish grouping). Within Wales the three Ramsars with marine features are: the Dee Estuary, Severn Estuary, Cors Fochno and Dyfi and Bury Inlet.

4.2 Sites of National Importance

4.2.1 Marine Conservation Zone

The Marine and Coastal Access Act 2009 provides for the designation of MPAs for nationally important marine habitats and species. Within Wales, these are known as MCZs. Wales has one MCZ, the Skomer MCZ, which was designated in 2014 after 24 years of protection as a Marine Nature Reserve. Skomer MCZ is designated as it supports a huge diversity of species of conservation concern including small sea squirts and anemones, subtidal habitats (e.g. kelp forests), fish such as the ballan wrasse *Labrus bergylta* and grey seals.

4.2.2 Site of Special Scientific Interest

SSSI designations were originally notified under the National Parks and Access to the Countryside Act 1949 whereby the best examples of the UK's flora, fauna, or geological or physiographical features where given statutory protection, this protection was re-notified within Section 28 of the Wildlife and Countryside Act 1981 (as amended). In Wales, there are 105 SSSI that support 85 marine features cited as part of the designation (47 benthic habitats and species, 30 bird species, five fish species and three marine mammals).

4.3 Section 7 Habitats and Species

Section 7 of the 2016 Environment (Wales) Act relates to 'Biodiversity lists and duty to take steps to maintain and enhance biodiversity' (see also Section 3.3.5); this replaces the duty in Section 42 of the Natural Environment and Rural Communities (NERC) Act 2006. The Act noted that species and habitats lists would duly be published; these are now available from the Wales Biodiversity Partnership Website.

Many marine and coastal species and habitats are amongst those specified in the Act; these have been extracted from the lists available on the Wales Biodiversity Partnership Website, and are listed in Appendix D.

4.4 Receptor baseline description

The main focus of this work is on four receptor groups, marine habitats, fish, marine mammals and birds. A high-level overview of the distribution and occurrence of these features within Welsh Waters is provided below. This has been based on previous strategic level reviews at the scale of Welsh Waters (and beyond), including the WNMP strategic baseline, the NRW Guidance notes on habitat surveys, the NRW review of SPAs in Welsh waters and the 2019 Welsh Government report on MPAs. In practice, there is considerable site specific variability in the physical, chemical and biological environments throughout Welsh waters across a range of temporal and spatial scales. Furthermore, the life history and behavioural traits of these features determines their potential exposure and sensitivity to the range of pressures that may arise from activities in the marine environment. This in turn influences the types of mitigation and compensation measures that could be required to minimise and offset potential adverse effects.

4.4.1 Marine habitats

Welsh waters have a particularly high marine biological diversity as a result of the variety of habitats and species present, many of which are afforded protection within the MPA Network as described above. Depths in the east of the Wales' Exclusive Economic Zone (EEZ) are typically less than 50 m but reach over 100 m in western areas. The physical environment is strongly influenced by coastal processes, with influxes of water from the Celtic Sea and the continental shelf current. Overall mean water flow is northward; a large tidal range and strong tidal currents mean that most of the water is well mixed, although some seasonal stratification occurs in deeper areas (DECC, 2016). The diverse array of tidal currents and tidal range also influence biological diversity.

The underlying geology ranges from large subtidal sandbanks to areas of mixed sediment and rocky reef. Large expanses of shallow subtidal sediments occur throughout Welsh waters. Sands, gravels and mixed sediments are most common, but muds accumulate locally (DECC, 2016). Large expanses of subtidal rock are relatively uncommon in Welsh waters due to the widespread deposition of subtidal sediments. In Wales this habitat is mainly a coastal fringing habitat, although there are significant offshore reefs and glacial rocky deposits (e.g. the Sarns in west Wales).

Biogenic reefs, where the habitat is created by the animals themselves, are also common within Welsh waters including blue mussel (*Mytilus edulis*) and horse mussel (*Modiolus modiolus*) beds as well as ross worm (*Sabellaria spinulosa*), honeycomb worm (*S. alveolata*) and tubeworm (*Serpula vermicularis*). The ross worm is particularly widespread and common within the Severn Estuary, but occurs mostly as crusts or isolated individuals, only rarely forming low-lying reefs. There have been recent discoveries of *Sabellaria* reefs occurring in deeper water off Anglesey than previously recorded (ABPmer, 2019).

Subtidal seagrass beds (*Zostera*) have been recorded around Wales. These can occur as isolated intertidal or subtidal beds (such as the Welsh Grounds bed in the Severn Estuary), or as one continuous bed where the intertidal and sublittoral stands merge (for example, at Porthdinllaen on the north Llŷn coast).

Intertidal habitats including rocky shores, sediment (mud and sand) and saltmarsh are common around the Welsh coast. Primary areas for extensive rocky coast are the shores of Pembrokeshire and the Gower Peninsula in the southwest and the Isle of Anglesey and the Llŷn Peninsula in the northwest; however, the habitat is found around the whole of the Welsh coastline (NRW, 2019b). Rocky shore habitats occur in areas of more exposed coastline. Intertidal sediment habitats (predominantly mudflats and/or sandflats) are also found around the whole of the coast of Wales. They are most extensive in the larger sheltered Welsh estuaries (Dee, Dyfi, Dysynni, Dwyryd, Mawddach, Milford Haven/Daugleddau, Burry Inlet/Loughor, Taf-Tywi-Gwendraeth (Three Rivers estuaries), Severn, Usk, Wye), and bays (Red Wharf Bay, Traeth Lafan, Swansea Bay). They are also present in many smaller estuaries, inlets and embayments and along substantial stretches of the Welsh coast (NRW, 2019b).

Saltmarshes are found in all major estuaries and inlets around the Welsh coast. They also occur in other sheltered locations such as in the lee of spits at Abermenai Point, Anglesey or in the shelter of islands such as Holy Island. The total area of saltmarsh habitat in Wales is estimated to be around 7-8,000 ha, representing some 17 % of the total area in England and Wales as a whole (Phelan *et al*., 2011).

4.4.2 Fish

A number of fish species in Wales are subject to high levels of environmental protection (e.g. through Section 7, Annex II or Schedule 5 of WACA), as well as being commercially important. Beam trawl surveys of the fish community of the entire Irish Sea (which incorporates most of Wales' Marine Plan Area) identified three distinct categories of demersal fish (Defra, 2005). Sandy, inshore areas are dominated by flatfish species, including plaice (*Pleuronectes platessa*), solenette (*Buglossidium luteum*), sole (*Solea solea*) and dab (*Limanda limanda*) and other bentho-demersal fish such as the tub gurnard (*Trigla lucerna*), lesser weever fish (*Echiichthys vipera*), dragonets and gobies. The offshore assemblage is characterised by species such as thickback sole (*Microchirus variegatus*), lemon sole (*Microstomus kitt*) and red gurnard (*Chelidonichthys cuculus*) as well as by elasmobranchs such as the greater spotted dogfish (*Scyliorhinus stellaris*), the cuckoo ray (*Leucoraja naevus*) and spotted ray (*Raja montagui*). The third grouping is found over muddy sediments found to the west of the Isle of Man and is characterised by the presence of witch and long rough dab (*Hippoglossoides platessoides*). Otter trawl surveys reveal a distinction between western (the east coast of Ireland) and eastern (the west coast of Wales) inshore fish assemblages in the Irish Sea, with haddock (*Melanogrammus aeglefinus*), Norway pout (*Trisopterus esmarkii*) and various clupeid species all more abundant along the east coast of Ireland (DECC, 2016).

Dab, plaice, solenette and common dragonet (*Callionymus lyra*) are the most abundant species within the Irish Sea, along with large numbers of sole, poor-cod (*Trisopterus minutus*) and whiting (*Merlangius merlangus*). The inshore grounds are generally sandy with flatfish, tub gurnard and sand gobies (*Pomatoschistus minutus*) all abundant. Inshore sandbanks along the Welsh coast have been identified as possessing a distinctive community typified by low species diversity and shared indicator species such as lesser weeverfish (DECC, 2016). Carmarthen Bay, an extensive sandy area between Pembrokeshire and The Gower Peninsula, is an important nursery ground for flatfish and its sandbanks are characterised by sand sole (*Solea lascaris*) and lesser/greater sandeels (*Ammodytes tobianus*/*Hyperoplus lanceolatus*). Further offshore, the grounds become coarser and spotted ray,

cuckoo ray, lesser-spotted dogfish (*Scyliorhinus canicula*), red gurnard and thickback sole dominate the fish assemblage.

Larger species such as thornback ray (*Raja clavata*) and spotted ray are thought to have declined in Welsh waters in recent years, whereas smaller species such as cuckoo ray and small-eyed ray (*R. microcellata*) may have increased (DECC, 2016). Basking sharks are annual visitors to Welsh waters as they migrate between summer and winter foraging areas, with recent tagging studies around the Irish Sea hotspot (off Isle of Man) having shown the movement through Welsh waters (Dolton *et al*., 2020).

Given the proximity of the Welsh Waters to the Atlantic Ocean, warm temperate and subtropical pelagic fish species are relatively commonplace (Stebbing *et al.*, 2002; cited in DECC, 2016). Several southerly species have increased in frequency of occurrence and/or relative abundance in recent years, including John dory (*Zeus faber*), black seabream (*Spondyliosoma cantharus*), anchovy (*Engraulis encrasicholus*) and boarfish (*Capros aper*) (Pinnegar *et al*., 2002; cited in UKMMAS, 2010). Triggerfish (*Balistes capriscus*) experienced a dramatic increase in abundance in the region and this species has continued to be relatively abundant along Welsh coasts.

Several migratory fish species are present in Welsh waters, including sea trout, Atlantic salmon, European eel, sea lamprey, river lamprey, Allis shad and Twaite shad. Several of these species are afforded specific protection within Welsh waters as Section 7 species, and also through the network of SACs as some of the species are listed on Annex II (Atlantic salmon, sea and river lamprey and Twaite shad). Migratory fish migrate between marine and freshwater habitats for different parts of their lifecycle; for example Atlantic salmon begin their life in freshwater for two to four years before migrating to marine waters to forage, before then moving annually or interannually between the marine and freshwater environments. Sea trout follow a similar migration to that of Atlantic salmon, whereas shad species are mainly marine, only returning into freshwater to spawn (Welsh Government, 2017). These species of migratory fish are protected within the MPA network, and the linked freshwater SACs in which they spawn; these freshwater SACs should also be considered within any marine assessment due to the migratory nature of the features.

4.4.3 Marine mammals

Eighteen species of cetacean have been recorded in Welsh waters since 1990 (Baines and Evans, 2012). Of these, only five species (harbour porpoise *Phocoena phocoena*, Risso's dolphin *Grampus griseus*, common dolphin *Delphinus delphis*, bottlenose dolphin *Tursiops truncatus* and minke whale *Balaenoptera acutorostrata*) are either present at any time of the year or recorded annually as seasonal visitors (Reid *et al.*, 2003; Baines and Evans, 2012). Harbour porpoise and bottlenose dolphin are the only two species which are resident in Welsh inshore waters year-round.

The most abundant species is harbour porpoise which are widely distributed throughout the Celtic and Irish Seas during most months of the year (Reid *et al.*, 2003; Mackey *et al*., 2004; Baines and Evans, 2012; Hammond *et al*., 2017; Rogan *et al*., 2018). During the analysis for the Welsh marine atlas (Baines and Evans, 2012) there were approximately 35,700 sightings within the database, with the latest UK wide estimate (from 2016) estimating between 160,000 and 240,000 individual animals in UK waters. Their occurrence is not evenly distributed in Welsh waters, with apparent hotspots at the southwest coast of the Lleyn Peninsula, southern Cardigan Bay, in the vicinity of Strumble Head and the west and north Pembrokeshire Coast and Islands (Skomer and Ramsey) and in the Bristol Channel off the south coast of Wales around the Gower Peninsula and in Swansea Bay (Baines and Evans, 2012). There are three SACs which are referred to in Figure 1 as Harbour porpoise SACs, where they are the only feature, these are; the Bristol Channel Approaches/Dynesfeydd Môr Hafren SAC; the North Anglesey Marine/Gogledd Môn Forol SAC and the West Wales Marine/Gorllewin Cymru Forol SAC.

The second most common species is bottlenose dolphin, in Welsh waters, the population is centred on Cardigan Bay, although bottlenose dolphins are also regularly observed in the coastal waters between Cardigan Bay and Anglesey (Pesante *et al*., 2008a and 2008b), with concentrations in south Cardigan Bay, south of the Lleyn Peninsula and off Anglesey (Baines and Evans, 2012). During the analysis for the Welsh marine atlas (Baines and Evans, 2012), there were approximately 33,600 sightings within the database, with the latest UK wide estimate (from 2016) estimating between 6,000 and 18,000 individual animals in UK waters. There are also regular sightings in the coastal waters to the east of Anglesey around Bull Bay and towards the Llandudno coast (Evans *et al*., 2015). Bottlenose dolphins are most commonly seen in Cardigan Bay within 10 miles of the coast and particularly within two miles, sightings are greatest in the southern portion of the bay (Feingold and Evans, 2014). The importance of Cardigan Bay to this species has long been recognised and two SACs have been designated with this species as an interest feature. Bottlenose dolphin is a primary feature of the Cardigan Bay SAC located in the south of the bay off the coast of Cardigan, New Quay and Aberaeron, and a qualifying feature of the Lleyn Peninsula and the Sarnau SAC in the northern end of the bay and around the Lleyn Peninsula.

Occasional sightings and strandings of other cetaceans such as long-finned pilot whale (*Globicephala melas*), fin whale (*Balaenoptera physalus*) and killer whale (*Orcinus orca*) have been recorded, although these remain scarce (Baines & Evans, 2012; Deaville *et al*., 2016).

With regard to pinnipeds, grey seals (*Halichoerus grypus*) are regularly recorded in the Welsh waters with hotspots along the Pembrokshire coast, the Lynn Peninsular and within Cardigan Bay. Wales hosts approximately 2.5 % of the UKs grey seal population, with the latest estimation of approximately 3,750 individuals in 2016 (SCOS, 2019). Multiple MPAs (both SACs and SSSIs) are designated due to the presence of a haul-out or breeding site for seals. There are fewer records of common (harbour) seal (*Phoca vitulina*), with no known breeding site within Wales, and with any Irish Sea records coming from seals born in Ireland (Baines and Evans, 2012; DECC, 2016; SCOS, 2019).

The otter (*Lutra lutra*) is mainly a freshwater species, however, estuarine and marine areas also provide functionally important habitat. Otters are widespread in Wales, with the latest Wales-wide survey (2009-2010) finding signs of otter at 996 of 1,108 sites, indicating an increasing population (Stachan, 2015; JNCC, 2019). Otters are protected under various legislation and are classed as an EPS, thereby requiring a licence to disturb the species (NRW, 2020). Otter is a designated feature of two SACs (Pembrokeshire Marine/Sir Benfro Forol SAC and the Pen Llyn a`r Sarnau/Lleyn Peninsula and the Sarnau SAC) and 11 SSSIs.

4.4.4 Birds

Wales supports internationally important populations of breeding, overwintering and on passage bird species, which use coastal and marine areas. Areas which support the largest numbers of birds are incorporated in Wales' MPA network.

In the breeding season, large numbers of seabirds are recorded nesting at colonies on offshore islands and along the Welsh mainland coast including Manx Shearwater (*Puffinus puffinus*), Storm Petrol (*Hydrobates pelagicus*), Gannet (*Morus bassanus*), Puffin (*Fratercula arctica*), Razorbill (*Alca torda*), Guillemot (*Uria aalge*), tern species and gulls. The largest seabird breeding colonies are found at Skomer, Skokholm (Guillemot, Razorbill, Manx Shearwater and Puffin) and Grassholm (Gannet) in Pembrokeshire; sites around Anglesey (such as South Stack, Cemlyn Bay, Puffin Island and the Skerries); Bardsey Island and Carreg y Llam (Llŷn Peninsula); and New Quay Head in Cardigan Bay (NRW, 2018).

The highest densities of foraging seabirds (e.g. Tern species, Kittiwake *Alca torda*, Puffin, Guillemot, Razorbill and Shag *Phalacrocorax aristotelis*) within Welsh waters occur offshore from major breeding areas, such as the Pembrokeshire coast and islands, Anglesey and its associated islands, and the Llŷn Peninsula (Cleasby *et al*., 2018; Wakefield *et al*., 2017; Waggit *et al*., 2019; DECC, 2016; NRW Seabirds at Sea Evidence Base[5]).

Welsh Waters also supports large aggregations of wintering seaduck, diving duck, divers (*Gaviidae*) and grebe (*Podicepididae*). Important areas for these species include Liverpool Bay (for Red-throated Diver *Gavia stellate* and Common Scoter *Melanitta nigra*), Conwy Bay (Great-crested Grebe *Podiceps cristatus* and Red-breasted Merganser *Mergus serrator*), northern Cardigan Bay (Red Throated Diver) and Carmarthen Bay (Common Scoter) (NRW, 2018; DECC, 2016).

Estuaries and other intertidal areas all along the Welsh coast provide an important foraging resource to hundreds of thousands of wading birds that are present within the winter months (Frost *et al*, 2019). The Dee Estuary and the Severn Estuary hold the largest numbers of overwintering birds, both of which cross the Wales-England border, and therefore the largest congregation of birds wholly within Wales is at Bury Inlet, where over 40,000 birds overwinter annually. Internationally important numbers of several species of wader occur at these locations, including Eurasian Oystercatcher (*Haematopus ostralegus*), Black-tailed Godwit (*Limosa limosa*), Red Knot (*Calidris canutus*), Ringed Plover (*Charadrius hiaticula*), Dunlin (*Calidris alpine*) and Common Redshank (*Tringa totanus*) (Frost *et al*, 2019).

[5] https://lle.gov.wales/catalogue/item/SeabirdsAtSea/?lang=en

5 Mitigation Measures

Mitigation is here defined as "*a measure to avoid, reduce, minimise or cancel out one or more adverse impacts*" (NRW, 2018b). A wide range of mitigation measures have been employed to date (or have been proposed) for habitats, fish, marine mammals and birds as part of the marine consenting process. This section provides a summary of potential mitigation measures, including consideration of their potential effectiveness. Examples of enhancement measures that have been employed to date, which could effectively be used for mitigation purposes, have also been illustrated throughout this section.

The range of mitigation measures that are currently employed, or have been proposed, to avoid, reduce, minimise or cancel out adverse effects of projects/activities for habitats, fish, marine mammals and birds in the marine environment have also been captured within the accompanying spreadsheet [Mitigation_Summary_25Mar2020.xlsx]. The spreadsheet is structured in accordance with each of the receptor groups and has an accompanying set of "readme" information (see Section 2.3.1).

A series of over-arching principles relating to mitigation which should be considered when reviewing possible mitigation measures for each receptor are provided below. This is a followed by a synthesis of possible mitigation measures for each receptor in turn.

5.1 Over-arching principles

The over-arching principles of the mitigation hierarchy are summarised in Section 3 above. In summary, a sequential process should be adopted to avoid, mitigate and compensate negative ecological impacts, with compensation very much interpreted as a measure of last resort.

Mitigation measures should be considered from the start of the project design to allow for integrated solutions to any potential environmental effects and assessment of residual impacts. The mitigation measures themselves should be assessed for environmental impact (and in some instances will be subject to consenting), and any uncertainty in the effectiveness of the measures needs to be fully understood. The full implications of introducing any particular measure also need to be understood in the context of all other receptors (i.e. it is possible for a measure to have a positive effect for one receptor, whilst at the same time adversely affecting another). Similarly, some measures can have multiple environmental benefits, as well as providing budgetary and programme efficiencies to the project as a whole.

Ultimately, for larger projects, all mitigation measures are likely to require some form of options appraisal. This will be set in terms of the types and scale of environmental benefit (and certainty), as well as the implications for the overall technical (construction and operational requirements) and commercial/economic viability of the project (cost and programme requirements).

In determining and applying mitigation measures site, specific parameters will always form a key consideration. The types and scale of potential effects will need to be assessed on the basis of the likely exposure to different pressures, as well as the sensitivity and importance of the receiving environment. The potential effects arising from noise, for example, would largely depend on the source levels and propagation of the noise, spatial restrictions on movement (e.g. width of an estuary or tidal state), and the sensitivity of species in the vicinity of the works. This would result in seasonal and temporal differences in the application of respective mitigation measures.

The application of lessons learnt from previously applied mitigation measures will also be key to defining the levels of certainty that can be attached to a particular measure. This, in negotiation with

key stakeholders, will help to determine the most appropriate mitigation measures for a particular project which should go some way to facilitating the consenting process.

5.2 Example mitigation measures

Across industry, a wide variety of mitigation measures have been implemented or proposed to mitigate potential impacts of a scheme or activity on marine habitats and species. These broadly cover three categories; consideration of location, footprint and scale of scheme/activities; design of scheme/activities; and working practices that can be applied during the construction, operational, maintenance and decommissioning phases of a project.

Broken down across these categories are measures which address the breadth of the mitigation hierarchy, including avoidance of impact, minimisation of impact and restoration or compensation following potential impact (noting that compensation is discussed in Section 6). The proven success of these measures varies, dependent on the level of application to date and the availability of data/information to monitor and understand their potential effectiveness. Where examples of success (or otherwise) are available, these are discussed in the sub-sections below for habitats, fish, marine mammals and birds.

5.2.1 Consideration of location and scale of scheme/activities

The consideration of location, footprint and scale of a scheme/activities is typically undertaken throughout the planning/design phase of a development (see Table 3). This begins with the initial site selection process during the feasibility/constraints review (at a broad scale) but continues to contribute to scheme design (such as scale of a project or array design for MRE projects), and ultimately through to the micro-siting of marine infrastructure.

Effective consideration of constraints and opportunities during the initial site selection and feasibility review provides the opportunity for impacts on specific features to be avoided altogether. It is, however, recognised that for MRE projects, there will be specific construction, operation and maintenance requirements that will play a large part in determining where such activities can be undertaken. Furthermore, this will be influenced by the specific requirements of the technologies to be employed as part of a particular project. This will, in itself, result in spatial conflicts where the scheme requirements directly relate to the occurrence of specific ecological features (which are reliant on the same physical processes). The consideration of scheme location will therefore generally be included within initial project feasibility studies, which take into account environmental, social and technical constraints and opportunities. This process is often supported by early stakeholder engagement.

Similarly, and again reviewed during scheme feasibility and early stage design, based on the sensitivity of the surrounding environment (alongside other factors), the overall scale of a project can be adjusted in accordance with environmental constraints.

Following conclusion of the overall site selection location, the micro-siting of infrastructure may allow for avoidance of particularly sensitive areas, supported by site specific surveys. This approach is regularly applied across all project types in the marine environment.

The identification of a project location may, in some cases, be supported at a plan level, such as through the development of Draft Plan Option areas by Marine Scotland for Offshore Wind (Scottish Government, 2019).

Overall, it is considered best practice across all industries to avoid impacts where possible, either through avoiding sensitive locations, adapting the scale of development in accordance with environmental constraints and the micro-siting of infrastructure.

Table 3. Mitigation measure examples - Consideration of location and scale of scheme/activities

Mitigation Measure	Receptor	Description/Examples	Key considerations/practical application
Minimise disturbance, loss of habitat, impacts on migration pathways or sensitive sites by considering site selection and project scale	Habitats	It is a standard requirement for the need and alternatives of a particular project to be well defined as part of the assessment and consenting processes. At a project level, an example of a feasibility study incorporating environmental sensitivity of benthic habitats include the screening and scoping report produced for Project Erebus (Floating Offshore Wind), which included three separate options for the cable pathway for consideration against both technical and environmental constraints during early pre-application discussions with technical advisors at NRW (MarineSpace, 2019). Similarly, consideration of scale in the context of MRE projects could, for example, include a reduction in either the size or the number of devices in order to reduce the overall footprint of the project within a sensitive benthic habitat.	Key considerations include: ▪ Technical requirements for MRE installations (e.g. flow speeds, wind, waves, water depth, substrate). ▪ Environmental sensitivities (e.g. proximity to protected features). ▪ Grid connectivity. The inclusion of environmental sensitivities into site feasibility/discussion of alternatives is well demonstrated and is standard practice. Where avoidance is possible, it is considered a highly effective method of reducing/avoiding potential impacts. Predominantly informed by pre-existing data as opposed to specific monitoring campaigns that are subsequently employed to inform the project baseline and environmental assessments.
	Fish	During initial feasibility studies, the selection of a site incorporating the environmental sensitivity of fish receptors, such as the consideration of fish movement or migration pathways, is considered standard practice and is a key input into constraints analyses. However, the physical conditions required to ensure scheme viability (such as a large tidal range within relatively close proximity to the coastline for tidal energy projects) are likely to directly overlap with the occurrence of fish migration pathways. This includes, for example, the placement of barrages in tidal estuaries, which almost inevitably will be located on migration routes.	
	Marine mammals	A project specific feasibility study would take into account the potential impacts on marine mammal receptors to understand the relative level of constraint based on the type of activity being proposed. In this context, it should be noted that marine mammals are typically wide-ranging mobile species. Particularly high levels of constraint may, however, be experienced in areas of high abundance	

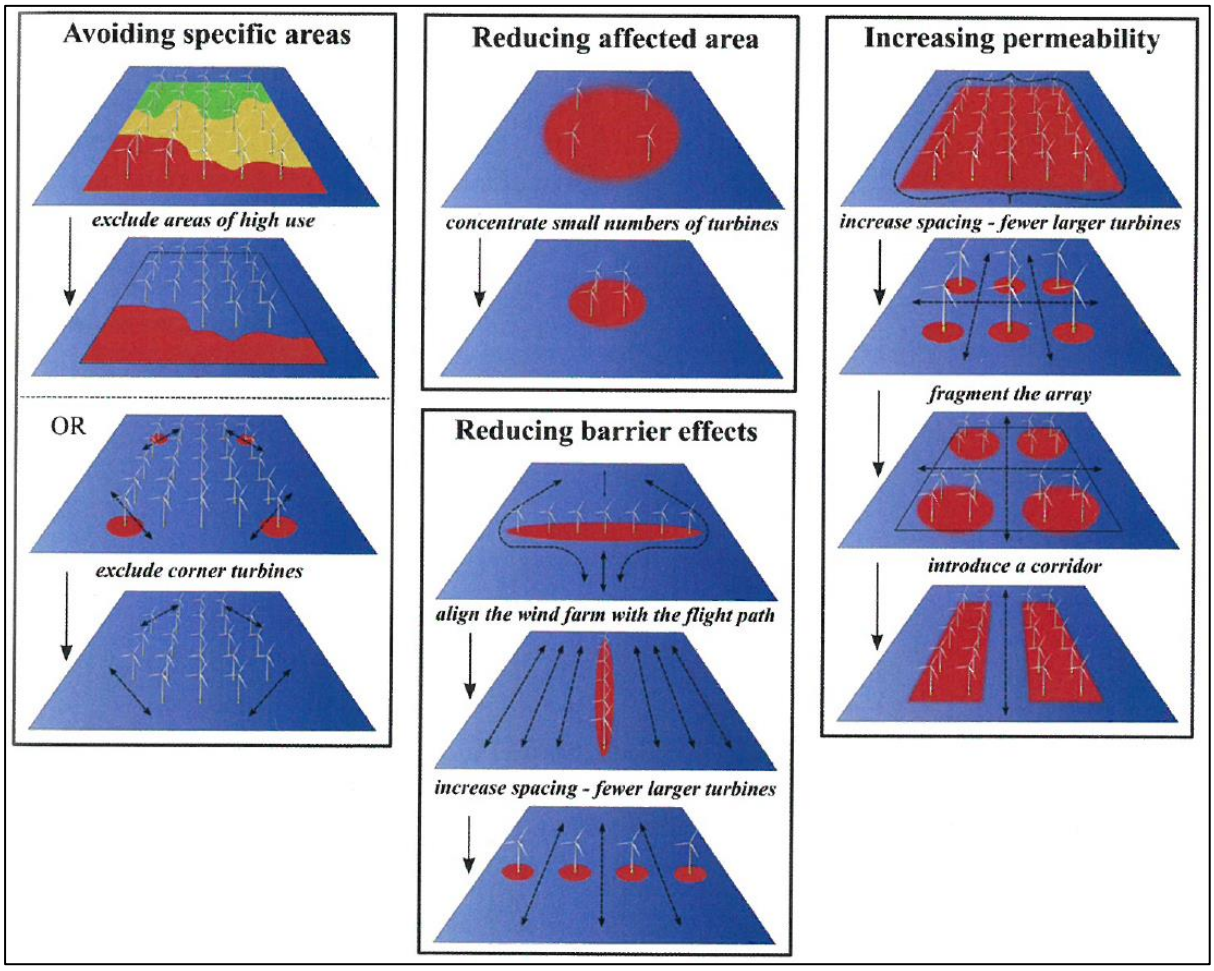
Mitigation Measure	Receptor	Description/Examples	Key considerations/practical application
		including, for example, seal haul out and pupping sites. It is assumed that, in principle, areas of greatest importance for supporting marine mammals will be avoided as far as possible when selecting the location for a particular project.	
	Birds	The overall location of a proposed project would be informed by an understanding of the presence of important breeding, feeding, roosting and overwintering grounds. This includes, for example, large expanses of mudflat and breeding colonies which typically support important bird numbers. It is assumed that, in principle, these important bird areas will be avoided as far as possible when selecting the location for a particular project.	
Minimise disturbance to sensitive locations with exclusion zones	Fish Habitat	The aggregates and MRE industries, for example, as best practice, implement exclusion areas to avoid some sensitive spawning or nursery habitats (JNCC and Natural England, 2011). It is recognised that these will also often overlap with sensitive benthic habitats and therefore the restriction of activity in sensitive locations will potentially support both habitat and the fish species.	The identification of areas within a site in order to identify potential exclusion zones relies on the collection of up to date data, combined with an in-depth understanding of key habitats for each species. Monitoring to establish the effectiveness of the exclusion zones will require repeated surveys. It is, however, recognised that potential changes in habitat quality or fish populations may not be linked to the activity, as there are other contributing factors to their status.

5.2.2 Design of scheme/activities

Where the complete avoidance of impact on a sensitive habitat or species is not a practicable solution, the more detailed design of the scheme provides an opportunity to further minimise adverse effects (see Table 4). In the context of MRE projects this may include, for example, the selection and design of a particular technology including the supporting infrastructure (e.g. the anchoring mechanism or pile design) as well as the overall layout of a scheme, such as taking account of environmental sensitivities in array design (see Figure 2).

The balance between temporary and permanent impacts also can influence the mitigation measures that are employed. For example, the balance between a larger temporary footprint against permanent, but smaller, habitat loss should be considered.

Furthermore, design of the scheme may offer opportunities to mitigate indirect impacts, such as those associated with changes in hydrodynamics or changes in sedimentary processes. For example, changes in the configuration of a MRE project may reduce changes to the hydrodynamic environment and therefore reduce associated impacts. This may include, for example, amendments to the layout of a particular array and associated infrastructure or the alignment of a barrage or lagoon structure. In practice, this type of design element is likely to be an iterative process informed by the evolving impact assessment.



Source: Harwood and Perrow, 2019

Figure 2. Using array design to reduce barrier or collision risks

Table 4. Mitigation measure examples – Design of scheme//activities

Mitigation Measure	Receptor	Description/Examples	Key Considerations/ Practical Application
Minimise disturbance to benthic habitats though infrastructure design - MRE projects	Habitats	When considering benthic habitats, MRE projects may mitigate habitat disturbance through the reduction in the footprint of individual devices or the anchoring approach (including consideration of eco-moorings which have a reduced scour footprint). For example, when considering development of offshore wind turbines, the use of three piles for a jacket/tripod foundation may have a smaller footprint than a single monopile, reducing footprint-related loss in a potentially sensitive area. Project Erebus (floating offshore wind project) currently proposes the use of drag anchors and catenary cables (MarineSpace, 2019). This technique means that, once the project is decommissioned, there will be no infrastructure remaining on the seabed and therefore impacts will only occur during the lifetime of the project. However, the footprint of the catenary cables and anchors may be significantly higher than other technological solutions, such as tension-leg, which would require a piled attachment with a permanent impact. Within other sectors, examples include consideration of design changes to reduce potential impacts, such as designing a raised slipway to sit on piles above a sensitive habitat rather than a solid slipway which would incur footprint loss underneath the structure. The same principles are also typically applied to ports, where options of open piled jetties versus reclaim options are frequently evaluated. The aggregates industry also provides examples of widely applied mitigations, such as ensuring that 0.5 m of sediment is retained above the underlying bedrock at the end of a dredge campaign (BMAPA, 2017). This facilitates the recovery of benthic habitats once dredging has ceased (JNCC and Natural England, 2011).	As outlined above, opportunities for mitigation as part of the scheme design are also influenced by the technical constraints/requirements of the project. The example discussed for Project Erebus also highlights the requirements to consider the balance between short and long-term impacts against the magnitude of the impact itself when selecting the design with the lowest impact. Similarly, a reduction in benthic footprint of a structure through the use of piling may have implications for other receptors. For example, piling activities may have significant noise impacts. As such, the sensitivity of receptors at the site in question should be considered and no one approach is necessarily always lower impact across all sites.

Mitigation Measure	Receptor	Description/Examples	Key Considerations/ Practical Application
Minimise habitat disturbance during decommissioning with the use of Best Practicable Environmental Option (BPEO) decommissioning standards	All	The application of Best Practicable Environmental Optioneering in the decommissioning process has the potential to mitigate potential impacts during this life-cycle phase. The BPEO process allows long-term projects to take into account up to date understanding of the balance of impacts when designing their decommissioning strategy. This has been raised in a number of examples, where projects have proposed assessment towards the decommissioning stage. When considering options for cable decommissioning, numerous projects including Marine Energy Test Area (META), Morlais and Project Erebus have identified the importance of balancing the impacts of removing the cable against impacts of leaving *in situ*.	When identifying the BPEO, the project will be required to consider the balance of impacts against all receptors, and the sensitivities of these receptors at any specific site. This should be undertaken close to the implementation of decommissioning, whereupon the most up to date scientific understanding of impacts, and the current state of the environment at the project site can be included in the consideration.
Minimise impacts on hydrographic factors and the sedimentary regime through design of infrastructure, demonstrated through appropriate modelling	Habitats	Reduction of impacts associated with changes in hydrodynamics can, in a sedimentary environment, be managed through design changes to reduce impacts. For example, scour protection is used widely across the Offshore Wind industry, whilst the fate of dredge arisings is considered in the assessment of dredge operations to, ensure that the hydrodynamic and sediment regimes of the dredge and disposal locations are not significantly impacted.	Predictive models are reliant on the use of up to date baseline physical data. Where MRE are proposing novel technology, there is likely to be increased uncertainty in the model outputs. However, in the UK generally, coastal models are considered well developed, and therefore confidence in their outputs is typically relatively high, assuming that the outputs are interpreted in the context of an expert geomorphological assessment. Determining cause and effect in dynamic environments can be difficult even where site specific monitoring is undertaken.

Mitigation Measure	Receptor	Description/Examples	Key Considerations/ Practical Application
Enhancement of infrastructure to increase species diversity	Habitats	Enhancement opportunities within the design of structures can be implemented as mitigation measures. For projects where the development site contains existing hard structures such as seawalls or quay walls, or where the construction of new such structures forms part of the proposals, features can be introduced to enhance the surface roughness and to create pits and water-retaining features. Such features are implemented to facilitate greater diversity of organisms occupying the engineered habitats. Examples can be categorised as follows: ▪ Retrofitting or including pocket rock pools onto vertical sea defences (e.g. 'vertipools'); and ▪ Increasing the surface roughness of structures by drilling holes or installing encasements/tiles. In addition, numerous techniques are conceivable to increase the surface roughness of coastal and marine structures, ranging from drilling (or including of) holes, replacing mortar, to attaching tiles, eco-concrete, and timber battens. Enhancements can also be undertaken to either retrofit existing rock armour to increase interest/diversity or include relevant structures during the installation of new rock armour. When using rock armour, locally sourced rock or rock of a comparable type will allow similar communities to develop to those on adjacent rocky shores. The use of a variety of rock types (as was proposed for Swansea Tidal Lagoon) can again add to heterogeneity and potentially support greater biodiversity. The Marineff project, a collaboration between France and the UK, is aiming to produce new ecological enhancement units to be integrated into the construction of coastal infrastructure (Marineff, 2020).	Opportunities for enhancement will be required to be balanced against the potential for compromising the integrity of a structure, reducing operational performance or increasing construction and/or maintenance costs. Further details and examples of all of these measures can be found in a review undertaken on behalf of NRW that looked at possible initiatives to enhance marine ecosystems, including a discussion of evidence gleaned from installation and monitoring to date (NRW, 2019a).

Mitigation Measure	Receptor	Description/Examples	Key Considerations/ Practical Application
	Fish	Incorporation of ecological enhancements into the scheme design, to encourage colonisation by native species, may also promote usage by some fish species. In addition, an increase or improvement in specific habitats that support fish species may also provide mitigation for loss of spawning habitats or additional benefits. This could, for example, include the placement of gravel substrate to create suitable spawning substrate (as considered when evaluating options for a Tidal Power Scheme on the Severn Estuary (ABPmer *et al.*, 2008)), or planting/relocation of seagrass to create suitable nursery habitat.	
	Birds	If a scheme or an activity would result in the removal of roosting structures (e.g. solid structures jetties, piers or quays) or increase in disturbance, the provision of additional roosting habitat could be included within the design phase to help mitigate any such impacts. As part of the design phase, there may also be opportunities to incorporate enhancement features. This could include, for example, the provision of bird roosting structures. It may also be possible to include screening measures to ensure that, once operational, a scheme does not result in increased levels of disturbance.	
Minimise impacts on habitats through micro-siting	Habitats	Micro-siting is the process for selecting the specific location of project infrastructure, taking into account technical and environmental factors. For the purposes of mitigating impacts on benthic habitats micro-siting has been proposed for the META project, which proposes that the specific location of infrastructure will be designed to avoid sensitive reef habitats following detailed benthic survey of the proposed sites (RPS, 2019). Similarly (and a common practice within the subsea cable industry), when considering potential impacts on the reef feature, the Greenlink project undertook a comprehensive survey to support the routing of the cable to avoid (as far as possible) reef feature within the Pembrokeshire Marine SAC (Greenlink, 2019).	The relative importance and sensitivity of receptors to pressures resulting from the development proposals would inform micro-siting. Monitoring data can be used to inform the potential value of micro-siting. Site specific parameters will also form an important consideration.

Mitigation Measure	Receptor	Description/Examples	Key Considerations/ Practical Application
Minimise disturbance with micro-siting	Mammals	Micro-siting within the overall scheme footprint provides an option to help minimise significant disturbance, displacement or underwater barrier effects to marine mammals. Allowing appropriate space around individual MRE devices with rotating underwater parts could, for example, minimise the potential for collision. This concept is displayed in Figure 2, which depicts design options for offshore wind structures to reduce impacts on birds. The principles could equally be applied under water and hence are of relevance to marine mammals.	
Minimise disturbance or displacement with micro-siting	Birds	Micro-siting within the scheme footprint would need to be considered to avoid significant disturbance, displacement or barrier effects (see Figure 2). An example of such micro-siting is provided by offshore wind farms which pose a risk to birds, through direct collision, or through increased energy expenditure to navigate around the turbine structures. Several wind farms have adapted the site layout in order to reduce impact (Harwood and Perrow, 2019). This mitigation can be achieved through increasing spacing to allow flight lines, create clusters of turbines to reduce inter-turbine space and make the birds navigate around the whole cluster and not between the turbines or decreasing the horizontal profile by producing one long line, instead of four medium size lines (see Figure 2). Micro-siting for other industries could include, for example, focussing more disturbing activities (i.e. movements of people/transport) within an area of a site thereby leaving some areas undisturbed. Any coastal development should design the site to allow screening of activities which may cause disturbance to bird receptors.	
Minimise impact on migration by installation of fish passes	Fish	Mitigation measures aimed at avoiding or minimising impacts for fish which may be implemented during the design of MRE projects vary considerably depending on the technology being proposed. For example, mitigation is regularly proposed for tidal barrage barrier effects to fish through the inclusion of fish passes into the design of the barrage itself, a principle which has been applied on multiple occasions in rivers across Wales.	Fish passes are regularly applied on migratory rivers with a body of evidence demonstrating their use by fish species. Monitoring of their success can be undertaken by comparing pre and post-installation metrics for the success of migratory fish, although it is recognised

Mitigation Measure	Receptor	Description/Examples	Key Considerations/ Practical Application
			that natural variability, and the influence of other anthropogenic factors, limits the ability to determine cause and effect.
Minimise or avoid requirements for percussive piling	Fish	The choice of foundation type may be considered as a mitigation measure, with different options providing different benefits or risks. Different foundation types will have significantly different piling requirements, a key factor in assessment of construction noise impacts on fish species. For example, the use of mono-bucket foundations for met masts at Dogger Bank has avoided the requirement for percussive piling (Thomsen and Verfuß, 2019). The impact that underwater noise will have on fish is also dependant on the characteristics of the site, where a constrained site, such as an estuarine location is likely to provide fewer opportunities for avoidance behaviour (particularly in an estuary where migration is known to occur). As a result, projects in more constrained sites are more likely to consider lower noise technologies than those in more open locations.	Reductions in the requirement for percussive piling will generally mitigate the impacts associated with underwater noise from developments. However, choice of foundation technology, resulting in a reduction in piling may, in some cases, equate to an increased footprint loss, and therefore the potential impacts should be considered holistically.
Minimise risk of disturbance by reducing artificial lighting//use of directional lighting	Fish	Fish species may also be impacted by visual disturbance in the environment, and therefore previous MRE projects (as well as wider marine and coastal activities) have proposed mitigation to reduce the input of artificial light into the wider environment. This includes the development of light management plans promoting overall reduction in artificial light and the use of directional lighting where possible.	The reduction of artificial lighting entering the marine environment associated with a development will inherently mitigate any impact pathways associated with artificial lighting.
Minimise risk of entrapment with sluice gates	Mammals	A potential way to mitigate entrapment of marine mammals within a lagoon structure could be placement of sluice gates. These gates would need to be incorporated during the design phase so that the efficiency of the design is not compromised by any post-design modifications. Within the design of the Swansea Bay Lagoon, sluice gates, specifically for the release of entrapped mammals, are proposed (Tidal Lagoon Swansea Bay, 2014).	Where sluice gates are incorporated as part of the design, monitoring of their usage by marine mammals, and record of any marine mammals present within the entrapment area not able to use the sluice to their detriment can be evaluated to determine their success.

Mitigation Measure	Receptor	Description/Examples	Key Considerations/ Practical Application
Minimise collision risk or noise impacts through the design of blade parameters	Fish	For tidal stream energy the design of the turbines is a key factor, affecting both the level of collision risk and the potential impacts arising from underwater noise. The influence of the turbine design on the noise produced by the turbines is well documented (RPS, 2019), although generally considered to be low. However, when considering collision risk, designing a 'fish-friendly' turbine is considered a key challenge for tidal stream energy projects, and the impacts of changing designs on fish collision risks are less well understood (ABPmer, 2020).	The design of turbine blade parameters for both offshore wind and underwater turbines has the potential to mitigate potential impacts, such as collision risk and underwater noise. The degree to which design changes are successful in mitigating impacts is currently uncertain in practice. However, research studies that have considered the behaviour of marine mammals in terms of use of the different parts of the water column and how this influences collision risk (Benjamins *et al.*, 2015; Copping *et al.*, 2016) support the potential reductions in impact offered by changing device design. For example risk can be reduced by decreasing the swept area and velocity of a turbine blade, hence reducing the likelihood and severity of any collision. i.e. a shorter blade, moving at 2 m/s (at the tip of the blade) would have reduced risk of collision, by reducing the swept area and velocity compared to a longer blade moving at 10 m/s (at the tip of the blade). For offshore wind, the principles are the same, however there is likely to be greater variability in the most appropriate parameters to use at any particular site,
	Mammals	In developing tidal energy, modifying the blade parameters to decrease the likelihood of collision is considered the main design specific mitigation available for reducing risk to marine mammal receptors. In contrast to offshore wind the design of tidal stream turbines is currently in the early phases of development with each developer using slightly different design principles. Blade parameters that can be modified include, blade length, blade profile (width and size of tip) and blade rotational speed. Each of these parameters contribute to the risk of collision with such devices and as such their application can be used to minimise adverse effects.	
	Birds	In addition to underwater collision, birds are susceptible to collision above water. The offshore wind sector is well developed and modifications to blade design/placement have been tested to potentially mitigate the risk of collision (Harwood and Perrow, 2019). The main way to modify the rotor blade is to decrease the length which in turn reduces the swept area. There is an efficiency offset with smaller blades however, and therefore more small bladed turbines would be needed to convert the same amount of energy as less large bladed turbines. It is generally considered less environmentally damaging to have fewer larger bladed devices compared to a greater number of smaller bladed devices (Cook *et al.*, 2011; Johnston *et al.*, 2014). The second parameter than can be modified is the hub height, where the higher the hub the less the potential risk of collision due to typically preferred flight heights (majority of reported flights <20 m) (Johnston *et al.*, 2014).	

Mitigation Measure	Receptor	Description/Examples	Key Considerations/ Practical Application
		The final parameter that has been tested on onshore wind farms is to change the colours of the blades to be more conspicuous. At an onshore site in Norway, painting one of the three blades another colour reduced the number of collisions by 70 %. This type of mitigation could potentially be replicated for offshore wind farms (King, 2019) recognising that this might also influence landscape and visual receptors.	based on the characteristics of the species present and their sensitivity to collision versus displacement. It is likely that the science behind collision risk will continue to develop, and therefore projects should ensure that current scientific consensus is taken into consideration in project design.
Minimise collision risk through providing new roosting//loafing platforms	Birds	Several species of bird have been shown to be attracted to offshore wind farms and use the structures as perches for foraging trips (terns, gulls and cormorants especially). This increases the risk of collision and as such can be mitigated for by provision of resting/roosting structures away from wind farms.	Whilst the provision of artificial resting or roosting sites is demonstrated to be successful in attracting birds, the effectiveness of using them to lure populations away from wind farms is less well established. There is also uncertainty as to the best distance to place such structures from a wind farm. The effectiveness of this as a mitigation measure could be monitored through monitoring the usage of the roosting structures and seabird density in the vicinity of a scheme (prior to and following implementation).
Consideration of infrastructure being used as predator perches or interfering with sight lines	Birds	The increased risk of predation from the introduction of predator perches or reduction in bird sight lines should also be considered as part of the design phase of a project. This is mainly a coastal impact, whereby the placement of new infrastructure could provide perching opportunities for predator birds (e.g. raptors) or reduce sight lines. The reduction in available perching platforms or design of infrastructure to be low profile could therefore be used as a possible mitigation measure for coastal birds.	Where a project is predicted to increase risk of predation due to introduction of predator perches, the reduction in these will directly mitigate this pathway.

5.2.3 Construction and Operational working practices

Following determination of the design and location of a project, the methodology for the construction, operation, maintenance and decommissioning of a scheme may also support the mitigation of potential impacts (see Table 5). These measures typically aim to reduce the impact or restore the environment following the realisation of potential impacts.

There are a number of measures which are requirements of legislation, and//or considered industry best practice which address the mitigation of marine pollution, and hence will mitigate this potential 'emergency' pathway for all receptors. These measures are driven by legislation, such as the International Maritime Organization conventions, with guidance derived from the legislation and best practice produced by governmental organisations (NRW *et al.*, 2017). Adherence to this guidance is regularly required for all projects and is enforced through general licence conditions.

Similarly, measures to manage suspended sediment concentrations, such as capturing drilling arisings, minimisation of dredging requirements, consideration of dredge techniques, scour protection and cable trenching/backfilling may also provide mitigation for all receptor pathways.

Following completion of an activity associated with a MRE scheme, there are also often requirements (potentially included in licence conditions) to restore the environment to as close to its pre-development state as possible. NRW generally takes the approach that removal of all infrastructure following decommissioning of a project is preferential. However, there is ongoing discussion across industry to ensure that decommissioning is undertaken in line with the best practicable environmental option (BPEO). This may balance removal against benefits of leaving some infrastructure in place (e.g. removal of buried cables may have greater impacts on the marine environment that leaving them in place), noting that oil and gas infrastructure is subject to the requirements of OSPAR 98/3.

Table 5. Mitigation measure examples –Construction and Operational working practices

Mitigation Measure	Receptor	Description/Examples	Key Considerations/Practical Application
Minimise changes to habitat quality with industry best practices for storage of fuels, oils and chemicals	Habitats	Potential mitigation for this pathway includes a number of measures considered to be industry standards. These measures include the implementation of industry best practice for storage and use of fuel, oils and chemicals), and compliance with legislation on selection and management of chemicals (for example choice of anti-foul paints in accordance with national legislation).	As included within the description, these measures are industry best practice and widely applied. They are therefore considered to be appropriate for the mitigation of potential impacts associated with fuels, oils or chemicals.
Minimise release of suspended sediments in the water with construction techniques	Habitats	The consideration of specific construction techniques, for example, capturing arisings from drilling activities to reduce potential increases in suspended sediment in the environment are widely applied. Similarly, the selection of a particular dredging technique can influence the implications for changes in water and sediment quality.	The adaptation of working practices, either through managing the techniques used or through timing restrictions are regularly applied to mitigate the effects of elevated SSCs. Monitoring can be used to determine the effectiveness of such measures.
	Fish	During construction industry standard mitigation measures can be applied to mitigate the risks of changes in water and sediment quality on fish species. This includes measures to ensure increased SSC do not adversely affect fish species during dredging activities (where monitoring and timing restrictions are frequently placed on such activities).	
	Birds	Generic measures to reduce any deterioration in water quality, in particular increased suspended sediment concentration (SSC), also help to mitigate the risk of reducing the ability of diving birds to detect their prey. This could be applicable to any construction activity including dredging which could be employed to implement an MRE project.	
Minimise impacts of construction on sediment processes with construction techniques	Habitats	When installing cables there are a number of potential methodologies which may reduce the potential impacts, dependant on location specific conditions. For example, the use of Horizontal Directional	The application of cable burying is applied across industries, and is considered to considerably reduce potential impacts.

Mitigation Measure	Receptor	Description/Examples	Key Considerations/Practical Application
		Drilling proposed by the Greenlink project (Greenlink, 2019) avoids impacts on the intertidal areas at the landfall location. Alternatively, projects may seek to reduce scour through cable burying. This provides both operational benefits (prevention of free-spanning) and environmental benefits (restoration of the marine environment following the burial process.	Projects will generally seek to limit exposed cables so far as is practicable, reducing the need for scour protection or cable mattressing as well as reducing the risk associated with scour associated with introduction of structures into a sedimentary environment. Whilst it is generally considered a lower impact, it is recognised that this may not always be the case, and that the methodology to be applied should be assessed on a project-by-project basis.
Minimise impacts to physical processes by undertaking work or operating at appropriate tidal states	Habitats	In the specific context of MRE projects that change the tidal regime, mitigation measures that have been considered include adapting the operational regimes of the turbines to minimise changes in water levels. This in turn reduces the scale of potential effects on both intertidal and subtidal habitats as well as the species supported by these features. For example, the Severn Tidal Power feasibility review considered the adaptation of the operational regime of the barrage on either a daily or seasonal basis in order to reduce impacts on habitat features (ABPmer *et al.*, 2008). Similarly, the implications of power generation on both spring and neap tides was also evaluated. Similar considerations were also made during the design and assessment of the Swansea Bay Tidal Lagoon proposals (Tidal Lagoon Swansea Bay, 2014).	Avoidance of key periods is applied regularly as a mitigation measure to minimise adverse effects. However, consideration must be given to the sensitive periods for different species, which may or may not overlap. Different species (both fish and bird species) are sensitive to different levels of noise, with highly sensitive bird species likely to be impacted up to 500 m away from the noise source (Cutts *et al.*, 2013). The distance between the source and receptor need to be considered along with the presence of any barriers and/or screening. Noise modelling undertaken for a project allows a "sensitive area" map to be created which could then inform the construction programme/measures required.
Minimise impacts through avoidance of sensitive periods	Fish	Avoidance of key spawning or migration periods/seasons are used throughout industry and included as licence conditions, such as for work proposed on Swansea West Pier, where a licence condition restricts piling activity to exclude a period of 1 hour either side of high tide (NRW, 2019).	

Mitigation Measure	Receptor	Description/Examples	Key Considerations/Practical Application
	Birds	The seasonal timing of construction activities is the main way to mitigate major disturbance impacts on bird receptors. The bird population of Britain is enlarged between October and March, when hundreds of thousands of birds migrate to Britain to overwinter, away from their breeding areas in higher latitudes. Restrictions on winter construction is commonplace for many coastal developments. For example, a Development Consent Order (DCO) condition for the Swansea Tidal Lagoon was the avoidance of seawall construction between October to March (Tidal Lagoon Swansea Bay, 2014). Alongside important overwintering numbers there are large populations of breeding seabirds which also need to be protected seasonally, the proposed Wylfa Nuclear Power Station identified specific construction activities that could not be undertaken during the breeding season for terns, specifically blasting activities (Horizon, 2018).	
Consideration of the introduction of invasive non-native species and development of a Biosecurity Management Plan	Habitats Fish	Biosecurity management plans are also becoming more commonplace and include a variety of working practices aimed at reducing the potential risk for introduction or spread of Invasive Non-Native Species (INNS). These practices may include (but not be limited to) requirements for hull inspections (or hull cleaning if required), particularly where vessels are moving from a spatially separate area to undertake the work, management of ballast water (in accordance with international regulations) and further industry or location specific measures. For example, the regional biosecurity plan for Bristol Channel (and Celtic Sea) region produced by the British Marine Aggregates Producers Association (BMAPA) identifies a broad range of mitigation, incorporating both best practice measures and location specific considerations (ABPmer, 2019).	Biosecurity management plans may be successful at avoiding introduction of new INNS at a project level. Many of the requirements will be driven by legislative requirements, such as the International convention for the control and management of ships ballast water and sediments. However, the detailed content of such plans will be driven by the specific characteristics of the location itself or origin of any project vessels and sensitivity of receptors. For example, projects currently proposing to use Holyhead port are more likely to require additional measures due to the presence and potential for spread of carpet sea-squirts *Didemnum vexillum*.

Mitigation Measure	Receptor	Description/Examples	Key Considerations/Practical Application
Minimise underwater noise with construction techniques	Fish Birds Mammals	Reduction in noise levels at source may be achieved through the use of lower impact piling techniques, such as through drilling or vibro-piling rather than percussive piling. For example, the under development 'Blue Hammer' uses gas compression/water movement to drive a pile with reduced levels of underwater noise. Also piling at/around low water when piling in the intertidal, so as to reduce the likelihood of noise travelling through the water column.	Lower impact piling techniques are less proven to provide the required construction specification, with technology such as the 'Blue Hammer' not yet commercially viable (Thomsen and Verfuß, 2019). These techniques may also increase the length of time that piling is required for, and therefore balancing time against noise level may be required depending on the characteristics of the site and the project.
Minimise underwater noise with implementation of noise reduction measures	Fish Mammals Birds	Reduction in the transmission of noise impact in the environment may be achieved through the use of bubble curtains, sound dampers or resonators.	The efficacy of these methodologies varies, with bubble curtains, sound dampers and resonators demonstrated to provide noise reduction. However, the success of bubble curtains in excluding species from an area of high noise emissions is also uncertain.
Minimise impacts through deterring receptors from the area	Fish Mammals	The use of acoustic deterrent devices (ADD) are suggested, to reduce the probability of fish presence in the impact radius.	Acoustic deterrent devices increase the overall levels of anthropogenic noise in the environment, and may not deter all species. The use of acoustic deterrents for fish is not yet demonstrated as a successful approach. For mammals, the use of noise to exclude animals from an area is used regularly but underwater the effectiveness of any such measure is hard to ascertain due to the difficulties in monitoring effect (MMO, 2018). In addition, the use of ADD in the long-term may cause large areas of displacement for some species, causing impacts through habitat exclusion.

Mitigation Measure	Receptor	Description/Examples	Key Considerations/Practical Application
	Birds	There are a variety of bird scarers that can be deployed to reduce collision risk by deterring their use of certain structures. These include both visual and acoustic devices. Playing the alarm call of each bird species (at random) may deter species from resting on the device structures.	Deterrence as a long term mitigation for bird species is not considered likely to be successful and has little or no proven worth as habituation occurs (Cook *et al.*, 2011; Harwood and Perrow; 2019).
Minimise underwater noise impacts with soft start piling	Fish Mammals	JNCC protocols require the use of soft start procedures whereby the intensity of an activity is slowly increased, over a pre-defined period (e.g. 30 minutes). This allows any marine mammals that were not detected during the pre-start period of searching to move away prior to the generation of higher noise levels.	The implementation of soft-start procedures is industry standard and is used across a wide range of marine sectors. Although widely used across Europe, the efficiency of soft-start in injury avoidance is not certain (OSPAR, 2009, Boyle and New, 2018)
Minimise underwater noise impacts through use of live marine mammal monitoring	Mammals	The Joint Nature Conservation Committee (JNCC) marine mammal observer (MMO) protocol (for explosives, seismic surveys and piling; JNCC, 2010a, 2010b and 2017 respectively) is the key guidance document applied to avoid impacts associated with noise (displacement, disturbance, change in behaviour etc.) and marine mammals within UK waters. The standard protocol is applied when marine mammals have been screened into an assessment and known to be in the vicinity of a project. If any marine mammal is observed prior to the commencement of a 'noisy' activity as part of the pre-start search, then the start has to be delayed in order for the marine mammal to move outwith an area of impact (e.g. 500 m from noise source). Recently the need to have Passive Acoustic Monitoring (PAM) has become an increasingly common requirement within marine licence conditions.	The use of MMOs is only effective when marine mammals are at the surface, and in good sighting conditions. There is therefore a limitation in applying this mitigation at night or in poor weather (e.g. rain/fog). On the other hand PAM has the potential to allow construction activities to be undertaken during periods of bad weather when visual detection would not be possible. However, it is only effective if the species of interest produces sound most of the time.
Consideration of electric and magnetic fields	Fish Mammals	The impact of Electromagnetic fields from operational cables is considered as standard practice in environmental assessments. Based on calculations, increases in burial depth or additional armouring during cable installation have the potential to reduce emissions and hence avoid changes in fish or marine mammal behaviour.	The impact of EMF on species is not yet well documented, with new research regularly being released for specific species (e.g. Hutchison *et al.*, 2020). Therefore, there is some uncertainty as to what environmental limits should be.

Mitigation Measure	Receptor	Description/Examples	Key Considerations/Practical Application
Minimise risk of collision with changes to operational regimes	Fish	During the operation of turbines, the consideration of operational regimes may mitigate impacts on fish species. This includes management of turbine speeds, which may vary collision risk, reducing operations in key fish migration periods and, for tidal lagoons, management of water levels.	Management of an operational regime will be specific to the sensitivity of receptors in a particular location and the operating requirements of a project. There are also difficulties associated with the effectiveness of shut down clauses. This includes, for example, the difficulty in monitoring and detecting the presence of birds in proximity to such devices (ABPmer, 2020).
	Mammals	Adaptive management, using real-time monitoring against defined thresholds of acceptable levels of impact to adapt the operational regime of the turbines, can be used to reduce risk to marine mammals.	
	Mammals	During the operational phase of a MRE project that includes underwater turbines management of the operational regime can also be employed to minimise collision risk. This was done successfully at Strangford Loch in Northern Ireland, where whenever the tidal turbine was operational a marine mammal observer was employed to ensure that when a marine mammal was seen within a set-distance of the device it would be shut down (ABPmer, 2020).	
	Birds	Potential measures associated with the operational regime for birds include active acoustic monitoring, which could shut down a device if any bird gets within a set distance. This can be applied both above and under-water, as shut down clauses could linked to with radar systems able to identify flying objects over a wide range (Harwood and Perrow, 2019).	
Minimise entrapment/ entrainment with capture and release	Mammals	As part of Swansea Tidal Lagoon's mitigation strategy, a capture and release policy was also proposed so that if any marine mammal didn't escape through the sluice gates then it would start a process to try and capture the animal.	There is uncertainty as to the effectiveness of this, as impacts associated with catch and release, such as acute stress responses (Wilson *et al.*, 2014), are not well understood.
Mitigating disturbance through financial contributions to management schemes	Birds	Some bird receptors are highly sensitive to visual disturbance. Such pressures can be exacerbated by urban growth and, in some instances, organisations have been set up (funded by housebuilders) to mitigate for this increased pressure.	The payment in to such schemes can help provide certainty to developers. The benefits, however, may be realised in areas remote from where the impact occurs.

Mitigation Measure	Receptor	Description/Examples	Key Considerations/Practical Application
		The generated funds are used for a variety of purposes including raising public awareness of bird disturbance issues, to provides wardens and rangers and to actively monitor the coastlines (e.g. Bird Aware Solent, Bird Aware Essex Coast, and Suffolk Coast Recreational Disturbance Avoidance Mitigation Strategy; Bird Aware Solent, 2017, Essex County Council, 2019 and Hoskin *et al*, 2019, respectively).	

6 Compensation Measures

Compensation is defined as *"a measure to make up for the negative effects of a plan or project. The term should only be used appropriately in the context of the different legislation requirements when referring to specific measures"* (NRW, 2018b). This section provides a summary of potential compensation measures, including consideration of their potential effectiveness and practical application in Welsh waters. Whilst the focus is on such measures for the purposes of compensation, it should be noted that most will also have wider applicability in terms of providing mitigation and enhancement opportunities.

In 2016, Defra commissioned a review of the Effectiveness of Natura 2000 Sites Compensation Measures in England which was largely focussed on the perceived success of intertidal habitat creation schemes. This was set in the context of trying to relate how compensation schemes had developed in the context of their respective objectives. Key findings from the Defra (2016) review have been captured within the relevant sections below along with more recent examples from project team experience, where available.

A series of over-arching principles relating to the provision of compensation is provided below. This is followed by a synthesis of possible compensation measures for each receptor in turn. It should be noted, however, that benefits for one receptor could have implications (both positive and negative) for the wider receiving environment.

A summary of consultation responses on this subject area can be found in Appendix C. Specific comments made in relation to each of the receptors are included in the respective sections below.

6.1 Process

The whole process of securing and agreeing mitigation and compensation measures takes into consideration a large number of factors. This is largely driven by the type, complexity and scale of impacts arising from a particular project, along with the sensitivities and importance of the receiving environment. This includes consideration of potential impacts (direct, indirect and cumulative) arising from all phases of a potential project. In addition, ensuring compliance with all legislative and policy drivers is also an important component of this process (see Section 3).

As highlighted within the WNMP, the evidence base also needs to be proportionate to the scale of effects. The availability of proven measures, with a high degree of certainty of success, is also an important consideration. This was also noted by several respondents to the questionnaire (see Appendix C).

There is also the need to have the requisite confidence that, once implemented, the compensatory measures will be effective and, in the specific context of the Habitats Regulations, that there will be no adverse effect on integrity. This can be delivered through the timing of delivery and the ratio of compensation provided, as well as the form of compensation.

In previous cases involving the delivery of compensation, a range of ratios have been applied to achieve the habitat creation objectives of a particular scheme or strategy (see Table 6). This has largely been driven by the type of project/strategy that results in the loss or damage and hence generates the requirement to provide compensatory habitat. For coastal defence projects in England, and the potential intertidal habitat requirements arising from coastal squeeze, a ratio of 1:1 (habitat loss : habitat gain) has been applied, in general, to offset predicted losses over the next 50 years. In

contrast to these coastal defence strategies, a ratio of at least 2:1 has more typically been applied where the required habitat gains are associated with the compensatory requirements for an identified development. The ratio of replacement to loss has risen to around 4:1 in some instances, for example, where achieving the required functionality cannot be resolved by smaller ratios and by compensating for losses at different Natura 2000 site much further afield.

The setting of appropriate objectives and implementing monitoring and management programmes (in which adverse effects and the success of compensation are both monitored and compared) is also key to understanding the effectiveness of compensation.

Current guidance for the delivery of compensatory habitat from a Habitats Regulations perspective references the requirement to deliver like for like replacement. The MCAA also reference measures of equivalent environmental benefit and therefore compensation requirements will depend on which sites are being affected. This forms a key consideration when evaluating the level of certainty that can be achieved through the implementation of a particular measure.

In contrast to the above, a recent case example, Hornsea 3, is proposing to provide compensatory measures of higher ecological function rather than on a like for like basis (GoBe, 2020). In this instance it is proposed to create an area of Blue mussel beds to compensate for the loss of subtidal sandbank (albeit additionally proposing to remove an unidentified amount of ghost fishing gear from other subtidal sandbank habitat) at a replacement scale of approximately 1:1. This is on the assumption that an adverse effect on integrity is concluded. Should such a package of measures be successful in being approved by regulators, this would set a precedent that could potentially be applied for future development proposals.

It is also important to recognise that the provision of measures is required to be additional to normal practice under the Habitats and Birds Directives. The principle of additionality was raised by a number of the respondents to the questionnaire.

There are several examples of projects being adopted and underpinned by a legal agreement which, in turn, has allowed the relevant Statutory Nature Conservation Body to have the confidence needed to support the compensation proposed. These include:

- Harwich Haven Channel Deepening Mitigation and Monitoring Plan, active since 1998;
- Trinity Terminal III Phase 2 Extension Compensation, Mitigation and Monitoring Agreement at the Port of Felixstowe (2003);
- Lappel Bank and Fagbury Flats - Environmental Monitoring and Management Plan for Allfleet's Marsh (2003);
- Immingham Outer Harbour Environmental Monitoring and Management Plan on the Humber (2004);
- Seaforth River Terminal Monitoring and Mitigation Plan on the Mersey (2005);
- London Gateway Port Compensation, Mitigation and Monitoring Agreement (2008);
- The Bristol Port Company's (TBPC) Steart Habitat Creation Scheme (2008);
- Able Marine Energy Park (2013); and
- Pagham Harbour coastal protection works (2017).

The securing of adaptive processes within legal agreements, therefore, has been increasingly used for large-scale projects. These legal agreements are generally accompanied by objectives for habitat delivery, or for the specific numbers of target species to be accommodated (typically invertebrates and/or birds), where applicable.

There are also a number of key practical elements which potentially influence the effective delivery of compensatory measures. These include, for example, the requirement to obtain separate consents to implement the measures (including all of the respective assessments and permissions) and the timescales this may take to achieve. Such measures also typically overlap with both the terrestrial and marine planning regimes which further complicates this process. It is also not uncommon for such schemes to encounter objections from local residents over concerns over changes in access and flood risk. In addition, the costs of securing and delivering compensatory measures is not insignificant.

The alignment of the timings of the potential impacts and the ability to deliver the required compensatory measures is also a key consideration. One such example includes the stated requirement within the Bristol Port Company legal agreement to deliver compensatory habitat at Steart at least one over wintering period before the impacts at Avonmouth are realised. A similar issue has also been identified with respect to the application of beneficial use where the timing of the availability of sediment, and the consenting of such an operation, would often be difficult to coincide with the timescales of the predicted adverse effects.

The delivery of a number of compensatory measures is also dependent on the availability of suitable land. This land is typically outside of the ownership of the project applicant and as such requires the purchase/lease of large expanses of what is currently typically agricultural land. This has obvious implications for the cost of such initiatives as well as the availability, and potential competition for suitable land, within the flood plain. This can be an issue in Wales, where coastal floodplains are frequently not very extensive.

Compensatory managed realignment schemes for example have average per-hectare costs of just over £80,000, more than twice the cost of schemes implemented for other reasons such as generic habitat creation (ABPmer, 2015 values adjusted for inflation). This has been attributed to a combination of generally higher land costs, more involved assessments and monitoring as well as greater site preparation/embankment construction (ABPmer, 2015).

Where such measures cannot be implemented in Welsh waters (either due to lack of land availability or suitable conditions/functionality), they may need to be provided outside of Wales. This would introduce further complexities with regard to the damage occurring in Wales, but also the potential benefits being experienced elsewhere as well as the practicalities/legislative powers of being able to enforce such measures.

The extent to which compensation objectives are being met is generally regularly reviewed through monitoring, with more formally defined review periods typically in the region of five to 10 years (see examples below). For most UK compensatory sites with specific compensation objectives it is, however, uncertain how these sites will be 'signed off' and the habitat deemed acceptable compensation for that which was lost. The duration of these types of agreements also introduces uncertainty, as a developer may become insolvent over such a time period. A mechanism to ensure delivery is fulfilled into the longer term (as required by a number of legislative drivers) is therefore important.

For all sites considered within the Defra 2016 review of existing Birds and Habitats Directive compensatory measures, no official sign off procedure was put in place from the outset, so in practice was considered uncertain what would happen at the sites at the end of the review period. This is further complicated by the issues surrounding understanding of natural variability in dynamic systems, as well as other external influences.

Table 6. Compensation schemes and ratios employed to date (where known)

Location of Compensation	Extent of Habitat Lost or Changed (ha)	Extent of Habitat Created (ha)	Approx. Gain: Loss Ratio	Background Details
Coastal Squeeze (CS)				
Brandy Hole, Crouch	12 ha	12 ha	**1:1**	Managed realignment in Essex / England. Undertaken to compensate for CS losses
Cwm Ivy, Loughor	Unknown	39 ha	**Unknown**	Unmanaged realignment in Wales. Facilitated by NRW through some land purchase, buying of rights to flood; also footpath negotiations with local authority.
Jubilee Marsh (Wallasea); Crouch Estuary	Unknown	165 ha	**Unknown**	Managed realignment in Essex / England. Implemented by RSPB, but with buy in from Environment Agency for this element, to compensate for CS in East Anglia.
Greatham North & South, Tees Estuary	Unknown	62 ha	**Unknown**	Managed realignment in Hartlepool (North East England). Environment Agency CS schemes.
Medmerry - Selsey Peninsula	n/a	183 ha	**1:1**	Managed realignment in West Sussex / England. Implemented as part of Solent Dynamic Coast project.
Steart Marsh, Bristol Channel	unknown	262 ha	**Unknown**	Managed realignment in Somerset / England. Implemented to compensated for CS losses as part of the Severn flood risk management strategy. Wider scheme also includes an RTE and freshwater mitigation areas.
Paull Holme Strays, Humber Estuary	n/a	80 ha	**4:1 (Direct)** **1:1 (CS)**	Managed realignment in Yorkshire, England. Predicted losses are not comparable with the area created because it formed part of the overall Humber flood defence strategy (Environment Agency, 2006)
Coastal Defence Works				
Morfa Friog, Mawddach Estuary	Unknown	7 ha	**Unknown**	Managed realignment in Gwynedd, implemented to compensate for impacts in relation to the Fairbourne flood defence scheme.
Hilgay (Environment Agency), Norfolk	n/a	40 ha	**n/a**	Terrestrial wetland created in East Anglia / England, implemented as part of Cley/Salthouse Flood Management scheme. Part of a bigger 65 ha project

Location of Compensation	Extent of Habitat Lost or Changed (ha)	Extent of Habitat Created (ha)	Approx. Gain: Loss Ratio	Background Details
Morecambe Coastal Defence Works and Hesketh Out Marsh, Ribble Estuary	11 ha	52 ha (of a 180 ha site)	**4:1**	Managed realignment in England. Loss of sandflat under the footprint of a breakwater (7 ha) and under the mitigation area (4 ha) in Morecambe (Young Associates, 2001) compensated for by saltmarsh realignment. Implemented 2008 (ABPmer website www.abpmer.net/omreg)
Rye Harbour	3.1 ha	6.1	**2:1**	Regulated tidal exchange scheme in England. Implemented as compensation for Pett Frontage Tidal Defence Scheme.
Port Development				
Allfleet's Marsh (Wallasea Island North Bank); Crouch Estuary	54 ha	115 ha	**2:1**	Managed realignment in Essex / England. Habitat created many years after the losses associated with East Coast port developments
Welwick, Chowder Ness and Doig's Creek; Humber Estuary	31 ha	59 ha	**2:1**	Managed realignment schemes in north-east England. Losses associated with port development on the Humber Estuary
Trimley Realignment, Orwell Estuary	4 ha, plus 0.2 ha annually (indirect)	12.5 ha	**3:1**	Implemented realignment scheme in Suffolk / England. Losses associated with Trinity III Felixstowe Port Development
Little Oakley; Hamford Water	72 ha (69 ha of direct loss)	105 ha	**1.5:1**	Planned managed realignment / intertidal habitat to be created as a result of losses associated with port development (http://www.hict.co.uk/data/downloads/incombination028-067.pdf)
Site A and Site X – Thames Estuary	5 ha plus change in 25 ha functionality (68 ha subtidal outside of EMS)	105 ha	**Losses not all within EMS**	Habitat created as a result of losses associated with port development at London Gateway. Now known as 'Stanford Wharf' and 'Salt Fleet Flats Reserve', with the latter including some Environment Agency buy in to use for CS compensation.
Steart Habitat Creation Scheme, Bristol Channel	113 ha (33.5 ha direct loss, not all EMS; rest functional /in-direct)	120 ha	**Losses not all within EMS**	Proposed managed realignment in Somerset / England. Compensation for consented Bristol Deep Sea Container Terminal

Location of Compensation	Extent of Habitat Lost or Changed (ha)	Extent of Habitat Created (ha)	Approx. Gain: Loss Ratio	Background Details
Cherry Cobb Sands, Humber Estuary	52 ha intertidal 23 ha subtidal	88 ha intertidal mudflat 38.5 ha wet grassland	**Not directly comparable**	Proposed regulated tidal exchange in north-east England. Acknowledges reduction in mudflat over time. Ongoing intervention within regulated tidal exchange. Precedent in terms of taking subtidal SAC
Other Developments				
Gwent Levels Habitat Creation, near Newport, Wales	200 ha (SSSI)	438 ha	**2:1**	Terrestrial wetland scheme in Wales. To offset impacts of the Cardiff Bay barrage. Habitat types lost and gained are reportedly very different (Burton, 2006). Implemented 2000.
Chetney, Kent	3.9 ha	22 ha	**5.5:1**	Grazing marsh scheme in Kent / England. Highways Agency scheme – A249 Iwade to Queensborough road improvement scheme.

EMS – European Marine Site
Source: Defra, 2019 and ABPmer OMReg database (unless stated otherwise)

6.2 Habitats

Marine renewables projects (and indeed all activities in the marine environment) have the potential to adversely affect both intertidal and subtidal habitats. Sections 6.2.1 and 6.2.2 below discuss measures (summarised in Table 7) which could potentially be implemented to compensate for the associated losses/damage to such features in intertidal and subtidal environments (respectively). Table 8 provides a case example of how measures could be applied in practice.

6.2.1 Intertidal

The creation of intertidal habitat to compensate for losses associated with either specific developments (typically ports) or more strategic provisions to address coastal squeeze have become relatively common place. The most commonly applied techniques to create such habitat have included:

- Managed realignment;
- Regulated tidal exchange (RTE);
- Sediment recharge;
- Manipulation of natural processes; and
- Wider techniques.

Hybrids of these techniques are also feasible and have indeed been implemented (see Table 6).

Managed realignment

Managed realignment is generally viewed as the main option for the creation of intertidal habitat, but it can also be used to create subtidal habitat in low lying areas, or in combination with sediment reprofiling. It involves the deliberate breaching, or removal, of existing seawalls, embankments or dikes in order to allow the waters of adjacent coasts, estuaries or rivers to inundate the land behind. This measure had a large amount of stakeholder support from respondents of the questionnaire undertaken for this study (see Appendix C).

To date, at least 100 managed realignment schemes have been implemented across Northern Europe, 52 of these are in the UK, and three in Wales (ABPmer, 2020). Around a third of the UK schemes (and one in Wales) were primarily motivated by compensation requirements, including in relation to port developments and flood defence schemes or strategies. There are three Welsh compensatory schemes:

- The 7 ha Morfa Friog managed realignment in Gwynedd, which was implemented in 2015 to compensate for impacts in relation to the Fairbourne flood defence scheme (NRW, 2015);
- The 39 ha Cwm Ivy scheme on the Gower Peninsula, which represents an unusual scheme in that it occurred through no-active-intervention of a failing flood bank, and it breached 'naturally' in 2014 (National Trust, 2020). The process was facilitated by NRW through some land purchase, a rights of flood agreement, and also conservation management and rights of way/Wales Coast Path negotiations with local authority (NRW, personal communication).; and
- The 0.1 ha 'Crofty' scheme, also on the Gower Peninsula, linked to the provision of upper saltmarsh habitat creation for Penclawdd Flood Risk Management Scheme (NRW, personal communication).

The UK schemes were generally implemented on uninhabited agricultural land without significant existing infrastructure or nature conservation designations (though the fronting estuarine habitats

have frequently been highly designated). Many of these areas would have previously been intertidal habitats, having been claimed decades or centuries earlier. Evidence from implemented schemes suggests that these have tended to be successful in establish intertidal habitats, and have tended to show rapid ecological development in terms of supporting invertebrates, birds and establishing saltmarsh. However, it is important to ensure that such sites are designed appropriately, notably in relation to having the correct elevation to deliver certain habitat types and having appropriately designed drainage channels and creeks to enhance marsh development and fish usage. Past projects have also shown the value of maximising the degree of on-site morphological complexity to create multiple ecological niches and enhance the level of biodiversity achieved (ABPmer, 2017).

Managed realignment can be especially valuable for saltmarsh creation, though functional equivalency with adjacent mature marshes can take several years to achieve (e.g. Brown *et al.*, 2007). Mudflat creation has also been successfully achieved in many cases, though in estuaries with a high sediment load, such as the Humber and the Severn, rapid accretion has occurred, elevating significant proportions of managed realignment sites out of the mudflat range after a few years (Halcrow *et al.*, 2012). However, in estuaries with lower sediment loads, accretion rates over mudflats tend to be significantly lower, and mudflat can thus be expected to be maintained for several decades; for example, at Allfleet's Marsh on Wallasea Island (Essex, England), around 95 % of the original mudflat extent is still retained 14 years post breach (ABPmer internal analysis, 2020). Saline lagoons, (bird) islands, transitional and 'terrestrial' habitats are also frequently included within managed realignment boundaries.

Regulated tidal exchange

RTE is a form of managed realignment/intertidal habitat creation that allows the controlled inundation of defended land by saline water through the use of weirs, sluices, culverts and/or pipes inserted into a flood protection embankment. RTE differs from managed realignment in that the sea wall remains intact. Furthermore, through the use of tidal exchange mediums such as sluices and culverts a high degree of control is retained, the tidal flow and water exchange volumes are restricted and the existing defence line tends to require continued maintenance, and in some cases, upgrades. Opinions on the suitability of the technique for compensation purposes were generally inconclusive from questionnaire respondents (see Appendix C).

To date, a large number of mostly small-scale RTE projects (23) have been undertaken in the UK, mostly in England (with none in Wales). The majority of these measure less than 20 ha. However, two larger-scale projects have recently been implemented, including the 187 ha dynamic lagoon area on Wallasea Island in Essex (England), and the 84 ha Otterhampton Marsh at Steart in Somerset (England). At least two of the schemes have been implemented for compensatory purposes, namely Otterhampton Marsh and Rye Harbour Farm (Sussex, England) (Defra, 2016).

The main habitats created with RTEs in the UK have been saline lagoons, saltmarshes and mudflats. The propensity of RTEs leading to saline lagoon creation is related to the reduced tidal amplitude experienced due to the exchange pipes/culverts generally severely restricting exchange, and the pooling of water in lower lying areas. (Bird) islands are also frequently included within the boundaries of RTE schemes, as are transitional and 'terrestrial' habitats.

A novel suggestion related to the often-rapid transition of mudflat to saltmarsh in estuaries with high suspended loads was made for a proposed RTE scheme on the Humber in England. The proposed RTE at Cherry Cobb Sands, which formed part of the compensation package for the Able Marine Energy Park (AMEP) required (amongst others) a commitment to ongoing dredging intervention to maintain mudflat within the scheme (AMEP, 2013). It is however worth noting that this dredging solution was not generally well received by NGOs, notably the RSPB (RSPB, 2016).

Sediment recharge

Soft sediment recharge in intertidal areas is a process by which dredged sediments are placed over or around intertidal mudflats and saltmarshes to either create habitat (most often saltmarshes), or restore or protect intertidal habitats from ongoing erosion (Nottage and Robertson, 2005; Cefas, 2009; Defra and Environment Agency, 2007). This approach is particularly valuable for protecting habitats that are sediment starved or subject to erosion and where the introduction of dredge arisings will allow the habitat to cope with, or respond to, sea level rise.

Similar to managed realignment, this option had a significant amount of support by the respondents of the questionnaire (see Appendix C).

In the UK, approximately 20 intertidal recharge projects have been undertaken to date; some of which recur on a regular basis. These have all been in England, with many projects in Essex, Suffolk and on the South Coast. Two of these projects (Allfleet's Marsh and Trimley Marsh, in Essex) formed components of compensatory managed realignment schemes which included the beneficial use of sediment as land forming materials prior to breaching the sea walls. One stand-alone beneficial use scheme at Lymington in the Solent (South England) (see Image 5) was effectively implemented for compensatory purposes, although at the time, it was interpreted as being 'mitigation' (prior to rules changing/being clarified due to European Court of Justice judgements, notably the 2014 Briels judgement[6]).

Source: ABPmer, 2018

Image 5. Photographs from the Lymington project

The direct placement of material onto the subtidal in order to elevate an area into the intertidal, and thus create mudflat, has never been practiced in the UK. There have, however, been examples of this in the USA and Japan, where recharge has been very widely practiced for decades (PIANC, 2009).

Several large-scale port expansion projects have also recently demonstrated that elevations can be built up from subtidal, albeit requiring significant engineering effort (for example, the 2,000 ha Maasvlakte 2 expansion at the port of Rotterdam (Port of Rotterdam, 2014)). Another Dutch example is the Marker Wadden scheme. This took place in the non-tidal Dutch Markermeer lake, and involved

[6] This Habitats Directive case-law judgement (the 'Briels case') from May 2014 clarified that mitigation measures were those that reduced or avoided effects, but not measures that involved restoration of habitat within a European site, which were seen as 'compensatory'. This led to a clarification by Natural England (2015) that the creation of habitat to offset loss or damage within the same European/Ramsar Site will not normally be considered as mitigation.

the formation of new islands measuring 300 ha. These have been formed by creating sand bunds with dredged materials (reinforced with some quarried stone), and filling these bunds with materials dredged from the lake bottom on the exposed west face (Boskalis, 2019).

A similar scheme was mooted in relation to tidal power schemes in the UK, and modelled on behalf of The Crown Estate (HR Wallingford, 2013), namely bunding with recharge behind for three tidal bays in the Severn Estuary and Inner Bristol Channel.

Coarse sediment recharge (which is generally practiced for beach nourishment purposes) is not a technique which has been used for compensation purposes, but could be used. A comparatively new method of sediment recharge is noteworthy here: the 'Sand Engine' or 'Sand Scaping' method. This is a form of nourishment, whereby large amounts of sand or shingle are applied to a discrete area of the shoreline. This material is then redistributed by wind and waves, stimulating natural development of the coast. This new method of nourishment was first applied (and conceived) in the Netherlands. It aims to serve more functions than flood protection alone, such as increasing the coastal buffer zone, and enlarging the coastal intertidal zone for recreational and ecological benefits.

The Dutch Sand Engine (see Image 6) was implemented in South Holland in 2011, by depositing 21.5 million m^3 of materials. It has an expected lifetime of 20 years, relieving sand nourishment efforts for this period, it is therefore predicted to be more efficient and effective than traditional recharge methods which are typically undertaken every 3-5 years. However, there are still many uncertainties, for example regarding the speed of the sand dispersal and hence the lifetime the nourishment (Stive *et al*., 2013).

Source: Stive *et al*. 2013

Image 6. Aerial photograph of the Dutch Sand Engine after completion (September 2011)

A small variation of this Sand Engine concept was recently trialled in Poole Bay, England (2014-2017), the first time the method has been applied in the UK. This scheme made use of 35,000 m^3 of locally-dredged sediment which was placed subtidally near to the shore, allowing the prevailing waves and tidal currents to move material toward and along the beach. 14 months following deposition, monitoring showed that some sediment had moved shoreward to the beach, however it was considered difficult to assess the long-term fate of the stockpile material (Environment Agency, 2018). A £22 million 'sand scaping' scheme has also recently been implemented in Norfolk, England (at Bacton, see BBC, 2018a). This has involved the placement of 1.5 million m^3 of sand in front of the Bacton Gas Terminal, with the sand being expected to move in an easterly direction with the net littoral drift.

Manipulation of natural processes

The manipulation of natural processes encompasses projects which alter the existing sedimentary regime along a shoreline in order to protect habitat and possibly create mudflat. This includes a wide range of possible techniques such as introducing obstructions or altering shorelines. In the UK, to date, these have generally focussed on saltmarsh erosion protection and mudflat accretion encouragement. For example, at Rhymney Great Wharf (Cardiff, Glamorgan), sedimentation polders were constructed in order to encourage sedimentation over the fronting mudflats; however, no noticeable increased accretion has been observed to date (JBA Consulting *et al*., 2018).

There are techniques which can potentially be used to expand mudflat seawards, onto existing subtidal areas, though there are no known (intentional) examples of this in the UK, with success generally very much dependent on local conditions, notably sediment loads.

There are, however, examples of the application of this technique elsewhere in Europe, notably the Netherlands and Germany, where, for example, sedimentation polders using concrete-reinforced brushwood fence lines are often employed to accrete new mudflats in front of new dykes (e.g. Dornbusch, 2019). Such structures are installed in areas which are exposed to relatively high tidal or wave energy forces which would normally prevent the settling of sediments or re-suspend any that had settled during slack periods. This is provided that the suspended sediment loads in the system are high enough for accretion to take place (which it tends to be in the Dutch and German Wadden Sea, where sedimentation polders are used). Thus, the artificial import of sediment is not necessary, but instead, structures are put in place to reduce energy and encourage sediments to settle and accrete. In the past, the main methods used for increasing sedimentation in intertidal areas have included brushwood fencing, polders/sedimentation fields, wave breaks or groynes.

The introduction of such structures would require their own consents and the influence on other receptors including the physical, chemical and ecological environment and other seas users (e.g. shellfisheries and navigation) would need to be fully evaluated. The certainty of achieving the desired habitats will again influence the degree of acceptability of measures as part of a compensation package.

Wider techniques

Some other techniques have been used to create compensatory intertidal habitat, though there are few examples. These include the provision of creation of non like for like, but functionally related habitat compensation for the loss of SSSI habitat, rocky habitat translocation, legacy funds, enhancement measures and designation of additional areas.

Habitat creation and translocation

Whilst not a typical example of compensation provision, measures undertaken in relation to the construction of the Cardiff Barrage involved the creation of wet grassland and saline lagoon habitats (at Uskmouth and Goldcliff), as well as enhancing existing ornithological interests in the reedbeds at Uskmouth (Burton *et al*., 2002). This was undertaken to compensate for the enclosure of a 200 ha area of intertidal mudflats and saltmarsh area at the mouth of the Severn Estuary, which was not European protected, but designated as a SSSI. The SSSI was designated as it regularly held a nationally important population of particular waterbirds (Dunlin and Redshank) and its saltmarshes provided shelter and roosting sites and were utilised by seed eating birds (Crompton, 2002).

At Morecambe Bay (Lancashire, England) skear habitat was created/translocated in 2006 as compensation for the loss of European protected bird habitat under the footprint of the Morecambe Town Phase VI defences. The rocky habitat which would have been lost was excavated, translocated and repositioned in front of the new breakwater (see Image 7). This has been considered a success with regards to maintaining the integrity of the Morecambe Bay European Marine Site in favourable condition (ABPmer, 2005).

Image 7. Breakwater at Morecambe (Lancashire, England) with innovative rocky habitat mitigation area in front

Legacy fund

One example is known of where a developer has provided a sum of money to enable grass roots environmental schemes in the vicinity of the scheme to go ahead. The concept is that an annual budget is established, with parties making bids to the fund, which is managed by a collaboration between the developer, regulators and an NGO. This has been practiced with the 'Wytch Farm Landscape and Access Enhancement Fund' in Dorset, England. The Dorset Area of Outstanding Natural Beauty (AONB) contains the largest on-shore oilfield in Europe, at Wytch Farm near Corfe Castle. As part of a planning application to extend the working life of the oilfield by a further 20 years, the oilfield operator, Perenco UK has provided a sum of £1.7 million for landscape, biodiversity and sustainable transport projects to enhance the AONB. This sum is being used to fund 'physical works' projects that compensate for the environmental impacts of the further retention of the oilfields infrastructure in the landscape. Applications are administered by the Dorset AONB Partnership on behalf of Perenco; projects have to be located within priority areas identified by the partnership (Dorset AONB Partnership, 2020).

Enhancements

A wide range of measures which are typically employed for enhancement or improvement purposes could also be potentially implemented as compensatory measures. Management plans for MPAs could be consulted for ideas, as these would, amongst others, identify measures to support achievement of site conservation objectives, including for offshore sites with subtidal habitat, sea bird and marine mammal features.

The undertaking of 'biodiversity improvement/uplift of existing habitats' as a compensatory measure constituted an option in the survey questionnaire sent out for this project. Out of 16 respondents who answered the respective question, 50 % thought this could be applied as a compensatory option, whilst conversely 32 % selected 'no', and the remainder 'don't know'.

However, where European sites are affected, due to the principles of additionality outlined in Section 3.1.3 such improvements would need to applied:

- In designated sites that are not affected by the proposed development (or where the benefits of the measures help to protect features associated with designated sites that are not affected by the proposed development); and
- Where they are not already required to support achievement of the conservation objectives for those features in the relevant sites.

This could include, for example, the removal of redundant structures that are affecting the quality of designated features. Such opportunities would need to be reviewed on a local basis. In addition, the removal of existing pressures in the intertidal zone (e.g. bait digging) could potentially form part of a compensation package.

Designation

Theoretically, it could be possible to designate additional locations as SACs in order to compensate for losses to existing sites. However, based on current research there appears to be no precedent for this in the UK or Europe more widely. Potential locations for additional designations would need to be evaluated against the site selection criteria laid down in the Habitats Directive and in relation to the potential contribution they might make in compensating for the respective impacts. Areas of search for new SAC site designations would need to focus on areas supporting potentially qualifying features. This could include features within areas currently classified as SPAs but which were not already protected by the SPA designation. Habitat enhancement may be required in order to ensure that areas are of a sufficient quality to be designated. Similarly, it may be possible to extend the boundary of an already designated site.

This option was also posed to survey respondents (for both intertidal and subtidal habitats); 56 % of those answering the respective question thought this could be an option, whilst 19 % did not think so, and the rest selected 'don't know'.

6.2.2 Subtidal

The range of opportunities to compensate for subtidal habitat impacts is limited, particularly in delivering like-for-like habitat. Consequently, examples of implemented subtidal compensatory schemes are rare, and no implemented schemes are known in the UK, though many implemented managed realignment schemes include saline lagoons. These are often incidentally created when borrowing materials for seawall construction (e.g. Medmerry, West Sussex, England), but also purposely constructed to maximise biodiversity. For example, over 12 such lagoons were included by the RSPB at different elevations at Jubilee Marsh, Wallasea Island, Essex, England.

Infrastructure enhancement is also an option with regard to compensation in subtidal environments. For example, the Dutch consultancy Bureau Waardenburg (2017) assessed different eco-friendly designs for the enhancement of scour protection for offshore wind farm developments in the North Sea. Options presented as part of the study considered a mixture of large structures which provide holes (including artificial reefs), smaller-scale structures to provide habitat complexity and materials that provide or mimic natural substrates (e.g. seaweed mattresses).

Targeted sediment placement could conceivably be used to create areas of sediment characteristics suited for the development of specific habitat types and supported assemblage. A key consideration for this would be the impacts on underlying habitats and the compatibility of such measures with the natural physical processes operating in an area. Also, like for like would be difficult to achieve. For example, due to the complexity of sandbank features, which are largely driven by physical processes, recreating such a feature would be very challenging.

For some shallow subtidal biogenic habitats (some of which may extend into the intertidal), creation should be feasible based on foreign examples for example, but UK restoration success has often not been proven to a sufficient extent, or at all. For example, seagrass restoration has been conducted for over 50 years globally, but successful UK examples have been scarce (e.g. MMO, 2018). A noteworthy pilot project has recently been initiated near Dale in West Wales, led by Swansea University (Project Seagrass, 2020). In addition, oyster reef restoration has a long history in the US, but few successful examples in the UK (MMO, 2018), although several recent and ongoing initiatives are likely to report success in the near future. These include the Essex and Solent Oyster restoration initiatives in England (e.g. Blue Marine Foundation, 2020), and the Glenmorangie project in Scotland. For example, the latter has included the laying of shell clutch and placement of oysters, with the aim of the reefs becoming self-sufficient and sustaining 4 million oysters in a 40 ha area (BBC, 2018b). It was also proposed to create oyster spatting ponds, populated with oysters dredged from the footprint of the Swansea Bay Tidal Lagoon (Tidal Lagoon Swansea Bay plc, 2014).

Finally, whilst *Sabellaria* reef restoration has not been undertaken in the UK, ready natural colonisation of artificial structures and materials by *S. alveolata* (see Image 8) would seem to indicate that the creation of such reefs should be feasible in the right circumstances (notably in close proximity to existing reefs, i.e. within larvae dispersal range) (MMO, 2018).

Image Credit: AER

Image 8. Sabellaria alveolata colonising artificial material in intertidal area

Similarly, where there is potential loss of a habitat underneath the footprint of a scheme the relocation of key species may offer opportunities to mitigate the impact. For example, the construction of the Pendennis wet dock in Falmouth harbour would have led to construction over seagrass beds. In order to mitigate this (included as a licence condition), the seagrass was removed from the footprint and transplanted into a nearby location in the Helford River. The transplanted seagrass is understood to

have established and continued to grow in the new location (Collins, 2018). Large scale transplantation of seagrass might be problematic in Wales, even where such habitat is not located in designated areas, as the habitat itself is a Section 7 habitat (see Appendix D).

The best opportunities for subtidal compensation are likely to relate to removal of other human activity pressures. Like MPA management measures, this might target reduction/removal of fishing gear pressures or extractive pressures (e.g. aggregate extraction), for which compensation payments might be required. There may also be opportunities associated with oil and gas or OWF decommissioning to facilitate natural restoration of affected habitat. Stakeholder views on the suitability of this as a compensation measure were generally inconclusive (see Appendix C).

The proposed Hornsea 3 OWF has identified potential compensation for subtidal sandbank, through the establishment and management of Blue Mussel beds, and removal of ghost fishing gear (GoBe, 2020). These are clearly not like for like measures, and the acceptability of them for the purposes of compensation is currently under consideration by the Secretary of State, with a decision due in June 2020.

The same principles as highlighted above with respect to designation of additional intertidal habitat would apply equally to subtidal habitats.

Table 7. Possible compensatory measures for habitats

Type of Intervention	Strengths	Limitations	Relevant Examples	Stakeholder Views as to Suitability as Compensation Measure (N= 16, see Appendix C)
Intertidal				
Managed realignment. Could include facilitating 'un'-managed realignment through the acquisition of land behind defences selected for No Active Intervention.	Proven technique to create intertidal habitat	Site availability. Predicting how site will evolve through time and the overall functional value of the habitat. May tend to saltmarsh quickly in estuaries with high suspended loads. Like for Like habitat may be difficult to achieve.	Numerous examples, see ABPmer's OMReg website[7].	Yes – 14 No – 0 Don't know - 2
Regulated tidal exchange	Proven technique to create intertidal habitat	Like for Like habitat may be difficult to achieve. Likely to require some level of ongoing intervention.	Numerous examples, see ABPmer's OMReg website[7]	Yes – 6 No – 2 Don't know – 5 Not stated - 11
Beneficial use	Proven technique to create intertidal habitat	Availability of suitable sediment and alignment of timescales. Can be technically challenging and costly. Timing of permissions in the context of requirement. Can be difficult to get permission for such measures in designated sites. Scale at which can be undertaken.	Limited use as compensatory measures, but many general examples, see ABPmer's OMReg website[7]	Yes – 13 No – 0 Don't know – 3

[7] https://www.omreg.net/

Type of Intervention	Strengths	Limitations	Relevant Examples	Stakeholder Views as to Suitability as Compensation Measure (N= 16, see Appendix C)
Manipulation of natural processes	Proven technique to create intertidal habitat	Introduction of artificial structure. Implications for natural processes and wider receptors.	Limited use as compensatory measures, one example is Rhymney Great Wharf (Cardiff) sedimentation polder.	No specific comments
Biodiversity improvement/uplift of existing habitats	Proven to deliver ecological enhancement	Unlikely to provide like-for-like compensation for MRE projects. Need to demonstrate additionality.	No examples of use as compensatory measure.	Yes – 8 No – 3 Don't know – 5
Pressure reduction (e.g. bait digging)	Alleviate known pressures which have been identified	Need to demonstrate additionality.	No examples of use as compensatory measure.	Yes – 5 No – 4 Don't know – 6 Not stated - 1
Designate additional habitat.	Expand Natura 2000 network Would formalise management measures and associated requirements	Timescales to achieve Requires considerable resource and data.	No examples of use as compensatory measure.	Yes – 9 No – 3 Don't know – 3 Not stated - 1

Type of Intervention	Strengths	Limitations	Relevant Examples	Stakeholder Views as to Suitability as Compensation Measure (N= 16, see Appendix C)
Subtidal				
Infrastructure enhancement e.g. bioblocks, ECOncrete®	Proven to deliver ecological enhancement	Unlikely to provide like-for-like compensation for MRE projects	No examples of use as compensatory measure, but many enhancement examples, see for example Ecostructure[8] and Marineff[9] websites.	Yes – 5 No – 1 Don't know – 8 Not stated - 2
Subtidal habitat recreation – oyster, seagrass, reefs	Provide valued ecosystem components	Unlikely to provide like-for-like compensation. No successful UK examples/not proven/difficult to deliver.	European Native Oyster Restoration Initiative, Blackwater Estuary. Seagrass Restoration Project, Dale Bay, Pembrokeshire.	Yes – 14 No – 0 Don't know – 2
Sediment placement	Can create suitable sediment characteristics for target habitat	May not be compatible with long-term physical processes regime; Will smother existing subtidal habitat.	No offshore examples for habitat creation.	No specific comments
Reduction/removal of existing pressure	Directly benefits feature	Risk of challenge on grounds of additionality (additional to measures required to achieve favourable condition).	No examples of use as compensatory measure but many examples of MPA management measures (though with little monitoring of effectiveness).	Yes – 9 No – 1 Don't know – 5 Not stated - 1

8 http://www.ecostructureproject.eu/
9 http://marineff-project.eu/en/

Type of Intervention	Strengths	Limitations	Relevant Examples	Stakeholder Views as to Suitability as Compensation Measure (N= 16, see Appendix C)
Designate additional habitat. Could include implementation of *de-facto reserves* around MRE infrastructure.	Provides additional protection	Potentially long timescale to designate new site and introduce management measures.	No examples of use as compensatory measure.	Yes – 9 No – 3 Don't know – 3 Not stated - 1 (note: this was one combined option for intertidal and subtidal).

Table 8. Habitats case examples

Parameter	Case Example 1	Case Example 2
Potential Impact	Placement of infrastructure on mobile sandbank	Permanent loss of designated habitat feature
Informing compensation package	Need to understand: ▪ Zone of influence (ZOI) – direct, indirect and cumulative effects ▪ Magnitude of effect ▪ Timescale of effect – temporary/permanent ▪ Features that could be affected ▪ Connectivity and understanding of functioning – both in terms of physical processes and supporting ecological features ▪ Conservation objectives ▪ Condition status of the feature ▪ Existing management measures	
Possible measure	Enhancement - removal of an equivalent area of debris to that lost under the footprint	Designation of additional area or extension of designated site boundary.
Key considerations – principles of application	The ability of the measure to achieve like for like habitat replacement. Added complexity of the mobile nature of the sandbank. Timing of delivery in relation to loss. Wider changes to the functionality of the area/impacts on all receptors based on the placement of the infrastructure. Additionality – the provision of measures that are additional to normal practice under the Habitats and Birds Directives.	Would need to meet qualifying criteria for designation. Would require sufficient data to enable designation. Would require sufficient certainty that overall coherence of feature and supporting functionality is maintained. Habitat enhancement may be required in order to ensure that areas are of a sufficient quality to be designated.
Key considerations – practical delivery perspective	Feasibility of removal of debris on the scale required. Wider permissions required to undertake the works.	Purchase/lease of non-designated area. Current land ownership (competition for land and cost implications). May require a change in land use. Introduction of management scheme and associated measures. Timescales and resources to achieve designation would likely be considerable.

Parameter	Case Example 1	Case Example 2
How overcome?	Could remove a greater footprint of debris than area lost under infrastructure. Could form part of a package of measures which includes ongoing enhancement/management.	Scale of land to be designated in relation to the loss. Demonstrable increase in ecological value through management and monitoring.
Compensation package	The overall compensation package will be required to detail specific objectives for the designated feature, as well as management and monitoring regimes. Furthermore, definition of the roles and responsibilities of the applicant/governmental or non-governmental organisations and other stakeholders need to be considered and provision made to support the measures for the lifetime of the project. The timeline for the implementation of measures also needs to be considered, with sign-off of the measures not only required from a compensation point of view, but ensuring that all other consents are in place before the compensation package is accepted as sufficient. Legal agreements may be required to ensure all such measures can be secured.	
Stakeholder opinion	No specific comments raised.	Designation of additional habitat generally perceived as feasible, but no consensus on suitability as a measure.

6.3 Fish

There are few examples where compensatory measures have been applied to compensate for realised impacts on fish species directly. However, some measures that may be applied in the future as compensation have been applied in the past with proven success, generally as part of river or fisheries stock management.

Potential compensatory measures for fish, Table 9, could include measures that are designed to either improve fish stocks directly or the remove/minimise existing pressures. Increasing stocks or improvements in spawning or nursery habitat (supporting increased breeding success), could be used to achieve the former. Measures to reduce pressures could include the removal of barriers to migration or movement, reductions in fishing effort, improvement of current environmental parameters impacting fish stocks (i.e. water quality improvement or pollution reduction) or increased management of sensitive sites. Table 10 provides a case example of how measures could be applied in practice.

Direct stock enhancement, through the use of artificial hatcheries to boost production of fry or translocation of fish to boost fish populations in a specific location, has been used in the UK and internationally. One implemented, and ongoing, stocking compensation case study is known from North-East England, namely the River Tyne salmon stocking scheme, which dates back to the late 1970s. A dedicated hatchery was set up to produce 160,000 juvenile salmon a year for stocking the Tyne to compensate for the loss of the Kielder Burn spawning grounds, which were cut off from the river by the building of the Kielder reservoir (Northumberland). For seven years the hatchery also stocked an additional 200,000 salmon to mitigate for the river disruption from the building of the second Tyne Tunnel, and incidents of mortality of adult fish returning to spawn from incidents of low oxygen levels in the estuary (Milner *et al.*, 2004). Similar stocking exercises were also previously practiced in Wales. However, as of 2014, NRW ceased enhancement and mitigation stocking of salmonids, based on a review which concluded that '*on the basis of scientific evidence the use of salmon stocking for enhancement and mitigation by both NRW and 3rd parties delivers poor outcomes for salmon populations and may have negative impacts*' (NRW, undated).

This was in line with some earlier reviews of stocking, which questioned its efficacy, potentially attributing recovery to other factors such as water quality improvement, discussed below, and identifying low survival rates from hatchery to adulthood (Milner *et al.*, 2004). In addition, such schemes require consideration of the balance between risks introduced by the scheme, such as reduction in genetic diversity in a population associated with artificial hatcheries, or introduction of diseases or parasites associated with translocation of live fish. Current policies tend to steer away from hatchery schemes, partly due to high costs, but also due to the potentially low survival rates and the risks identified above.

The following fish compensation measures were considered as part of the Severn Tidal Power SEA (but not implemented) (Severn Tidal Power, 2010):

- Translocation and species introduction: this was proposed to involve establishing a self-sustaining breeding population into a river where it is not currently established. This was considered an option twaite shad and allis shad, but not for salmon or lampreys, as they were 'already widely distributed'; and
- Stocking in rivers at distance to the Severn: this would have involved stocking fish into a river to increase the size of the population. It was considered that stocking with fish would only likely to be successful if used together with other measures. Stocking was proposed for

salmon and the two shad species, and it was noted that stocking was well established as a technique for salmon although not as a compensatory measure.

Improvements in spawning or nursery habitats can take the form of habitat cleaning (specifically gravel cleaning), introduction of suitable substrate or increases in quality or extent of nursery habitats (such as seagrass beds). Fish are also likely to benefit from the increased complexity provided by the introduction of specifically enhanced structures (e.g. scour protection features), with concepts similar to BioReefs or BioBlocks having been investigated.

These measures have been implemented with the intent of encouraging increases in fish stocks with some impacts on fish species observed (Shackle *et al*. 1999). However, the use of such measures as part of compensation packages remains largely untested where it is difficult to attribute any observed benefits directly to the measures. In addition, the benefits, where observed, may be short lived (gravel cleaning is stated to be on a scale of 3 to 12 months (Bašić *et al.*, 2017)) and therefore require ongoing management. The requirement for any such ongoing management would need to be fully understood and captured within the respective compensation package. The introduction of 'appropriate spawning media' at suitable locations around the lagoon wall 'to give herring spawning habitats with different degree of exposure' was, however, suggested as part of the proposed Swansea Bay Tidal Lagoon (Tidal Lagoon Swansea Bay plc, 2014).

It is also noteworthy that many implemented managed realignment and RTE schemes have been proven to be highly beneficial for fish (e.g. Colclough *et al*., 2005), and would often include design features which maximise opportunities. For example, at Jubilee Marsh, Wallasea, Essex, slopes of the creeks were designed to be gentle, and many deeper pools dug amongst the creeks to provide 'fleeing' places during low tide. However, these measures were not required for compensatory purposes, but included as what was viewed as good practice.

The implementation of measures to reduce existing pressures are widely discussed as potential compensation, albeit more often discussed regarding reducing pressures on bird species (discussed below). In the context of fish, pressures are generally related to barriers to migration or movement as well as pressures increasing fish mortality above natural levels, such as fishing or pollution events.

Current barriers to migration may either increase energetic requirements or prevent migration altogether. Where these are present, measures can comprise either removing or reducing the barrier. Examples of removal of weir structures which may act as barriers are available and have been considered to have a beneficial impact on the fish populations of specific rivers. However, as discussed in Dickie *et al*. (2014), the management of the permeability of rivers to fish species has already been identified as required to meet obligations under the WFD, and demonstrating additionality may therefore be difficult in the context of providing compensation through this mechanism under a legislated framework.

One WFD related compensation measure is known from England. In relation to the Green Port Hull development, ABP supported a project to improve the Humber River basin for migratory fish species. ABP awarded the Rivers Trust £180,000 to implement a series of projects that reconnect the upstream rivers within the Humber catchment, to improve the chances of fish successfully spawning and migrating. The results have been described as 'remarkable', with salmon recorded at upstream spawning grounds for the first time in 100 years. Individual projects included the removal of a weir at Breary Banks, installing fish passes along the River Don and installing a channel bypass at the River Laver. ABP's grant also helped the Rivers Trust secure £2 million of additional funding, which in total has led to the opening up of 70 km of habitat for migratory fish (YouTube, 2018).

Reduction in fisheries pressures have also been mooted as potential compensation for impacts on fish species in order to support fish stocks. However, where such a measure may be required as a management measure for fish populations in the absence of the proposed development, it may be difficult to demonstrate 'additionality'. In addition, the complexities of managing mobile species mean that the pressure may be displaced, and therefore the overall beneficial impact on the species reduced significantly. Where fisheries controls have been implemented in the UK for designated site management, these have been reasoned as principally for the purposes of habitat rather than focussed on benefitting fish populations. However, more widely fisheries management (such as the implementation of quotas) is applied with the intention of supporting fish populations. In addition, fisheries management measures for designated sites outside the UK have been concluded as being beneficial to fish populations, although difficulties in attributing these benefits to the measures are recognised (Ojeda-Martinez, 2007).

Mitigation measures designed to reduce pressure through the improvement of water quality, may similarly struggle to demonstrate additionality, as it is often required as part of measures under other legislation, such as the WFD or part of management plans for designated sites. The use of such measures has, however, been considered as successful in restoring fish populations in rivers (Milner *et al,*. 2004). As discussed below in Table 10, measures designed to improve water quality of riverine systems may be difficult to implement in practice, due to considerations around land ownership and practicalities in the reduction of current effluent sources where these are not managed by an applicant.

The designation of additional sites has also been proposed as a compensatory measure as European guidance indicates that it may be possible to compensate for impacts to designated features through the inclusion of additional sites within the overall SAC list. It should be noted, however, that there is currently no formal process by which this might be progressed. In addition, the designation of the site, and implementation of subsequent management measures to deliver an observable benefit is likely to have a significant timescale.

Table 9. Potential compensatory measures for fish

Type of intervention	Strengths	Limitations	Relevant Examples	Stakeholder Views as to Suitability as Compensation Measure (N= 15, see Appendix C)
Stock enhancement	Often practiced measure to support stocks of e.g. salmon and sea trout	Efficacy can be low. May affect natural gene pool. Consideration required for transmission of parasites/diseases from introduced stocks.	The Kielder hatchery on the River Tyne was originally set up to compensate for loss of spawning/rearing area from the construction of Kielder reservoir (Milner *et al* 2004). In addition, also used in Wales (pre-2014) e.g. River Dee salmonoids.	Yes – 5 No – 3 Don't know - 7
Removing/reducing barriers to migration	Proven measure to support stock recovery of e.g. salmon and sea trout	May be difficult to demonstrate additionality where management is already identified as required under other legislative regimes.	No examples of use as compensatory measure but widely used in fisheries management e.g. Rivers Tyne, Calder, Mersey and Don	Yes – 9 No – 2 Don't know - 4
Reduction/removal of existing pressure	Directly benefits feature	Risk of challenge on grounds of additionality. Fisheries reduction or exclusions may be difficult to implement in practice.	No examples of use as compensatory measure but reduction in commercial netting pressure used in fisheries management e.g. Severn, Solway	Yes – 9 No – 3 Don't know - 3
Improvements to spawning habitat	Range of potential measures available depending on species. Methods to improve habitat quality are relatively well understood.	May be difficult to demonstrate additionality where management is already identified as required under other legislative	No examples of use as a compensatory measure but proposed for and used in riverine fisheries management (Shackle *et al.*,	Yes – 10 No – 1 Don't know – 4

Type of intervention	Strengths	Limitations	Relevant Examples	Stakeholder Views as to Suitability as Compensation Measure (N= 15, see Appendix C)
		regimes. Difficult to attribute any observed benefits directly to the measures. Likely to require ongoing management.	1999, Wild Trout Trust, 2012)	
Water quality improvement	Considered as making a successful contribution to the restoring of fish populations in rivers	May be difficult to demonstrate additionality where management is already identified as required under other legislative regimes. Measures typically required on land outside control of applicant.	Improvements in water quality have not been implemented as a compensatory measure. However, successes of improvements in water quality in supporting fish populations have been observed. E.g. the River Tyne (Milner *et al*. 2004)	Yes – 7 No – 3 Don't know - 5
Designate additional sites	Provides additional protection	Potentially long timescale to designate new site and introduce management measures. Potential risk of challenge on grounds of additionality.	No examples of use as compensatory measure	Yes – 3 No – 6 Don't know - 6

Table 10. Fish case examples

Parameter	Case Example 1	Case Example 2
Potential Impact	Increased mortality from predation as a result of entrainment of fish in a tidal lagoon leading to a significant adverse effect on Atlantic salmon *Salmo salar* at a population level	Introduction of tidal barrage compromising European Eel *Anguilla anguilla* migration into upper reaches of the estuary
Information required to inform the compensation package	Need to understand: ▪ Zone of influence (ZOI) – direct, indirect and cumulative effects ▪ Number of individuals affected and potential population level effects ▪ Timescale of effect – temporary/permanent ▪ Features that could be affected ▪ Connectivity and understanding of functioning – both in terms of physical processes and supporting ecological features ▪ Conservation objectives ▪ Condition status of the feature ▪ Existing management measures	
Possible measures	Re-stocking of fish	Removal of barriers to migration on another estuary to encourage increased opportunities for Eel migration
Key considerations – principles of application	There is uncertainty as to the success in the return of introduced migratory fish stocks to a river, and therefore as to the success of implementing such measures. Uncertainty as to determining the likely collision and mortality rates, therefore demonstrating that the compensation measures are sufficient may be complex.	Demonstrating the success of the scheme in order to offset against the scale of the impact may be difficult to monitor. The success of the scheme may be gradual, whereas the impact may be immediate. Ensuring that the proposed estuary is suitable for re-colonisation by Eel (i.e. other restrictions currently present in addition to physical barriers).

Parameter	Case Example 1	Case Example 2
Key considerations – practical delivery perspective	Sourcing of sufficient live fish Wider permissions for release of fish into riverine environment Concerns that introducing of stocks from hatcheries may impact on the natural gene pool, or introduce other issues such as parasites or disease into the natural population. Potential for requirement of ongoing action (repeated stock enhancement) where the effect has the potential to be realised throughout the life-cycle of the project.	There may be issues with land-ownership where barriers are not owned by the applicant. Reductions in barriers in an estuary may require separate assessment to ensure that there are no impacts on other topics, such as flood risk management.
How overcome?	Whilst the practical challenges are included here, they are not considered insurmountable. However, the uncertainty in demonstrating success in supporting fish populations may be more difficult to achieve. This has the potential to be achieved through ongoing monitoring of both the number of collisions and wider fish populations through survey. Adaptive management, based on an ever-improving evidence base for collision risk could also be applied to support this measures.	Barriers are often owned by the Environment Agency. However in a number of cases the intent to manage these barriers is already identified, therefore collaboration with other organisations and/or provision of funding to support schemes may overcome the barriers. This has been applied by ABP on the Humber (Youtube, 2019). Monitoring of both the impacted and compensatory estuaries may support evidencing the success of the scheme in offsetting impacts, although causality may still be difficult to establish.
Compensation package	The overall compensation package will be required to detail specific objectives for the designated feature, as well as management and monitoring regimes. Furthermore, definition of the roles and responsibilities of the applicant/governmental or non-governmental organisations and other stakeholders need to be considered and provision made to support the measures for the lifetime of the project. The timeline for the implementation of measures also needs to be considered, with sign-off of the measures not only required from a compensation point of view, but ensuring that all other consents are in place before the compensation package is accepted as sufficient. Legal agreements may be required to ensure all such measures can be secured.	
Stakeholder opinion	No clear consensus, with slight majority unsupportive.	Broadly supportive, though some opposed/undecided.

6.4 Marine mammals

Although development in the marine environment has the potential to significantly impact marine mammal species, to our knowledge there are currently no examples where compensatory measures have been applied to compensate for realised impacts on marine mammals directly.

However, a number of compensation measures are either proposed in guidance, such as those for otter (Natural England and DEFRA, 2019), or have been identified as possible, principally through reduction or removal of current pressures on marine mammal features; these are summarised in Table 11. Table 12 provides a case example of how measures could be applied in practice.

Compensation for otter species has more options than for other, more spatially mobile species. This is due to the constrained areas in which otter are generally found in the UK, i.e. riverine or sea loch environments. Therefore, measures to support a specific population through either habitat creation (construction of artificial holts, or creation/restoration of other habitats) or providing viaducts/underpasses or bridge ledges to reduce interaction between cars and otter (reduction of a pressure) can conceivably be implemented.

For marine mammal species which forage more widely (grey seal, harbour porpoise, dolphin and whale species), however, it is more difficult to specifically target measures for a specific population, with the exception of better management of seal breeding or haul out sites through wardening. This is because the presence or absence or individuals from a population within the vicinity of works (again with the exception of seal haul out sites) is difficult to predict, and the water column itself is the key habitat (albeit in some cases the composition of the water column is influenced by the benthic environment).

Therefore, reduction of known current pressures on marine mammals, such as through reductions in underwater noise from other sectors (e.g. reduction in explosions/seismic survey), reduction in fishing pressures (either directly by reducing by-catch or indirectly through reducing fishing pressures on prey populations). Reduction in fisheries by-catch is possibly the most tangible measure, but clear monitoring of the effectiveness of such measures would be needed. Any measures proposed would need to be additional to those required to achieve favourable condition.

The designation of additional sites has also been proposed as a compensatory measure as European guidance indicates that it may be possible to compensate for impacts to designated features through the inclusion of additional sites within the overall SAC list. It should be noted, however, that there is currently no formal process by which this might be progressed. In addition, the designation of the site, and implementation of subsequent management measures to deliver an observable benefit is likely to have a significant timescale.

Table 11. Possible compensatory measures for marine mammals

Type of Intervention	Strengths	Limitations	Relevant examples	Stakeholder Views as to Suitability as Compensation Measure (N= 15, see Appendix C)
Improvement or creation of habitat for otter, such as through construction of artificial holts/installation of viaducts, underpasses or bridge ledges	Direct benefit to feature. Could be put in place before disturbance occurs, proven to work.	Land ownership – if outside control of applicant. May require separate permissions. Risk of challenge on grounds of additionality.	Artificial holts have been constructed as part of river management. However, the efficacy of these is currently uncertain, although usage of the holts has been recorded (Cowell *et al.*, 2001).	Yes – 7 No – 0 Don't know – 7 Not stated - 1
Wardening of breeding/haul-out sites for seals	Could be used to reduce disturbance at breeding/haul-out sites	Benefits uncertain. Risk of challenge on grounds of additionality	No examples of use as compensatory measure but wardens in place for some colonies to manage disturbance	Yes – 5 No – 3 Don't know – 6
Reduce or remove pressure on fisheries by-catch	Directly benefits feature	Risk of challenge on grounds of additionality Quantifying benefits subject to same uncertainties as quantifying by-catch impacts	No examples of use as compensatory measure but reduction in commercial fishing by-catch forms part of Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas, (ASCOBANS)	Yes – 9 No – 2 Don't know – 4

Type of Intervention	Strengths	Limitations	Relevant examples	Stakeholder Views as to Suitability as Compensation Measure (N= 15, see Appendix C)
Reduce or remove pressure on marine mammal prey resources (e.g. reduction in commercial fishing pressure)	Directly benefits feature	Risk of challenge on grounds of additionality. Link between food availability and population viability difficult to monitor	No examples of use as compensatory measure but reduction in commercial fishing pressure proposed as possible measure for some marine mammal MPAs	Yes – 10 No – 2 Don't know – 3
Reduce other pressures on marine mammals (e.g. underwater noise from oil and gas exploration or collision risk from commercial shipping)	Directly benefits feature	Risk of challenge on grounds of additionality. Quantification of benefit difficult to assess	No examples of use as compensatory measure. Some examples of speed restriction measures for commercial vessels to reduce collision risk	Proposed by a respondent, so not voted upon.
Designate additional sites	Provides additional protection	Potentially long timescale to designate new site and introduce management measures	No examples of use as compensatory measure	No specific comments

Table 12. Marine mammals case example

Parameter	Case Example 1
Potential Impact	**Collision mortality with tidal stream turbine leading to a significant adverse effect on bottlenose dolphin *Tursiops truncatus* at a population level**
Information required to inform the compensation package	Need to understand ▪ Zone of influence (ZOI) – direct, indirect and cumulative effects ▪ Number of individuals affected and potential population level effects ▪ Timescale of effect – temporary/permanent ▪ Features that could be affected ▪ Connectivity and understanding of functioning – both in terms of physical processes and supporting ecological features ▪ Conservation objectives ▪ Condition status of the feature ▪ Existing management measures
Possible measures	Reduction of fishing pressure – bycatch.
Key considerations – principles of application	There is uncertainty as to a successful methodology for reducing the pressure, reducing fishing effort in key areas may have benefits, but may displace fishing effort leading to higher bycatch in other regions. Current levels of the pressure are uncertain, and therefore demonstrating a reduction in this has inherent difficulty. Uncertainty as to determining the likely collision and mortality rates, therefore demonstrating that the compensation measures are sufficient may be complex. It may be difficult to demonstrate the 'additionality' of measures applied.
Key considerations – practical delivery perspective	Reductions in fishing efforts can be controversial, and may be difficult to enforce, as it has a potential direct economic impact on the fishing industry. As a result it may prove to be an expensive measure.

Parameter	Case Example 1
How overcome?	Whilst the practical challenges are included here, they are not considered insurmountable. However, the uncertainty in demonstrating success may be more difficult to achieve. Ongoing monitoring of both the number of collisions and wider bottlenose dolphin populations through survey may provide some evidence, but the counterfactual (effect in the absence of the measures) is difficult to elucidate. Adaptive management, based on an ever-improving evidence base for collision risk should also be applied to support this measure.
Compensation package	The overall compensation package will be required to detail specific objectives for the designated feature, and monitoring regimes to determine achievement of these. Furthermore, definition of the roles and responsibilities of the applicant/governmental or non-governmental organisations and other stakeholders should be considered and provision made to support the measures for the lifetime of the project. The timeline for the implementation of measures should also be considered, with sign-off of the measures not only required from a compensation point of view, but ensuring that all other consents are in place before the compensation package is accepted as sufficient.
Stakeholder opinion	Majority of respondents supportive in principle, though two (out of 15) opposed the measure, with one noting the issue of additionality, i.e. that government should be doing this already.

6.5 Birds

W here compensatory measures have been implemented for birds, these are predominantly through habitat creation, which has been demonstrated as being effective in supporting waterbird (including all waders, wildfowl and seabirds) or terrestrial bird populations. Compensatory measures for seabirds have not yet been implemented in the UK, although the creation of tern nests was accepted as a compensatory measure for proposed coastal defence works at Pagham (the scheme has not yet been implemented). Possible compensatory measures for birds are described below and summarised in Table 13. Table 14 provides a case example of how measures could be applied in practice.

Compensatory habitat creation would often also be of benefit for marine and coastal birds. As such, many of the managed realignment sites listed in Table 6 above (Section 6.1) were implemented for such purposes, including the English schemes at Allfleet's Marsh, Chowder Ness and Welwick. These have often been accompanied by detailed targets for birds, for example, for the 2006 Allfleet's Marsh scheme, the site, which mostly consists of mudflats, had the following targets for intertidal birds (Jacobs and ABPmer, 2012):

- An assemblage of roosting waterbirds, comprising, on a 5-year mean peak basis, at least 3,600 waterbirds in similar proportions to those historically supported by Fagbury Flats (one of the sites it compensated for), in particular Ringed Plover, Grey Plover, Dunlin and Turnstone;
- An assemblage of feeding waterbirds, comprising, on a 5-year mean peak basis, at least 2,800 waterbirds in similar proportions to those historically supported by Lappel Bank and Fagbury Flats (the two sites it compensated for), in particular Shelduck, Dunlin and Redshank; and
- The necessary intertidal habitat composition (mainly mudflat and saltmarsh habitat) and extent that provides the opportunity for the full assemblage of waterbirds to feed and roost within the site.

It is worth noting that such bird targets have tended to be less prescriptive with more recent schemes.

Managed realignment schemes also typically include enhancement measures for birds, as good practice measures rather than for compensatory purposes. For example, isolated islands are frequently created (e.g. 12 islands created as part of the Medmerry project (West Sussex, England); some of which were shingle-topped) (ABPmer, 2015).

As noted in Section 6.2.1, managed realignment schemes often create mudflat, which acts as both feeding and roosting habitat for waterbirds. Where such schemes have been monitored, densities of most wader species typically increase during the first two to four winters following inundation; this largely reflects the rate of increase in biomass of their main invertebrate prey. Waders which feed primarily on larger bivalves (which can take several years to attain maximum size), would be expected to take longer to attain maximum densities than waders that feed on more rapidly maturing, smaller benthic invertebrate species (Natural England, 2015a).

A report reviewing compensatory mudflat schemes (Natural England, 2015a) found that there was generally a lack of studies comparing densities of waterbirds at intertidal habitat creation sites with nearby mudflats, but limited evidence suggests that densities of feeding waterbirds at intertidal habitat creation sites can, at some sites, attain similar, or even higher, densities than mean feeding densities on the rest of the adjoining estuary. However, numbers of feeding waterbirds at intertidal habitat creation sites unsurprisingly subsequently decline when newly created mudflat is colonised by saltmarsh plants. It is conceivable that densities of benthic invertebrates, and therefore feeding waders, might be lower at sites where high rates of accretion smother benthic invertebrates, but no studies investigating this have been identified. In some situations, created mudflat might be at a

higher elevation to most of the rest of the existing mudflat on an estuary, and thereby provide important feeding opportunities for birds during periods of the tide when little other intertidal feeding habitat is available.

Large scale managed realignment was also envisaged as being required should a Severn Tidal Barrage be implemented (Severn Tidal Power, 2010). This was mostly away from the Severn Estuary/Bristol Channel region, due to land availability and suitable land being within the limits of the barrage. For such distant habitat creation, it was caveated that this would likely be less effective than implementing such measures locally, and that some species may take many years to re-distribute to new sites created at a distance. Furthermore, there would be a risk '*that this measure may not be effective for some species and that some of the functions of the Severn Estuary may not be met*', particularly as many of the bird species that would benefit from these measures can be very site-faithful.

In addition to considering large scale intertidal habitat creation through managed realignment, it was also considered important that a range of habitats be provided '*that fulfil the range of ecological requirements of each species guild in close proximity to each other*'. For example, the provision of high tide roosts and new freshwater wetland habitats at sites close to the Severn Estuary were also discussed as part of what a potential compensation package might look like. It was thought likely that the creation of freshwater wetlands would be an effective, or partially effective, measure for species that regularly use freshwater sites (such as Shelduck, Dunlin, Redshank, Ringed Plover and Grey Plover). It was however caveated that freshwater wetlands '*tend to support only low densities of species that primarily feed on intertidal mudflat invertebrates or bivalves, thus this measure is likely to be effective at only a very low level for these species guilds*' (HM Government *et al*., 2010).

Two pertinent Welsh non-managed realignment compensatory bird measures include the following:

- Port of Mostyn slate roost (outer Dee Estuary): in order to compensate for an intended berth extension, the Port of Mostyn deposited slate materials north of the port, to raise a section of upper intertidal zone and create an area that is exposed (and accessible by roosting waterbirds) on most high waters. This involved translocating locally available materials a very short distance away within the boundaries of the dock estate.
- Mumbles Pier Kittiwake platforms (Swansea Bay): in order to compensate for a likely disturbance in relation to a new lifeboat station being constructed at the end of the pier, new wooden platforms were added to the adjacent pier to create additional nesting habitat. Kittiwakes had been nesting on the old Mumbles Pier for over 20 years, and the new platforms proved successful. However, for nesting structures like this to be properly utilised they have to be deployed in habitat already occupied by kittiwakes, or the target species. They are therefore most effective when implemented near such colonies.

In addition, the creation of the skear/cobble habitats at Morecambe Bay (noted in Section 6.2.1) above was motivated by it acting as sub-roosts and supplementary feeding grounds for wading birds.

Measures to enhance existing habitat or create suitable habitat for tern species has been used widely both in the UK and abroad, though not generally for compensation purposes. Newly formed islands and rafts have the potential to provide higher quality, and more undisturbed, habitat than nearby natural habitat. This is because they are initially vegetation free, usually lack mammalian predators and their inaccessibility will often limit human disturbance. This could reduce the need for other measures such as fencing and wardening. Previous studies have found that nest success can be higher on artificial habitats (82 %), than in the natural habitat (58 %) (Pakanen *et al*., 2014). As such, artificial habitats can be very productive breeding sites for habitat deprived tern populations, but management should focus on improving both natural and artificial habitats.

Other existing examples of habitat enhancements which could be used as compensation, but have not been applied to date, include:

- The installation of floating saltmarsh islands to provide bird roosting and fish hiding places (as recently trialled in Swansea dock in relation to a Swansea University PhD study; see Frog Environmental, 2020');
- The use of rafts in sheltered harbours and estuaries covered in suitable substratum such as gravel, sand or shingle (Dunlop *et al*., 1991; RSPB, 2018);
- The creation of a new island habitat feature for terns (Burgess and Hirons, 1992; Fasola and Canova, 1996);
- The addition of suitable nesting substratum to an existing beach, spit, dock or island features not currently used as a nesting site by terns (Pakanen *et al*., 2014; Flyde Bird Club, 2018; Allcorn, 2003); and
- The addition of suitable nesting substratum to enhance existing colonies (Langstone Harbour Board, 2013, 2014; Allcorn, 2003).

Wardening could also be viewed as a compensatory action. For example, the use of wardening schemes and cameras to identify intruders (predators or human) entering zoned off areas can be employed to protect tern nests. The presence of full-time and/or volunteer wardens to protect the area is considered essential for the protection of eggs at most UK tern colonies. At the Little Tern colony in Gronant Dunes (North Wales), trail camera technology is used to monitor predators at night (RSPB, 2010; ABPmer, 2015).

Limiting access to nesting colonies via the addition of roped off areas, fencing or more sophisticated mesh electric fencing can be implemented, though again not typically done as a compensation measure to date (identified as an in-principle compensatory measure to exclude predators if compensation is required for the Norfolk Vanguard Offshore Wind Farm (Vattenfall, 2020)). The exclusion of disturbance sources and predation from an area is a commonly used technique to help protect nesting birds. For example, nests have been protected on Lindisfarne (Northumberland, England) since 1993 where Oystercatchers were the primary predators and this site has maintained a 100% success rate since implementation (Allcorn, 2003). Such methods can also be used to enhance areas with high levels of tourism or coastal recreation.

Following successful eradication programmes aiming to reduce predator pressure on nesting seabirds (such as rat eradication on the Shiant Islands) (Main *et al*. 2020), Hornsea 3 OWF has proposed the use of predator control as a compensatory measure. They are proposing to identify islands with Kittiwake populations currently impacted by rat predation and propose to eradicate rats on these islands (GoBe, 2020). The acceptability of this measure is not yet tested (expected to be determined by the Secretary of State in June 2020), and it's applicability in Wales is uncertain, with eradication programmes already in place. In these circumstances it would need to be demonstrated that such measures go beyond those stated in MPA management schemes to ensure additionality.

Reduction in pressures on prey species should also be considered when reviewing impacts on seabird populations. For example, linkages have been identified between reductions in sandeel populations and corresponding impacts on Kittwake, particularly in the North Sea (Cook *et al*., 2014). As such, consideration of reduction in pressures on sandeel may be considered as measures to offset potential impacts on Kittiwake populations, which have been highlighted as a concern for development of offshore wind on the east coast of the UK. It should be noted, however, that there are no longer any sandeel fisheries in operation. Outside of the UK, the Port of Rotterdam's Maasvlakte II construction, whereby a loss of 3,125 ha of shallow subtidal sandbank habitat was incurred in a potential SPA, prompted the creation of a no bottom trawling reserve measuring 25,000 ha marine reserve (within the now established SPA) (EC, 2003; van der Meulen, 2016).

Direct pressure on bird species from fisheries through by-catch has the potential to be reduced as part of a compensation package. Similar to the reduction in this pressure (and pressure on prey species) for marine mammals, discussed above, there may be practical difficulties in reducing fisheries pressures. Difficulties likely to be encountered are that fisheries measures may be controversial or difficult to enforce. In addition, it is likely to be difficult to demonstrate cause and effect, affecting confidence in the effectiveness of the measure. Additionality was also highlighted as an issue by stakeholders, some of whom also caveated this for other measures listed as potential compensatory options for birds (see Appendix C, Table C5, for more detail).

Table 13. Potential compensatory measures for birds

Type of Intervention	Strengths	Limitations	Relevant Examples	Stakeholder Views as Compensation Measure (N= 15, see Appendix C)
Intertidal creation/restoration through managed realignment or beneficial use	Proven measure of attracting large number of birds to a previously unused area.	Risk of challenge on grounds of additionality, movement of birds, not an increase.	Multiple schemes on the Humber Estuary support large numbers of SPA features.	Yes – 14 No – 0 Don't know – 1
Creation of roost sites	Proven measure attracting populations displaced from current sites	In order to be effective, the created site should be as close as possible from the lost roosting site	Artificial nesting sites have been designed and built in multiple locations, including as compensation for lost roosts at Green Port Hull on the Humber.	Yes – 13 No – 0 Don't know – 1 Not stated - 1
Predator control, habitat management	Proven measure to reduce egg/chick predation and improve breeding success	Risk of challenge on grounds of additionality	No examples of use as compensatory measure, but used in SPA management e.g. Lindisfarne, Lundy Island and proposed as a compensatory measure at Hornsea 3 OWF (GoBe, 2020).	Yes – 11 No – 3 Don't know – 1
Wardening	Proven measure to protect nesting birds	Risk of challenge on grounds of additionality	No examples of use as compensatory measure, but used in SPA management e.g. North Denes (Norfolk) and Chesil Beach (Dorset)	Yes – 7 No – 5 Don't know – 2 Not stated - 1

Type of Intervention	Strengths	Limitations	Relevant Examples	Stakeholder Views as Compensation Measure (N= 15, see Appendix C)
Artificial nesting (Terns/Kittiwake)	Proven measure to support breeding success	Risk of challenge on grounds of additionality	In Pagham Harbour tern habitat restoration has been proposed as compensation (not yet implemented). No major examples of use of these types of structures as compensatory measure, but used for site management and/or mitigation measures e.g. Hayling Island, Medmerry, Mumbles Pier	Yes – 14 No – 0 Don't know – 0 Not stated - 1
Reduce or remove pressure from fisheries by-catch (long-lines, nets)	Directly benefits feature	Risk of challenge on grounds of additionality, very limited information on fisheries by-catch. Detailed monitoring required to establish benefit	No examples of use as compensatory measure but reduction in commercial fishing by-catch proposed as possible measure for some offshore SPAs	Yes – 10 No – 3 Don't know – 2
Reduce or remove pressure on sea bird prey resources (e.g. reduction in commercial fishing pressure)	Directly benefits feature	Risk of challenge on grounds of additionality. Link between food availability and population viability difficult to monitor	No examples of use as compensatory measure but reduction in commercial fishing pressure proposed as possible measure for some offshore SPAs	Yes – 11 No – 3 Don't know – 1
Reduce or remove pressure from disturbance	Directly benefits feature	Risk of challenge on grounds of additionality Difficult to quantify current effects on bird species	Identified as part of a strategic approach in the management of Natura2000 sites in the UK (Natural England, 2015b)	No specific comments

Type of Intervention	Strengths	Limitations	Relevant Examples	Stakeholder Views as Compensation Measure (N= 15, see Appendix C)
Designate additional sites or extend site boundaries	n/a	Birds Directive requires Member States to classify all suitable territories, so no scope for further designations	n/a	Yes – 3 No – 6 Don't know – 3 Not stated - 2
Contribution of developers to a centralised scheme	Allows smaller projects to contribute to a larger scheme with potential for more significant benefits. Provides greater certainty to applicants.	Assessing the required contribution of a developer may be difficult. Larger schemes may not be implemented before impacts from contributing projects are realised.	A scheme currently operating in two locations seeks to use developer contributions to support a team of rangers to help reduce the impact of disturbance through education. (Birdaware, 2017)	No specific comments

Table 14. Birds case example

Parameter	Case Example 1
Potential Impact	**Collision mortality with tidal stream turbine leading to a significant adverse effect on a SPA bird feature.**
Information required to inform the compensation package	Need to understand: ▪ Zone of influence (ZOI) – direct, indirect and cumulative effects ▪ Magnitude of effect ▪ Timescale of effect – temporary/permanent ▪ Features that could be affected ▪ Connectivity and understanding of functioning – both in terms of physical processes and supporting ecological features ▪ Conservation objectives ▪ Condition status of the feature ▪ Existing management measures
Possible measures	Predator control at nesting site/colony
Key considerations – principles of application	Number of moralities considered to be attributable to collision would be difficult to define. This would have implications for understanding population level effects. Need to understand the current mortality of chicks at the colony to understand potential benefits of introducing the measure. A colony would need to be affected enough that predation removal will have a beneficial effect. Ability to measure the success of the measure in the context of natural variability and wider anthropogenic changes.
Key considerations – practical delivery perspective	Need to ensure that the predator that needs to be controlled is not also a protected species (e.g. otter). Feasibility of eradication measures particularly where outside the control of the applicant. Both lethal and non-lethal methods of deterrent should be considered. Potential for requirement of ongoing action (repeated predation control).

Parameter	Case Example 1
How overcome?	Whilst the practical challenges are included here, they are not considered unsurmountable. Likely to be required as part of a package of measures. Adaptive management, based on an ever-improving evidence base for collision risk should also be applied to support this measure.
Compensation package	The overall compensation package will be required to detail specific objectives for the designated feature, as well as management and monitoring regimes. Furthermore, definition of the roles and responsibilities of the applicant/governmental or non-governmental organisations and other stakeholders need to be considered and provision made to support the measures for the lifetime of the project. The timeline for the implementation of measures also needs to be considered, with sign-off of the measures not only required from a compensation point of view, but ensuring that all other consents are in place before the compensation package is accepted as sufficient. Legal agreements may be required to ensure all such measures can be secured.
Stakeholder opinion	Fairly supportive of this option in principle, with some minor opposition.

6.6 Wider principles

The final question of the questionnaire related to the wider principles of ensuring that there is no future decline in marine biodiversity and mechanisms to achieve better environmental outcomes. In summary, out of 21 respondents, 10 provided answers on this question. In total, 21 individual suggestions were made. A synthesis of findings and stakeholder views is provided below with further detail available in Appendix C.

Several respondents highlighted net gain as a possible solution to ensure no future decline of marine biodiversity. It was highlighted, however, that further clarification of how this could work in practice is required. As noted in Section 3.2.4, biodiversity net gain will soon be written into law in England, though related to developments requiring terrestrial planning permission only (including intertidal). Consideration of the application of this principle to wider consenting regimes has, however, been consulted upon and as yet no definitive position has been published. In Wales, as noted in Section 3.4, net gain is currently not specifically noted in legislation or policy, however, 'enhancement' as specified in policy ENV_01 of the WNMP would typically be interpreted in a similar fashion by NRW.

It is also of note that the Chief Planner of the Planning Directorate wrote to planning officers in October 2019 emphasising the importance of securing biodiversity enhancement/gain. The letter stated that:

> *' where biodiversity enhancement is not proposed as part of an application, significant weight will be given to its absence, and unless other significant material considerations indicate otherwise it will be necessary to refuse permission.'*

One respondent mooted that, rather than focussing on the provision of like for like compensation, it should be considered whether greater value/benefit could be delivered 'by doing something different'. This suggestion is related to the concept of habitat equivalency/measures of '*equivalent environmental benefit*', which was introduced in Section 3.2.2 in relation to the MCAA and damaging actions in MCZs. It is also worth noting that a systematic approach to ecological equivalence was investigated in relation to Severn Tidal Power (Treweek Environmental Consultants, 2010). This study noted that 'in simple terms equivalence is achieved when losses due to an impact and gains due to compensation are balanced', and that such compensation could be achieved via 'out of type' compensatory measures, or those within the same type of ecosystem/functional ecological unit.

Some respondents recommended a more strategic approach to the provision of mitigation, compensation and environmental enhancements. This could include, for example, the co-ordination of a centralised funding mechanism which developers could pay in to. There would be several benefits to such an approach in ensuring maximum environmental benefits could be achieved as well as providing developers with a level of certainty and confidence in their proposals. Such an approach could also be used to ensure a more consistent approach to agreeing and securing compensation, mitigation and enhancement requirements. It may also help to avoid competition for suitable parcels of land (or equivalent). There would, however, be many challenges to such an approach, including the overarching management requirements and the associated administrative costs. It would also be challenging to demonstrate compliance with all of the legislative and policy drivers at the scale of individual projects.

Habitat banking was furthermore discussed by one respondent in a follow up phone call, in relation to collaboration on intertidal habitat schemes, and the ability to bank achieved habitat creation until a compensatory need arises. Banking is also being discussed in relation to biodiversity net gain, where the setting up of formal banks is being considered, with some private companies already offering such

a service in terrestrial settings. Defra (2018) for example noted that this market based environmental solution could 'provide an effective and efficient way to combine many small developer contributions towards larger scale green infrastructure, provide a simple process for developers and a commercial opportunity for landowners and brokers in conservation activity'.

Similarly, some respondents recommended more government investment and/or strategic planning for the provision of environmental enhancements. This included calls for funding to support coastal squeeze mitigation in areas where private landowners decided to hold the line, as well as to facilitate adaptation projects whereby the current funding threshold (for flood defence projects) is not reached due to a relatively low number of people and properties at risk.

A number of suggestions were also made in relation to the consenting process as a whole. It was firstly acknowledged that decision making should take account of all policy and legislative requirements with a full audit trail maintained. It was also suggested that there should be better consideration of in-combination and cumulative effects to ensure that all potential environmental impacts are fully understood. Furthermore, it was stated that there should be better enforcement, monitoring and regulation of post-consent requirements. This would ensure a process of impact verification as well as providing the opportunity to develop the evidence base for future development proposals. It was also highlighted that consent should not be granted for developments that cannot avoid environmental degradation (unless a suitable package of compensation, mitigation and enhancement measures is agreed). Such a suggestion could also relate to the concept of allowing projects to proceed on the basis of adaptive management where the parameters of such an approach can be agreed.

Wider suggestions included the designation of further MPAs (and introduction of safeguarding measures) as well as the implementation of no take zones to allow marine biodiversity to recover. Similarly, stakeholders highlighted the importance of strategic research to better understand environmental effects of emerging technologies as well as the effectiveness of any compensation, mitigation and enhancement measures.

7 Conclusions

7.1 Summary

A wide range of mitigation and compensation measures have been employed to date for the four key receptor groups which have been the focus of this project: marine habitats, fish, marine mammals and birds. These have been undertaken (or considered) to ensure compliance with a wide range of policy and legislative drivers, as well as to support sustainable development in Welsh and wider UK waters. An overview of such measures, along with an understanding of their relative effectiveness, provides a useful resource to inform environmental assessments and ultimately the consenting process. This project sought to fulfil such a remit.

The mitigation hierarchy defines a sequential process that should be adopted to avoid, mitigate and compensate negative ecological impacts, with compensation very much interpreted as a measure of last resort. In this context, mitigation measures should be considered from the very outset of a potential development and may be employed throughout all stages of the project lifecycle. When introducing and securing such measures, it is important to understand the level of certainty and confidence that they can be applied successfully within a particular situation. This also requires the understanding of the effects of the measures across receptor types, as well as how they influence the commercial viability of a project.

The specific understanding of compensatory requirements is very much driven by the underlying legislative or policy driver. The whole process of securing and agreeing compensation measures takes into consideration a large number of factors and there is considerable guidance, case law and precedent that can be drawn upon to inform these requirements, particularly in relation to the EU Birds and Habitats Directives. Specific examples in relation to the provision of compensation in the marine environment have to date been largely limited to intertidal habitats, birds and fish. Greater consideration is, however, being given to more novel compensation measures both for these receptors and marine mammals.

There are a number of complexities in defining and securing mitigation and compensation packages. This was re-iterated by stakeholders in responding to the questionnaire where they ranked 'reaching agreement on compensation packages' highest when identifying the main challenges when identifying and securing compensatory measures. Other key challenges were identified as 'delivering like for like', 'additionality' 'certainty of effectiveness', 'timing issues' and 'costs'. Additional challenges raised by stakeholders ranged widely, from legislative conflicts to uncertainty around the role of net gain, as well as compensation having to date not been applicable for certain industries, notably fishing and aggregates. Several respondents caveated that many of the measures listed in the questionnaire would be considered mitigation, and not compensation, in Birds and Habitats Directives terms, and that the latter requires stringent interpretation of what can be undertaken.

As highlighted in Section 6.1 there are also a number of key practical elements which potentially influence the effective delivery of compensatory measures. These include, for example, the requirement to obtain separate consents to implement the measures, overlap with both the terrestrial and marine planning regimes and the alignment of timings of the potential impacts and the ability to deliver the required compensatory measures. It is also not uncommon for such schemes to encounter objections from local stakeholders and numerous on-site hurdles which can slow implementation.

The delivery of a number of compensatory measures are also dependent on the availability of suitable land (for which there can be considerable competition). Where such measures cannot be

implemented in Welsh waters, they may need to be provided outside of Wales. This introduces further complexities with regard to the damage occurring in Wales, but the potential benefits being experienced elsewhere, as well as the practicalities/legislative powers of being able to enforce such measures.

The extent to which compensation objectives are being met is generally regularly reviewed through monitoring, with more formally defined review periods typically in the region of five to 10 years. These, amongst others, serve to evaluate the success of such schemes, with success generally being variable when assessed against a number of criteria. In implemented cases, the key issue of loss of intertidal habitat extent has generally been satisfied (Defra, 2016). However, given the dynamic nature of the marine environment, such habitats are often subject to change post implementation, notably the transitioning of mudflat to saltmarsh in estuaries with high suspended sediment loads. In addition, where bird targets were set, these have also sometimes proven challenging to demonstrate, particularly in the context of disentangling changes in bird numbers from natural variation.

For most UK compensatory sites with specific compensation objectives, it is also often uncertain how these sites will be 'signed off' and the habitat deemed acceptable compensation for that which was lost. The duration of these types of agreements also introduces uncertainty as a developer may become insolvent over such a time period. A mechanism to ensure delivery is fulfilled into the longer term (as required by a number of legislative drivers) is therefore important.

7.2 Recommendations

Overall, it was suggested by stakeholders that there is a requirement for greater guidance and clarity on the whole process of agreeing mitigation and compensation requirements for individual projects. This would ideally capture all stages in the process from understanding the initial adverse impacts, identifying and agreeing the respective measures, setting objectives and ultimately how compliance will be demonstrated. In practice any new guidance would need to build on existing guidance and might prove difficult to achieve given the complexities of site and project specific issues. The sign off process in particular might benefit from further clarification. Such guidance would also need to be designed to meet the needs of developers, regulators and wider stakeholders.

As highlighted above, there are a number of possible mitigation, compensation and enhancement measures that can be applied for marine ecological receptors. It is important that the evidence base is maintained and advanced where necessary, to better understand the levels of certainty that can be assumed in terms of the likelihood of successful application. In determining and applying such measures, site-specific parameters will always form a key consideration.

This could be achieved through more regular/coordinated strategic reviews of post-consent monitoring data. It is currently felt that maximum benefit is not being gained from this valuable data source. More widely, research from academia and other forums could also form a greater component of the evidence base. The challenges associated with this include the resources to administer and co-ordinate such initiatives as well as the sensitivity of academics in relation to sharing data prematurely, and that of developers in sharing privately owned data. There are, however, a number of sector bodies that do actively promote the principles of shared learning for the benefit of the industry as a whole. These include the development of best practice guides for particular sectors.

With the development of new and emerging technologies, and the expansion into new areas and increasing project scales, the requirement for additional mitigation and compensation measures to secure the network of protected ecological features in Welsh waters is becoming more apparent. This has resulted in a need to understand the breadth of mitigation and compensation opportunities that may be relevant to, and can be factored into, the marine consenting process. There is also a

requirement for greater research, and ultimately policy decisions, in relation to the overall acceptability, legal compliance and practical application of mitigation/compensation options and any alternative solutions. This should include consideration, not only of possible measures, but the principles of delivering compensation of equal or greater functional equivalence (as opposed to like for like). This could also include the concept of allowing projects to proceed on the basis of adaptive management, for example for techniques with a weaker evidence base, where the parameters of such an approach can be agreed. Stakeholder views (as were started to be gathered as part of this project) will also play a key role in this process. In this context the Offshore Wind Sector is currently working with RenewableUK in partnership with The Crown Estate to consider this issue.

In terms of the wider principles of ensuring that there is no future decline in marine biodiversity and mechanisms to achieve better environmental outcomes, several stakeholders highlighted net gain as a possible solution. In Wales, net gain is currently not specifically noted in legislation or policy, however, 'enhancement' as specified in policy ENV_01 of the WNMP would typically be interpreted in a similar fashion by NRW. Further clarification of how this could work in practice is required.

Consideration should also be given to a more strategic, holistic approach to the provision of mitigation, compensation and environmental enhancements in the marine environment. This could also include the concept of habitat banking to provide greater flexibility in the delivery of compensation. It could also, for example, comprise the co-ordination of a centralised funding mechanism which developers could pay in to. There would be several benefits to such an approach in ensuring maximum environmental benefits could be achieved, as well as providing developers with a level of certainty and confidence in their proposals. There would, however, be many challenges to such an approach, including the overarching management requirements and the associated administrative costs. It would furthermore be challenging to demonstrate compliance with all of the legislative and policy drivers at the scale of individual projects.

8 References

Able Marine Energy Park (AMEP). (2013) *Cherry Cobb Sands and Keyham Drain studies*. Teeside: Able UK, p. 175.

ABPmer. (2000) *Climate Change and Coastal Erosion*. ABP Marine Environmental Research Ltd. Report No. R.1111.

ABPmer. (2005) *Proposed Phase Vi and VII Morecambe Coastal defence works ecological monitoring 2002-2004*. ABP Marine Environmental Research Ltd. Report No. R.1057.

ABPmer. (2008) *Severn Tidal Power - Preliminary Review of Possible Mitigation and Compensation Requirements under the Habitats Directive.* ABPmer in association with Parsons Brinckerhoff Ltd and Black & Veatch Ltd.

ABPmer. (2015) *The cost of undertaking managed realignment schemes in the UK; a briefing note.* Southampton: ABPmer, p. 7.

ABPmer. (2017) *UK marine habitat creation schemes; a white paper*. Southampton: ABPmer, pp. 25.

ABPmer (2018) *Beneficial Use of Dredge Sediment in the Solent (BUDS), Phase 1 Project Scoping and Partnership Building.* A report for Solent Forum by ABPmer. Report No. R.2845. p. 111.

ABPmer. (2019) *Appendix G of the Area 531 Environmental Statement, (Marine Aggregate Extraction).* Report for Tarmac Marine and Hanson Aggregates Marine Ltd. ABPmer Report No. R.3078. (available via MMO public register, MLA/2019/00457).

ABPmer. (2020) *Review of Potential Collision Between Tidal Stream Devices and Marine Animals*. A report for Natural Resources Wales by ABPmer. *In Press.*

Allcorn, R.I. (2003) *Proceedings of a Symposium on Little Terns* Sterna albifrons. Sandy: The Royal Society for the Protection of Birds (RSPB). p. 97.

Baines, M.E. & Evans, P.G.H. (2012) *Atlas of the Marine Mammals of Wales*. Countryside Council for Wales. Monitoring Report No. 68. 2nd Edition. p. 139.

Bašić, T., Britton, J.R., Rice, S.P. & Pledger, A.G. (2017) Impacts of gravel jetting on the composition of fish spawning substrates: Implications for river restoration and fisheries management. *Ecological Engineering*. 107. p. 71-81.

Benjamins S., Dale A.C., Hastie G., Waggitt J.J., Lea M.A., Scott B. & Wilson, B. (2015) Confusion reigns? A review of marine megafauna interactions with tidal-stream environments. *Oceanography and Marine Biology: An Annual Review*. 53 (53). p. 1-54.

Bird Aware Solent. (2017) *Solent Recreational Mitigation Strategy*. Southampton: Bird Aware Solent. p. 28.

Blue Marine Foundation. (2020) Solent Oyster Restoration [Viewed: March 2020]. Available at: https://www.bluemarinefoundation.com/projects/solent/

Boskalis. (2019) *Marker Wadden* [online]. [Viewed: October 2018]. Available at: https://boskalis.com/csr/cases/marker-wadden.html.

Boyle, G. and New, P. (2018) *ORJIP: impacts from piling on fish at offshore wind sites: collating population information, gap analysis and appraisal of mitigation options*. London: The Carbon Trust.

British Broadcasting Corporation (BBC). (2018a) *Bacton Gas Terminal to be protected by sandscaping plan* [online]. [Viewed: March 2019]. Available at: https://www.north-norfolk.gov.uk/sandscaping.

British Broadcasting Corporation (BBC). (2018b) Dornoch Firth: Extinct oyster reefs restoration starts [online]. [Viewed: November 2018]. Available at: https://www.bbc.co.uk/news/uk-scotland-45829130.

British Marine Aggregate Producers Association (BMAPA) & The Crown Estate. (2017) *Good Practice Guidance: Extraction by Dredging of Aggregates from England's Seabed*. London: BMAPA & The Crown Estate. p. 24.

Brown, S.L., Pinder, A., Scott, L., Bass, J., Rispin, E., Brown, S., Garbutt, A., Thomson, A., Spencer, T., Moller, I. & Brooks, S.M. (2007) *Wash Banks Flood Defence Scheme*. Freiston Environmental Monitoring 2002-2006. Dorchester: Centre for Ecology & Hydrology. p. 378.

Bureau Waardenburg. (2017) *Eco-friendly design of scour protection: potential enhancement of ecological functioning in offshore wind farms*. Report for Ministry of Economic Affairs. Culemborg (the Netherlands): Bureau Waardenburg. p. 98.

Burgess, N.D., & Hirons, G.J. (1992) Creation and management of artificial nesting sites for wetland birds. *Journal of Environmental Management*. 34 (4). p. 285-295.

Burgess-Gamble, L., Ngai, R., Wilkinson, M., Nisbet, T., Pontee, N., Harvey, R., Kipling, K., Addy, S., Rose, S., Maslen, S., Jay, H., Nicholson, A., Page, T., Jonczyk, J., & Quinn, P. (2018) *Working with Natural Processes – Evidence Directory*. Bristol: Environment Agency. p. 304.

Burton, N.H. (2006) The impact of the Cardiff Bay barrage on wintering waterbirds, In Boere, G.C., Galbraith, C.A. & Stroud, D.A. Waterbirds around the world. Edinburgh: The Stationary Office. p. 805.

Burton, N.H., Rehfisch, M.M. & Clark, N.A. (2002) Impacts of Disturbance from Construction Work on the Densities and Feeding Behaviour of Waterbirds Using the Intertidal Mudflats of Cardiff Bay, UK. *Environmental Management*. 30 (6). p. 865–871.

Cefas, (2009) *Beneficial use of fine-grained maintenance dredged material* [online]. Available at: http://www.cefas.defra.gov.uk/our-science/assessing-humanimpacts/dredged-marine-sediments.aspx?RedirectMessage=true.

Charted Institute of Ecology and Environmental Management (CIEEM). (2018) *Guidelines for ecological impact assessment in the UK and Ireland (terrestrial, freshwater and coastal)*. London: CIEEM. p. 94.

Chartered Institute of Ecology and Environmental Management (CIEEM). (2018) *Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine version 1.1*. Winchester: Chartered Institute of Ecology and Environmental Management.

Cleasby, I.R., Owen, E. Wilson, L.J. & Bolton M. (2018) *Combining habitat modelling and hotspot analysis to reveal the location of high-density seabird areas across the UK: Technical Report*. Bedfordshire: RSPB Centre for Conservation Science. Research Report No. 63.

Colclough, S., Fonseca, L., Astley, T., Thomas, K. & Watts, W. (2005) Fish utilisation of managed realignments. *Fisheries Management and Ecology*. 12. p. 351-360.

Collins, K., 2018. *Helford River EFM. Presentation at the RYA in Hamble on 1 Nov 2018* [online]. Available at: https://www.rya.org.uk/SiteCollectionDocuments/legal/Web%20Documents/Environment/EFM_documents/4_Collins.pdf.

Cook, A.S.C.P., Dadam, D., Mitchell, I., Ross-Smith, V.H. & Robinson, R.A. 2014. Indicators of seabird reproductive performance demonstrate the impact of commercial fisheries on seabird populations in the North Sea. *Ecological Indicators*. 38. p. 1-11.

Cook, A.S.C.P., Ross-Smith, V.H., Roos, S., Burton, N.H.K., Beale, N., Coleman, C., Daniel, H., Fitzpatrick, S., Rankin, E., Norman, K. & Martin, G. (2011). *Identifying a Range of Options to Prevent or Reduce Avian Collision with Offshore Wind Farms using a UK-Based Case Study*. British Trust for Ornithology (BTO). Research Report no. 580.

Copping A, Sather N, Hanna L, Whiting J, Zydlewski G, Staines G, Gill A, Hutchison I, O'Hagan A, Simas T, Bald J, Sparling C, Wood J. & Masden E. (2016) *Annex IV 2016 State of the Science Report: Environmental Effects of Marine Renewable Energy Development Around the World*. A report for U.S. Department of Energy by the Pacific Northwest National Laboratory. p. 224.

Crompton, D. (2002) Cardiff Bay Barrage. *Proceedings of the Institution of Civil Engineers - Water Maritime Engineering*. 154 (2). p. 81–88.

Cutts, N., Hemingway, K. & Spencer J. (2013) *Waterbird Disturbance Mitigation Toolkit - Informing Estuarine Planning & Construction Projects* [online]. Available at: http://bailey.persona-pi.com/Public-Inquiries/M4%20-%20Revised/11.3.67.pdf.

Deaville, R., Jepson, P. D., Perkins, M., Bronlow. A., Davison, N., ten Doeschate, M., Smith, B., Lyal, R., Allan, L., Sabin, R. C. & Penrose, R. (2016) *UK Cetacean Strandings Investigation Programme - Annual Report for the period 1st January – 31st December 2015*. Report for Department for Environment, Food and Rural Affairs (Defra) by CSIP. Contract no. MB0111.

Defra. (2014) *Marine Strategy Part Two: UK Marine Monitoring Programmes*. London: Department for Environment, Food and Rural Affairs (Defra). p. 86.

Defra. (2015) *Marine Strategy Part Three: UK programme of measures*. London: Department for Environment, Food and Rural Affairs (Defra). p. 162.

Defra. (2015) *Biodiversity 2020: a strategy for England's wildlife and ecosystem services*. London: Department for Environment, Food and Rural Affairs (Defra). Contract no. CR0327. p. 210.

Defra. (2018) Net gain - Consultation proposals. London: Defra. P.55.
Defra and Environment Agency, 2007. Saltmarsh management manual. R&D Technical Report SC030220. Almondsbury: Environment Agency, p. 129.

Department of Energy and Climate Change (DECC). (2016) *UK Offshore Energy Strategic Environmental Assessment: OESEA3 Environmental Report*. Department of Energy and Climate Change. p. 591.

Dickie, I., Doku, A., Guiu, R., Wade, R., Ramsden, L., Hall, L., Hill, M. & Butterworth, A. (2014) *An estimation of the benefits of enhanced regulations for fish barrier management*. London: eftec. Report for Department for Environment, Food and Rural Affairs (Defra) by eftec. p. 59.

Dolton, H.R., Gell, F.R., Hall, J., Hall, G., Hawkes, L.A. & Witt, M.J. (2020) Assessing the importance of Isle of Man waters for the basking shark *Cetorhinus maximus*. *Endangered Species Research*. 41. p. 209-223.

Dornbusch, U. (2019) *Fact-finding tour: Saltmarsh (Vorland1) management in Germany*. Worthing: Environment Agency & Natural England. p. 28.

Dorset AONB Partnership. (2020) *Wytch Farm Landscape and Access Enhancement Fund*. [Viewed: February 2019]. Available at: https://www.dorsetaonb.org.uk/wp-content/uploads/2019/05/wytch-farm-fund-how-to-apply-FINAL_002.pdf.

Dunlop, C.L., Blokpoel, H., & Jarvie, S. (1991) Nesting rafts as a management tool for a declining common tern (*Sterna hirundo*) colony. *Colonial Waterbirds*, p. 116-120.

Essex County Council. (2019) *Essex Coast Recreational disturbance Avoidance & Mitigation Strategy (RAMS) - Habitats Regulations Assessment Strategy document 2018-2038*. Available at: https://www.basildon.gov.uk/media/9067/Essex-Coast-Recreational-Disturbance-Avoidance-Mitigation-Strategy-RAMS-Habitats-Regulations-Assessment-2018-2038/pdf/Essex_Coast_Recreational_Disturbance_Avoidance___Mitigation_Strategy_(RAMS)_Habitats_Regulations_Ass.pdf.

European Commission (EC). (2003) *Opinion of the Commission concerning the "Request by the Netherlands for advice and exchange of information with the European Commission within the framework of the Birds and Habitats Directives ", in relation to the "Project Mainport Rotterdam" Development Plan*. Brussels: European Commission. p. 10.

European Commission (EC). (2007) *Guidance document on Article 6(4) of the 'Habitats Directive'. 92/43/EEC*. Brussels: European Commission. p. 30.

European Commission (EC). (2017a) *Environmental Impact Assessment of Projects Guidance on the preparation of the* Environmental Impact Assessment Report (Directive 2011/92/EU as amended by 2014/52/EU). Luxembourg: European Commission. p. 130.

European Commission (EC). (2017b) *Common Implementation Strategy for the Water Framework Directive and the Floods Directive - Guidance Document No. 36, Exemptions to the Environmental Objectives according to Article 4(7)*. Brussels: European Commission. p. 83.

European Commission (EC). (2018) *Managing Natura 2000 sites. The provisions of Article 6 of the 'Habitats' Directive 92/43/EEC*. Brussels: European Commission. p. 86.

Feingold, D. & Evans, P.G.H. (2014) *Bottlenose Dolphin and Harbour Porpoise Monitoring in the Cardigan Bay and Pen Llŷn a'r Sarnau Special Area of Conservation 2011 – 2013*. Bangor: Natural Resources Wales. Evidence Report No. 4. p. 120.

Fasola, M & Canova, L. (1996) Conservation of gull and tern colony sites in north-eastern Italy, an internationally important bird area. *Colonial Waterbirds*. 19. p. 59-67.

Flyde Bird Club. (2018) *Preston Docks Common Terns*. [Viewed: February 2019]. Available at: http://www.fyldebirdclub.org/preston-dock-terns.html.

Frog Environmental. 2020. BioHaven® Floating Wetlands [online]. [Viewed: March 2020]. Available at: https://frogenvironmental.co.uk/biohaven-floating-wetlands/.

Frost, T.M., Austin, G.E., Calbrade, N.A., Mellan, H.J., Hearn, R.D., Robinson, A.E., Stroud, D.A., Wotton, S.R. & Balmer, D.E. (2019) *Waterbirds in the UK 2017/18: The Wetland Bird Survey*. Norfolk: British Trust for Ornithology. BTO, RSPB, & JNCC in association with WWT. p. 39.

GoBe. (2020) *Ørsted Hornsea Project Three, Appendix 2: Compensatory Measures*. In: Application for a Development Consent Order, The Proposed Hornsea Project Three Offshore Wind Farm Order (Application Reference En010080).

Greenlink Interconnector Limited. (2019) *Greenlink Marine Environmental Statement – Wales*. Report No. P1975_R4484_RevF1.

Halcrow, ABPmer & Institute of Estuarine and Coastal Studies. (2012) *Humber Estuary Managed Realignments: Lessons for the Future*. Volume 1 – Review Document. Leeds: Halcrow. p. 259.

Hammond, P.S., Lacey, C., Gilles, A., Viquerat, S., Boerjesson, P., Herr, H., Macleod, K., Ridoux, V., Santos, M., Scheidat, M. and Teilmann, J. (2017) *Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys*. Wageningen Marine Research.

Harwood, A., & Perrow, M. (2019) *Mitigation for birds with implications for bats*. In: Perrow, M.R. (ed.) Wildlife and Wind Farms, Conflicts and Solutions. Vol. 4 Offshore: Monitoring and Mitigation, Chapter: 8. Publisher: Pelagic Publishing, Exeter, UK.

HM Government. (2018) *A green future: our 25-year plan to improve the environment*. London: HM Government, p. 151.

HM Government, South West RDE & Welsh Assembly Government. (2010) *Severn Tidal Power Report on Possible Compensatory Measures under Article 6(4) Habitats Directive*. London: Department of Energy and Climate Change. p. 63.

Horizon. (2018) *Wylfa Newydd Project. 6.4.13 ES Volume D – WNDA Development. D13 – The Marine Environment*. Available at: https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010007/EN010007-001442-6.4.13%20D13-The%20marine%20environment%20(Rev%201.0).pdf.

Institute of Environmental Management and Assessment (IEMA). (2011) *Special Report – the State of Environmental Impact Assessment Practice in the UK*. London: IEMA, p. 102.

Hoskin, R., Liley, D. & Panter, C. (2019) *Habitats Regulations Assessment: Recreational Disturbance Avoidance and Mitigation Strategy for Ipswich Borough, Babergh District, Mid Suffolk District and East Suffolk Councils – Technical Report*. Wareham: Footprint Ecology. p. 139.

HR Walligford. (2013) *Severn tidal power habitat creation*. Wallingford: HR Walligford. p. 54.

Hutchison, Z.L., Gill, A.B., Sigray, P., He, H. and King, J.W. (2020) Anthropogenic electromagnetic fields (EMF) influence the behaviour of bottom-dwelling marine species. Scientific Reports, 10(1), pp.1-15.

JBA Consulting, CH2M Hill, Forest Research, James Hutton Institute, Lancaster University & Newcastle University. (2018) *Working with Natural Processes – Evidence Directory*. Bristol: Environment Agency. p. 304.

Jacobs & ABPmer. (2012) *Allfleet's Marsh (formerly Wallasea Wetland) Monitoring Programme (April 2006 to August 2011). Non-technical summary*. London: Jacobs. p. 19.

Langstone Harbour Board. (2013) *Annual Report 2013*. Hayling Island: Langstone Harbour Board. p. 25.

Langstone Harbour Board. (2014) *Annual Report 2014*. Hayling Island: Langstone Harbour Board. p. 24.

Johnston, A., Cook, A.S., Wright, L.J., Humphreys, E.M. & Burton, N.H. (2014) Modelling flight heights of marine birds to more accurately assess collision risk with offshore wind turbines. *Journal of Applied Ecology*. 51 (1). p. 31-41.

Joint Nature Conservation Committee (JNCC). (2019) *Fourth Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2013 to December 2018. Supporting documentation for the conservation status assessment for the Species: S1355 – Otter (Lutra lutra). WALES*. Available at: https://jncc.gov.uk/jncc-assets/Art17/S1355-WA-Habitats-Directive-Art17-2019.pdf.

Joint Nature Conservation Committee (JNCC). (2019) *Ramsar Convention*. [Viewed: March 2020]. Available at: https://jncc.gov.uk/our-work/ramsar-convention/.

Joint Nature Conservation Committee (JNCC) & Natural England (NE). (2011) *General advice on assessing potential impacts of and mitigation for human activities on MCZ features, using existing regulation and legislation*. Peterborough: JNCC. Advice for the regional Marine Conservation Zone projects by JNCC. p. 107.

King, S. (2019) *Seabirds: Collision*. In Perrow, M.R. (ed.) Wildlife and wind farms, conflicts and solutions. Volume 3. Offshore: Potential Effects. Exeter: Pelagic Publishing. p. 206-234.

Mackey, M., Didac, P.G. and O'Cadhla, O. (2004) *SA678 Data Report for Offshore Cetacean Populations*. Coastal & Marine Resources Centre, Environmental Research Institute, University College Cork. p. 47.
Marine Management Organisation (MMO). (2013) *Marine conservation zones and marine licensing*. Newcastle: MMO. p. 9.

Main, C.E., Bell, E., Floyd, K., Tayton, J., Ibbotson, J., Whittington, W., Taylor, P.R., Reid, R., Varnham, K., Churchyard, T. and Bambini, L. (2019) *Scaling down (cliffs) to meet the challenge: the Shiants' black rat eradication*. In Island invasives: scaling up to meet the challenge. *Proceedings of the International Conference on Island Invasives* 2017, p. 138-146.

Marine Management Organisation (MMO). (2018) *Marine conservation zones and marine licensing*. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/410273/Marine_conservation_zones_and_marine_licensing.pdf. p. 1-9

Marine Management Organisation (MMO). (2018) *Identifying sites suitable for marine habitat restoration or creation (MMO1135)*. Newcastle: MMO. Report for the MMO by ABPmer and AER. p. 99p.

Marine Protected Area (MPA) management steering group. (2018) *Marine Protected Area Network Management Action Plan for Wales*. [Viewed: February 2019] Available at: https://beta.gov.wales/sites/default/files/publications/2018-09/marine-protected-areas-network-management-action-plan-for-wales-2018-2019.pdf.

MarineSpace Ltd. (2019) *Simply Blue Energy 1 Floating Offshore Wind Farm: Environmental Impact Assessment Scoping Report*.

Merchant, N.D., Andersson, M.H., Box, T., Le Courtois, F., Cronin, D., Holdsworth, N., Kinneging, N., Mendes, S., Merck, T., Mouat, J. & Norro, A.M. (2020) Impulsive noise pollution in the Northeast Atlantic: Reported activity during 2015–2017. *Marine Pollution Bulletin*. 152. p. 110951.

Milner, N.J., Russell, I.C., Aprahamian, M., Inverarity, R., Shelley, J. & Rippin, P. (2004) *The role of stocking in recovery of the River Tyne salmon fisheries*. Cardiff: Environment Agency. Fisheries Technical Report No. 2004/1.

MMO. (2018) *Assessing Non-Lethal Seal Deterrent Options: Literature and Data Review*. A report for the Marine Management Organisation. Project No. 1131. p. 45.

Morris, R.K.A., Harley, M. Cottle, R., Banks, B., Doody, J.P., Brown, A.E., Weston, A., Hart, R. & Prince, S. (2016) *Review of the Effectiveness of Natura 2000 Sites Compensation Measures in England*. London: Department for Environment, Food and Rural Affairs (Defra). Contract No. WC1076. p. 107.

National Trust. (2020) Cwm Ivy: Where the sea comes in. Available at: https://www.nationaltrust.org.uk/whiteford-and-north-gower/features/cwm-ivy-where-the-sea-comes-in [last accessed March 2020]

Natural Capital Committee (NCC). 2018. *Annual Report 2018*. Fifth report to the Economic Affairs Committee. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/677873/ncc-annual-report-2018.pdf.

Natural England. (2015a) *Creating and Sustaining Compensatory Mudflat*. Report for Natural England by ABPmer. p. 95.

Natural England. (2015b) *Public Access and Disturbance Theme Plan. A strategic approach to identifying and addressing significant effects on the features of Natura 2000 sites*. York: Natural England. p. 40

Natural England, Imperial College & Defra. (2020) *Intertidal Habitats: Biodiversity Metric 2.0*. York: Natural England. p. 17.

Natural Resources Wales (NRW). (2015) *New saltmarsh habitat completes Fairbourne flood defence scheme*. [Viewed: March 2020]. Available at: https://naturalresources.wales/about-us/news-and-events/news/new-saltmarsh-habitat-completes-fairbourne-flood-defence-scheme/?lang=en.

Natural Resources Wales (NRW). (2018a) *Special Protection Areas in Welsh waters: Indicative site level feature condition assessments 2018*. Bangor: NRW. Evidence Report No. 236. p. 44pp.

Natural Resources Wales (NRW). (2019a) *Supporting the implementation of the Welsh National Marine Plan: Enhancing marine ecosystems*. Cardiff: NRW. Report for NRW by ABPmer. p. 107.

Natural Resources Wales (NRW). (2019b) *Benthic habitat assessment guidance for marine developments and activities. Guidance Notes: GN030 a-f.* [Viewed: March 2020]. Available at: https://naturalresources.wales/guidance-and-advice/business-sectors/marine/marine-and-coastal-guidance/?lang=en.

Natural Resources Wales (NRW). (2019c) *Marine Licence: CML1858, Construction of a new retaining wall aligned immediately seaward of the existing Inner West Pier in the River Tawe, Swansea, and associated dredge works* [online]. Available at: https://publicregister.naturalresources.wales/Search/Results?SearchTerm=cml1858.

Natural Resources Wales (NRW). (2020a) *Do I need a European Protected Species Licence?* [Viewed: March 2020]. Available at: https://naturalresources.wales/permits-and-permissions/species-licensing/european-protected-species-licensing/do-i-need-a-european-protected-species-licence/?lang=en.

Natural Resources Wales (NRW). (2020b) *Water Vole Licensing* [online]. [Viewed: March 2020]. Available at: https://naturalresources.wales/permits-and-permissions/species-licensing/uk-protected-species-licensing/water-vole-licensing/?lang=en.

Natural Resources Wales (NRW). (2020c) *Welsh National Marine Plan (WNMP) Policies – Template for Applicants*. Cardiff: Natural Resources Wales. p. 10.

Natural Resources Wales (NRW). (2020d) *Otter Licensing* [online]. [Viewed: March 2020]. Available at: https://naturalresources.wales/permits-and-permissions/species-licensing/european-protected-species-licensing/otter-licensing/?lang=en.

Natural Resources Wales (NRW), the Northern Ireland Environment Agency (NIEA) & the Scottish Environment Protection Agency (SEPA). (2017) *Guidance for Pollution Prevention Works and maintenance in or near water: GPP 5*. Available at: https://www.netregs.org.uk/media/1303/gpp-5-works-and-maintenance-in-or-near-water.pdf.

Natural Resources Wales (NRW). undated. *Skomer Marine Conservation Zone – Marine life in an underwater refuge* – Information Leaflet [online]. [Viewed: March 2020]. Available at: https://cdn.naturalresources.wales/media/678314/skomer-marine-conservation-zone-leaflet-eng.pdf?mode=pad&rnd=131481310400000000.

Natural Resources Wales (NRW), undated. Salmon and Sea Trout Stocking in Wales. Available at: https://naturalresources.wales/media/1436/salmon-and-sea-trout-stocking-in-wales.pdf [last accessed March 2020]

Nottage, A. and Robertson, P.A. (2005). *The saltmarsh creation handbook: a project manager's guide to the creation of saltmarsh and intertidal mudflat*. RSPB Management Guides.

Ojeda-Martínez, C., Bayle-Sempere, J.T., Sanchez-Jerez, P., Forcada, A. & Valle, C. (2007) Detecting conservation benefits in spatially protected fish populations with meta-analysis of long-term monitoring data. *Marine Biology*. 151(3). p. 1153-1161.

OSPAR. (2009). Overview of the impacts of anthropogenic underwater sound in the marine environment. Biodiversity Series. London: OSPAR Commission.

Pakanen, V.M., Hongell, H., Aikio, S., and Koivula, K. (2014). Little tern breeding success in artificial and natural habitats: modelling population growth under uncertain vital rates. *Population Ecology*. 56 (4). p. 581-591.

Pesante, G., Evans, P.G.H., Anderwald, P., Powell, D. & McMath, M. (2008a) *Connectivity of Bottlenose Dolphin in Wales: North Wales Photo Monitoring Interim Report 2008*. Bangor: Countryside Council for Wales (CCW). Marine Monitoring Report No. 62. p. 42.

Pesante, G., Evans, P.G.H., Baines, M.E. & McMath, M. (2008b) *Abundance and Life History Parameters of Bottlenose Dolphin in Cardigan Bay: Monitoring 2005-2007*. Bangor: Countryside Council for Wales. Marine Monitoring Report No. 61. p. 7581.

Phelan, N., Shaw, A. & Baylis, A. (2011) *The extent of saltmarsh in England and Wales: 2006-2009*. Bristol: Environment Agency. p. 48.

PIANC. (2008) *Working with Nature*. PIANC Position Paper. Brussels: PIANC.

Pinnegar, J.K., Jennings, S., O'brien, C.M. and Polunin, N.V.C. (2002) Long-term changes in the trophic level of the Celtic Sea fish community and fish market price distribution. *Journal of Applied Ecology* 39 (3), p. 377-390.

Port of Rotterdam, (2014) *Port Statistics*. Rotterdam: Port of Rotterdam Authority. p. 22.

Project Seagrass. (2020). *Project Seagrass | Advancing the conservation of seagrass* [online]. [Viewed: March 2020]. Available at: https://www.projectseagrass.org.

Reid, J.B, Evans, P.G.H. & Northridge, S.P. (2003) *Atlas of cetacean Distribution in North west European waters*. Peterborough: Joint Nature Conservation Committee. p. 76.

Rogan, E., Breen, P., Mackey, M., Cañadas, A., Scheidat, M., Geelhoed, S. & Jessopp, M. (2018) *Aerial surveys of cetaceans and seabirds in Irish waters: Occurrence, distribution and abundance in 2015-2017*. Dublin: Department of Communications, Climate Action & Environment & Department of Communications, Climate Action & Environment, National Parks and Wildlife Service (NPWS), Department of Culture, Heritage and the Gaeltacht. p. 297.

RPS. (2019) *Marine Energy Test Area (META) Environmental Impact Assessment*. Report for Marine Energy Wales by RPS. Report no. Rev.03.

Royal Society for the Protection of Birds (RSPB). (2010) *Norfolk biodiversity action plan: Little Tern* Sternula albifrons *(formerly* Sterna albifrons*)*. Sandy: RSPB.

Royal Society for the Protection of Birds (RSPB). (2016) *Written Summary of the Oral Case put at the Issue Specific Hearing on Compensation Proposals held on 12 and 13 November 2012. In the matter of: Planning Application for construction of the Able Marine Energy Park on the South Bank of the River Humber at Immingham, North Lincolnshire*. Sandy: RSPB. p. 33.

Royal Society for the Protection of Birds (RSPB). (2018) *Wave after wave of fledglings. Conservation success for the West Hayling Common Tern colony* [online]. [Viewed: January 2019]. Available at: https://community.rspb.org.uk/placestovisit/langstoneharbour/b/weblog/posts/wave-after-wave-of-fledglings.

Scottish Government. (2019) Draft Sectoral Marine Plan for Offshore Wind Energy - 2019.

Severn Tidal Power. (2010) Potential for Compensatory Measures. London: DECC, on behalf of Welsh Government and South West Regional Development Agency. p. 63.

Shackle, V.J., Hughes, S. & Lewis, V.T. (1999) The influence of three methods of gravel cleaning on brown trout, *Salmo trutta*, egg survival. *Hydrological Processes*. 13 (3). p. 477-486.

Special Committee on Seals (SCOS). (2019) *Scientific Advice on Matters Related to the Management of Seal Populations: 2018*. A report for the Natural Environment Research Council by SCOS. p. 155.

Stachan, R. (2015) *Otter Survey of Wales 2009-10*. Cardiff: Natural Resources Wales. p. 105.

Stebbing, A.R.D., Turk, S.M.T., Wheeler, A. & Clarke, K.R. (2002) Immigration of southern fish species to south-west England linked to warming of the North Atlantic (1960-2001). *Journal of the Marine Biological Association of the United Kingdom* 82. p. 177-180.

Stive, M.J., de Schipper, M.A., Luijendijk, A.P., Aarninkhof, S.G., van Gelder-Maas, C., de Vries, J.S.V.T., de Vries, S., Henriquez, M., Marx, S. & Ranasinghe, R. (2013). A new alternative to saving our beaches from sea-level rise: The sand engine. *Journal of Coastal Research* 29 (5), p. 1001-1008.

The Marineff project [online]. [Viewed: March 2020] Available at: http://marineff-project.eu/en/.

The Planning Inspectorate. (2019) *The Water Framework Directive Advice note eighteen: The Water Framework Directive*. Bristol: The Planning Inspectorate. p. 15. Available at: https://infrastructure.planninginspectorate.gov.uk/wp-content/uploads/2017/06/advice_note_18.pdf.

Thomsen, F. and Verfuß, T. (2019). Mitigating the effects of noise. Chapter 7 from Wildlife and Wind Farms, Conflicts and Solutions Vol.4 ed. Perrow, M.)

Tidal Lagoon Swansea Bay plc. (2014) *Environmental Statement, Chapter 23. Mitigation and Monitoring*. Cardiff: Tidal Lagoon Swansea Bay plc. p. 51. Available at: https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010049/EN010049-000345-6.2.23%20ES%20Mitigation%20and%20Monitoring.pdf.

Treweek Environmental Consultants. (2010) Severn Tidal Power Equal Value Investigation. Cullompton: Treweek Environmental Consultants. p. 104.

UK Marine Monitoring and Assessment Strategy Community (UKMMAS). (2010) *Charting Progress 2 Feeder report: Healthy and Biological Diverse Seas Feeder report*. Published by Department for Environment Food and Rural Affairs on behalf of UKMMAS. p. 682.

Van der Meulen. (2016) Environmental Compensation for Port Extension: The Case of Rotterdam Harbour and Nature Compensation, Policy and Practice. *Journal of Renewable Energy and Sustainable Development*. 2 (2). p. 147-153.

Vattenfall. (2020) Norfolk Vanguard Offshore Wind Farm, Habitats Regulations: Derogation, Provision of Evidence - Appendix 2 Alde-Ore Estuary SPA In Principle Compensation Measures for lesser black-backed gull.

Waggitt, J.J., Evans, P.G.H., Andrade, J., Banks, A.N., Boisseau, O., Bolton, M., Bradbury, G., Brereton, T., Camphuysen, C.J., Durinck, J. & Felce, T. (2020) Distribution maps of cetacean and seabird populations in the North-East Atlantic. *Journal of Applied Ecology*. 57. p. 253-269.

Wakefield, E.D., Owen, E., Baer, J., Carroll, M.J., Daunt, F., Dodd, S.G., Green, J.A., Guilford, T., Mavor, R.A., Miller, P.I. & Newell, M.A. (2017) Breeding density, fine-scale tracking, and large-scale modeling reveal the regional distribution of four seabird species. *Ecological Applications*. 27 (7). p. 2074-2091.

Welsh Government. (2017) Welsh National Marine Plan – Habitats Regulation Assessment.

Welsh Government. (2018) *Marine Protected Area Network Management Framework for Wales 2018–2023* [Viewed: March 2020]. Cardiff: Welsh Government. Report by Marine Protected Area Management Steering Group. p. 61. Available at: https://gov.wales/sites/default/files/publications/2018-09/marine-protected-areas-network-management-framework-for-wales-2018-2023.pdf.

Welsh Government. (2019) *Designating a Strategic Development Plan Boundary and Establishing a Strategic Planning Panel (SPP)*. Cardiff: Welsh Government. p. 12.

Wilson, S.M., Raby, G.D., Burnett, N.J., Hinch, S.G. and Cooke, S.J. (2014) Looking beyond the mortality of bycatch: sublethal effects of incidental capture on marine animals. Biological Conservation. 171. p .61-72.

YouTube. (2018) *The Green Port Hull Fish Mitigation Project* [online]. [Viewed: February 2018] Available at: https://www.youtube.com/watch?v=T67obuJ2674.

9 Abbreviations

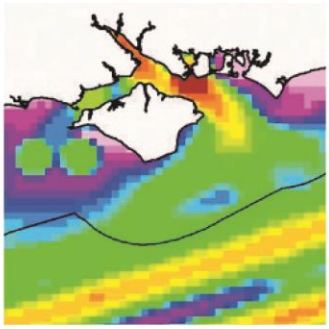
ADD	Acoustic Deterrent Devices
AMEP	Able Marine Energy Park
AONB	Area of Outstanding Natural Beauty
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas
BMAPA	British Marine Aggregate Producers Association
BPEO	Best Practicable Environmental Option
CIEEM	Charted Institute of Ecology and Environmental Management
CPO	Compulsory Purchase Order
CRMP	Coastal Risk management Programmes
CS	Coastal Squeeze
DCO	Development Consent Order
DCP	Development Control Practice
DEFRA	Department for Environment, Food & Rural Affairs
DNS	Developments of National Significance
EC	European Commission
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EMF	Electric and Magnetic Forces
EMS	European Marine Site
EPS	European Protected Sites
ES	Environmental Statement
FCRM	Flood and Coastal Risk Management
FCS	Favourable Conservation Status
GES	Good Environmental Status
HRA	Habitat Regulation Assessment
IEMA	Institute of Environmental Management and Assessment
IFCA	Inshore Fisheries Conservation Agency
INNS	Invasive Non-Native Species
IPENS	Improvement Programme for England's Natura 2000 Sites
IROPI	Imperative Reasons of Overriding Public Interest
JNCC	Joint Nature Conservation Committee
MCA	Maritime and Coastguard Agency
MCAA	Marine and Coastal Access Act
MCS	Marine Conservation Society
MCZ	Marine Conservation Zones
META	Marine Energy Test Area
MHWS	Mean High Water Springs
MMO	Marine Management Organisation
MOD	Ministry of Defence
MPA	Marine Protected Area
MR	Managed Realignment
MRE	Marine Renewable Energy
MSFD	Marine Strategy Framework Directive
NAI	No Active Intervention
NCC	Natural Capital Committee
NDF	National Development Framework
NERC	Natural Environment and Rural Communities

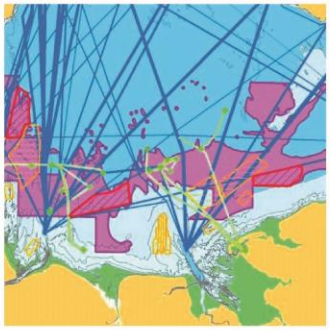
NGO	Non-Governmental Organization
NHCP	National Habitat Creation Programme
NMPF	National Marine Planning Framework
NNRP	National Natural Resource Policy
NRW	Natural Resources Wales
NSIP	Nationally Significant Infrastructure Projects
OWF	Offshore Wind Farm
PAM	Passive Acoustic Monitoring
PIANC	World Association for Waterborne Transport Infrastructure
PPW	Planning Policy Wales
PROW	Public Rights Of Way
RSPB	Royal Society for the Protection of Birds
RTE	Regulated Tidal Exchange
RUK	RenewableUK
RYA	Royal Yachting Association
SAC	Special Area of Conservation
SEA	Strategic Environmental Assessment
SETP	Severn Estuary Tidal Power
SLR	Sea Level Rise
SMNR	Sustainable Management of Natural Resources
SMP	Shoreline Management Plan
SPA	Special Protection Areas
SSC	Suspended Sediment Concentration
SSSI	Sites of Special Scientific Interest
SWW	Surface Water and Wastewater
TAP	Thematic Action Plan
TBPC	The Bristol Port Company
UKHMA	United Kingdom Harbour Masters' Association
UN	United Nations
WACA	Wildlife and Countryside Act
WFD	Water Framework Directive
WNMP	Welsh National Marine Plan
ZOI	Zone of Influence

Cardinal points/directions are used unless otherwise stated.

SI units are used unless otherwise stated.

Appendices




Innovative Thinking - Sustainable Solutions

ABP mer

A Stakeholder Engagement - Questionnaire

A.1 Online questionnaire - English

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A.2 Online questionnaire - Welsh

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B Stakeholder Engagement - Organisations

Table B1. Organisations contacted to fill in the online questionnaire

Organisation
Aquafish Solutions Ltd
Aquatera Ltd
ARUP
Atkins
Bangor University (SEACAMS 2)
Blue-C-Ecology
British Marine
British Marine Aggregate Producers Association (BMAPA)
British Ports Association (BPA)
Cadw
Dee Conservancy
Defra
Devon and Severn Inshore Fisheries Conservation Agency (IFCA)
DTA Ecology
Environment Agency
Environmental Resources Management (ERM)
European Subsea Cables Association (ESCA)
GoBe
Gwynedd Archaeological Trust
Hartley Anderson Ltd
Howell Marine Consulting
Jacobs
Marine Conservation Society (MCS)
Marine Energy Wales
Marine Management Organisation (MMO)
Marine Scotland
MarineSpace
Maritime and Coastguard Agency (MCA)
McArthur Green
Ministry of Defence (MoD)
National Trust
Natural England
Natural Resources Wales (NRW)
Oil and Gas UK (OGUK)
RenewableUK (RUK)
Royal Commission on the Ancient and Historical Monuments of Wales
Royal Haskoning DHV
Royal Society for the Protection of Birds (RSPB)
Royal Yachting Association (RYA)

Organisation
RPS Group
RSK Environment Ltd
Seabed User & Developer Group (SUDG)
SeaWatch Foundation
Severn Estuary Partnership
Shellfish Association of Great Britain
Swansea University (SEACAMS 2)
The Crown Estate (TCE)
Thomson Ecology
Trinity House
UK Chamber of Shipping
United Kingdom Harbour Masters' Association (UKHMA)
United Kingdom Major Ports Group (UKMPG)
Wales Environment Link
Water UK
Welsh Fisherman's Association
Welsh Government
Welsh Local Government Association (WLGA)
Welsh Ports Group
Whale and Dolphin Conservation Society
Wildlife Trust
Wood Plc
World Wildlife Fund (WWF)
Xodus Group

C Stakeholder Responses

In total, 94 individuals from 63 organisations were sent an invite to the survey (see Appendix B for list of organisations). 27 responses were received from 24 organisations. Six of the respondents did not complete the questionnaire beyond the privacy notice and/or the introductory/profile questions, and as such only 21 responses were received and have been analysed below. Providing contact details was optional, therefore, multiple responses per organisation could only be identified from the 14 responses that provided. One NGO provided a pooled response from amongst the multiple employees contacted.

The second question in the survey (after the privacy notice question) sought to profile the respondents, with chosen answers shown in Table C1 (see Appendix A for questionnaire). Multiple answers from each respondent was possible, therefore, some respondents specified a mixture of roles/organisations they worked for. Employees from government bodies were the most numerous respondents, with nine responses, followed by consultancies, NGOs, industry bodies and developers. Six participants did not specify who they worked for/what their role was.

Table C1. Respondent organisation

Organisation Category	Count
Consultancy	4
Developer (person who applies for permissions for developments)	1
Government body (licensing/regulatory advice/programme lead/implementer)	9
Industry body	2
NGO	2
NGO & developer	1
Wider stakeholder/consultee	1
Not specified	1

The third question related to the sectors which were relevant to the respondents. Again, multiple responses were possible and indeed 112 options were selected amongst the 21 participants, approximately 5 per person. As shown in Table C2, the most frequently chosen category was 'renewable energy', followed by 'coastal development/infrastructure', 'environmental management' and 'ports and shipping'.

Table C2. Respondent sector

Marine Sector Category	Count
Aggregates	9
Aquaculture	4
Coastal development/infrastructure including coastal defence	13
Defence (military)	3
Dredging and disposal	10
Environmental management	12
Fisheries	3
Oil and gas	4
Ports and Shipping	11
Renewable Energy	14
Subsea Cabling	10
Surface water and wastewater treatment	4
Tourism and recreation	6
All	6
Other (government programme lead)	1
No answer	5

The fourth question related to the main challenges faced when identifying and securing compensatory measures. Results are summarised in Table C3, noting that respondents were able to choose up to five options.

Table C3. Main challenges when identifying and securing compensatory measures

Answer Choice	Count
Reaching agreement on compensation packages	14
Delivering like for like	12
Certainty of effectiveness	10
Timing issues	8
Understanding cumulative effects	7
Cost	7
Land availability/competition	6
Scarcity of evidence leading to an increase in compensatory requirements	6
Additionality – the provision of measures that are additional to normal practice under the Habitats and Birds Directives	5
Reaching agreement on monitoring arrangements	4
Sign off of delivery of compensation measures	3
Incorporation into Natura 2000 network	1
Other	9

Abridged clarifying answers regarding 'other' (noting that these have also been anonymised to reduce the likelihood of identification):

- Restraints are **more far reaching** in the reality of compensation provision in Wales. The **conflict of current legislation** is paramount in affecting the cost and difficulty of achieving a managed realignment [e.g. Electricity Act or PROW legislation may trump other statutory drivers for providing habitat offset]. Sites which provide the best opportunities for provision of compensation habitat are mainly but not exclusively agricultural. The loss and change in land use may be **at odds with the vision of Farmer Unions and land owners**. Most sites have **extensive electricity and other services** - so the although not prohibitive - add to the cost of compensation provision. **Internal Drainage responsibilities of NRW may be at odds** with developing sites through coastal transition either through managed realignment or no active intervention process. **Archaeological and historical features** are often within the flood plain of coastal adaptation target areas. **Multiple land ownership** requires NRW to negotiate a Rights To Flood agreement with a large number of proprietors. Hence a site may face **negative NRW and Welsh Government reputational risk** when CPO route is used for those unwilling to negotiate in coastal adaption projects when the five case business assessment concludes managed realignment or retreat scenarios. These and **other restraints (landscape, road infrastructure** etc. etc.) may not prevent habitat creation through coastal adaptation and transition - BUT it will make the process slower and more expensive to resolve.
- Determining **how to provide compensation for species loss.**
- The **lack of a strategic/joint up approach to compensation** which acknowledges that many developments contribute in varying degrees to the magnitude of the in-combination impact which needs to be compensated for - given that the implementation of certain measures may practically be best delivered in a strategic way rather than piecemeal by individual developers as each case goes through planning.
- The **uncertainty that surrounds compensation discussions** - most notably getting any agreement from regulators what would be acceptable.
- The **move towards 'net gain' or biodiversity enhancement** as it is being described by Welsh Government [and how this] may change this [approach], but as yet there is not direct link to true marine (offshore) activities.
- The **fishing industry** in Wales [...] has **never had any discussion/experience/engagement** in relation to compensatory measures.
- The **process by which DCO considers compensatory measures**.
- Most of the above are relevant– to some extent the selection of just 5 is arbitrary. Note, we are not sure that 'like for like' is a particularly helpful term. The **key test is whether compensation will meet the ecological requirements of the affected Natura 2000 feature(s) and thereby maintain the ecological coherence of the network of sites**. The challenge is **identifying practical, deliverable and effective measures that will achieve that objective.**
- **Quantifying the damage and agreeing the conclusions of that.**

This question was answered by all bar one of the respondents (i.e. n=20), with respondents choosing 4.6 options on average. 'Reaching agreement on compensation packages' ranked highest of all of the aspects. Three of the nine 'other' responses were also related to this, for example one NGO noted that '*the challenge therefore is identifying practical, deliverable and effective measures*' that will achieve

the objective of maintaining the ecological coherence of the network of Natura 2000 sites. 'Delivering like for like', 'certainty of effectiveness', 'timing issues' and 'costs' also received many votes. Nine respondents also ticked 'other', with clarifying answers ranging widely, from legislative conflicts to uncertainty around the role of net gain, as well as compensation having to date not been applicable for certain industries, notably fishing and aggregates (with the latter industry having developed many mitigation strategies; and not dredging where compensation would be triggered).

The subsequent four questions focused on feasible compensation measures for the four receptor groups which were the focus of the survey, namely: (marine) habitats, birds, fish and mammals. Firstly, Table C4 displays the survey results for habitats.

Table C4. Feasible compensation measures for marine habitats

Potential habitat compensation measures (I = intertidal, S = subtidal)?	Answer Choice		
	Yes	No	Don't know
Managed realignment (I)	14	0	2
Regulated tidal exchange (I)	6	2	5
Beneficial use/sediment placement (I & S)	13	0	3
Biodiversity improvement/uplift of existing habitats (I)	8	3	5
Pressure reduction (e.g. bait digging) (I)	5	4	6
Designate additional habitat (I & S)	9	3	3
Infrastructure enhancement (S)	5	1	8
Subtidal habitat recreation/restoration – e.g. seagrass (S)	14	0	2
Reduction/removal of existing pressure (e.g. seagrass swing moorings) (S)	9	1	6
Other/missing:	6		

Abridged clarifying answers regarding 'other'/missing measures (noting that these have also been anonymised to reduce the likelihood of identification):

- A key missing measure is that of **enforcing a no active intervention (NAI)** of [government] assets. Coupled with a right to flood agreement and through full consultation, whilst mitigating/managing flood detriment and impacts on distribution network/road infrastructure etc. (costs shared with 3rd parties when appropriate), and also clearly matching habitat conservation objectives. [Thus,] compensation habitat can be created as part of a process of managing assets and delivering adaptation and transition on the coast in vulnerable areas.
- A possible measure may be around **enforcement/restriction of access around some developments/infrastructure**- i.e. *de-facto* reserves (e.g. MOD sites, offshore wind sites).

Abridged answers focussing on complexities involved in compensation, rather than proposing 'missing' measures:

- These are just environmental compensation measures as opposed to replacing recreational opportunities, loss of access, economic opportunities, cultural heritage. If that is the focus of the study then it's fine, but it would be worth considering marine developments in a more holistic manner if this is to inform all marine licencing. **There are too many…. 'it depends on'**…. to be able to answer these questions [type of habitat, scale, replicability, ecosystem services, experience/technological feasibility].
- **Difficult to answer the above**, because the application of each will depend on the local circumstances. All may or may not therefore be relevant. A key question (which relates back to the net gain/enhancement question) is **whether compensation has to be like for like necessarily**? Can greater value/benefit be delivered by doing something different - either in isolation, or by contributing to a **wider programme**. Objective should be to ensure you get the biggest benefit for the investment that is being made - albeit it is recognised this **will depend on the legal constraints** you may have to work within. Data/evidence in an offshore setting is the key weakness - so monitoring of existing sites could be considered an option to ensure there is a better understanding of feature extent/status.
- A number of the above should be implemented as part of the Habitats Directive in meeting Favourable Conservation Status, rather than as compensation. **Need to prove additionality rather than measures just delivering improvement.** [measure also proposed by this respondent, hence there being 7 bullets in total]
- All these measures have so many variables that will determine their success, it is very difficult to say what can and cannot work, and whether the type of compensation offered will be sufficient to address loss of/to the feature in question. This is especially true in the marine environment, where there may be a significant lag between loss of/to feature(s) and development, establishment, and overall success of a measures. In addition, some of these measures are not yet well tested (e.g. trials for oyster and seagrass restoration in Wales are still being undertaken) meaning we may not be able to rely on these measures as suitable compensation until their success has been better established.
- Have ticked YES above because the question has been framed as 'in principle'. **In reality what can be used now with certainty is much more constrained**. Any list of 'in principle' measures for possible future consideration would need to be assessed against multiple criteria in terms of availability of a robust evidence base, how likely it is to be

Potential habitat compensation measures (I = intertidal, S = subtidal)?	Answer Choice		
	Yes	No	Don't know
achievable and whether it will meet the compensation objective of maintaining ecological coherence of the Natura 2000 network. Whether an individual measure is 'in principle' a possible compensation for a specific development is a different issue to whether or not a measure might in principle be applied. It must also be noted that delivering and maintaining some types of intertidal habitat is much more **challenging** than others [..., and] also highly location specific. Application of compensation to the sub-tidal environment is even more challenging. Finally, reference to "improvement" and "enhancement" of existing habitats must take full account of the need to demonstrate **additionality** to other requirements to maintain or restore habitats to favourable conservation status.			

This question was answered by 16 out of 22 respondents. In summary, 'managed realignment' and 'beneficial use' where considered the most feasible measures for intertidal habitats. The designation of additional habitat also received many 'yes' votes, for both intertidal and subtidal elements. For subtidal habitats, 'biogenic habitat creation (oyster, seagrass, reefs)' obtained the most 'yes' votes, as did the reduction of existing pressures.

There was, however, some uncertainty over several of the measures, for both intertidal and subtidal measures, as evidenced by the several 'I don't know' answers, particularly in relation to 'infrastructure enhancement' and 'intertidal pressure reduction'. The latter also received the most 'no' votes, followed by biodiversity improvement/uplift, and the designation of additional habitat. Six respondents noted that there were 'missing' measures by checking the relevant box in the questionnaire. Most of these respondents highlighted a myriad of complexities related to the provision of habitat compensation, rather than listing missing measures. Complexities highlighted included the fact that (as one NGO stated) '*whether an individual measure is 'in principle' a possible compensation for a specific development is a different issue to whether or not a measure might in principle be applied*'. Additional measures identified through the 'missing' question, included the enforcement of (Shoreline Management Plan (SMP)) no active intervention (NAI) and the implementation of de-facto reserves around some new infrastructure, such as offshore wind parks or MOD sites.

Table C5 displays the survey results for feasible bird compensation measures. This question was answered by 15 out of 22 respondents. In summary, all but two of the listed measures received 10 or more 'yes votes', with 'intertidal habitat creation' and the 'creation of roosting and nesting sites/features' ranking the highest. '

Wardening/awareness/disturbance reduction' received almost as many 'no' votes as 'yes' votes, indicating that this could be a relatively controversial bird compensatory measure. The designation of additional sites received a particularly high number of 'no' votes, with several respondents utilising a textbox to elaborate on reasons for this. For example, one NGO clarified that

> *'the rationale for selection of SPA is different to that for SAC. For SPA, any site that exceeds the qualifying threshold should be SPA. This is because all 'most suitable territories' are required to be classified as SPAs. This contrasts with SACs which were selected on the basis of 'representativity' of suitable qualifying habitat (...).'*

Some respondents also noted that, for SPAs, many of the listed measures are not additional, or may be classed as mitigation. With regard to additional measures identified through the 'missing' question, only one measure which had not effectively been included in the list of measures was highlighted, namely the implementation of de-facto reserves around some new infrastructure (such as offshore wind sites) by enforcement/restriction of access.

Table C5. Feasible compensation measures for marine birds

Potential Bird Compensation Measures	Answer Choice		
	Yes	No	Don't Know
Intertidal habitat creation/restoration	14	0	1
Enhancement of existing sites – e.g. predator control, habitat management, shingle placement	11	3	1
Wardening/awareness/disturbance reduction	7	5	2
Artificial nesting (e.g. Terns/Kittiwake)	14	0	0
Creation of roost sites/features	13	0	1
Reduce or remove pressure from fisheries by-catch (long-lines, nets)	10	3	2
Reduce or remove pressure on sea bird prey resources (e.g. reduction in commercial fishing pressure)	11	3	1
Designate additional sites	3	6	3
Other/missing	6		

Abridged clarifying answers regarding 'other'/missing measures (noting that these have also been anonymised to reduce the likelihood of identification):

- **Creating other habitat features** (Annex 1 Features such as intertidal mud and sand and saltmarsh) may also create large scale wetland areas. Most sites will create these wetlands that will persist for many years. […] The value of wetlands in the short-term are demonstrated by the managed realignment at Cwm Ivy Marsh undertaken by NRW in collaboration and partnership with the National Trust in 2015.
- Improving nesting, roosting and foraging habitats for birds (e.g. alternative nesting sites away from disturbance). A possible measure may be around enforcement/restriction of access around some developments/infrastructure- i.e. *de-facto* reserves.

Abridged answers focussing on complexities involved in compensation, rather than proposing 'missing' measures:

- A number of the measures (such as removing pressures) would be **considered to be mitigation measures (i.e. reducing or removing the pressure) not compensation.**
- Goes back to the direct/indirect nature of compensation - **all may/may not be applicable, depending on the application under the legal structures/restrictions in place**. The more flexible you can be, the more options that will be available.
- A number of the above should be implemented as **part of the Habitats Directive in meeting Favourable Conservation Status, or are mitigation** rather than compensation. Need to prove additionality rather than just delivering improvement. [measure also proposed by this respondent, hence there being 7 bullets in total].
- **All these measures have so many variables that will determine their success, it is very difficult to say what can and cannot work**, and whether the type of compensation offered will be sufficient to address loss of/to the feature in question […]. There are **complexities around designating additional sites for mobile species**, given population thresholds required to achieve designated status.
- Our **comments under [previous] question in respect of "in principle" and "additionality" apply equally here**. We have said no in relation to designation as a possible measure for birds on the basis that the rationale for selection of SPA is different to that for SAC. **For SPA, any site that exceeds the qualifying threshold should be SPA**. This is because all "most suitable territories" are required to be classified as SPAs. This contrasts with SACs which were selected on the basis of "representativity" of suitable qualifying habitat: therefore it is possible undesignated areas of SAC quality may be available for designation. Therefore there should not 'in principle' be sites of SPA quality that are not notified and therefore capable of being substituted in the series.

Table C6 displays the survey results for feasible fish compensation measures. This question was answered by 15 out of 22 respondents. In summary, there was a considerable amount of uncertainty with regard to options for this receptor, with all the measures receiving 'yes', 'no' and 'don't know' 'votes'. 'Improvements to spawning habitat', 'reduction/removal of existing pressure' and 'removing/reducing barriers to migration' were given the most 'yes' votes, but all also received at least one 'no' vote and several 'don't know' votes. Again, the designation of additional sites appeared to be the most 'controversial', with three 'yes', five 'no' and six 'don't know' votes. The textbox option was for this question only utilised to discuss complexities, with no 'missing'/additional measures proposed. Several respondents noted that most of the options would generally be viewed as mitigation, with some debating complexities around designating additional sites for mobile species.

Table C6. Feasible compensation measures for marine fish

Potential Fish Compensation Measures	Answer Choice		
	Yes	No	Don't Know
Stock enhancement	5	3	7
Removing/reducing barriers to migration	9	2	4
Improvements to spawning habitat	10	1	4
Reduction/removal of existing pressure e.g. reduction in fishing effort	9	3	3
Water quality improvement/pollution reduction measures	7	3	5
Designate additional sites	3	5	6
Other/missing	6		

Abridged clarifying answers regarding 'other'/missing measures (noting that these have also been anonymised to reduce the likelihood of identification):

- [none]

Answers focussing on complexities involved in compensation, rather than proposing 'missing' measures:

- **Designating additional sites should not be considered as an equal value compensation measure** - but rather the **impact should be managed through mitigation and design features** to avoid detriment to pelagic and demersal fish - with particular emphasis on avoiding a barrier to migration and spawning.
- **Most of these measures would be mitigation not compensation** so would be considered before the compensation stage.
- **There are too many.... 'it depends on'**.... to be able to answer these questions [type of impact, scale, replaceability]. Why we aren't doing all these 'compensatory actions' anyway given the climate and nature emergencies? **You'd really want compensatory action to go above and beyond all reasonable measures of ecosystem based management**.
- Not able to comment directly - but **same principles apply [all may/may not be applicable, depending on the application under the legal structures/restrictions in place.** The more flexible you can be, the more options that will be available.].
- **Most of these proposals are mitigation or improvement/management rather than compensation**. - Fishing pressure/water pollution etc. form part of existing environmental improvement requirements and so do not provide additionality.
- **All these measures have so many variables that will determine their success, it is very difficult to say what can and cannot work**, and whether the type of/to compensation offered will be sufficient to address loss of the feature in question [...]. There are **complexities around designating additional sites for mobile species**, given population thresholds required to achieve designated status.

Table C7 displays the survey results for feasible marine mammal compensation measures. This question was answered by 15 out of 22 respondents. In summary, there again appeared to be a considerable amount of uncertainty with regards to options for this receptor, particularly with regard to otters, which are classed as marine mammals in Wales. For other marine mammals, the reduction of pressure on the prey resource was given the most 'yes' votes, followed by the reduction of pressure though fisheries by-catch and lastly the 'wardening of seal haul out/breeding sites'. All three of these measures received a fair amount of 'no' and 'don't know' votes, chiefly the wardening. One measure was identified through the 'missing' question, namely the reduction of other pressures on marine mammals, e.g. in relation to underwater noise from oil and gas exploration or collision risk from commercial shipping. Several respondents highlighted in the textbox that many of the measures generally constituted mitigation rather than compensation and that some, such as by-catch, were measures government needed to implement anyway.

Table C7. Feasible compensation measures for marine mammals

Potential Mammal Compensation Measures	Answer Choice		
	Yes	No	Don't Know
Construction of artificial holts for otters	7	0	7
Installation of viaducts, underpasses or bridge ledges for otters	7	1	7
Creation or restoration of otter habitats	7	0	7
Wardening of breeding/haul-out sites for seals	5	3	6
Reduce or remove pressure on fisheries by-catch	9	2	4
Reduce or remove pressure on marine mammal prey resources (e.g. reduction in commercial fishing pressure)	10	2	3

Potential Mammal Compensation Measures	Answer Choice		
	Yes	No	Don't Know
Other/missing	5		
Abridged clarifying answers regarding 'other'/missing measures (noting that these have also been anonymised to reduce the likelihood of identification): ▪ **Removal of additional pressures for marine mammals** such as underwater noise from oil and gas exploration or collision risk from commercial shipping. Answers focussing on complexities involved in compensation, rather than proposing 'missing' measures: ▪ Again, I **would view these measures as mitigation not compensation**. Mitigation measures would be applied as part of the European Protected Species licence. ▪ **There are too many.... 'it depends on'**.... to be able to answer these questions [species, scale, sensitivity of behaviour/location (e.g. haul out)]. **Some** of these 'compensatory measures' the **government are required to deliver anyway**, such as by-catch reduction - so having them as compensation for development is a bit disingenuous. This question also doesn't speak to the **social justice implications of some users** e.g. energy power plants, using a reduction in other users access e.g. reducing fishing pressure, to compensate. It **assumes that we have the information, experience and technology to successfully deliver** these compensatory actions - which often in the marine environment we don't. ▪ Ditto **[all may/may not be applicable, depending on the application under the legal structures/restrictions in place**. The more flexible you can be, the more options that will be available.]. ▪ Again, **more mitigation and management than compensation**. ▪ The **last three measures**, again, I have **accepted these only in principle** as compensation measures given the varying factors that would determine their success and also whether they would be suitable to compensate for the loss incurred to the N2K site in question (e.g. whether the site is used primarily for feeding, breeding, hauling, etc.). [measure also proposed by this respondent, hence there being 6 bullets in total].			

As one of the closing questions, respondents were asked about additional actions which they thought could be taken to achieve better environmental outcomes, given the documented continued decline in marine biodiversity. Out of 22 respondents, 10 provided answers on this question; these are summarised in Table 8. In total, 21 individual suggestions were made. Several respondents highlighted net gain as a possible solution, with one commenting that more information about benefits and risks were required, and that there would need to be support with funding and incentivisation. Another suggestion in relation to activities such as fishing was that subsidies could be made contingent on net gain actions being undertaken. Several respondents requested more government investment and/or strategic planning. Many other individual suggestions were made and are listed in Table C8.

Table C8. Additional actions proposed to achieve better environmental outcomes

Respondent Group	Answer [Slightly Abridged and Anonymised]
Consultancy	▪ Understanding how **net gain** can be achieved in the marine environment through new or existing regulatory process is going to be critical to achieving better environmental outcomes
Consultancy	▪ **More investment in marine protection & delivery** against existing legislation to reach, maintain or improve upon Favourable Conservation Status/Good Ecological Status. ▪ **Decline consent for developments that cannot avoid environmental degradation.** ▪ **Better consideration of cumulative effect**.
Government body	▪ Currently Welsh Government are managing the impact [actions taken by] risk management authorities, only for plans and projects in hold-the-line [SMP] policy areas (for which the IROPI is based). Therefore, the **need for strategic habitat offset provision by private flood asset owners** (e.g. Network Rail) **needs to be encouraged and enforced** (political pressure beyond marine licence control). ▪ Additionally, NAI and MR policy areas [**where assets are privately maintained** may still be subject to] **coastal squeeze, directly effecting European Protected sites**. This is because [of] socio-economic drivers for continued land use - particularly for agriculture. There is currently no Welsh Government Programme to manage and deliver this offset [...]. There is scope for delivering mitigation outcomes through habitat creation in large scale coastal adaptation schemes but this **requires additional funding commitments**[..]. ▪ Funding currently earmarked for match (funding) of risk management **authority Coastal Risk management Programmes (CRMP) cannot be used for coastal adaption projects where there is a low threshold of people and properties at risk**. This places a priority away from habitat and

Respondent Group	Answer [Slightly Abridged and Anonymised]
	conservation compliance yet this is also a statutory requirement in the Marine Licence process and Habitat Regulations. Therefore [...] **this should be re-evaluated.**
Government body	▪ Measures which **reinstate/restore natural geomorphological functioning** (i.e. erosion, transportation and deposition of sediment in the coastal, estuarine and marine environments) where these have historically been inhibited should be prioritised. There is a growing body of evidence which demonstrates that systems which are free to function naturally and adapt to natural functioning provide multiple benefits and offer greater long term sustainability than more artificial measures.
Government body	▪ Given the changes planned to the subsidies offered to landowners to move towards an approach focussed on public money for public goods, perhaps something similar is needed in the marine environment. So, any **subsidies from the public purse** e.g. subsidised red diesel for fishing boats, subsidies for renewable energy developments **are made contingent on delivery of net environmental gain** (quite apart from the role of the latter sector in reducing C emissions). The more measures that are put in place to deliver environmental gain – e.g. measures to reduce accidental by catch of seabirds and marine mammals - the greater is the subsidy offered. Activities that cause significant environmental damage receive no subsidy at all.
Government body	▪ **No take zones** to allow marine biodiversity to recover.
Government body	▪ We need to find ways to **take every opportunity to deliver nature based solutions/ecological enhancement** - can be considered in relation to any investment/installation but need more information about benefits and risks, and **need support with funding and incentivisation**.
Industry body	▪ **Net gain.**
Industry body	▪ **More joined up thinking** - what needs to happen to deliver bigger/better outcomes for the environment as a whole - particularly against the backdrop of climate change. Is the fragmented, site-specific driven approach actually delivering the best outcomes for the marine environment as a whole? This requires **more flexible thinking - and also a clear plan** (with associated mechanisms) to work towards. For example, if the conclusion is that salt marsh creation around the Welsh coast can deliver the best 'bang of the buck' in terms of multiple outcome benefits, such as carbon storage, flood protection, habitat creation etc., you need a strategy in place that makes this clear, and a mechanism for all the various potential contributors to feed in.
NGO	▪ **Post-consent monitoring should be better enforced, monitored and regulated** to ensure compliance and to develop our collective understanding of whether different compensation measures are effective over a long time period. ▪ Principally, the overall ambition of developing compensatory measures should be to maintain the integrity of the N2K site. Where this can't realistically be achieved, we need to be having more honest conversations about what we are prepared to lose for the sake of development, given we are now waking up to the reality that we are facing a nature emergency.
NGO	▪ We are facing the twin crises of global biodiversity collapse and climate change. ▪ Marine planning and management must address these twin challenges and **take an integrated and holistic perspective to zoning and consenting of activities and to securing positive management** of marine biodiversity. ▪ This includes the **further designation of marine protected areas** and **instituting measures to safeguard their interest.** ▪ In a **Wales context, consenting of marine activities should consider the requirements of the Environment (Wales) Act to achieve sustainable management of natural resource**. ▪ **Marine birds across the UK are struggling more than any other bird group**. Recent evidence provided under the Marine Strategy Consultation showed that marine birds will fail to achieve Good Environmental Status (GES) by 2020. Across all indicators measures, marine birds are also the only indicator in continued decline compared to 2012. If we are to achieve better environmental outcomes, the recovery of our marine bird populations remains key. **Some of the measures suggested in the questionnaire require underpinning with targeted research**. There is a pressing need to better understand the **impact of fishing activities** as well as **climate change on populations of forage fish** on which the recovery of these seabird depends. An understanding of the trends on forage fish should ultimately **inform the future protection of foraging areas, as complementary to breeding sites**, where needed.
NGO and developer	▪ **All the 'compensatory' actions listed should be part of the UK Marine Strategy delivery achieve good environmental services.** We shouldn't be in a place where these actions only happen to offset damage.

The last content question of the survey was an open-ended question asking whether respondents had any other comments regarding compensation in the marine environment. Answers, shown in Table C9, were very varied with few common themes beyond several respondents again caveating that many of the measures listed in the questionnaire would be considered mitigation, and not compensation, in Birds and Habitats Directives terms, and that the latter would require stringent interpretation of what can be undertaken.

Table C9. Additional (closing) comments on compensation in the marine environment

Respondent Group	Answer [Mostly Un-abridged, but Anonymised] (
Government body	The National Habitat Creation Programme (**NHCP) is Welsh Government's programme for provision of coastal compensatory measures in Wales** to provide environmental offset for coastal plans and projects relating to Risk Management Authorities. The role of NHCP is closely aligned to supporting compliance with the" Well-being of Future Generations Act" and the "Environment (Wales) Act" through the provision of nature-based solutions to coastal transition and adaptation. This is an emerging theme and emphasis within the Public Service Board "Place Plans", the National Strategy and the Marine Area Statement in the context of coastal zone management. Therefore, the NHCP also serves to support Welsh Governments Natural Resources Policy; reflected in the National Flood Risk Management Strategy, the Flood and Coastal Risk Management's (FCRM) Thematic Action Plan (TAP) and the Priority Implementation Plans (PIPs). Through a complex process of appraisal, planning and project delivery, the **NHCP addresses the requirements for managing the integrity of the Natura 2000 and achieving good environmental quality relating to the "Habitats" and "Water Framework" Directives.** In the context of coastal adaptation this translates not only to provision of compensatory habitat creation but much wider benefits of well-being and socio-economic value through either phased or more immediate coastal transition. **Opportunities for creating compensatory habitat is closely aligned to adaptation plans** associated with changing priorities of NRW's flood risk management assets (including asset maintenance withdrawal) in coastal areas that are distant from priority hold-the-line policy areas. NHCP is therefore facilitating implementation of the Shoreline Management Plan (SMP2) through planning and translating phased or more immediate transition of the coast while managing flood risk implications to land, infrastructure and services etc. The **NHCP continues to appraise sites for coastal transition**, and (when appropriate) engage with landowners, local authorities, service providers and stakeholders. Through the process of Flood Risk Management governance and close communication with Welsh Government these options for coastal transition can be aligned to priorities for coastal management and change. The pace of delivery can reflect the availability of grant-in-aid-funding and the needs of the Natura 2000 for habitat-offset resulting from plans and projects. Also responding to the needs for sustainable management of FCRMs coastal assets. Notably the pace of delivery must allow for the timeframe of project delivery at a site level (e.g. 3-10 years) and the time-lag for subsequent habitat creation which can take many years to establish and replace the Annex 1 habitat features lost through coastal squeeze.
Government body	It is likely that the **degree of uncertainty around the effectiveness of proposed compensation measures** in the marine environment will be **even greater** than in the terrestrial environment. That poses a **dilemma** because in theory a high degree of uncertainty should preclude Article 6(4) tests being passed and so consents should be refused. However, given the societal and political appetite to deliver Net 0 targets it **must be expected that many renewable energy developments will be consented one way or another**. There is therefore a **risk that focussing on the uncertainties** - particularly associated with very ambitious ideas around compensation measures e.g. fisheries closures **may mean that such potentially big win compensation measures are not considered** and we end up with consents being granted linked to small scale unambitious but perhaps more certain compensation packages. There is probably going to be a balance to be struck between agreeing to small-scale relatively certain compensation packages and large scale ambitious but uncertain measures. There **is an argument that there should be a halt to consenting decisions for renewables until such time as the evidence base around potential compensation measures that is needed to inform decisions is fully worked up**. There is a risk that precedents will be set by now by imminent consenting decisions linked to compensatory measures which are not well evidenced or thought through.
Government body	**Need to be clear about the difference between mitigation and compensation**. Mitigation measures would be considered at an earlier stage of HRA. If effects can be removed through mitigation, then compensation is not required.
NGO & developer	A requirement for existing developments to monitor and evaluate impact should be the first step in providing the evidence base that would underpin these types of discussions.
Industry body	Particularly in the marine environment there are huge opportunities to ensure that compensation makes a valuable contribution to the environment. We have been constrained by 'like for like' too long, with in the intertidal and potentially now in marine; we need to be more creative and look at **linking compensation with net gain**.

Respondent Group	Answer [Mostly Un-abridged, but Anonymised] (
Industry body	Almost goes without saying, but the offshore environment is a completely different game **data/evidence and activity pressure management** is arguably the most effective means to ensure improvements. Direct compensatory intervention is very complicated, very expensive and arguably unproven. [E.g. for marine aggregates], the policy direction [is] to avoid significant impacts in the first place, rather than relying upon restoration or compensation.
Government body	Most of the measures listed in the questionnaire could enhance the marine environment and contribute to ecosystem resilience BUT I **am most familiar with compensation in the relatively strict sense of the Habitats Directive which is perhaps more constrained in its approach, than might be intended here**. Major constraints to habitat creation at the coast arise from existing land use, public rights of way, major infrastructure e.g. railways (not devolved). This means that **we have very limited opportunities that are easy or cheap to deliver.**
Consultancy	In my opinion, it is **difficult to describe restoration of an existing habitat or species as compensation if the feature is already directly designated or set out as supporting an existing designated feature**. **Uplifting** existing habitat **or reducing pressure** that is already having an impact on a species **should be part of the existing management of that particular feature** rather than seen as compensation for further impact.
Consultancy	**Most measures seen in this questionnaire relate to feature management or mitigation rather than compensation**. Marine habitats and species rely upon suitable environmental conditions and so it is **difficult to engineer environmental compensation, particularly subtidal**.
NGO	We **note that the study is scoped to cover all drivers for compensation**. However, what might be acceptable will **depend on the legislative requirements** set out for any specific compensation regime e.g. whether it is a requirement of the Nature Directives or not. In a Wales context we suggest that consideration of compensation **should also consider the attributes that underpin ecosystem resilience as set out in the Environment (Wales) Act**. Some possible marine developments might be of such a scale as to require compensation outside Wales. For example, a draft policy in the Wales National Marine Plan supporting multiple tidal lagoons is likely to have required inter-tidal habitat creation outside Wales. Although this policy was withdrawn in the adopted Marine Plan **there is still an ambition within Welsh Government for tidal lagoon energy**. Using this as an example of possible marine consenting, **a pre-requisite for bringing forward such a policy would in our view be a strategic compensation study to identify the scale of compensation that might be required, the scientific evidence base, whether it was ecologically feasible, capable of being secured and successfully implemented in advance of any predicted damage**. This should look at the availability of inter-tidal habitat creation sites in Wales (under varying lagoon development scenarios) to establish an upper limit of what might be possible in Wales, together with a consideration of the potential outside Wales and what mechanisms would be necessary to achieve this.

D Habitats and Species

D.1 Environment (Wales) Act 201

The Environment (Wales) Act 2016 provides the legislative framework for the sustainable management of natural resources. Central to this is building resilience into natural systems and communities, in order to tackle the challenges faced now and into the future. The Act includes a provision for NRW to report on the current state of natural resources, ecosystems and the benefits they provide through the publication of a State of Natural Resources Report (SoNaRR). The SoNaRR highlights the condition and extent of Wales' natural resources, their ability to respond to pressures including climate change, and their ability to provide benefits for society (CCC, 2016).

The Act also requires Welsh Ministers to prepare a National Natural Resource Policy (NNRP) which will draw on the evidence from SoNaRR to set out the priorities for the sustainable management of natural resources at a national level. It will outline how the sustainable management of Wales' natural resources will provide benefits to society and the economy as well as the environment, supporting the goals outlined in the Wellbeing of Future Generations (Wales) Act (CCC, 2016).

Section 7 of the Act (Biodiversity lists and duty to take steps to maintain and enhance biodiversity) replaces the duty in Section 42 of the NERC Act 2006. It noted that priority lists for species and habitats would duly be published. Marine and coastal species and habitats have been extracted from the lists available on the Wales Biodiversity Partnership Website, and are listed in Table D1 and Table D2.

Table D1. Marine and coastal species listed as being of principal importance in Wales

Species	
Cnidaria	
Eunicella verrucosa	Pink sea-fan
Haliclystus auricula	A stalked jellyfish
Lucernariopsis campanulata	A stalked jellyfish
Coastal and marine Birds	
Anser albifrons subsp. flavirostris	Greenland greater Whitefronted Goose
Branta bernicula subsp. bernicula	Dark-bellied Brent Goose
Charadrius hiaticula	Ringed Plover
Cygnus columbianus subsp.	Bewick's Swan
Larus argentatus subsp. argenteus	Herring Gull
Larus ridibundus	Black-headed Gull
Limosa lapponica	Bar-tailed Godwit
Numenius arquata	Eurasian Curlew
Pluvialis apricaria	Golden Plover
Puffinus mauretanicus	Balearic Shearwater
Sterna dougallii	Roseate Tern
Vanellus	Northern Lapwing
Fish	
Alosa	Allis shad
Alosa fallax	Twaite shad
Ammodytes marinus	Sand-eel
Anguilla anguilla	European eel

Species	
Clupea harengus	Herring
Dipturus batis	Common skate
Gadus morhua	Cod
Galeorhinus galeus	Tope shark
Hippocampus guttulatus	Long snouted seahorse
Lamna nasus	Porbeagle shark
Lophius piscatorius	Sea monkfish
Merlangius merlangus	Whiting
Merluccius	European hake
Molva molva	Ling
Osmerus eperlanus	Smelt (Sparling)
Palinurus elephas	Crayfish, crawfish or spiny lobster
Petromyzon marinus	Sea lamprey
Pleuronectes platessa	Plaice
Prionace glauca	Blue shark
Raja brachyura	Blonde ray
Raja clavata	Thornback ray
Raja undulata	Undulate ray
Rostroraja alba	White or Bottlenosed skate
Salmo salar	Atlantic salmon
Salmo trutta	Brown/Sea trout
Salvelinus alpinus	Arctic char
Scomber scombrus	Mackerel
Solea solea	Sole
Squalus acanthias	Spiny dogfish
Squatina squatina	Angel shark
Trachurus trachurus	Horse mackerel
Invertebrates	
Alkmaria romijni	Tentacled lagoon worm
Arctica islandica	Icelandic cyprine or Oceanquahog
Atrina fragilis	Fan mussel
Edwardsia timida	Burrowing anemone
Ostrea edulis	Native oyster
Tenellia adspersa	Lagoon sea slug
Mammals and turtles	
Balaenoptera acutorostrata	Minke whale
Balaenoptera physalus	Fin whale
Caretta caretta	Loggerhead turtle
Cetorhinus maximus	Basking shark
Delphinus delphis	Common dolphin
Dermochelys coriacea	Leatherback turtle
Globicephala melas	Long-finned pilot whale
Grampus griseus	Risso's dolphin
Hyperodon ampullatus	Northern bottlenose whale
Lagenorhynchus acutus	Atlantic white-sided dolphin
Lagenorhynchus albirostris	White-beaked dolphin
Lutra lutra	Otter
Megaptera novaeangliae	Humpback whale
Orcinus orca	Killer whale

Species	
Phocoena phocoena	Harbour porpoise
Stenella coeruleoalba	Striped dolphin
Tursiops truncatus	Bottlenose dolphin
Ziphius cavirostris	Cuvier`s beaked whale
Plants	
Anotrichium barbatum	Bearded red seaweed
Cruoria cruoriaeformis	A red seaweed
Dermocorynus montagnei	A red seaweed
Lithothamnion corallinoides	Coral maerl
Padina pavonica	Peacock's tail
Phymatolithon calcareum	Common maerl

Table D2. Marine and coastal habitats listed as being of principal importance in Wales

Category	Habitat Name
Littoral Rock	Intertidal boulder communities
	Sabellaria alveolata reefs
	Estuarine rocky habitats
Littoral sediment	Intertidal boulder communities
	Intertidal mudflats
	Seagrass beds
	Sheltered muddy gravels
	Peat and clay exposures
Sublittoral rock	Coastal saltmarsh
	Fragile sponge & anthozoan communities on subtidal rocky habitats
	Carbonate reefs
Sublittoral sediment	Tidal swept channels
	Subtidal mixed muddy sediments
	Mud habitats in deep water
	Musculus discors beds
	Blue mussel beds
	Horse mussel beds
	Maerl beds
	Saline lagoons
	Subtidal sands and gravels
Supralittoral rock	Maritime cliff and slopes
Supralittoral sediment	Coastal sand dunes
	Coastal vegetated shingle

Mitigation Summary Spreadsheet

This report is also supported by an accompanying Microsoft Excel spreadsheet:

- Mitigation_Summary_25Mar2020.xls

Contact Us

ABPmer

Quayside Suite,
Medina Chambers
Town Quay, Southampton
SO14 2AQ

T +44 (0) 23 8071 1840
F +44 (0) 23 8071 1841
E enquiries@abpmer.co.uk

www.abpmer.co.uk