gwerth mewn gwahaniaeth
delivering on distinction

# Morlais Project

# Document MOR-RHDHV-DOC-0164 Outline Marine Biodiversity Enhancement Strategy

Applicant: Menter Môn Morlais Limited

Document MOR-RHDHV-DOC-0164: Outline Marine Biodiversity Enhancement Strategy

Author: MarineSpace Ltd

| Morlais Document No.: MOR-RHDHV-DOC-0164<br>File No.: MMC555 | Status:<br>Draft | Version No:<br>F1.3 | Date:<br>January 2021 |
|---|---|---|---|

## TABLE OF CONTENTS

## GLOSSARY OF ABBREVIATIONS

| | |
|---|---|
| BAP | Biodiversity Action Plan |
| BRUV | Baited Remote Underwater Video |
| DDV | Drop Down Video |
| ECC | Export Cable Corridor |
| EIA | Environmental Impact Assessment |
| ES | Environmental Statement |
| EUNIS | European Nature Information System |
| GBS | Gravity Based Structure |
| GIS | Geographical Information System |
| HDD | Horizontal Directional Drilling |
| INNS | Invasive Non-Native Species |
| MDZ | Morlais Demonstration Zone |
| ML | Marine Licence |
| MNCR | Marine Nature Conservation Review |
| NRW | Natural Resources Wales |
| ODA | Onshore Development Area |
| OEL | Ocean Ecology Ltd |
| OfDA | Offshore Development Area |
| ROV | Remotely Operated Vehicle |
| RPA | Relevant Public Authorities |
| SAC | Special Area of Conservation |
| SMNR | Sustainable Management of Natural Resources |
| VER's | Valued Ecological Receptors |
| WNMP | Welsh National Marine Plan |

## GLOSSARY OF TERMINOLOGY

| | |
|---|---|
| Anthozoa(n) | A class of marine animals including sea anemones and coral. |
| Benthic | The lowest level of a body of water including the sediment surface. |
| Biodiversity Offsetting | A policy approach that seeks to minimise the environmental impacts of a development project by ensuring that any damage in one place is compensated for elsewhere. |
| Biogenic | Something that is produced or brought about by living organisms, such as a reef. |
| Biotope | A region of habitat associated with a particular ecological community. |
| Circalittoral | The region of a sea or ocean below the infralittoral zone to the maximum depth at which photosynthesis is still possible. |
| 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. |
| Ecological Enhancement | An environmental improvement that may intensify or increase the quality, value or extent of a resource. |

| | |
|---|---|
| Ecology | The relation of organisms to one another, and to their physical surroundings. |
| Eulittoral | The area of the shore between the spring high and spring low tide lines. |
| Gravel | Loose, rounded fragments of rock larger than sand but smaller than cobbles. Sediment larger than 2mm (as classified by the Wentworth scale used in sedimentology). |
| Habitat | The environment of an organism and the place where it is usually found. |
| Infralittoral | The region of shallow water closest to the shore, excluding the intertidal, dominated by algae. |
| Intertidal | Area on a shore that lies between Lowest Astronomical Tide (LAT) and Highest Astronomical Tide (HAT). |
| Littoral | The area of a sea or lake between the high water mark and the edge of the continental shelf. |
| Mitigation | A measure to avoid, reduce, minimise or cancel out one or more adverse impacts. |
| OSPAR | OSPAR (Oslo and Paris Convention) Biological Diversity and Ecosystem List of threatened and /or declining species and habitats. |
| Repowering | The removal of a tenant's infrastructure at the end of a demonstration period and replacement with the infrastructure of a new tenant, and reinstallation via the original construction method. |
| Restoration | To return an environmental resource, for example a habitat, species, waterbody or landscape feature, to a former known and preferred condition or state. |
| Section 7 | (Formally BAP/Section 42) List of the habitats and species of principal importance for the purpose of maintaining and enhancing biodiversity in relation to Wales. |

# 1. INTRODUCTION

## 1.1. BACKGROUND AND SCOPE

1. Menter Môn Morlais Limited ('the applicant', hereafter referred to as Menter Môn) is seeking a Transport and Works Act Order (TWAO) and Marine Licence (ML) for the Morlais Project (hereafter referred to as the Project).

2. The Project is described in the Project Description chapter of the Environmental Statement (ES) (**Chapter 4, Project Description**). In summary, the Project consists of three distinct areas within which components of the Project will be installed:

- The Morlais Demonstration Zone (MDZ), within which arrays of tidal devices and associated infrastructure such as foundations, array hubs, inter array cables, cable protection and other associated infrastructure will be deployed.
- The Export Cable Corridor (ECC), within which up to nine export cables and associated cable protection will be laid. The ECC also includes the intertidal area, where the export cables will make landfall via either horizontal directional drilling (HDD) or trenching.
- The MDZ and ECC areas combined can be referred to as the Offshore Development Area (OfDA).
- The Onshore Development Area (ODA) shares the export cable landfall with the ECC, with export cables then passing to a landfall substation, and from there via an onshore cable route to a grid substation and connection to grid.

3. Features of conservation importance have been identified within the OfDA. Across the intertidal and subtidal area, three Annex I Reef features have been identified (bedrock; stony; and biogenic reef). These three reef habitats are afforded protection under the Habitats Directive. The extent and quality of these features (as defined by Environmental Impact Assessment (EIA) characterisation surveys undertaken in 2018) is summarised in Section **Error! Reference source not found.**. The ES for the Project identified that the placement of project infrastructure on the seabed would result in the loss of some of these features across areas of the OfDA (summarised in Section 3).

4. Other habitats and species of conservation importance have also been predicted to be present within, and in the region of the Project Area, such as Environment (Wales) Act 2016 Section 7 (formally BAP/Section 42) habitats and species, and OSPAR threatened and / or declining species and habitats (e.g. fragile sponge and anthozoan communities) (summarised in Section 3.4).

5. The Morlais ES had assessed that without mitigation measures, the long-term loss of benthic habitat (more specifically, Annex I reef features) via initial placement of project infrastructure (and any subsequent re-powering) would result in a moderate adverse impact. To mitigate this impact, micro-siting of devices away from the most high-quality habitat was proposed.

6. A pre-construction Annex I survey was also proposed that would define the spatial extent of these sensitive habitats closer to actual installation activities which in turn, would increase the effectiveness of micro-siting (Section 5.2). These measures are captured in draft Marine Licence

conditions proposed by Menter Môn and have been discussed with Natural Resources Wales Advisory Team (NRW(A)); these are subject to determination of the Marine Licence application.

7. The ES concluded that the successful implementation of these mitigation measures would result in the potential impact to Annex I features being reduced to a minor adverse effect.

8. The Annex I reef features in the OfDA are not a designated feature of the North Anglesey Special Area of Conservation (SAC). However, following consultation with NRW(A) it was proposed that should the primary mitigation option of micro-siting away from Annex I reef features not be feasible during planning and installation, additional mitigation would be required to offset the potential loss of some of these habitats.

9. Following a consultation meeting with NRW's Advisory Team on 6 November 2020, NRW(A) have suggested that marine biodiversity enhancement be considered as a mitigation measure.

10. Menter Môn have agreed in principle to this and proposed that the production of a Marine Biodiversity Enhancement Strategy be a pre-commencement condition on the Morlais Marine Licence, i.e. produced post-consent but pre-installation. NRW(A) have in turn requested that to provide more certainty on this strategy, an *Outline* Marine Biodiversity Enhancement Strategy be prepared pre-consent.

11. This document, therefore, represents the Morlais Outline Marine Biodiversity Enhancement Strategy.

## 1.2. DATA SOURCES

12. The Outline Marine Biodiversity Enhancement Strategy (hereafter referred to as the Outline Strategy) will utilise key sources of information to outline the broad enhancement options for the Project, this will include (but not be limited to):

- Eco-friendly design of scour protection: potential enhancement of ecological functioning in offshore wind farms (Bureau Waardenburg, 2017);
- LLe Geo-Data Portal for Wales (Welsh Government, 2020a);
- Morlais Demonstration Zone (MDZ) Benthic Ecology Characterisation Survey 2017 (Ocean Ecology Ltd, 2018);
- Morlais Project Environmental Statement Chapter 9: Benthic and Intertidal Ecology (RHDHV, 2019b); and
- Supporting the implementation of the Welsh National Marine Plan: Enhancing marine ecosystems (Armstrong *et al.*,2019).

13. In addition to this, relevant scientific research and case studies will be referenced where appropriate. It is anticipated that as the Project progresses, the Outline Strategy may be required to be supported further with additional information, following relevant discussions and consultation with NRW(A).

### 1.3. PURPOSE OF THIS DOCUMENT

14. This document seeks to set out an outline for appropriate marine biodiversity enhancement options for the OfDA of the Project. The proposed Outline Strategy will focus on enhancement options that may be appropriate to be implemented over the operational lifetime of the Project, i.e. the stage of the Project where long-term habitat loss has been predicted via the EIA process.

15. At this initial (outline) stage, this document does not provide detailed prescriptive measures, but instead focuses on providing a framework for future decision-making, related to marine biodiversity enhancement options for the Project currently judged to be feasible. Information presented is based upon current knowledge of enhancement options.

16. As this is a topic area that is developing at a rapid pace, it is fully expected that additional marine biodiversity enhancement options will emerge over time. Therefore, the Outline Strategy is intended to be a live document that evolves and is updated throughout the project planning and consenting phase, with input from appropriate consultees. Eventually, this Outline Strategy will become the full Morlais Marine Biodiversity Enhancement Strategy document for agreement, post consent.

## 2. RELEVANT MARINE POLICY AND PLANS

17. The Welsh National Marine Plan (WNMP) was formally adopted by Welsh Government in Autumn 2019. With reference to ecological enhancement, Policy ENV_01 of the WNMP (Resilient marine ecosystems) has the following aim:

*'To ensure that biological and geological components of ecosystems are maintained, restored where needed and enhanced where possible, to increase the resilience of marine ecosystems and the benefits they provide. Under this policy, the sensitivities of marine ecosystems and ecosystem impacts should be taken into account when developing proposals and, where possible, proposals should also demonstrate how they will contribute to ecosystem protection, restoration and/or enhancement*.' (Welsh Government, 2019).

18. Under ENV_01, the following guidance includes:

*'147. RPAs[1] should satisfy themselves that proposals have:*

- *adequately investigated and evaluated the significance of identified impacts on marine ecosystems of their proposed activity or development; and,*
- *taken appropriate measures to avoid, minimise or mitigate the identified impacts in a manner that is proportionate to their significance; and/or,*
- *where necessary, submitted a suitable case for proceeding which sufficiently demonstrates the overriding benefits of proceeding'.*

[1] Relevant Public Authorities.

*'148. [……….] Proposals should demonstrate how they maintain and enhance these habitats and species, including protecting them from potential impacts or promoting their restoration and/or enhancement.*

*'149. Proposals are encouraged to contribute to the restoration or enhancement of marine ecosystems. Incorporating restoration and/or enhancement of marine ecosystems into proposals does not have to be expensive or complex. It could include using different substrates for building on the foreshore that are favourable to postconstruction colonisation by a range of species. Small changes to intertidal structures that allow the formation of crevices in walls or pools at low tide as opposed to the structure drying out entirely can provide an additional environment for rock pool species that would otherwise be unable to exist there. Developers should engage with NRW for advice on enhancement to ensure any proposed enhancement is suitable.'* (Welsh Government, 2020b).

# 3. SENSITIVE SEABED HABITATS WITHIN THE MORLAIS PROJECT AREA

## 3.1. OVERVIEW

19. As detailed in Section 1, the EIA for the proposed Morlais Project identified a number of sensitive seabed habitats within the Morlais OfDA and intertidal areas. These include three Annex I Reef features (bedrock; stony; and biogenic reef); habitats protected under Section 7 of the Environment (Wales) Act 2016 (formally BAP/Section 42 habitats), and OSPAR threatened and / or declining species and habitats (e.g. fragile sponge and anthozoan communities).

20. The following section provides more details of the current understanding of the extent and nature of these habitats in the Morlais OfDA and intertidal areas.

## 3.2. SUBTIDAL ANNEX I REEF HABITATS

21. Within the EU Habitats Directive, marine reef features are defined as such:

'*Reef can be either biogenic concretions or of geogenic origin. They are hard compact substrata on solid and soft bottoms, which arise from the sea floor in the sublittoral and littoral zone. Reefs may support a zonation of benthic communities of algae and animal species as well as concretions and corallogenic concretions.'* (European Commission, 2013).

22. Chapter 9 of the Morlais ES (RHDHV, 2019) presents an indicative distribution of Annex I reef habitats within the OfDA (**Chapter 9, Benthic and Intertidal Ecology**).

23. Subtidal and Intertidal surveys were undertaken in 2018 by Ocean Ecology Ltd (OEL) in order to characterise the site for EIA purposes. These surveys involved the collection of marine data, including high resolution seabed imagery, grab and core samples, quadrat data and aerial imagery in order to derive a detailed biotope map of the OfDA. Prior to site-specific surveys, a detailed desk-based study was also undertaken.

24. This EIA characterisation exercise showed that the subtidal environment within the OfDA was comprised of a complex mosaic of biotopes, dominated by circalittoral and/infralittoral rock and coarse sediments. A total of 15 subtidal EUNIS habitats were mapped. Figure 3.1 shows the habitat mapping across the MDZ and the south ECC (full extent of the north ECC route was not mapped).

25. Within the OfDA, extensive areas of both Annex I stony and bedrock reef were recorded. The deeper areas of the site from the north east spreading along the eastern central area of the site to the south west of the OfDA were characterised by coarse sediments (A5.14) representative of Annex I stony reef habitat. The amount of overlying sediment was reduced in the slightly shallower waters in central, southern and northern areas where tide-swept and mixed faunal turf communities (A4.11 / A4.13) representative of Annex I bedrock reef were prevalent.

26. Areas of Annex I stony reef habitat were frequently overlain by varying coverage of *Sabellaria spinulosa* tube aggregations representative of Annex I biogenic reef in some areas (A4.22). Biogenic reefs of *S. spinulosa* were observed across 16 stations and the quality of the reefs and levels of 'reefiness' varied, however typically present in 'low' to 'medium' levels of reefiness.

27. All of these reefs were extremely variable, both in structure and in the communities they support. They ranged from vertical rock walls to horizontal ledges, sloping or flat bed rock, broken rock, boulder fields, and aggregations of cobbles.

28. Closer to shore, sediment biotopes dominated which ranged from coarse gravels (A5.14) to subtidal sands (A5.2) and at Abraham's Bosom, transitioning into macrophyte dominated infralittoral rock in the shallow subtidal and sublittoral fringes across the whole area.

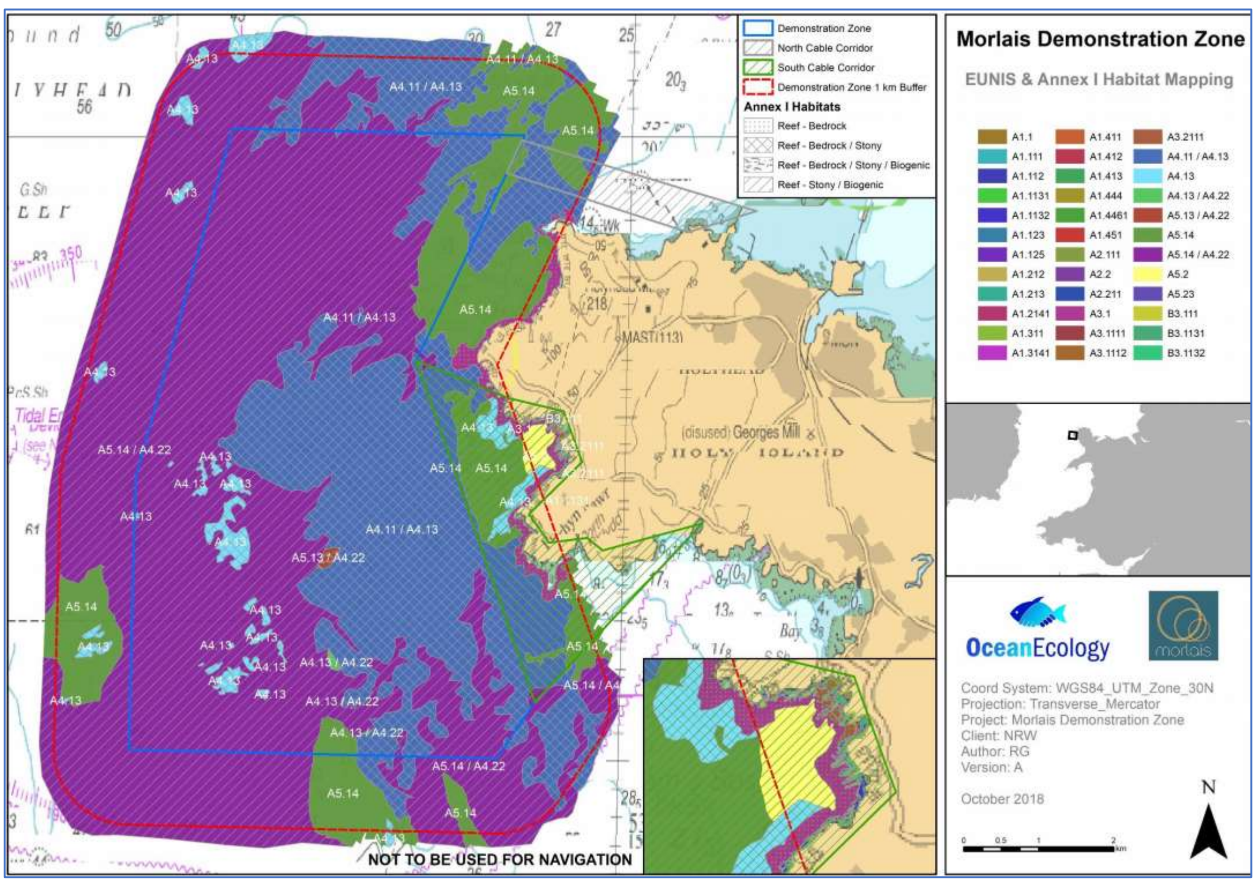


**Figure 3.1: EUNIS and Annex I habitat mapping across the subtidal OfDA (MDZ and South ECC) (Landfall location 'Abraham's Bosom' presented in the insert) (From: Ocean Ecology Ltd, 2018).**

### 3.3. INTERTIDAL ANNEX I REEF HABITATS

29. Marine intertidal Phase I and mapping surveys were conducted around the proposed cable landfall at Abraham's Bosom (landfall option for the south ECC route). The intertidal areas support a wide variety of littoral rock biotopes interspersed with discrete patches of barren shingle and occasional areas of sandy substrate.

30. A total of 28 intertidal EUNIS habitats were mapped and the communities identified were those which are typically associated with high energy intertidal habitats, such as:

- A1.111 (LR.HLR.MusB.MytB) *Mytilus edulis* and barnacles on very exposed eulittoral rock;
- A1.1131 (LR.HLR.MusB.Sem.Sem) *Semibalanus calanoids*, *Patella vulgata* and *Littorina* spp. on exposed to moderately exposed or vertical sheltered eulittoral rock;
- *Fucus* spp. on exposed to moderately exposed upper eulittoral rock; and
- A1.412 (LR.FLR.Rkp.FK) Fucoids and kelp in deep eulittoral rockpools.

31. Within the intertidal zone the immediate seabed was covered by an expanse of bedrock reef, tailing into stony/bedrock reef in the north east and south east of the site. All areas of littoral rock biotopes (A1(LR)) within the intertidal area were representative of Annex I reef (Figure 3.2).

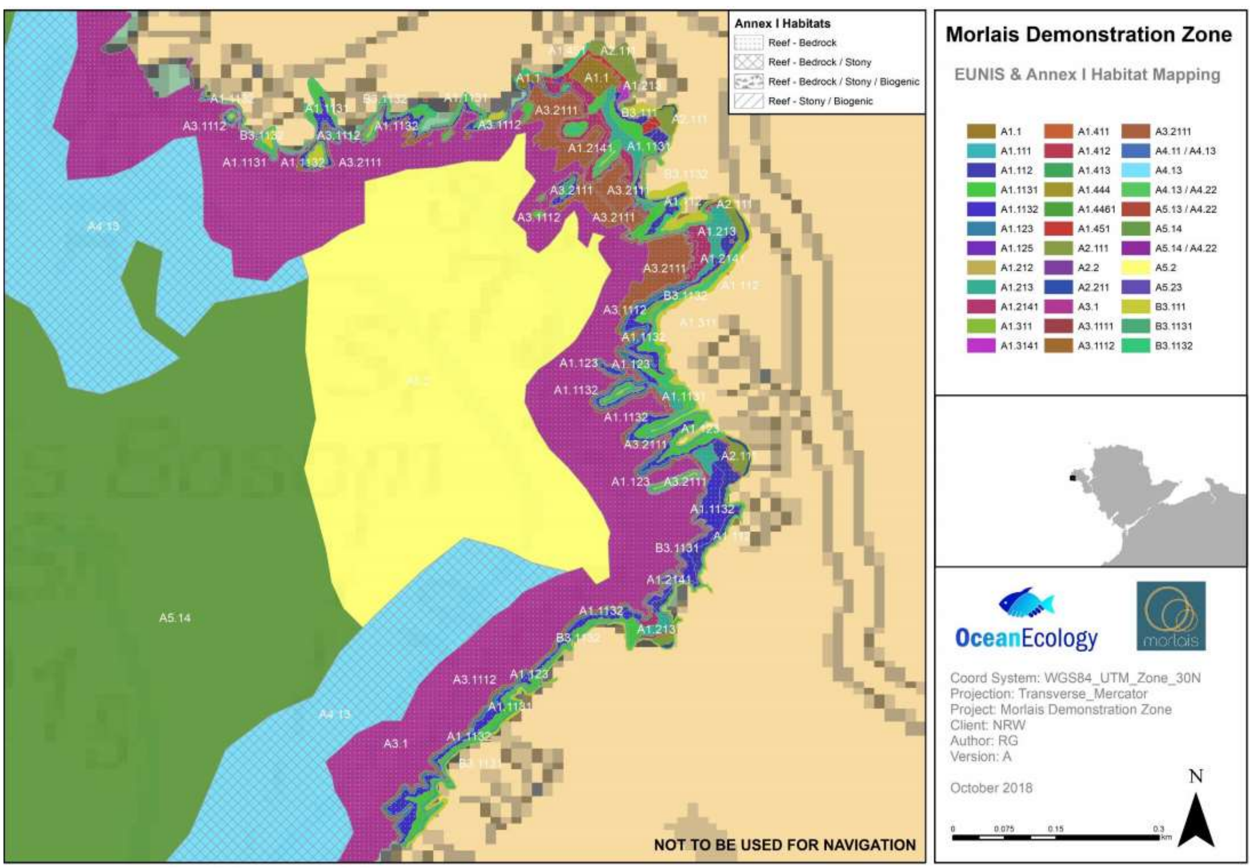


**Figure 3.2: EUNIS and Annex I habitat mapping across the proposed Project landfall location 'Abraham's Bosom' (From : Ocean Ecology Ltd, 2018).**

### 3.4. OTHER IMPORTANT CONSERVATION FEATURES

32. In addition to Annex I reef habitats, there are also Environment (Wales) Act 2016 Section 7 (formerly BAP/Section 42) and OSPAR threatened and/or declining species and habitats present within or near to the Morlais OfDA and intertidal areas. Much of the data records for these important features are sourced from historic 1994 Marine Nature Conservation Review (MNCR) records (Welsh Government, 2020a).

33. It was reported that *Musculus discors* (discord mussel) bed habitats are present to the North of Holyhead (outside of the Project boundary). Similarly, in shallower waters on the east and west sides of Holy Island, seagrass (recent and historic records) has been reported.

34. To the south of the OfDA, historic (1996) records of *Arctica islandica* (ocean quahog) was recorded as present in tide-swept sandy sediments habitats, and two records of *Haliclystus auricula* (Kaleidoscope jelly fish) found intertidally and subtidally, outside of the Project; both recorded as being associated with kelp communities. It is reported that *H. auricula* populations have declined since 1979 and is rarely reported now (Tyler-Walters *et al.,* 2017). Two records of intertidal under-boulder communities are reported south of the landfall location on the western side of Holy Island.

35. Between 1996 and 1997, three observations of fragile sponge and anthozoan communities was recorded in the area, with one <1km adjacent to the landfall site.

36. Subtidal horse mussel (*Modiolus modiolus*) beds have been recorded between 1966 and 2012 to the south of the OfDA, with some potential overlap along the north-western boundary.

## 4. VALUED ECOLOGICAL RECEPTORS

37. For the purpose of the EIA, marine habitats with similar physical, biological characteristics as well as conservation status/intertest were grouped together into “Valued Ecological Receptors” (VER’s). This approach enables habitats/biotopes with similar sensitivity to predicted project effects to be assessed together to avoid duplication of assessment effort.

38. Within the OfDA, 3 VER Habitat Groups were identified (Groups 9-11) and of those, Group 9 and 10 dominated in terms of spatial extent (>99%). Both these subtidal groups comprise biotopes relating to Annex I reefs (bedrock, stony and biogenic). Below is a summary description of Group 9 and 10:

- **VER Group 9**: High energy infralittoral and circalittoral rock/coarse sediment with Annex I stony/bedrock reef; and
- **VER Group 10:** Circalittoral *Sabellaria* reefs – Annex I biogenic reefs.

39. It is important to note that the mapping of the spatial extent of these VER’s has at this stage assumed that all of the subtidal parts of the OfDA are Annex I reef. Following the pre-construction surveys (see Section 5.2), the location and extent of qualifying Annex 1 features can be confirmed.

40. However, by assuming that these habitats exist throughout these areas (>99% of the OfDA was assigned as being VER9 or 10), a precautionary assessment was able to be presented within the Morlais ES (**Chapter 9, Benthic and Intertidal Ecology**).

41. It is anticipated that the pre-construction survey (planned to be undertaken no more than 12 months prior to the deployment of any marine project infrastructure) would provide an updated picture of the presence, spatial extent and quality of these Annex I features at a localised scale.

42. At the intertidal area of the landfall location in the ODA (Abraham's Bosom), 9 VER Groups (1-8 and 12) were identified and of those, 6 comprised biotopes relating to sub-features of Annex I reef habitats:

- **VER Group 1:** High energy littoral rock.
- **VER Group 2:** *Fucus* spp. on exposed to moderately exposed eulittoral rock.
- **VER Group 3:** *Pelvetia canaliculata* on sheltered littoral fringe rock and *Ascophyllum nodosum* on full salinity and eulittoral rock.
- **VER Group 4:** Coralline crust, Fucoids and kelps in eulittoral rock pools
- **VER Group 5:** Upper to mid-shore cave walls and wave surged overhanging lower eulittoral bedrock and caves.
- **VER Group 6:** *Ulva* spp. on freshwater influenced and /or unstable upper littoral rock.

43. Although these 6 VER Groups listed above had been identified as present, it was VER Group 1 (high energy littoral rock) and Group 12 (yellow and grey lichens on supralittoral rock) that dominated the intertidal zone; Group 12 does not support sub-features of Annex I reef.

## 5. IMPACTS AND MITIGATION

44. Chapter 9 of the ES presents the impact assessment and embedded mitigation for the benthic environment of the Project Area (**Chapter 9, Benthic and Intertidal Ecology Section 9.6 Impact assessment**).

### 5.1. PREDICTED HABITAT LOSS

45. From the initial placement of project infrastructure directly on the seabed, a direct long-term habitat loss will occur for the duration of the operation phase of the Project. In addition to the initial impact, repowering (removal of a tenant's infrastructure and replacement with infrastructure of a new tenant) of up to 50% of the berths may take place.

46. Following the initial placement of the full 240 MW of infrastructure, an area of up to 2,180,072 $m^2$ (2.18 $km^2$) would be lost.

47. Repowering will result in an additional permanent habitat loss of 52,504 $m^2$ (0.05 $km^2$). However, it is important to recognise that where original infrastructure has been removed, these seabed habitats will no longer be "lost". Dependant on the nature of the loss during initial placement of infrastructure, and on the sensitivity of the environment within its footprint, these habitat features may recover following removal during the repowering process.

48. Overall, the combined permanent habitat loss from initial installation and repowering is therefore predicted to be 2,232,576 $m^2$ (2.23 $km^2$).

49. The proposed total area of the OfDA (the MDZ and ECC) and the intertidal area is 39.75 $km^{2.}$ The MDZ comprises 35 $km^2$ and the ECC 4.75 $km^2$, of which the intertidal region is 0.01 $km^2$. Therefore, given that the worst-case scenario seabed footprint for a maximum design within the construction period of the project could result in the loss of up to 2,232,576 $m^2$, a worst-case scenario design would result in the loss of a **5.61 %** of the seabed within the Project area.

50. An important point to note is that the majority of this habitat loss (2,055,000 $m^2$ / 2.06 $km^2$) comprises the swept area of any catenary chains/cables possibly required as part of the overall project. This is a precautionary approach as in many areas, the movement of these chains/cables may not actually lead to a permanent loss of habitat, rather some temporary disturbance. It is noted however that even regular, temporary disturbance can still lead to habitat modification and/or loss. With a catenary mooring system, at any time only a portion of the mooring chains will lay upon the seabed and the remaining portion will be suspended in the water column. The amount of chain suspended at any time is in response to external forces (wind, wave and tides) and thus there will not be permanent contact on the seabed over the entire 2.06 $km^2$.

51. The actual amount of habitat that will definitely be lost over the project lifetime i.e. areas where foundations / mooring blocks / cable protection etc. will be initially deployed / installed via repowering, is predicted to be 177,576 $m^2$ (0.17 $km^2$). This latter figure equates to 0.42% of the overall OfDA area of 39.75 $km^2$.

52. It was not possible to provide a definitive calculation of the loss of each VER group (VERs summarised in Section 4 above) due to the uncertainty around the exact locations where project infrastructure will be deployed, and thus which VER groups would be impacted. Although the impact would occur at a scale which would be noticeable from monitoring, it would remain within the range of background natural variability. Following the pre-construction surveys, consideration will be given to the quality of the habitats pre-installation in order to ascertain recoverability. It is expected that the effect will be slowly reversable, following decommissioning (5-10 years).

53. It was assessed that overall, the impact predicted from the permanent loss of the most frequently occurring VER Habitat Groups (1, 9, 10 and 12) due to the placement of infrastructure from the project, is of a medium magnitude and a medium sensitivity to the receptors, resulting in an overall **moderate adverse impact**.

54. In order to mitigate this impact, the following mitigation measures are proposed.

## 5.2. PRE-CONSTRUCTION SURVEYS AND MITIGATION

55. Post-consent and no more than 12 months prior to the deployment of any project infrastructure, detailed pre-construction surveys will be carried out to identify the presence of any Annex I habitats which may be classified as reef features.

56. An appropriate spatial extent of pre-construction Annex I habitat survey would be defined and agreed with NRW prior to the survey but it is expected that it would cover the planned areas of project infrastructure deployment in the next 2-year period, along with an appropriate buffer around these areas where micro-siting may be required. Survey methodologies would follow accepted industry/NRW guidance, including a review of side-scan sonar data and ground truthing with drop-down video (DDV)/camera. Established methods of assessment and defining reef features (NRW 2019; Jenkins *et al.,* 2018; Irving, 2009; Gubbay, 2007) would be adopted and outputs of the survey would be discussed with NRW prior to deployment to ensure an agreed approach to micro-siting was developed.

57. Following these surveys, micro-siting of project infrastructure would be used to mitigate impacts to these receptors where possible. This would inform areas which should be avoided and areas which infrastructure should not be placed.

58. The residual impact on VER Habitat Groups 1, 9, 10 and 12, following the successful implementation of this mitigation measure was assessed to be adjusted to **minor adverse**.

59. However, if micro-siting is not possible, then additional mitigation via marine biodiversity enhancement may be required should loss of Annex I reef habitat occur– see below for more details on how this process is proposed to be implemented.

## 6. PROCESS FOR IMPLEMENTING ECOLOGICAL ENHANCEMENT MEASURES

60. The predicted worst-case habitat loss of up to 5.61% of the total Morlais OfDA and intertidal area was assessed as a **moderate adverse impact** with the Morlais ES. This conclusion of moderate adverse was based upon (magnitude of effect = medium x receptor sensitivity = medium).

61. The classification of effect magnitude as medium level was based on the fact that habitat loss of >3% of the proposed study area (5.61%) would arise via placement of project infrastructure.

62. As detailed above in Section 5.2, the primary mitigation measure that would be adopted to reduce the scale of this impact will be micro-siting of project infrastructure to avoid loss of Annex I reef habitats.

63. An initial proposal presented to NRW was that if micro-siting was to successfully reduce the amount of *any* Annex I/Section 7/HPI[2] habitat loss to <1% of the total area of the OfDA, then, adopting the logic of the EIA process, the magnitude of effect would change to low, resulting in the minor adverse impact predicted (post-mitigation) in the ES (**Chapter 9, Benthic and Intertidal Ecology Section 9.6 Impact assessment**).

64. However, following discussion on this specific point with NRW, more clarity was requested on this proposed use of a threshold. In particular, it is recognised that there are differences in sensitivity to habitat loss between different types of Annex I habitats.

[2] Habitats of Principal Importance

65. The following key principles are, therefore, proposed:

- Micro-siting to avoid loss of any Annex I habitat should be the primary form of mitigation;
- If micro-siting is not feasible, loss ($m^2$) of stony and/or bedrock reef totalling up to 1% of the total areas of the OfDA is acceptable;
- If the loss ($m^2$) of stony/bedrock reef exceeds 1% of the total area of the OfDA, appropriate biodiversity enhancement measures should be implemented;
- Any amount of habitat loss ($m^2$) of medium/high quality *S. spinulosa* reef (as defined by Gubbay, 2007) and/or Modiolus reef will require appropriate biodiversity enhancement measures to be implemented;
- If, following review of pre-construction survey data, NRW agree that some areas of *S. spinulosa* reef are low quality (as defined by Gubbay, 2007), then biodiversity enhancement will not be required;
- Any loss of low quality *S. spinulosa* reef will contribute towards the 1% of total area of OfDA measure.

66. With respect to biodiversity enhancement measures, potential exists for such measures to be (a) developed and installed *in situ* on project infrastructure already deployed; (b) factored into the design of project infrastructure not yet deployed (c) deployed away from actual project infrastructure, i.e. within other parts of the Morlais OfDA and/or (d) developed off-site.

67. This proposed approach is captured in the following draft proposed Marine Licence condition prepared by the applicant:

68. *"Where it is not possible to avoid damage/loss of certain Annex I habitats/HPI and/or Section 7 habitats via micro-siting, then further mitigation via biodiversity enhancement should occur. Details of proposed biodiversity enhancement measures should be presented in a project-specific "Biodiversity Enhancement Strategy (BES)" that should adhere to the principles and approach set out in the "Outline BES" produced by the licence holder pre-consent"*

69. Section 7 below provides an overview of the potential ecological enhancement options for the Project. These cover the proposed intertidal landfall site at Abraham's Bosom (Section 7.2); the southern ECC route (Section 7.3); and the subtidal MDZ (Section 7.4).

70. It is important to note, that at this stage, it is not known where within the OfDA the greatest percentage loss of Annex I reef habitat will occur and/or the quality of the features affected.

71. The potential risk to Section 7 and OSPAR habitats and species that may be present locally will also need to be better defined once pre-construction survey data and project deployment plans are available for review. As such, details of the most feasible options assessed at present, to be appropriate for each of the three defined areas are shown below.

72. In addition, a consideration of off-site options is also presented, and this would also need to be considered should on-site enhancement options be deemed not feasible.

# 7. MARINE ECOLOGICAL ENHANCEMENT OPTIONS

## 7.1. OVERVIEW

73. NRW interprets enhancement as: "*An environmental improvement that may intensify or increase the quality, value or extent of a resource*" (review by Armstrong *et al*., 2019).

74. Hard structures used in the marine environment are poor ecological surrogates for the natural environment. However, they do provide the greatest potential for ecological enhancement. There is increasing literature available comparing value of natural verses artificial hard materials and structures. There are two types of enhancement approaches that can be applied in the marine environment, Passive and Active.

**Passive Enhancement** may include:

- Decisions on material type (e.g. colour, roughness of rock);
- Positioning of material (e.g. boulders within rock armour, utilising natural surface heterogeneity);
- Monitoring (e.g. assessing effectiveness of method used); and
- Supporting academic research.

**Active Enhancement**:

- Can be done at the design stage or retrospectively
- Can involve modifying the chemistry or texture of artificial material (e.g. concrete) for species colonisation;
- Can involve retrofitting structures with habitat features;
- Translocation and restoration techniques (e.g. seagrass);
- Can be done at various scales (e.g. mm to m);
- A technical challenge; and
- Requires understanding of local ecological factors.

75. It is recommended that a combination of both active and passive approaches would be the most effective marine biodiversity enhancement strategy for the proposed Morlais project.

76. Enhancement options can take place on- and offsite. Onsite options will involve the introduction or modification of structures in order to increase complexity of their surfaces ('greening the grey'). Offsite options are more flexible and may involve the creation or manipulation of natural habitats and may overlap with options undertaken within the Onsite project areas.

77. Table 7.1 below summarises the potential enhancement options that may be appropriate for the Project. These are measures that have been or could be applied to the renewable and subsea cabling sectors (sectors relevant to this Project), for which marine licences tend to be sought in Wales. Where appropriate, examples of these options are presented below for each of the three Project areas in Sections 7.2 - 7.4.

**Table 7.1 Summary of potential enhancement options for renewable and subsea cabling sector (Modified from: Armstrong *et al.,* 2019). Yes= already employed; P = Potential to; and N/A = not applicable.**

| Enhancement Options | Renewable Energy | Subsea Cabling |
|---|---|---|
| **Onsite** | | |
| Vertical structure enhancements | Yes | n/a |
| Rock armouring | Yes | n/a |
| Scour protection | Yes | Yes |
| Reef restoration | P | P |
| Artificial reef creation | Yes | P |
| **Offsite** | | |
| Habitat management | Yes | P |
| Habitat creation | Yes | P |
| Co-location | P | P |

## 7.2. LANDFALL

78. The proposed landfall site is located at a small inlet 'Abraham's Bosom'. The site consists mainly of steep cliffs and rocky outcrops interspersed with discrete patches of barren shingle and occasional sandy substrate (see Section 3.3 for summary of biotopes and Annex I reef features present) (Figure 7.1).

**Figure 7.1 High resolution aerial image of the upper shore at Abrahams Bosom (From: Ocean Ecology Ltd, 2018).**

79. Currently, up to nine cables are to be laid at the landfall site and the preferred option is HDD (Horizontal Directional Drilling). However, if HDD is not viable then open cut trenching of cables (and back-filling) will be undertaken. Should trenching not be possible, then cables will be surface laid, with cables crossing the intertidal area requiring protection, using rock bags or concrete mattresses. Trenching is the worst-case scenario for the landfall site.

80. The estimated habitat loss at the intertidal area is 0.0074 $km^2$, which equates to 0.02% of the total Project area, this loss is 74% of the OfDA intertidal area, that itself is only 0.01 $km^2$ in size. Although this proportion loss of intertidal habitat is high, there is a much greater area of foreshore outside of this area available.

81. If trenching is to be done, then a detailed installation survey will first assess how the substratum will be reinstated with the right stratification of layers. Larger boulders will be moved sideways out of the cable trench corridor to an equivalent area of the shore,

82. prior to trenching work commencing. These boulders would then be used as the upper layer after backfilling the trench.

83. The dominance of rocky substrates at this site, and the method proposed should trenching be required, allows for both passive enhancement measures (e.g. positioning of replaced boulders) (Section 7.2.1) and active measures (e.g. retrofitting of rock pool) at this site (Section 7.2.2).

84. Should trenching not be required and cables will be surface laid, then measures of suitable scour protection design may provide suitable enhancement capabilities (Section 7.2.3).

### 7.2.1. Enhancement during Backfilling

85. During backfilling of the trenches at the landfall site, the simple measure of ensuring that boulders are re-positioned in as such a way so to increase surface heterogeneity will locally increase habitat complexity, providing additional niches and refuges for intertidal species. The benefit of this passive enhancement measure is that it will be using the local, natural material, in order to enhance the existing habitats that are present across the intertidal area.

86. If there is a requirement of artificial material to be placed on top of the backfilled trench, an additional measure may be to ensure the material type is sympathetic to the natural environment. Alongside this, the option of altering the structural heterogeneity can be undertaken by creating holes or groves into the artificial boulders. Multiple holes will help retain water at low tide thus mimicking natural microhabitats, and grooves will replicate the groove-microhabitats seen on a shore (Figure 7.2).

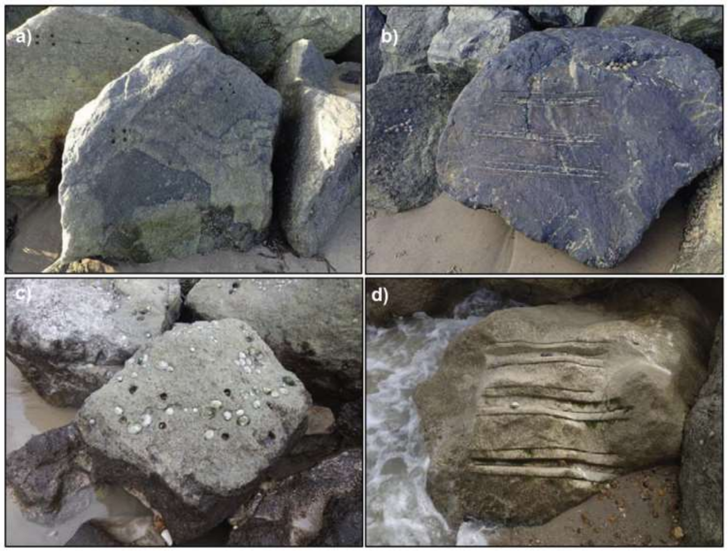


**Figure 7.2: Example of holes (a) and (c), and groves (b) and (d)on granite and limestone boulders (Hall *et al.,* 2018).**

87. As summarised in Section 3.4 above, a limited number of historical records of Section 7 and OSPAR intertidal under-boulder communities have been recorded south of the landfall location. Boulder shores can provide an array of fissures, crevices and holes, that will locally modify the local physical shore environment which will increase biodiversity. Local enhancement of these features at the landfall site may provide suitable habitats to support important under-boulder communities.

### 7.2.2. Vertical Structure Enhancements

88. The intertidal area at the proposed landfall location consists of steep cliffs and rocky outcrops. EUNIS habitats such as A1.412 Fucoids and kelp in deep eulittoral rockpools have been recorded as present, this ascribed biotope belongs to VER Habitat Group 4 which encompasses rock pool biotopes (Section 3.3).

89. The spatial extent of these features at the site may be locally enhanced through the retrofitting of pre-cast artificial tide pools to the natural bedrock. There are various options of artificial tide pools available, and a relatively good abundance of data on the effectiveness of these methods of enhancement; an expected artefact given the accessibility to the intertidal zone. The 'Vertipools' system has been used successfully on artificial structures such as seawalls, groynes, gabions and sheet piling (Figure 7.3). They are cast in concrete and finished to provide suitable surface complexity and design to suit the host environment (Hall *et al.,* 2019).

90. These modular pool features however, have been primarily designed to be attached to artificial coastal structures to increase habitat heterogeneity on less complex vertical features. Careful consideration would need to be given on the installation of such pools on natural rock, such as the structural integrity of the bedrock to withstand the installation process.

91. Alternative modular designs that can sit as part of the shore, and not vertically against a surface may offer a suitable practical alternative (e.g. ECOncrete® tide pool, Figure 7.3). These are not technically vertical structure enhancements, but they are providing a similar ecological benefit

through the creation of rock pool habitats. These could be positioned at or near to the backfilled trenches, at an appropriate tidal height.

92. An estimated cost of example models of modular pool structures are provided in Section 7.7.1; Table 7.2).

**Figure 7.3: (a) 'Vertipools' on a seawall (LEFT) and ECOncrete® tide pools amongst rock armouring/riprap (RIGHT).**

### 7.2.3. Scour Protection

93. For scour protection enhancement options for export cables that need to be laid on the surface at the landfall site, refer to options for enhancement, as summarised below in Section 7.3.1 for the ECC area.

94. These enhancement options for scour control, may also incorporate the approaches outlined above in 7.2.1 and 7.2.2 to include: orientation of material to optimise habitat heterogeneity, retrospective drilling of holes or groves and retrofitting small rock pool structures.

## 7.3. EXPORT CABLE CORRIDOR

95. Much of the area encompassing the south ECC route, has been predicted to be a mixture of bedrock and stony reef, with a transition to predominantly bedrock at the shallower inshore areas of the ECC (Figure 3.1). Where there are limited areas of sediment, burial of the nine cables in the ECC area may be possible but is not assumed. As such, for the ECC, armoured cables will be used, and cable protection will be deployed only when required to secure the position of cables on the seabed. For example, the limited sediment in the nearshore subtidal section within 'Abraham's Bosom', cable protection is expected.

96. The scour protection system of the nine export cables will involve rock bags, concrete mattresses, and split-pipe protection. As outlined in Section 5.2, micro-siting of cables and cable protection will be undertaken where possible, following pre-construction surveys, to avoid sensitive habitats.

#### 7.3.1. Scour Protection

97. Options of ecological enhancement of scour (cable) protection in order to promote ecological enhancement has been reviewed in detail for offshore windfarm projects (Bureau Waardenburg, 2017) and may provide a viable option of direct on-site enhancement where infrastructure (e.g. cables) has been installed. This study was based on North Sea hard substrate habitats, however the broad ecological processes involved will be comparable to the Project area in Welsh waters. A summary of these reviewed measures is listed below.

98. Four broad design principals of ecological enhancement of scour protection was proposed following the review by Bureau Waardenburg (2017):

**1. Adding larger structures** than conventional scour protection[3] to create large holes and crevices, to provide adequate shelter / holes for large mobile species. i.e. to create more habitat complexity on a large scale. Size of holes or crevices should be 1-2 m diameter or more.

*Examples: Reef balls and Xblock*

**2. Adding more small-scale structures** than conventional scour protection to create more small-scale holes and crevices but also attachment substrate and settlement substrate; i.e. to create more habitat complexity on a small scale. Size of holes and crevices should be a few cm-dm. This treatment may improve the habitat of egg-, larvae- or juvenile stages of many species and expected to improve habitat quality for small species (including adult stage), such as the rock gunnel and the shore clingfish.

*Example: boulders, scour gravel and BESE-elements®[4].*

**3. Providing or mimicking natural (biogenic**) chemical substrate properties to facilitate species. i.e. provide chalk-rich substrate such as concrete with added chalk, or even natural substrate such as shell material. This treatment may facilitate the settlement of specific target species that seek known- or unknown chemical cues that are normally associated with their natural settlement substrate.

*Example: empty mussel or oysters shells.*

**4. Active introduction of specimens of target species** to enhance establishment of new populations. This is to facilitate recruitment at locations where reproduction by naturally occurring adults is absent or to scarce. This treatment may facilitate the establishment of populations in areas beyond the reach of natural recruitment in the current situation.

*Example: live oyster cages.*

99. Of these measures listed above, a combination of adding larger and smaller structures across the protection area (**Option 1** and **2**) may be the most appropriate means in which to add habitat

[3] Conventional scour control protection includes boulders with maximum size of 70 cm.
[4] Biodegradable Elements for Starting Ecosystems (BESE) is a biodegradable three-dimensional solid gride, made of starch from potato waste.

complexity to this environment, and has the benefit of not being required to be species specific (e.g. active introduction methods).

100. At present, the scour protection options for the ECC includes rock bags and concrete mattresses. The addition of smaller or larger structures (e.g., **Option 1** and **2**) along with the initial placement of rock bags may be a suitable and practical option for enhancing this scour control system (see Figure 7.4 below for example of rock bags).

101. Alternatively, the benefit of using concrete mattresses as a scour control system is that there are now emerging products which are designed to provide both the scour protection capabilities and enhancement functions (Figure 7.4).

**Figure 7.4: Example image of rock bag scour control system (LEFT) and ECOncrete® marine mattress (RIGHT).**

102. Examples of scour protection enhancement options (as reviewed by Bureau Waardenburg, 2017) is shown in Figure 7.5 below. An estimated cost of some example scour protection options that may be feasible for the Project, are provided in Section 7.7.1; Table 7.2).

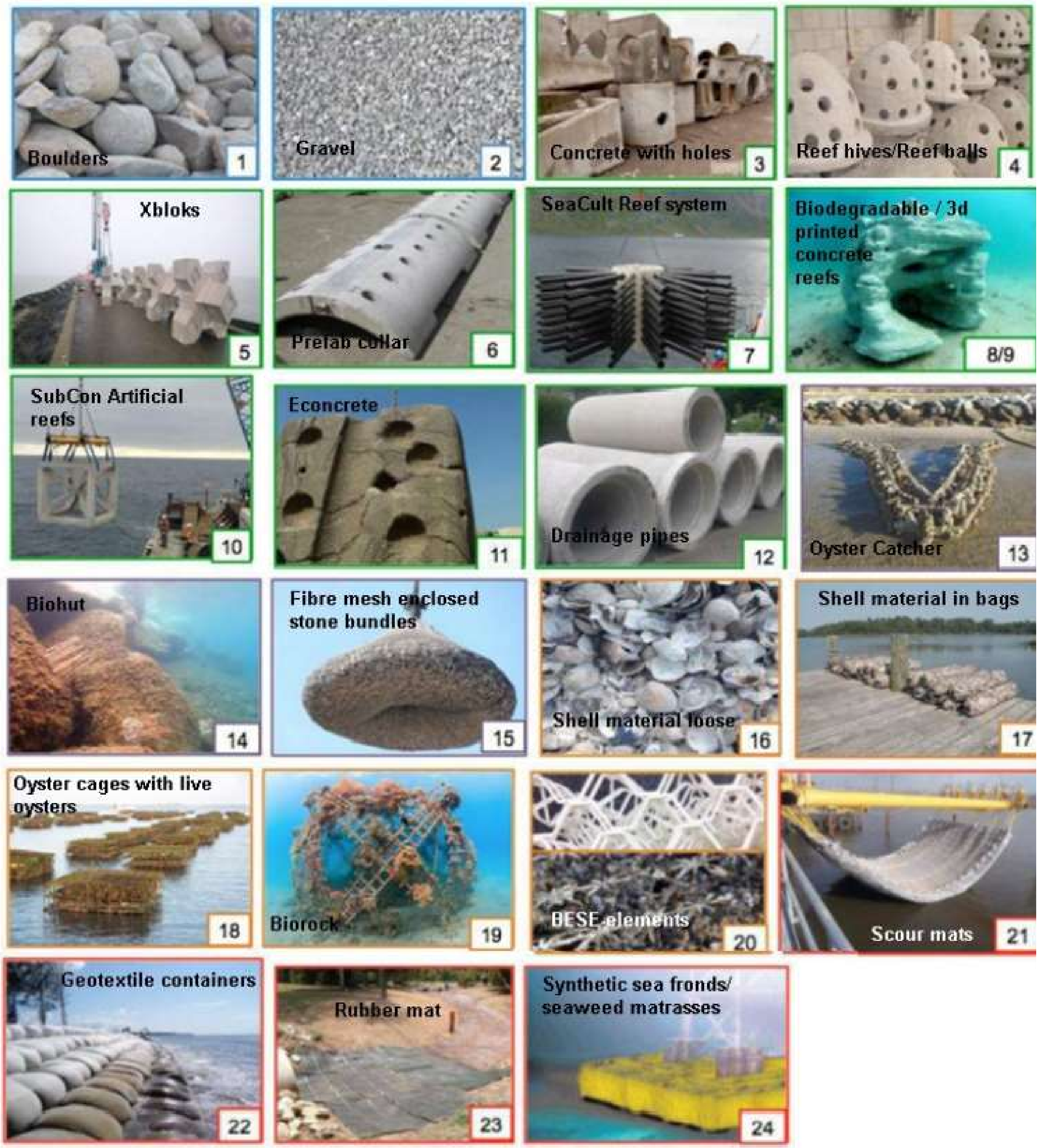


**Figure 7.5: Examples of scour protection enhancement options (From: Armstrong *et al.,* 2019 (Source: Bureau Waardenburg, 2019)). Note: not all options shown above are for consideration for the Project.**

## 7.4. MORLAIS DEMONSTRATION ZONE

103. A wide range of project infrastructure will be installed within the MDZ to support the range of possible device types that may be used, including piled and Gravity Base Structure (GBS) foundations; anchor mooring blocks; and cable protection measures. These installations will occur across a complex mosaic of biotopes, dominated by circalittoral and/infralittoral rock and coarse sediments. As summarised in Section 4, the area is dominated spatially by the VER Habitat Group 9 and 10, which comprise biotopes relating to stony/bedrock reef and biogenic *Sabellaria* reef, respectively. There is a degree of spatial partition within the MDZ, where in the deeper western areas, biotope complexes may support *Sabellaria* reef features (e.g., A4.22 *Sabellaria* reefs on circalittoral rock) alongside Annex I stony reef habitat, and towards the shallower areas of the MDZ, bedrock reef is present (Figure 3.1).

104. Due to the spatial variation in habitat features, and range in infrastructure to be installed on the seabed, there may be a number of different enhancement options available for the MDZ. A more focused approach can be established following the pre-construction surveys, and the determination of localised micro-siting options across the MDZ.

### 7.4.1. Scour Protection

105. As with the export cables, for certain parts of the MDZ, additional cable protection may be required to secure the inter array cables and prevent movement. For the array cables however, only rock bags and split-pipe protection are to be used. Following the enhancement options outlined in Section 7.3.1 for the ECC, a similar approach can, therefore, be applied for the inter-array cables in the MDZ, if enhancement is required at these locations.

106. The foundations for the tidal devices may be piled into the seabed, with monopile or pin-piles installed and/or be GBS. These may all require some form of scour protection. Figure 7.6 below illustrates the four different design example options, as described above in Section 7.3.1. Figure 7.6 presents the example for wind turbine mono piles.

107. It is proposed by Bureau Waardenburg (2019) that for **Option 1** (‘Treatment 1’) that by adding larger structures to existing scour protection should result in a minimum area of 10 m diameter, that is 1-3 m high. For **Option 2** (‘Treatment 2’), by adding more small-scale structures on top of other scour protection should result in a minimum 10 m diameter, with a thin layer (few cm) on top. **Option 1** and **2** may be the most feasible options for this Project.

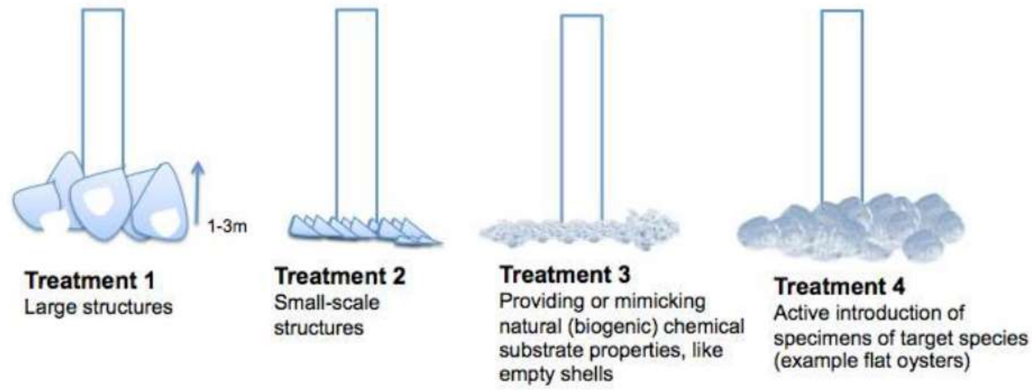


**Figure 7.6: Side view of scour control enhancement options (From: Bureau Waardenburg, 2019).**

108. These scour control enhancement options for the cables and device foundations in the MDZ (and ECC) will be most suitable for those area where there is predicted loss of Annex I bedrock or stony habitats. Application of the correct measure with an appropriate design, may provide important artificial habitats for colonising epifaunal species, supporting the widely distributed biotope complex of A4.11/A4/13 (very tide swept faunal communities on circalittoral rock/mixed faunal turf communities on circalittoral rock), across the MDZ (Figure 3.1). These artificial features may also support important commercial/conservation fish species by providing refuge, nursery and feeding grounds (see RHDHV, 2019c for baseline assessment of fish and shellfish species in the Project area).

### 7.4.2. Artificial Reef Creation

109. The option of artificial reef creation may be a feasible additional enhancement measure if required following initial assessment of enhancement options at the locations of project infrastructure placement. This enhancement measure would be deployed remotely from project infrastructure, but within the MDZ, to enhance areas of low-quality bedrock or stony reef. It is important to note that this method of artificial reef creation is not, however, considered by NRW to be a form of enhancement when applied in areas of naturally soft sediment (Armstrong *et al.,* 2019)[5].

110. In 1989, at Poole Bay, an artificial reef was created from concrete blocks and cement stabilised pulverised fuel ash from power stations. The results showed that these blocks were rapidly colonised by a wide variety of epibiota, fish and crustaceans (Review by Armstrong *et al.,* 2019).

111. There will be a design overlap with reef creation and enhancement measures for scour protection, as both will involve the physical placement and appropriate positioning of material on the seabed, increasing surface topography and creating additional reef like habitat for species. There is some overlap with material used, such as rocks, but with concrete used more for artificial reefs than for scour protection (Glarou *et al.,* 2020). Potential products are available

---

[5] This method would only be advocated as part of a licensed development where structures such as breakwaters might be needed, and therefore as a method of enhancing the licensed structure.

that may provide dual purposes for a project, where they can be used both for protecting subsea infrastructure as well as creating or restoring marine habitats across other areas of a project (e.g. Reef Cubes®; Figure 7.7).

**Figure 7.7: Reef Cubes®**

### 7.4.3. Biogenic Reef Restoration

**Management Options**

112. Within the MDZ, areas of Annex I stony reef habitat were frequently overlain by varying coverage of *S. spinulosa* tube aggregations representative of Annex I biogenic reef in some areas (A4.22). The quality of the reefs of *S. spinulosa* observed and levels of 'reefiness' varied, however typically present in 'low' to 'medium' levels. There are previous records of horse mussel (*M. modiolus*) beds around the margins of the MDZ (Section 3.4), however, none were reported from the 2018 baseline surveys (OEL, 2018).

113. As such, it is the potential loss of biogenic *S. spinulosa* reef habitat from within areas of the MDZ from installation and re-powering activities that is of consideration here. Unlike the enhancement options as described for scour protection across hard substrates (e.g. stony and bedrock reef habitats), onsite reef restoration has not yet been demonstrated for the renewables and subsea cable sectors (Table 7.1).

114. Numerous translocations or transplanting studies of biogenic features such as seagrasses has been undertaken as a restoration/enhancement technique. However, following an extensive literature review, no evidence has been found for translocation of *S. spinulosa* or other Sabellarid reefs. The exception was a translocation project, as part of the Tidal Lagoon Swansea Bay Project that translocated existing 'blocks' of honeycomb worm *Sabellaria alveolata* reef (sheet formations encrusting boulders and cobbles) from a potential area of impact, to a new viable intertidal 'receptor' site. It was demonstrated that all translocated specimens survived, however, this had been only monitored across a five-week period (review by Armstrong *et al.,* 2019; MarineSpace Ltd, 2015).

115. In consideration of the above it is concluded that at present, that if localised micro-siting away from Annex I *S. spinulosa* reef is not possible, then there may not be feasible enhancement measures to directly counteract the loss of this feature. Adaptive options may however include, placement of infrastructure across area of 'low reefiness' and avoiding areas of higher quality

reef. Any such micro-siting activities would be discussed in relation with the knowledge of extent and quality of Annex I reef present in the OfDA following the pre-construction surveys, and in consultation with NRW prior to deployment, to ensure an agreed approach was developed and implemented.

**Natural Recovery**

116. The potential colonisation of introduced artificial structures will be an important consideration during the re-powering process, should structures be removed that have been colonised and formed reef features on them during operation. Such a situation would be assessed on a case-by-case basis.

## 7.5. OFFSITE

117. Biodiversity offsetting are conservation activities that are designed to provide biodiversity gain, to compensate for residual losses. It is a policy approach that seeks to minimise the environmental impacts of a development project by ensuring that any impact in one place is compensated for elsewhere. Where appropriate, biodiversity offsetting is an option available to developers to fulfil their obligations under the planning system mitigation hierarchy (UK Government, 2020). Biodiversity offsetting is understood as a 'last resort' in a mitigation hierarchy.

118. Offsite options for the Project should only be considered if it is demonstrated that onsite enhancement or restoration options are not feasible.

119. Offsite enhancement are those that take place away from the Project area, and these can be wide ranging and flexible. They are designed to work with natural processes and to restore natural features. They do not necessarily have to replace or enhance the habitat being impacted by development but instead used to enhance alternative habitat or restore locally scarce recourse. In addition, offsite management options such as habitat creation or modification may be similar to those occurring within the Project area (Armstrong *et al*., 2019). Options available below to three broad measures of:

- Habitat creation, modification or management (e.g. planting of seagrass in a new site);
- Stock enhancement (e.g. release of cultured organism to enhance, conserve or restore fisheries); and
- Co-location (maximisation of marine space with integrated marine planning).

## 7.6. FURTHER OPTIONS

120. A potential scenario exists where both on-site and off-site enhancement options are deemed to be unfeasible for a range of reasons. In this scenario, Menter Môn would seek to engage with NRW to explore further measures that may be able to be implemented to meet an over-arching objective of reducing impacts on/enhancing condition of marine biodiversity.

121. Add details on these further options would be presented in the Final Marine Biodiversity Enhancement Strategy.

## 7.7. ADDITIONAL CONSIDERATIONS

122. There are a series of important considerations with relation to marine ecological enhancement options. These can include social, economic, and environmental (e.g. larval supply, local ecology, hydrodynamic regimes, tidal frame and gradient), Presented below is a summary of some examples of these considerations (cost and biosecurity).

### 7.7.1. Cost

123. Following the review by Armstrong *et al.,* (2019) of the costs of various marine ecological enhancement measures, Table 7.2 below summarises the estimated costs of various options that may be applicable to the Project (onsite options).

124. Costs for enhancement measures will range from simple, cost effect options such as reorientation of replaced natural rock and altering microhabitats by drilling holes, up to more costly habitat restoration and creation. is very simple and costs. It will be important that the costs of adopting ecological enhancement measures should be proportionate to the environmental damage, and that interventions should also be cost-effective (Armstrong *et al.,* 2019).

125. Similarly, considerations will need to be given to the cost of post-construction monitoring of the biodiversity enhancement measures (as outlined in Section 8 below). There may be the option of combining vessel use (e.g. combine monitoring with technical inspections or maintenance works) (Bureau Waardenburg (2017).

### 7.7.2. Biosecurity

126. There are over forty invasive non-native species (INNS) reported to occur within Welsh waters, seven of which are considered invasive with negative effects, these are: *Austrominius modestus* (intertidal barnacle); *Eriocheir sinensis* (Chinese mitten crab); *Botrylloides violaceus* (colonial ascidian); *Magallana gigas* (Pacific oyster); *Crepidula fornicata* (slipper limpet); *Didemnum vexillum* (carpet sea squirt); and *Sargassum muticum* (Japanese wireweed).

127. Furthermore, Anglesey is considered a focal point for INNS due to a high number of hotspots around its coast, including Holy Island and the Menai Strait. E.g., for the colonial ascidian *Didemnum vexillum* in Holyhead Port.

The biosecurity risk associated with the spreading of INNS during the construction and operation of the Project will be mitigated through use of best-practice techniques. An outline Invasive Species Management Plan will also be produced. These control measures will need to also consider the increased risk from INNS into the project area through the introduction of new material into the site from ecological enhancement measures. Post-construction monitoring of enhancement options (see Section 8 below) will also be designed to include the identification and reporting of any INNS present on artificial structures post colonisation

**Table 7.2: Cost summary of potential enhancement options for the Project (Review by: Armstrong *et al.,* 2019)**

| | Enhancement Type | Approximate Cost |
|---|---|---|
| **Vertical structure enhancements** | | |
| Small Pool Structures | 'Vertipools' | £175-£600 per unit (excl. installation) |
| | Confidential 'Vertipool' scheme | £2,500 (incl. installation and monitoring) |
| | Australian 'Flowerpots' | £170 per unit (incl. installation) |
| | ECOncrete® tide pools | £990 per unit (exc. tax/installation) |
| Tiles | ECOncrete® seawall tiles | £350 per $m^2$ |
| | Hartlepool textured panels | £8 - £30 per $m^2$ (additional cost) |
| **Scour protection (incl. reefs)** | | |
| Large Structures | Reef balls/Hives | £900 per unit |
| | Xblock | £700 per unit |
| Small Structures | Boulders, scour gravel | No additional cost to conventional scour protection |
| | BEDE elements | £3.50 per unit |

# 8. MONITORING

128. Following implementation of a given biodiversity enhancement option it is important that monitoring of these various measures is undertaken and aligns closely with NRW(A)'s expectations. Characterisation of the baseline will be provided following the detailed pe-construction surveys, and this can then be compared to the new artificial structures that have been incorporated into the Project. Here, any spatial and temporal colonisation patterns of sessile fauna, site utilisation by mobile fauna such as fish, and the presence of INNS (see Section 7.7.2 above) can be determined. This will improve the understanding of the impacts and relative benefits of artificial structures and ecological enhancement measures.

129. Presented here is a high-level overview of what may be undertaken within the different project areas following enhancement, with relevant examples from other projects and research studies so to indicate expected spatial extent and temporal timescales. A later, detailed review of the relevant published literature will be undertaken, to both help inform the scope of enhancement options and the subsequent monitoring plan and assessments.

## 8.1. INTERTIDAL MONITORING

130. Post-construction monitoring surveys across the intertidal areas at Abraham's Bosom (the landfall site) can be undertaken relatively efficiently and frequently given the limited issues regarding survey constraints (e.g., good site access, limited area, independent of weather conditions). However, if undertaking a single annual survey, it will be important to avoid monitoring during the winter months when algal growth is limited on the shore.

131. It may be expected that after a relatively short-term period (< 24 months) colonisation of the small retro-drilled holes (Figure 7.2) may occur. Within 18 months, macrofauna such as *Littorina* spp. (periwinkles) had been reported within the drilled holes and pools at the Shaldon and Ringmore tidal defence scheme in Devon (Coombes *et al*., 2012). A similar colonisation period was also reported by Evans *et al.* (2016) for drilled rock pools on a breakwater at Tywyn (West Wales) and with a similar species richness reported between natural and drilled rock pools. Colonisation studies such as those described above were undertaken with frequent monitoring in the early stages (e.g., monthly for the first 3 months and quarterly thereafter). Frequency of monitoring for the Project would need to be both suitable and adaptive, but it is likely that for the intertidal area, an indication of enhancement may be determined early on in the post-construction phase across these artificial features.

132. Larger enhancement options at the landfall site, such as retrofitted rock pools (Figure 7.3), may involve a longer monitoring programme. For retro-fitted Vertipools, seasonal surveys (quarterly) over the second and third year of monitoring and long-term change with monitoring after the fifth was undertaken at a seawall on the Isle of Wight (Hall *et al*., 2019). This longer-term project described here was able to initially demonstrate expected succession patterns (e.g., opportunistic algae to fucoids), an increase in number of functional groups, and the recovery of the local habitat from the impacts of installation of retrofitting itself (<3 years).

## 8.2. SUBTIDAL MONITORING

### 8.2.1. Scour Protection

133. As outlined in sections 7.3.1 and 7.4.1, scour protection will be required in certain areas within the ECC and the MDZ and this provides an enhancement option for these protective measures.

134. Monitoring of these artificial scour protection features and adjacent habitats is expected to be localised within the Project area. A detailed literature review by Bureau Waardenburg (2017) has summarised potential monitoring techniques for sour protection structures in offshore windfarms and of which some methods may be applicable to the Project (Table 8.1).

135. The wide range of options listed can be rationalised into an approach appropriate for the scale of proposed measures that may be required for the Project, but with an aim to be comparable to the methodology and data acquired from the pre-construction surveys. The methods also cover a range of invasive (e.g., grab sampling) and non-destructive techniques (e.g. DDV and BRUV) and so it is also important to ensure limited impact occurs to the subtidal environment during these monitoring surveys.

**Table 8.1: Summary of potential survey and monitoring methods for scour protection (adapted from the review by: Bureau Waardenburg, 2017). (GIS = Geographical Information System; DDV = drop down video, ROV = remotely operated vehicle; MNCR: Marine Nature Conservation Review)**

| Method | Parameter | Frequency | Analysis of Change |
|---|---|---|---|
| **BOAT BASED SURVEYS** | | | |
| **Acoustic** | • Substrate distribution<br>• Habitat/community distribution | Pre-installation, then 2-5 years | Visual comparisons, GIS spatial analysis |
| **DDV/photography** | • Distribution of habitat/community/biotope<br>• Presence of species<br>• Maintained presence of priority species at specific locations. | Pre-installations then annually | Statistical comparison of biotope composition of site. Simple comparison of presence. |
| **ROV video/photography** | As above for DDV | As above for DDV | As above for DDV |
| **Grab / core sampling** | • Species abundance (per unit area), richness and diversity<br>• Community composition | Annually, but at least 2 samples pre-installation to establish natural variability. | Statistical comparisons (e.g., ANOVA). |
| **Shrimp Trawl** | • Species abundance and weight per unit area<br>• Species richness and diversity<br>• Community composition | Pre-installation and annually | Statistical comparisons (e.g., ANOVA) |
| **Triple-D dredge** | As above for shrimp trawl | As above for shrimp trawl | As above for shrimp trawl |
| **Baited remote underwater video (BRUV)** | Presence/absence of large mobile species. | As above for shrimp trawling | Comparison of proportional occurrence. |
| **DIVER SURVEYS** | | | |
| **Core sampling** | As above for Grab/core sampling | As above for Grab/core sampling | As above for Grab/core sampling |
| **Video/photography** | • Broad community character<br>• Substrate condition | Pre-installation then every 3-6 months. | Simple visual comparison. |
| **Transects (visual survey)** | • Semi-quantitative species abundance (MNCR Phase 2)<br>• Biotope presence and distribution | Pre-installation then a minimum of 2 per year. | Direct comparison of community attributes. |
| **Quadrats** | • Species abundance (counts or % cover)<br>• Species richness/ diversity<br>• Abundance of selected conspicuous species | Pre-installation then a minimum of 2 per year. | Multivariate and univariate (ANOVA, GLM etc). |
| **Airlift sampling** | • Species abundance per unit area<br>• Species richness/ diversity<br>• Community composition | Annually after installations | n/a |
| **Net scrape sampling** | As above for airlift sampling | As above for airlift sampling | n/a |

### 8.2.2. Artificial Reef

The list of potential methodologies summarised in Table 8.1 above for scour protection may also be applicable for monitoring of artificial reefs (outlined in Section 7.4.2), as there will be a design overlap between these two types of enhancement measures, and research has shown that scour protection meets the requirements to function as an artificial reef (Glarou *et al.* ,2020).

## 9. SUMMARY

136. This Outline Strategy sets out initial thoughts on the key issues linked to potential marine biodiversity enhancement measures that may need to be adopted on the Morlais project. It aims to form the starting point for further discussions between Menter Môn and relevant consultees (e.g. NRW) as to the most feasible enhancement options for the Project should they be required. It is expected that this Outline Strategy will evolve during the planning and consenting process and that, post-consent, it will be updated to a Final Marine Biodiversity Enhancement Strategy document.

137. The document provides a summary of key seabed habitats in the Morlais OfDA and the potential role of biodiversity enhancement to act as a secondary mitigation measure if/when the primary measure of micro-siting is judged to be insufficient.

138. With respect to the *process* of potentially implementing enhancement measures the following key principles are proposed:

- Micro-siting to avoid loss of any Annex I habitat should be the primary form of mitigation;
- If micro-siting is not feasible, loss ($m^2$) of stony and/or bedrock reef totalling up to 1% of the total areas of the OfDA is acceptable;
- If the loss ($m^2$) of stony/bedrock reef exceeds 1% of the total area of the OfDA, appropriate biodiversity enhancement measures should be implemented;
- Any amount of habitat loss ($m^2$) of medium/high quality *S. spinulosa* reef (as defined by Gubbay, 2007) and/or Modiolus reef will require appropriate biodiversity enhancement measures to be implemented;
- If, following review of pre-construction survey data, NRW agree that some areas of *S. spinulosa* reef are low quality (as defined by Gubbay, 2007), then biodiversity enhancement will not be required;
- Any loss of low quality *S. spinulosa* reef will contribute towards the 1% of total area of OfDA measure.

139. Potential exists for enhancement measures to be (a) developed and installed *in situ* on project infrastructure already deployed; (b) factored into the design of project infrastructure not yet deployed; (c) deployed away from actual project infrastructure, i.e. within other parts of the Morlais OfDA; and/or off-site.

140. There may be a combination of enhancement measures that can be incorporated into the Project, each with a range of technical complexity and cost, which reflects the range of habitats and infrastructure that encompass the Project. Figure 9.1 below summarises the broad decision-making pathways for potentially exploring biodiversity enhancement options for the Project.

141. It will be important that in adopting enhancement measures that they meet the Welsh sustainable management of natural resources (SMNR) principles under the Environment (Wales) Act 2016. These principles are as follows:

- **Adaptive management** – Managed adaptively by planning, monitoring, reviewing and where appropriate changing action;
- **Scale** - Consider the appropriate spatial scale for action; •
- **Collaboration and engagement** - Promote and engage in collaboration and co-operation;
- **Public participation** - Make appropriate arrangements for public participation in decision making;
- **Multiple benefits** - Take account of the benefits and intrinsic value of natural resources and ecosystems; •
- **Long term** - Take account of the short, medium and long-term consequences and action;
- **Preventative action** - Take action to prevent significant damage to ecosystems; and
- **Building resilience** - Take account of the resilience of ecosystems, in particular the following aspects:
  - diversity between and within ecosystems;
  - the connections between and within ecosystems;
  - the scale of ecosystems;
  - the condition of ecosystems (including their structure and functioning); and
  - the adaptability of ecosystems.

In contrast to terrestrial systems, the more open and dynamic marine environment results in complex ecosystem processes occurring over a wider range of spatial and temporal scales. Thus, the principle of 'working with natural processes'/'nature-based solutions' is particularly important when considering the resilience of marine ecosystems and to consider how far to pursue ecological enhancement within a Project area or whether to consider broader offsite enhancement measures (Armstrong *et al.,* 2019).

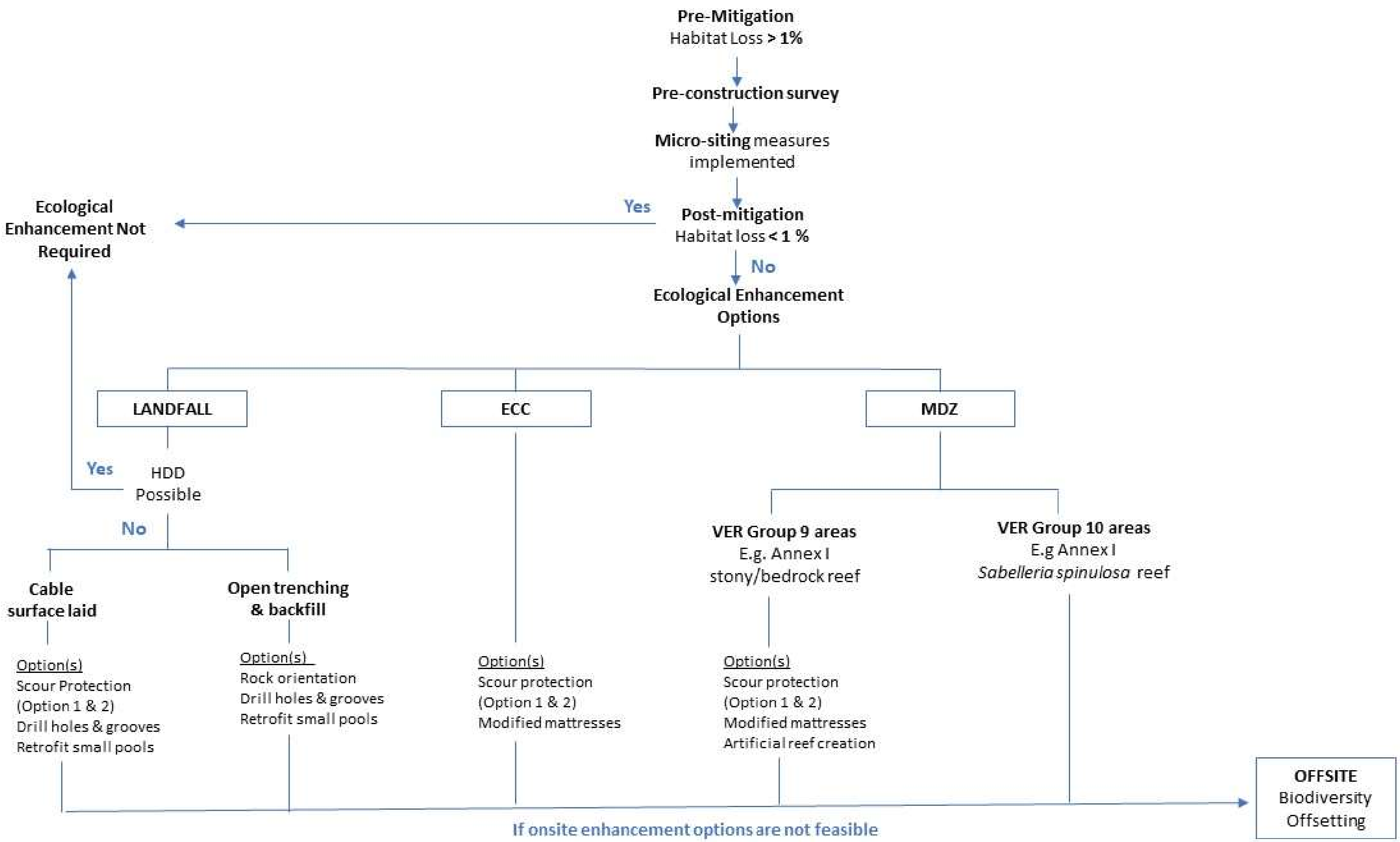


**Figure 9.1: Summary decision making process for ecological enhancement for the Project.**

## 10. REFERENCES

Armstrong, S., West, V.A., Hull S., Scott, C.R., 2019. Supporting the implementation of the Welsh National Marine Plan: Enhancing marine ecosystems. 106 pp NRW Bangor.

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, 98p.

Coombes, M.A., Naylor., L.A., Jackson, K.,Thompson, R.C., 2012. Shaldon and Ringmore Tidal Defence Scheme. Ecological Enhancement Monitoring Report (18 months port-construction). Report to the Environment Agency by the University of Exeter and University of Plymouth 20pp.

European Commission, 2013. Interpretation Manual of European Union Habitats. EUR28 Version. https://ec.europa.eu/environment/nature/natura2000/marine/docs/appendix_1_habitat.pdf [Accessed November, 2020].

Glarou, M., Zrust, M., Svendsen, J.C., 2020. Using artificial-reef knowledge to enhance the ecological function of offshore wind turbine foundations: implications for fish abundance and diversity. Journal of Marine Science and Engineering. 332, doi: 10.3390/jmse8050332.

Gubbay S., 2007.Defining and managing *Sabellaria spinulosa* reefs: Report of an inter-agency workshop. JNCC Report No. 405.

Hall, A.E., Herbert, R.J.H., Britton, R., Hull, S.J., 2018. Ecological enhancement techniques to improve habitat heterogeneity on coastal defence structures. Estuarine, Coastal and Shelf Science. 210, 68-78.

Hall, A.E., Herbert, R.J.G., Britton, J., Boyd, I.M., George, N.C., 2019. Shelving the coast with vertipools: retrofitting artificial rock pools on coastal structures as mitigation for coastal squeeze. Frontiers in Marine Science. doi: 10.3389/fmars.2019.00456.

Jenkins C., Eggleton, J., Barry, J., O'Conner, J., 2018. Advances in assessing *Sabellaria spinulosa* reefs for ongoing monitoring. Ecology and Evolution 2019: 1-15.

MarineSpace Ltd, 2015. Advice for Adaptive Environmental Management, and Marine Biodiversity Enhancement Measures for Coastal Lagoon Developments. 129 pp.

NRW, 2019. Benthic habitat assessment guidance for marine developments and activities. A guide to characterising and monitoring *Sabellaria* reef. Guidance Note: GN030d. 63 pp.

RHDHV, 2019a. Morlais Project Environmental Statement Chapter 4: Project Description Volume 1. 69pp.

RHDHV, 2019b. Morlais Project Environmental Statement Chapter 9: Benthic and Intertidal Ecology Volume 1. 75 pp.

RHDHV, 2019c. Morlais Project Environmental Statement Chapter 10: Fish and Shellfish Ecology Volume 1. 83 pp.

Ocean Ecology Ltd, 2018 Morlais Demonstration Zone (MDZ) Benthic Ecology Characterisation Survey 2017. Technical Report. 21 pp.

Tyler-Walters, H. and Neal, K.J. 2017. *Haliclystus auricula* Kaleidoscope jellyfish. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. [cited 12-11-2020]. Available from: https://www.marlin.ac.uk/species/detail/2051.

UK Government, 2013. Biodiversity offsetting.https://www.gov.uk/government/collections/biodiversity-offsetting [Accessed November 2019].

Welsh Government, 2019. Welsh National Marine Plan. November 2019. https://gov.wales/sites/default/files/publications/2019-11/welsh-national-marine-plan-document_0.pdf [Accessed November 2020].

Welsh Government, 2020a. Lle A Geo-Portal for Wales. Environment (Wales) Act 2016 Section 7 and OSPAR: Marine Habitats. http://lle.gov.wales/catalogue/item/MarineBAPOSPARHabitats/?lang=en [Accessed November 2020].

Welsh Government, 2020b. Welsh National Marine Plan Implementation Guidance. June 2020. https://gov.wales/sites/default/files/publications/2020-06/welsh-national-marine-plan-implementation-guidance.pdf [Accessed November 2020].