

Baseline Benthic Habitat Survey Report

For Carn Ar Wig and Porthlysgi Trial Farms

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1. Introduction

1.1. Câr-Y-Môr

For the Love of the Sea Ltd is a Community Benefit Society trading as Câr-Y-Môr. The society was registered in Aug 2019. This society now has over five hundred committed members. The Society is managed by twenty individuals, with combined experience in aquaculture and fisheries, marine conservation, community engagement, business development and management skills. Câr-Y-Môr also purchased Solva Seafoods in 2020 to create local jobs and develop a trading record. In 2023 the businesses were fully merged and it has acted as a route to sell seaweed and shellfish grown on the farms.

Câr-Y-Môr has pioneered Wales's first regenerative ocean farm, located on the St Davids Peninsula, with initial trial sites at Carn ar Wig and Porthlysgi. These sites cultivate mussels, native oysters, and scallops without the use of fertilisers, pesticides, or freshwater, providing a sustainable and nutritious food source. The success of these trial sites led to the establishment of a larger, 3-hectare site at St Justinians. The long-term goal is to inspire similar farming methods across Wales, enhancing local marine biodiversity, supporting community well-being, creating sustainable ocean jobs, and providing young people with pathways into the integrated Welsh seafood sector.

1.2. Trial Sites: Carn ar Wig and Porthlysgi

Carn ar Wig and Porthlysgi were the first trial sites established by Câr-Y-Môr to demonstrate the viability of restorative ocean farming. The surrounding sea has a salinity of 32-35 ppt salinity, with high tidal currents, delivering massive quantities of nutrient rich water to the farmed species. The water quality is classed as 'A Grade' (CEFAS, 2024) with no local significant freshwater input.

The farming operations at these sites involve the use of New Zealand-style longline systems for mussels and suspended lantern nets for oysters and scallops. The sites are visited regularly by the farm management team throughout the year. There are also cages placed on the seabed within the currently licensed areas which contain native oysters to be used in a local native oyster restoration project.



Figure 1. Current and Proposed Extension Areas at the Carn ar Wig Site. The current area is highlighted in orange, while the proposed extension area is shown in purple.

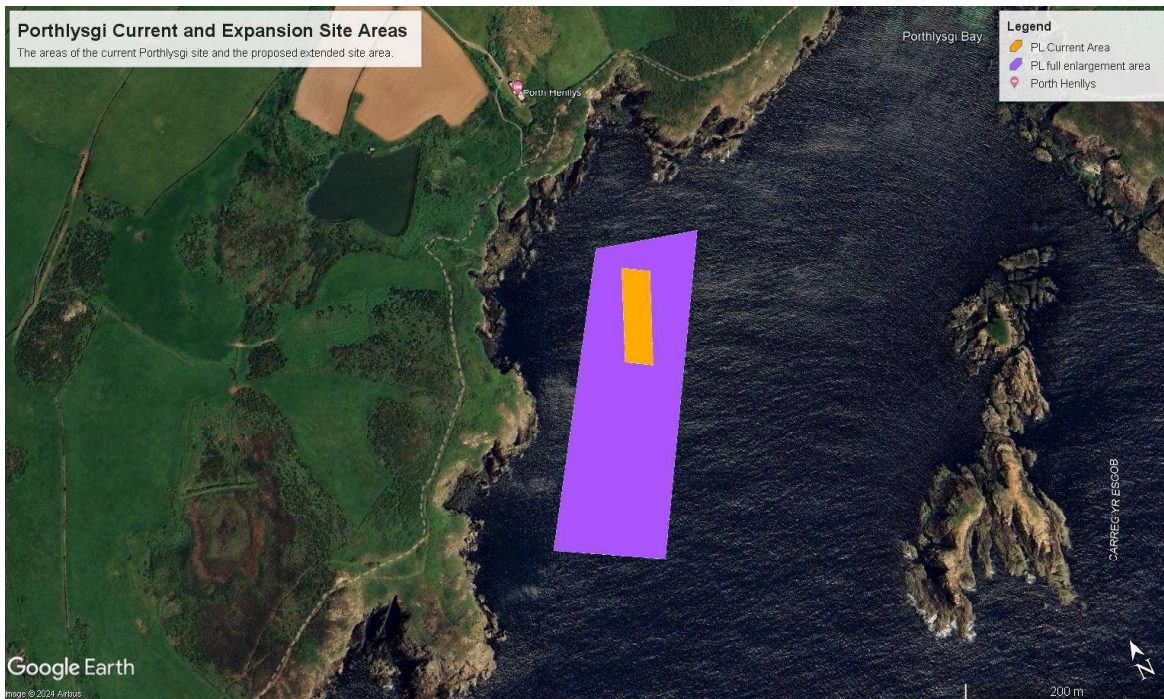


Figure 2. Current and Proposed Extension Areas at the Porthlysgi Site. The existing area is highlighted in orange, with the proposed extension area depicted in purple.

Trial Site Coordinates:

Site Name	Current Coordinates	Expansion Coordinates
Porthlysgi trial site	Longitude: -5.304682, Latitude: 51.863036 Longitude: -5.304309, Latitude: 51.862895 Longitude: -5.304918, Latitude: 51.862058 Longitude: -5.305277, Latitude: 51.862199	Longitude: -5.303353, Latitude: 51.863061 Longitude: -5.306021, Latitude: 51.860414 Longitude: -5.307452, Latitude: 51.860913 Longitude: -5.304722, Latitude: 51.863583
Carn ar Wig trial site	Longitude: -5.315736, Latitude: 51.868074 Longitude: -5.315337, Latitude: 51.867964 Longitude: -5.315830, Latitude: 51.867141 Longitude: -5.316227, Latitude: 51.867242	Longitude: -5.315380, Latitude: 51.867975 Longitude: -5.315872, Latitude: 51.867152 Longitude: -5.316970, Latitude: 51.867463 Longitude: -5.316296, Latitude: 51.868174 Longitude: -5.315539, Latitude: 51.868951 Longitude: -5.315034, Latitude: 51.868803

2. Objectives of the Baseline Benthic Habitat Survey

The objectives of conducting these surveys were as follows:

1. **Analyse previously established Broad-scale Habitat Maps** to provide insight on which areas of the current and proposed farms may need more detailed surveying if there is potential for protected or fragile habitats to be present. These maps will then be compared to actual broad-scale habitat maps produced from the survey data to see how this predicted data either differs from or supports the actual survey data.
2. **Conduct side-scan sonar surveys along predetermined transects** to produce detailed maps of the seafloor's physical structure within both the existing trial sites and the proposed extension areas. This will identify substrate types and key features such as sediment composition, rocky outcrops, and biogenic structures.
3. **Perform ground-truthing at predetermined locations** using drop-down video (DDV) systems to visually confirm the habitats and features identified by the side-scan sonar, ensuring accurate habitat classification and interpretation.
4. **Utilise remotely operated vehicles (ROVs) at selected locations**, particularly in complex or sensitive habitats, to enhance the ground-truthing process and provide high-resolution imagery for targeted inspection and sampling. ROV will only be used where DDV is ineffective.
5. **Assess the suitability and sensitivity of habitats** at the proposed extension sites, identifying any areas that may be particularly vulnerable to shellfish farming activities. This will include

assessing the risk of physical disturbance, changes in sediment composition, or alterations in benthic community structure.

6. **Use the baseline data to facilitate ongoing monitoring efforts**, enabling the detection of any changes or trends over time and assessing the long-term impacts of shellfish farming on benthic habitats.
7. **Provide robust, ground-truthed data** to inform decision-making processes for both the continued operation of existing trial sites and the development of proposed extension areas.

3. Survey Methodology

3.1. Survey Design

The survey undertaken covered both the current and proposed extension areas of the shellfish farms at Porthlysgi and Carn ar Wig. To ensure efficient data collection:

- **Predicted and Actual Broad-Scale Habitats:** Using data already available through NRW, predicted broad-scale habitat maps will be produced for the current and proposed farms at both locations to highlight areas of potential interest which would need more detailed surveying. Actual broad-scale habitat maps will then be produced from surveys using the methods described below.
- **Side-Scan Sonar:** Conducted with the Starfish 990F for high resolution imaging along predetermined transects with a 20-metre swath width. Transects are spaced and slightly overlapped to ensure complete coverage and eliminate dead zones as shown in Figure 3 and 4. This method will provide detailed maps of the seafloor's physical structure, including substrate types and key features.



Figure 3. Actual Side-Scan Sonar Transect undertaken at the Carn Ar Wig site. The red continuous line represents the path taken by the Starfish 990F to obtain side-scan data of the seabed across the full expansion site proposed at Carn Ar Wig.

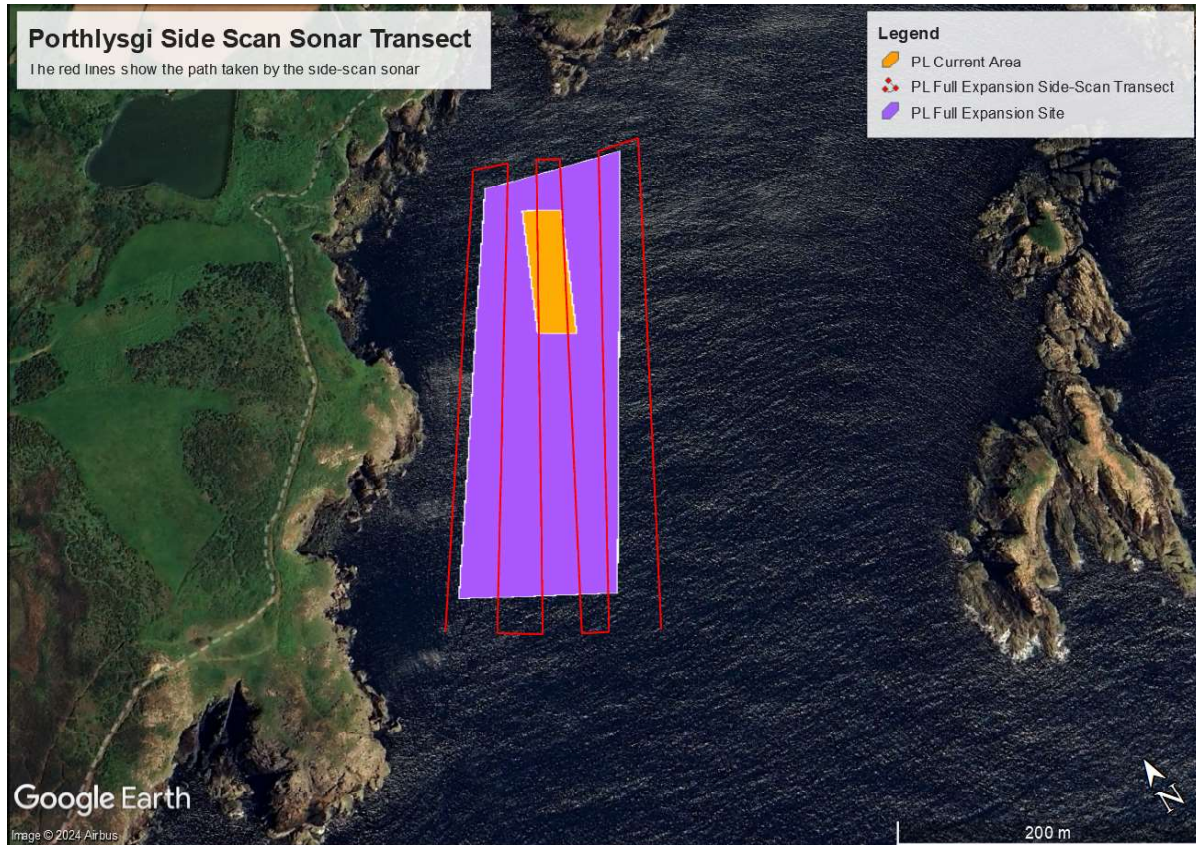


Figure 4. Actual Side-Scan Sonar Transect undertaken at the Porthlysgi site. The red continuous line represents the path taken by the Starfish 990F to obtain side-scan data of the seabed across the full expansion site proposed at Porthlysgi.

- **Diver Footage:** Ground-truthing was completed by using existing diver footage from previous maintenance dives on the current anchors and the ground chains. Stills from this footage have then been extracted and used here to show the seabed and habitats present where the anchors are currently having a potential effect on the seabed. Footage of maintenance performed on the oyster cages at Carn Ar Wig provides evidence of the habitat types that exist between the lines on the current farm.
- **Drop-Down Video (DDV) and ROV Surveys:** Further ground-truthing was completed by using a Drop Down Video (DDV) camera to take footage of the seabed around the proposed anchor locations for each farm. Stills from this footage have then been extracted and used here to show the seabed and habitats present where the anchors will have greatest effect. Footage of under the farms was also recorded to provide evidence of potential disturbance levels on the seabed as a result of the shellfish cultivation taking place above. As the footage from the DDV was of a high enough quality, it was decided that use of an ROV was not required at this stage. However, a previous report provided to NRW in 2021 had already completed ROV surveys on St Justinian's and Porthlysgi and so this data has been used here to complement the data for Porthlysgi.

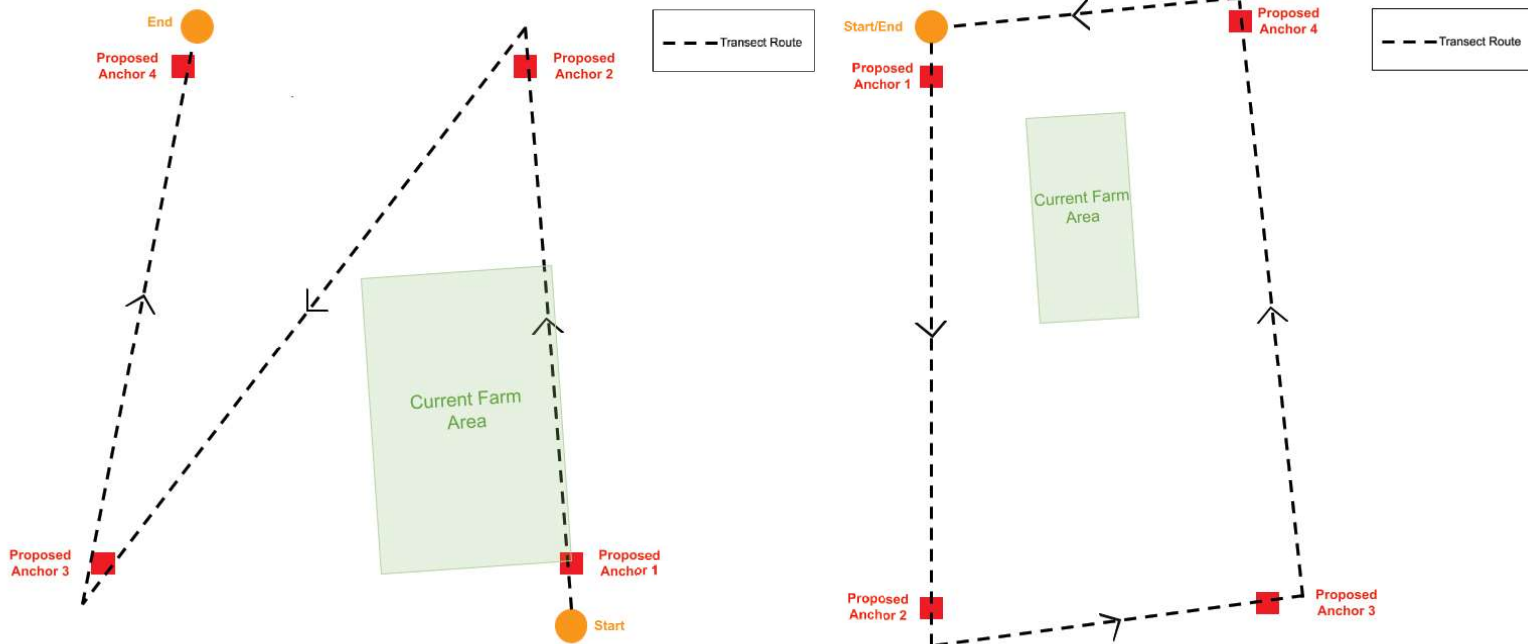


Figure 5. Transect Routes taken for the Drop Down Video collection at Carn Ar Wig and Porthlysgi. Red squares show the proposed anchor sites which were surveyed, and the green squares show the current farm areas in relation to this.

4. Results

4.1. Predicted Broad-Scale Habitats

The JNCC Combined Level 3 Map or the EUSeaMap 2023 would have been preferred for this comparison as they provide the most recent data compiled, however when looking at the farm areas in the Ramsey Sound there was not sufficient data to accurately assign habitat types to the farm locations. After discussions with NRW, it was decided that the most appropriate maps to use were the HABMAP Data catalogue (HABMAP Combined Map 2010) and the Article 17 predicted reef maps from DataMapWales which together show the predicted habitat types at both farms as well as potential protected reef areas. The data was imported into QGIS and the following maps were created.

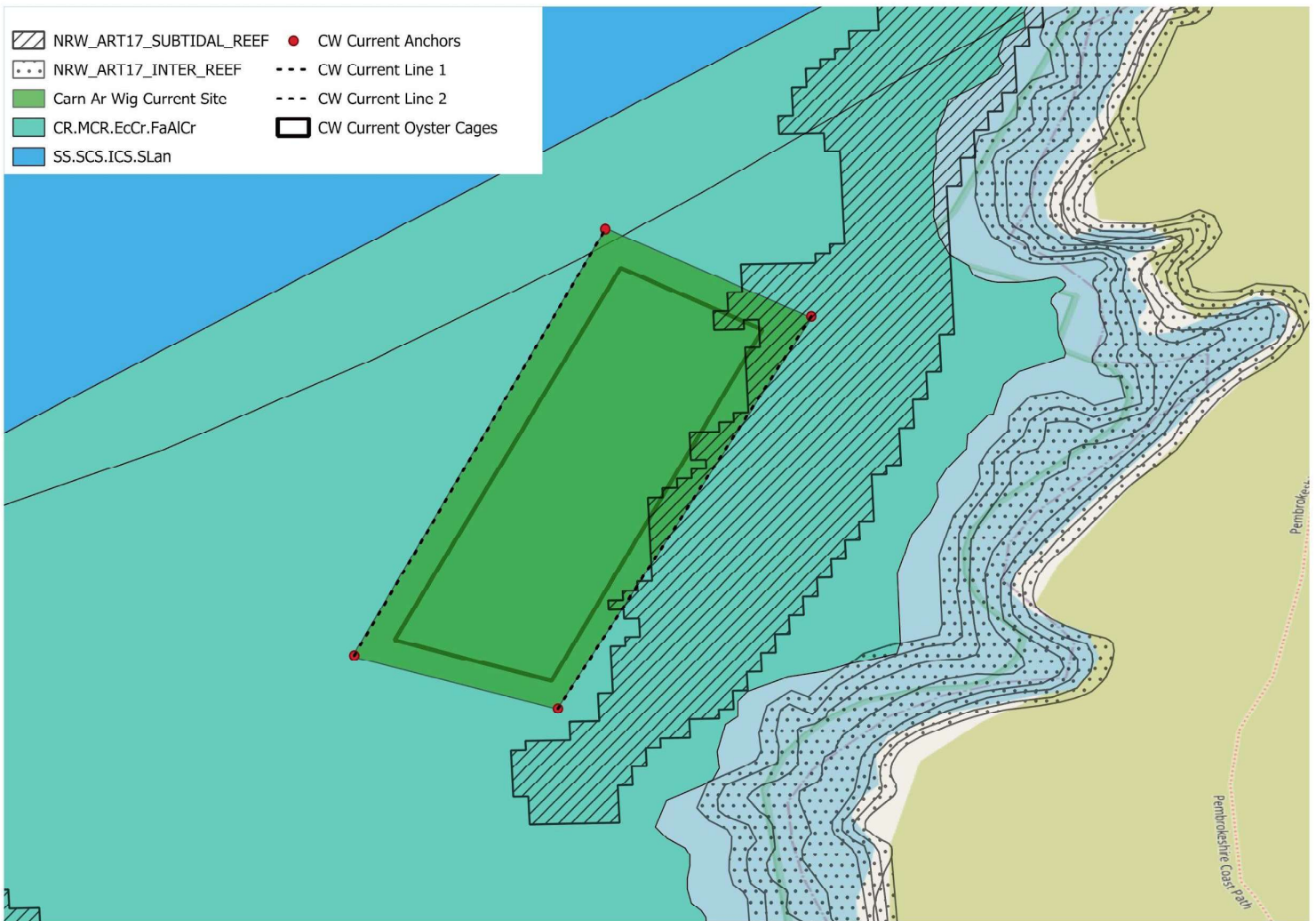


Figure 6. Predicted Broad-Scale Habitats at the current Carn Ar Wig Farm. Showing subtidal and intertidal reefs in black hashed/dotted areas, oyster cage locations inside the farm area and habitat types CR.MCR.EcCr.FaAlCr (Faunal and algal crusts on exposed to moderately wave-exposed circalittoral rock) and SS.SCS.ICS.SLan (Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand).

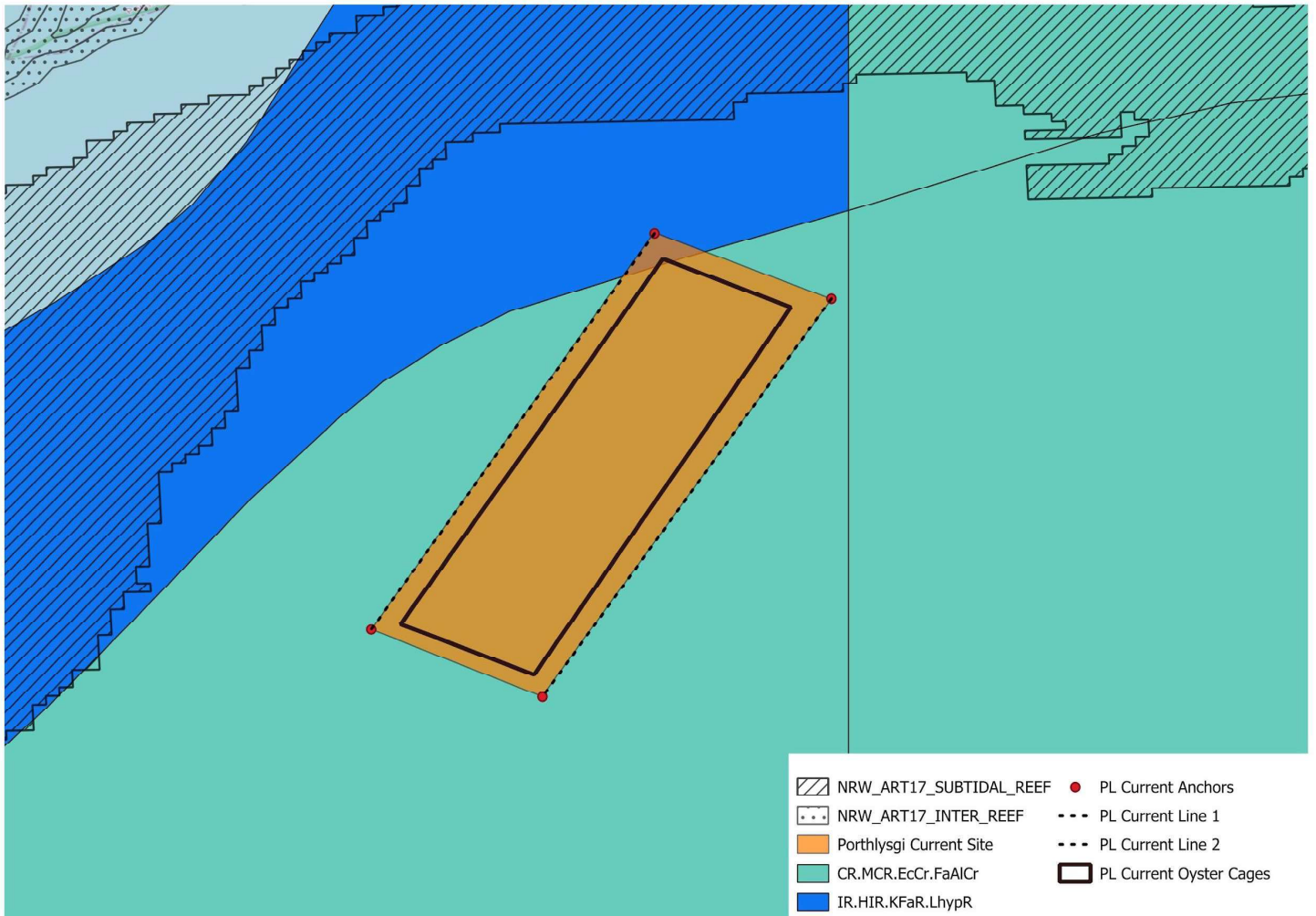


Figure 7. Predicted Broad-Scale Habitats at the current Porthlysgi Farm. Showing subtidal and intertidal reefs in black hashed/dotted areas, oyster cage locations inside the farm area and habitat types CR.MCR.EcCr.FaAlCr (Faunal and algal crusts on exposed to moderately wave-exposed circalittoral rock) and IR.HIR.KFaR.LhypR (*Laminaria hyperborea* with dense foliose red seaweeds on exposed infralittoral rock).

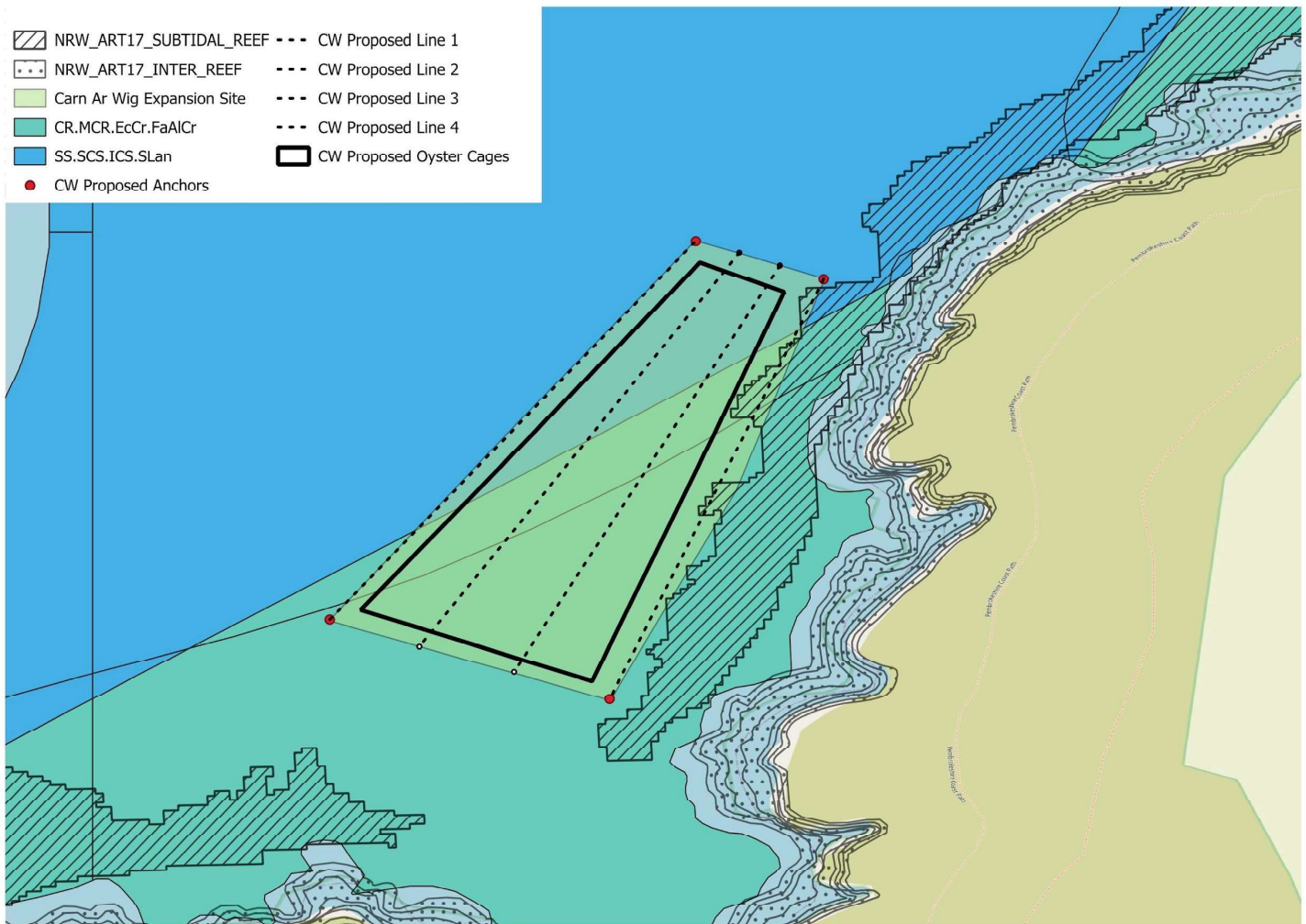


Figure 8. Predicted Broad-Scale Habitats at the proposed Carn Ar Wig Farm. Showing subtidal and intertidal reefs in black hashed/dotted areas, oyster cage locations inside the farm area and habitat types CR.MCR.EcCr.FaAlCr (Faunal and algal crusts on exposed to moderately wave-exposed circalittoral rock) and SS.SCS.ICS.SLan (Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand).

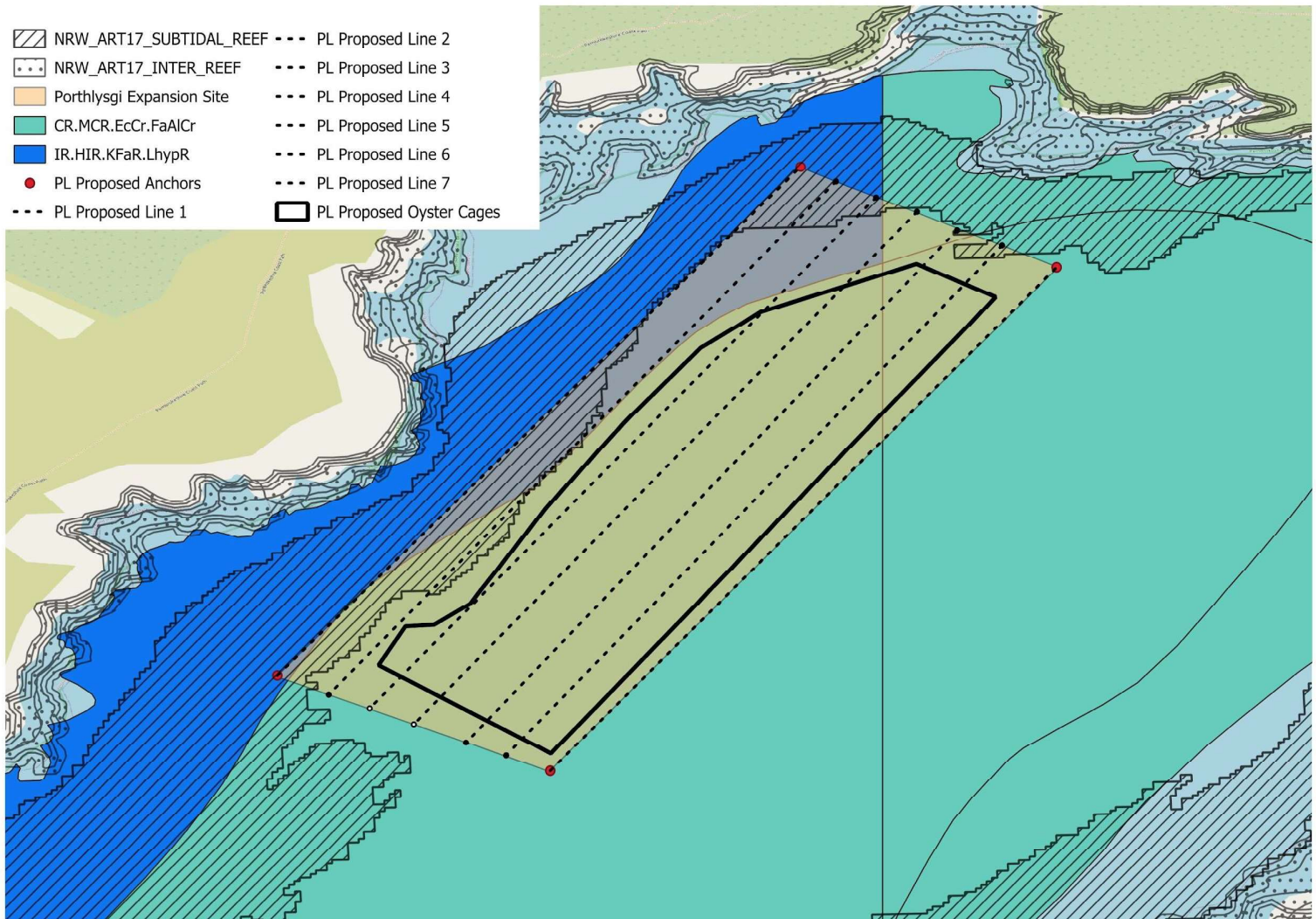


Figure 9. Predicted Broad-Scale Habitats at the proposed Porthlysgy Farm. Showing subtidal and intertidal reefs in black hashed/dotted areas, oyster cage locations inside the farm area and habitat types CR.MCR.EcCr.FaAlCr (Faunal and algal crusts on exposed to moderately wave-exposed circalittoral rock) and IR.HIR.KFaR.LhypR (Laminaria hyperborea with dense foliose red seaweeds on exposed infralittoral rock).

4.2. Side Scan Sonar Results

Both sites were surveyed for Side-Scan Sonar on the same day. As it had been decided that the high resolution Starfish Sonar would be used, the original side-scan transects were updated to increase the number of passes taken. This was because the high resolution sonar has a smaller swath width than the low resolution sonar which was described in the original plan. The data was imported into Google Earth Pro and then cleaned up to reduce overlapping of images and provide a clearer view of the data. Figures

10 to Figure 13 below show the Side-Scan images at each of the existing and proposed farm areas for Carn Ar Wig and Porthlysgi and Figures 14 to 17 show the potential habitat types derived from this data.



Figure 10. Actual Side-Scan Sonar undertaken at the current Carn Ar Wig site. Red lines represent the current longlines, anchors show the current anchors and blue lines represent the ground chain between anchors.



Figure 11. Actual Side-Scan Sonar undertaken at the proposed Carn Ar Wig site. Red lines represent the current longlines, anchors show the current anchors and blue lines represent the ground chain between anchors.

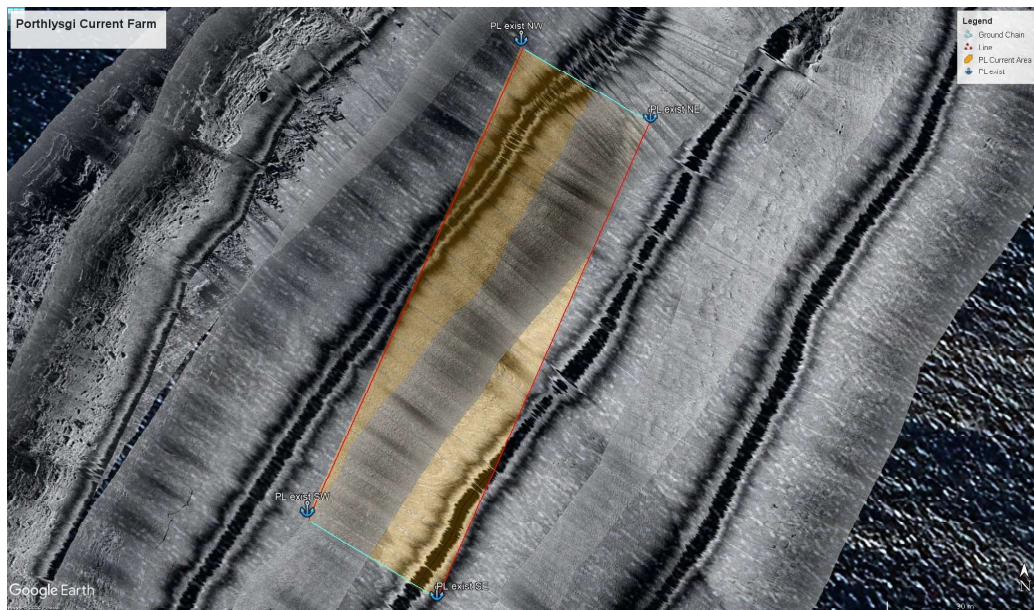


Figure 12. Actual Side-Scan Sonar undertaken at the current Porthlysgi site. Red lines represent the current longlines, anchors show the current anchors and blue lines represent the ground chain between anchors.



Figure 13. Actual Side-Scan Sonar undertaken at the proposed Porthlysgi site. Red lines represent the current longlines, anchors show the current anchors and blue lines represent the ground chain between anchors.

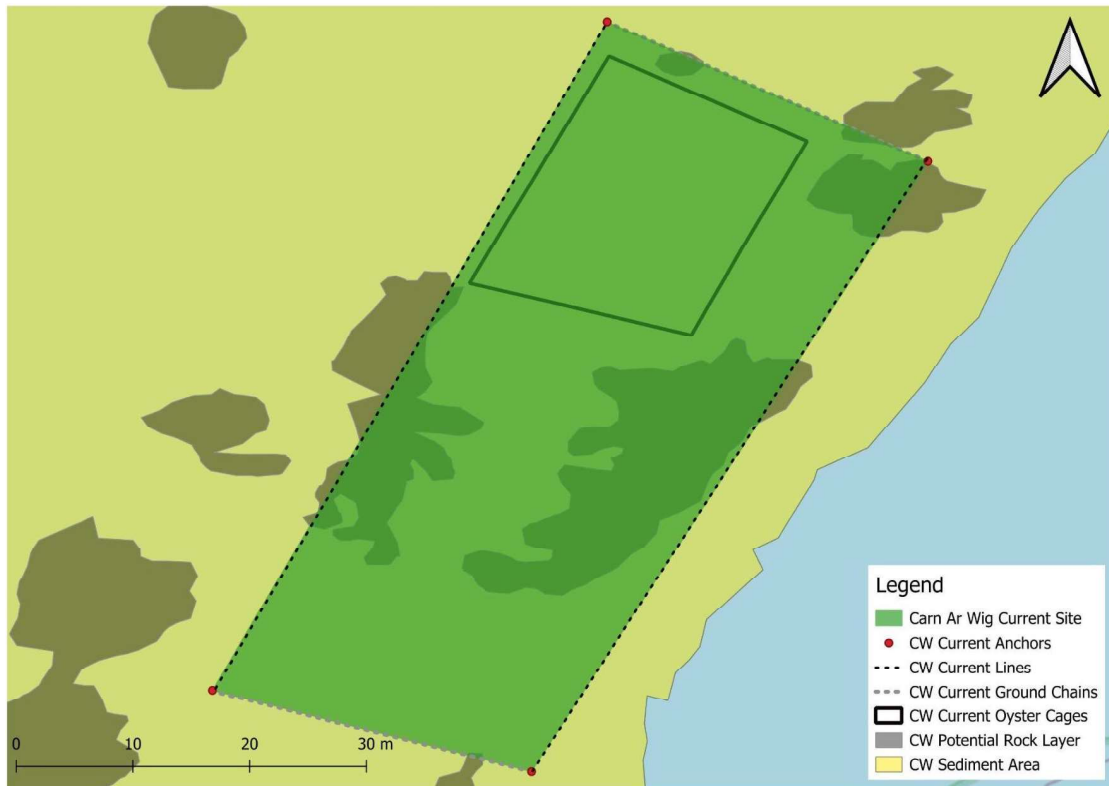


Figure 14. Actual Broad-scale Habitat derived from the Side Scan Sonar of the current Carn Ar Wig farm. Black lines represent the current longlines, red dots show the current anchors and grey lines represent the ground chain between anchors. Yellow areas are sediment and grey areas are potential rocky areas.

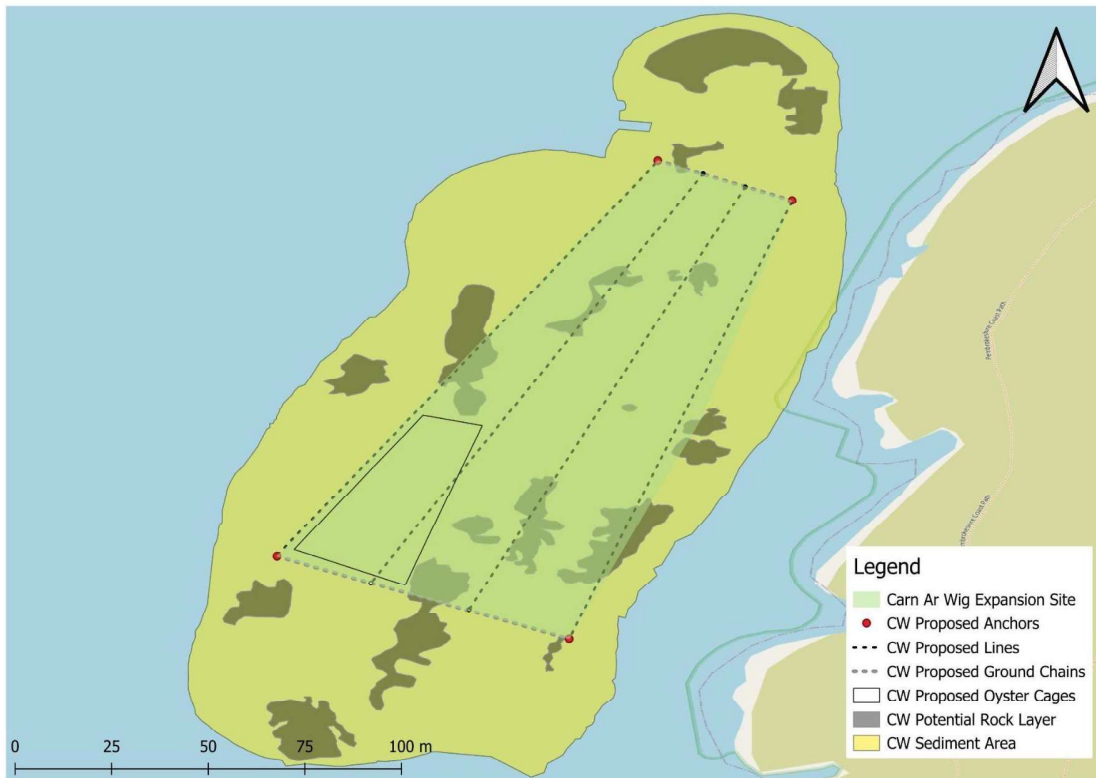


Figure 15. Actual Broad-scale Habitat derived from the Side Scan Sonar of the proposed Carn Ar Wig farm. Black dotted lines represent the proposed longlines, red dots show the proposed anchors and grey dotted lines represent the ground chain between anchors. Yellow areas are sediment and grey areas are potential rocky areas.

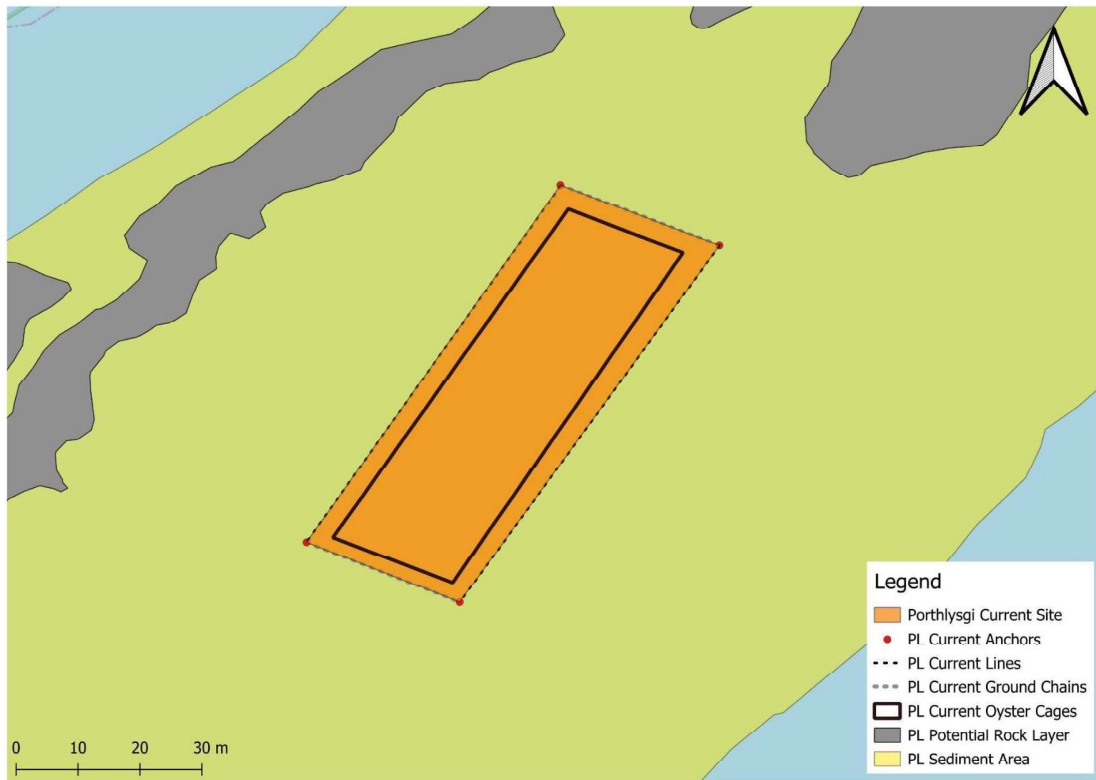


Figure 16. Actual Broad-scale Habitat derived from the Side Scan Sonar of the current Porthlysgi farm. Black dotted lines represent the current longlines, red dots show the current anchors and grey dotted lines represent the ground chain between anchors. Yellow areas are sediment and grey areas are potential rocky areas.

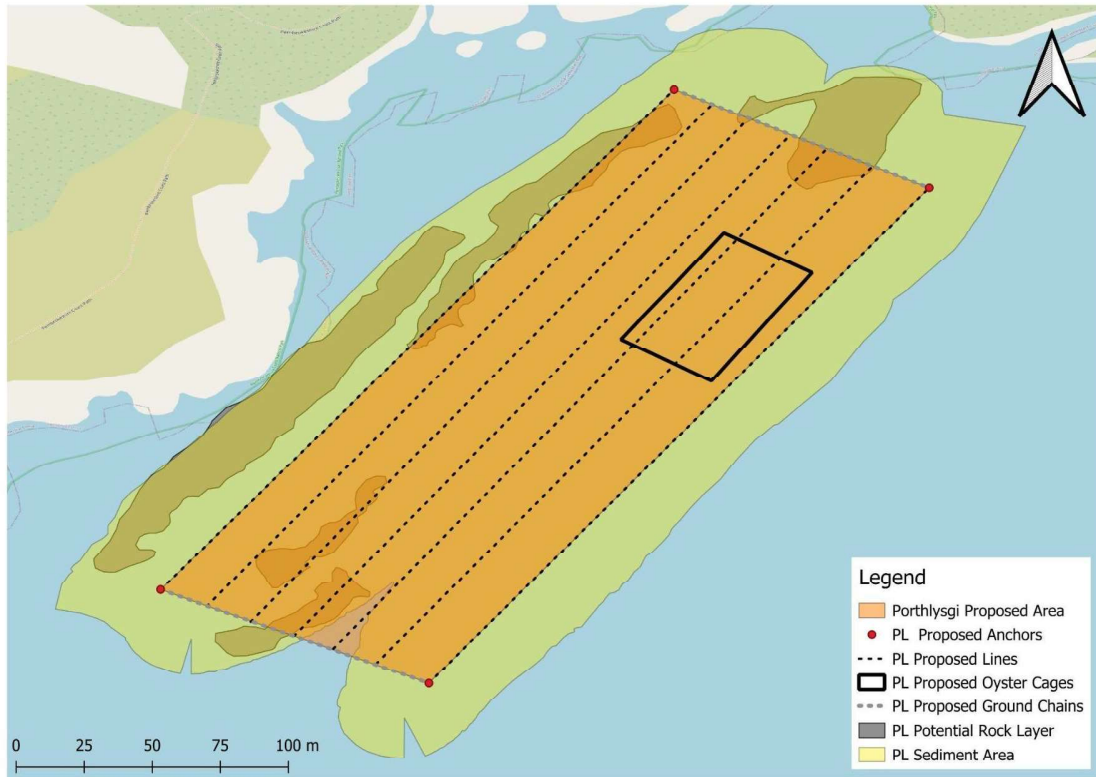


Figure 17. Actual Broad-scale Habitat derived from the Side Scan Sonar of the proposed Porthlysgi farm. Black dotted lines represent the current longlines, red dots show the current anchors and grey dotted lines represent the ground chain between anchors. Yellow areas are sediment and grey areas are potential rocky areas.

4.3. Diver Footage Results with Actual Broadscale Habitats

Previous diver footage was taken from the most recent maintenance dives which were performed during September 2024 at Porthlysgi and August 2024 at Carn Ar Wig. The figures below show the locations of still images taken from this dive footage, which can be seen along with interpretations of the habitat types in the discussion section of this report:



Figure 18. Ground Truthing Points from Diver Footage of the North end of the current Carn Ar Wig farm. Black dotted lines represent the current longlines, red dots show the current anchors and grey dotted lines represent the ground chain between anchors. Yellow areas are sediment and grey areas are potential rocky areas and black circles indicate ground truthing points.



Figure 19. Ground Truthing Points from Diver Footage of the South end of the current Carn Ar Wig farm. Black dotted lines represent the current longlines, red dots show the current anchors and grey dotted lines represent the ground chain between anchors. Yellow areas are sediment and grey areas are potential rocky areas and black circles indicate ground truthing points.

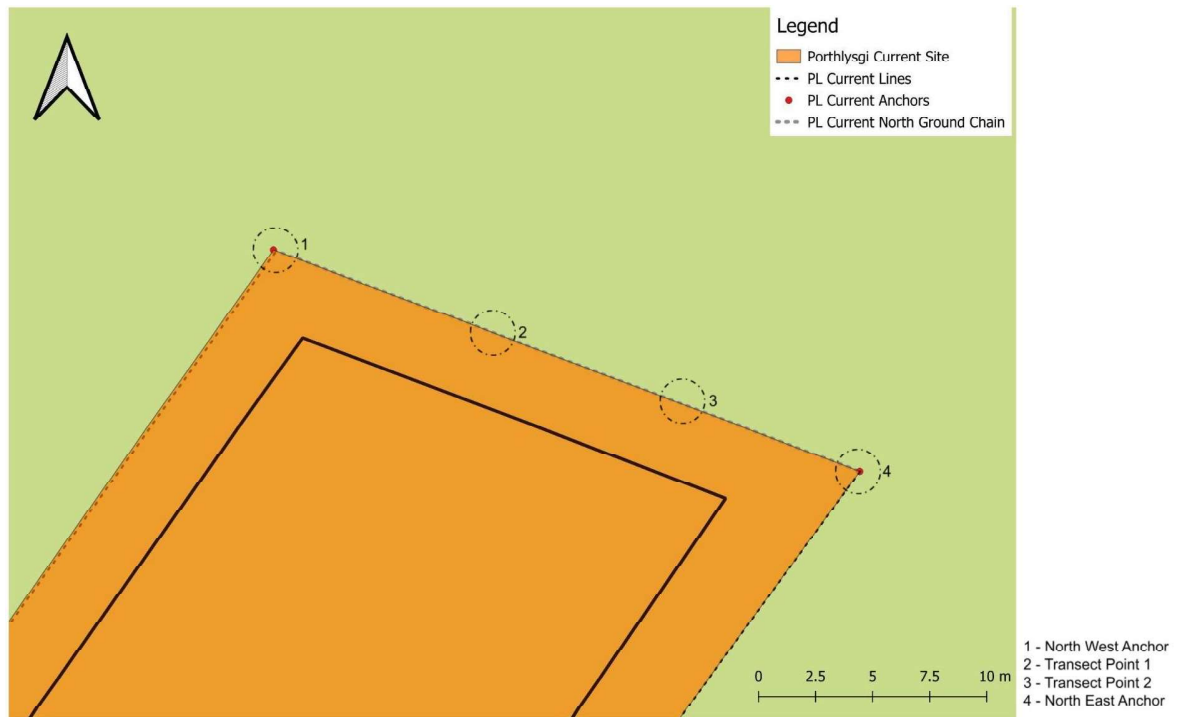


Figure 20. Ground Truthing Points from Diver Footage of the North end of the current Porthlysgi farm. Black dotted lines represent the current longlines, red dots show the current anchors and grey dotted lines represent the ground chain between anchors. Yellow areas are sediment and grey areas are potential rocky areas and black circles indicate ground truthing points.



Figure 21. Ground Truthing Points from Diver Footage of the South end of the current Porthlysgi farm. Black dotted lines represent the current longlines, red dots show the current anchors and grey dotted lines represent the ground chain between anchors. Yellow areas are sediment and grey areas are potential rocky areas and black circles indicate ground truthing points.

4.4. Drop Down Video (DDV) Footage Results with Actual Broadscale Habitats

Drop Down Video (DDV) footage was taken using a camera on a frame suspended from the Car Y Mor work barge which then followed the transect route as shown in Figure 5. The figures below show the locations of still images taken from this DDV footage, which can be seen along with interpretations of the habitat types in the discussion section of this report:

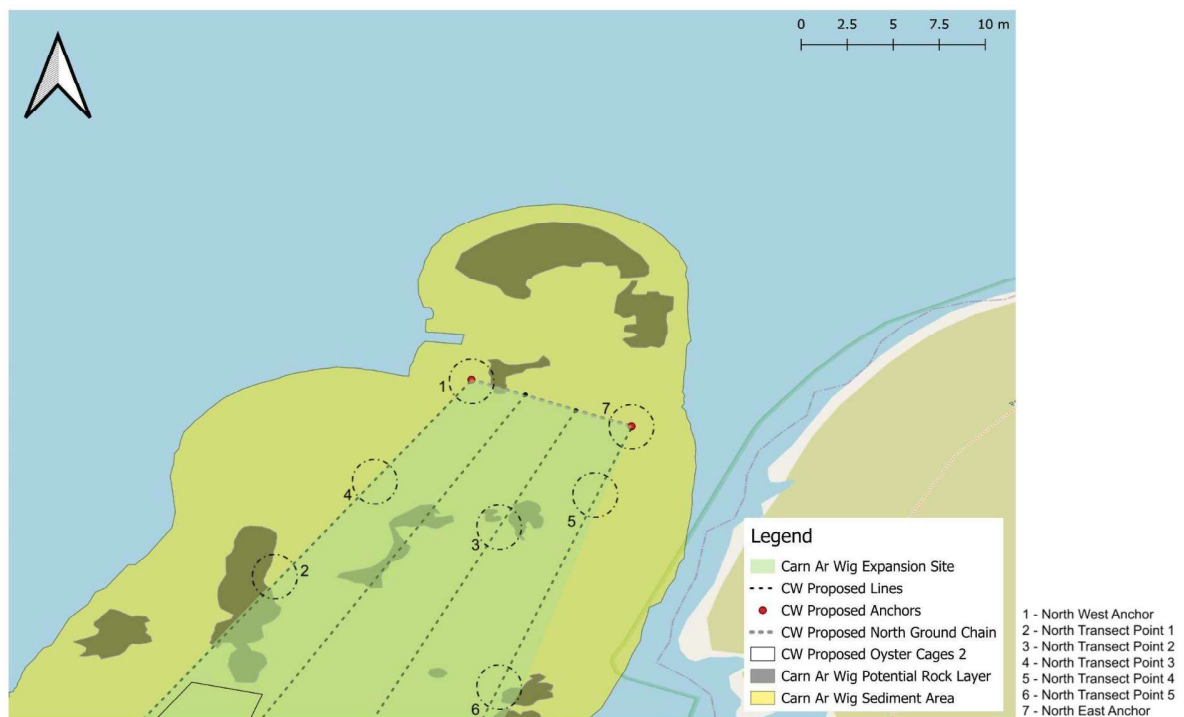


Figure 22. Ground Truthing Points from DDV Footage of the North end of the proposed Carn Ar Wig farm. Black dotted lines represent the current longlines, red dots show the current anchors and grey dotted lines represent the ground chain between anchors. Yellow areas are sediment and grey areas are potential rocky areas and black circles indicate ground truthing points.

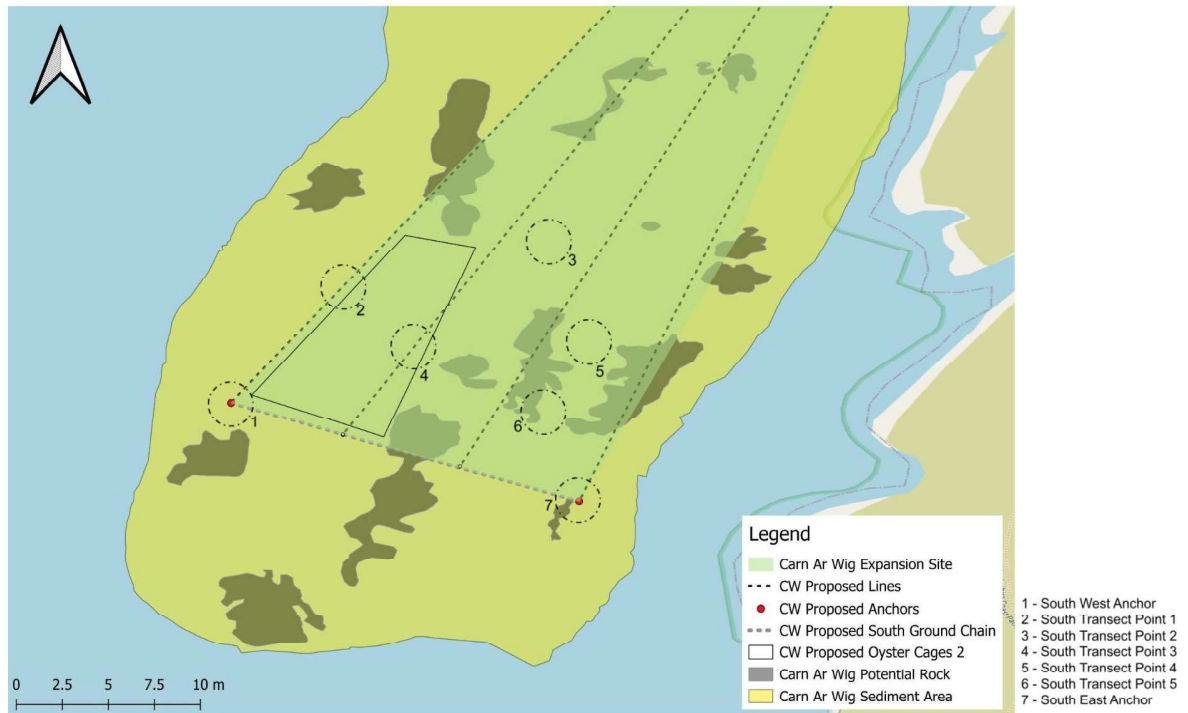


Figure 23. Ground Truthing Points from DDV Footage of the South end of the proposed Carn Ar Wig farm. Black dotted lines represent the current longlines, red dots show the current anchors and grey dotted lines represent the ground chain between anchors. Yellow areas are sediment and grey areas are potential rocky areas and black circles indicate ground truthing points.

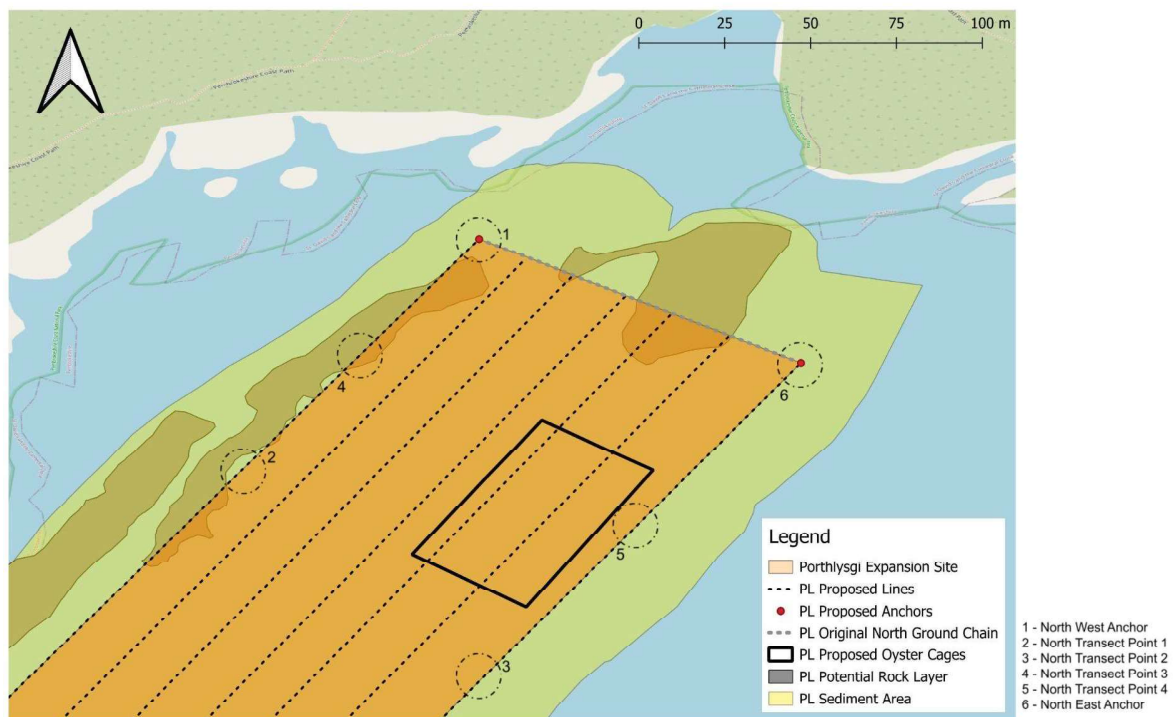


Figure 24. Ground Truthing Points from DDV Footage of the North end of the proposed Porthlysgi farm. Black dotted lines represent the current longlines, red dots show the current anchors and grey dotted lines represent the ground chain between anchors. Yellow areas are sediment and grey areas are potential rocky areas and black circles indicate ground truthing points.



Figure 25. Ground Truthing Points from DDV Footage of the South end of the proposed Porthlysgi farm. Black dotted lines represent the current longlines, red dots show the current anchors and grey dotted lines represent the ground chain between anchors. Yellow areas are sediment and grey areas are potential rocky areas and black circles indicate ground truthing points.

Figure 26. Actual Broadscale Habitats derived from ROV surveys at the current Porthlysgi farm.
Showing current farm lines, anchors and oyster cage deployment area and habitat types as described during the 2021 ROV Survey.



Figure 27. Actual Broad-Scale Habitats derived from ROV surveys at the proposed Porthlysgi Farm. Showing proposed farm lines, anchors and proposed oyster cage deployment area and habitat types as described during the 2021 ROV Survey.

5. Discussion of Results

5.1. Predicted Broad-Scale Habitats

5.1.1. Carn Ar Wig Current Farm

According to the HABMAP Combined Map 2010, the predicted habitat for the current farm at Carn Ar Wig (Figure 6) is 'Faunal and algal crusts on exposed to moderately wave-exposed circalittoral rock' (**CR.MCR.EcCr.FaAlCr**), which is a Level 5 biotope. For the purpose of this report only habitats to Level 3 need to be described and so this can be followed back up the hierarchy to the Level 3 habitat 'Moderate energy circalittoral rock'. This habitat can be described as occurring 'mainly on exposed to moderately wave-exposed circalittoral bedrock and boulders, subject to moderately strong and weak tidal streams' (JNCC (2022) The Marine Habitat Classification for Britain and Ireland Version 22.04. [14/02/2025]. Available from: <https://mhc.jncc.gov.uk/>).

The EU Habitats Directive Article 17 requires monitoring and protection of reefs and therefore these must also be taken into consideration during this survey. Using data from NRW displayed on the DataMapWales website, Figure 6 shows the location of both intertidal and subtidal reefs at the current Carn Ar Wig farm location. There is no intertidal reef within the farm boundaries but some subtidal reef is predicted along the eastern edge of the farm.

5.1.2. Carn Ar Wig Proposed Farm

According to the HABMAP Combined Map 2010, the predicted habitat for the proposed farm at Carn Ar Wig (Figure 8) is a mixture of both **CR.MCR.EcCr.FaAlCr** and 'Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand and mixed gravelly sand' (**SS.SCS.ICS.SLan**), which are both again Level 5 habitats. For the purpose of this report only habitats to Level 3 need to be described and so these can both be followed back up the hierarchy to their corresponding Level 3 habitats. As above, this is 'Moderate energy circalittoral rock' for **CR.MCR.EcCr.FaAlCr**, also described already in Section 5.1.1. The Level 3 habitat for **SS.SCS.ICS.SLan** is 'Sublittoral coarse sediment'. This habitat can be described as 'including coarse sand, gravel, pebbles, shingle and cobbles which are often unstable due to tidal currents and/or wave action. These habitats are generally found on the open coast or in tide-swept channels of marine inlets' (JNCC (2022) The Marine Habitat Classification for Britain and Ireland Version 22.04. [14/02/2025]. Available from: <https://mhc.jncc.gov.uk/>).

Using data from NRW displayed on the DataMapWales website, Figure 8 shows the location of both intertidal and subtidal reefs at the proposed Carn Ar Wig farm location. There is no intertidal reef within the farm boundaries but some subtidal reef is predicted along the eastern edge of the farm.

5.1.3. Porthlysgi Current Farm

According to the HABMAP Combined Map 2010, the predicted habitat for the current farm at Porthlysgi (Figure 7) is a mixture of both **CR.MCR.EcCr.FaAlCr** and '*Laminaria hyperborea* with dense foliose red seaweeds on exposed infralittoral rock' (**IR.HIR.KFaR.LhypR**), which are both again Level 5 habitats. As above, the Level 3 habitat for **CR.MCR.EcCr.FaAlCr** is 'Moderate energy circalittoral rock', also described

already in Section 5.1.1. The Level 3 habitat for **IR.HIR.KFaR.LhypR** is 'High energy infralittoral rock'. This habitat can be described as 'Rocky habitats in the infralittoral zone subject to exposed to extremely exposed wave action or strong tidal streams. Typically the rock supports a community of kelp *Laminaria hyperborea* with foliose seaweeds and animals, the latter tending to become more prominent in areas of strongest water movement' (JNCC (2022) The Marine Habitat Classification for Britain and Ireland Version 22.04. [14/02/2025]. Available from: <https://mhc.jncc.gov.uk/>).

Using data from NRW displayed on the DataMapWales website, Figure 8 shows the location of subtidal reefs at the current Porthlysgi farm location. There is no subtidal reef within the farm boundaries.

5.1.4. Porthlysgi Proposed Farm

According to the HABMAP Combined Map 2010, the predicted habitat for the proposed farm at Porthlysgi (Figure 9) is the same as the current farm, as described in Section 5.1.3. above.

Using data from NRW displayed on the DataMapWales website, Figure 9 shows the location of both intertidal and subtidal reefs at the proposed Porthlysgi farm location. There is no intertidal reef within the farm boundaries but some subtidal reef is predicted along the northern and western edges of the farm.

5.2. Side-Scan Sonar

5.2.1. Carn Ar Wig Side-Scan Sonar

The side scan sonar footage taken at Carn Ar Wig shows the whole proposed farm area to be situated over a mixture of coarse substrate with smaller rocks and some sand. There is also a significant amount of larger boulders distributed over the whole area. These boulders appear to be spread far enough apart that they could be avoided when placing anchors suggesting it is unlikely to cause any significant issues.

5.2.2. Porthlysgi Side-Scan Sonar

The side scan sonar for Porthlysgi shows the cliffs on the west side of the farm with some rocky areas mainly just outside of the proposed farm area. As the scan progresses further east the seabed type changes to sandy substrate with a few pebbles/cobbles sparsely distributed across the area.

5.3. Ground Truthing with Diver Footage

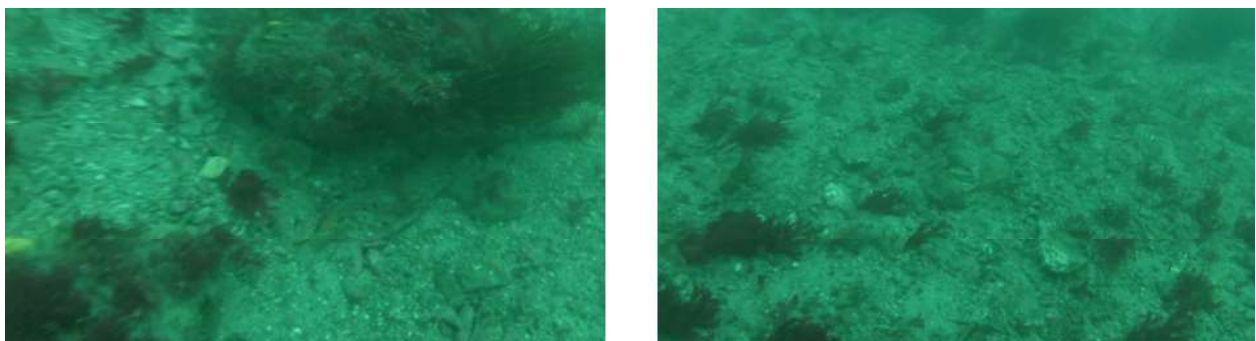
5.3.1. Carn Ar Wig North Current Farm

5.3.1.1. North West Anchor



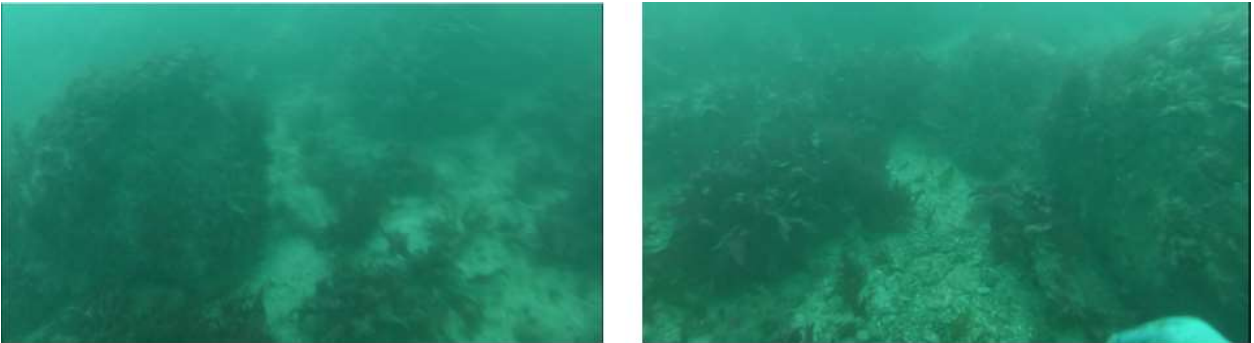
The sonar data showed the current North West anchor was likely to be sediment, the diver footage images here show that there are small rocks around the anchor site but the substrate underneath is a coarse sediment type.

5.3.1.2. North Transect Point 1



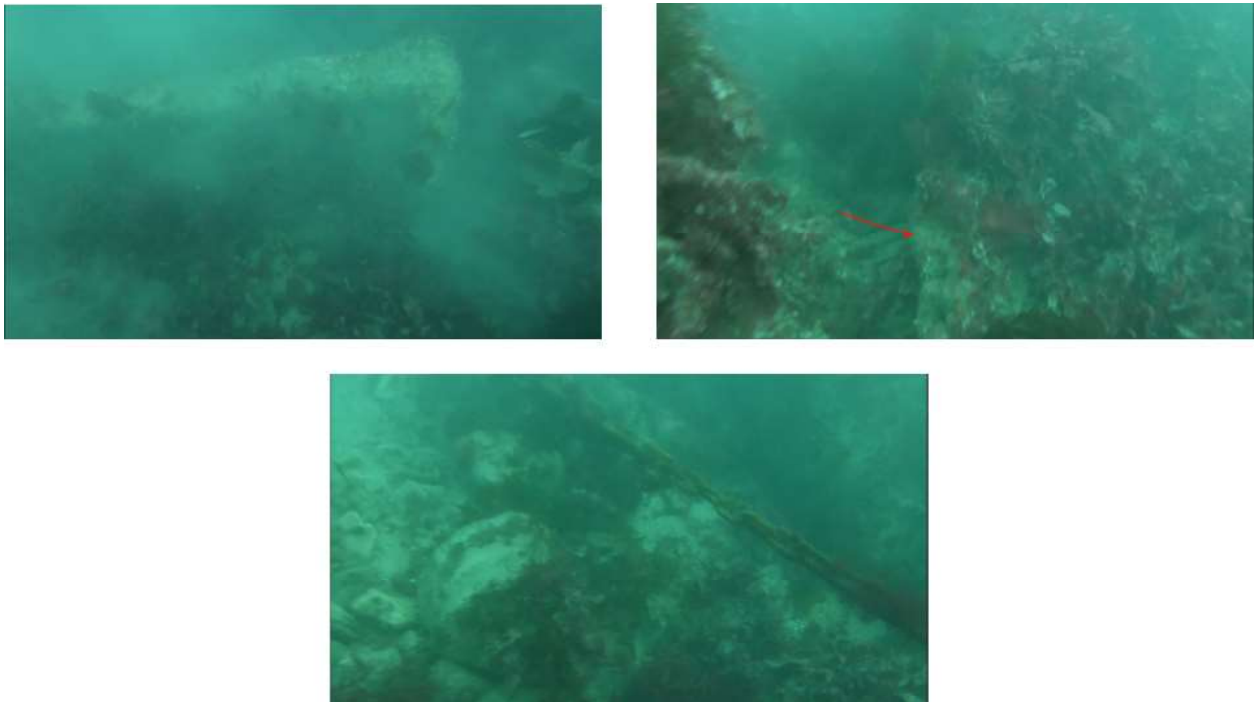
The sonar data showed the current North Transect Point 1 was likely to be sediment, the diver footage images here show in the left hand image that there are small rocks littered around the area but the main sediment type is a coarse sediment and the right hand image shows coarse sediment only with some small seaweed growth.

5.3.1.3. North Transect Point 2



The sonar data showed the current North Transect Point 2 was likely to be rocky, the diver footage images here show in the left hand image that there are larger rocks/small boulders around the area covered in red seaweed growth, with a coarse sediment between them and this is also shown in the right hand image.

5.3.1.4. North East Anchor



The sonar data showed the current North East Anchor was likely to be rocky. The top left image taken from the diver footage shows the anchor surrounded by red seaweeds, with the top right image showing the anchor buried in red seaweeds (red arrow points to the anchor partly visible). The bottom image shows the ground chain just off the anchor over some large rocks which have some red seaweed cover.

5.3.2. Carn Ar Wig South Current Farm

5.3.2.1. South West Anchor



The sonar data showed the current South West Anchor was likely to be sediment. The top left image taken from the diver footage shows the ground chain with a good level of seaweed cover on a mixture of sand and coarse sediment. The top right image shows more sand with some green and red seaweed cover and the bottom image shows the anchor with a good coverage of seaweed on sandy substrate.

5.3.2.2. South Transect Point 1



The sonar data showed the current South Transect Point 1 was likely to be sediment. The left image taken from the diver footage shows a good level of green and red seaweed cover on coarse sediment. The right image shows more coarse sediment with more green and red seaweed cover.

5.3.2.3. South Transect Point 2



The sonar data showed the current South Transect Point 2 was likely to be rocky. The left image taken from the diver footage has low visibility but shows a few larger boulders with a good level of seaweed coverage and some sediment between the boulders. The right hand image shows a big boulder in the foreground (labelled with a red arrow), which is obscured by a high level of seaweed cover.

5.3.2.4. South East Anchor



The sonar data showed the current South East Anchor was likely to be sediment. The top left image taken from the diver footage has low visibility but shows the anchor in the foreground covered with seaweed and sediment in the background. The top right image shows the anchor again covered with seaweed and surrounded by sand. The bottom image shows more of the anchor with the same seaweed cover and sandy sediment surrounding it.

5.3.3. Porthlysgi North Current Farm

5.3.3.1. North West Anchor



The sonar data showed the current North West Anchor was likely to be sediment. The left image taken from the diver footage shows the anchor in the foreground (indicated by the red arrow) covered with red

seaweeds and sitting on a sandy substrate. The right image has lower visibility but again shows the anchor and some ground chain covered with seaweed and surrounded by sand.

5.3.3.2. North Transect Point 1



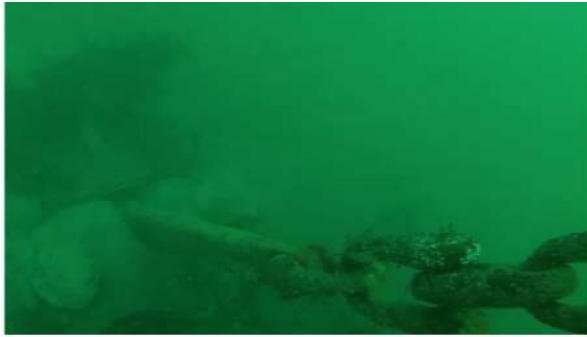
The sonar data showed the current North Transect Point 1 was likely to be sediment. The image taken from the diver footage has low visibility but shows a coarse sediment with some very small patches of seaweeds.

5.3.3.3. North Transect Point 2



The sonar data showed the current North Transect Point 2 was likely to be sediment. Both images taken from the diver footage show a sandy substrate with some kelps lying on the surface. Although hard to confirm through video footage it is highly likely this is debris from the farm above as there are no rocks for the holdfasts of the kelp to attach on to.

5.3.3.4. North East Anchor



The sonar data showed the current North East Anchor was likely to be sediment. The left image taken from the diver footage shows the anchor half buried in sandy substrate. The right image shows a close up of the anchor buried in the sand.

5.3.4. Porthlysgi South Current Farm

5.3.4.1. South West Anchor



The sonar data showed the current South West Anchor was likely to be sediment. The left image taken from the diver footage shows the anchor resting on top of some small boulders. The right image again shows the anchor and some ground chain resting on some smaller rocks with a small level of red seaweed coverage.

5.3.4.2. South Transect Point 1



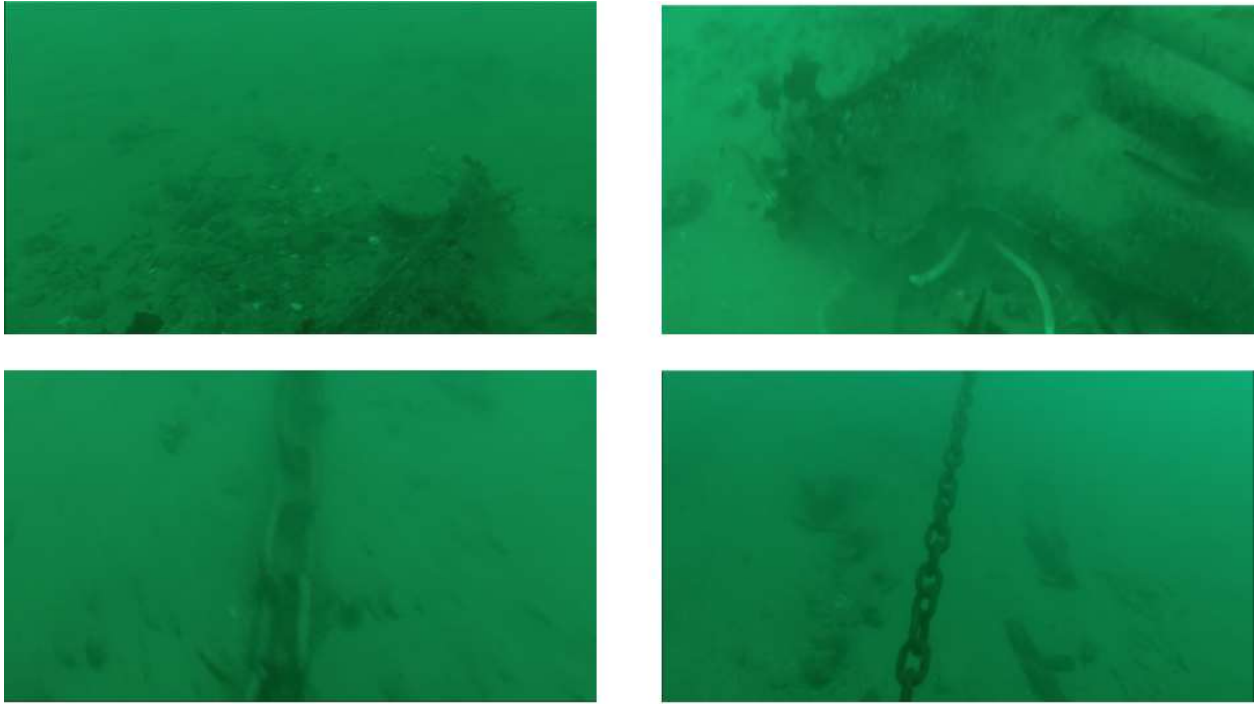
The sonar data showed the current South Transect Point 1 was likely to be sediment. The image taken from the diver footage shows coarse sediment with some small coverage of seaweeds and a few smaller pebbles scattered around the area.

5.3.4.3. South Transect Point 2



The sonar data showed the current South Transect Point 2 was likely to be sediment. The image above shows a coarse sediment with one kelp blade lying on the surface; as above this is likely to be debris from the farm above.

5.3.4.4. South East Anchor

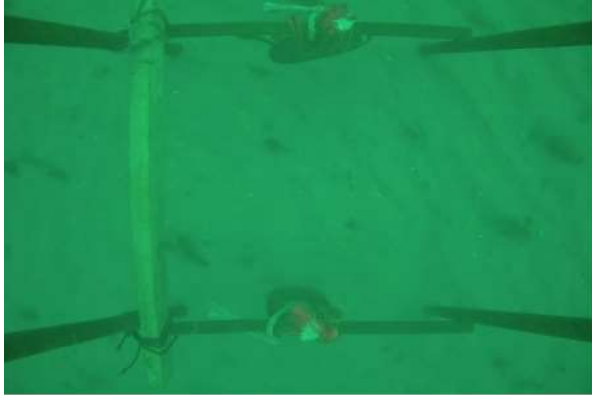


The sonar data showed the current South East Anchor was likely to be sediment. The top left image taken from the diver footage shows the anchor in the foreground resting on coarse sediment. The top right image shows the anchor in more detail with a small amount of seaweed coverage and also on coarse sediment. The bottom left image shows part of the ground chain lying on sand and the bottom right image shows the ground chain again over some coarse sediment.

5.4. Ground Truthing with Drop Down Video Footage

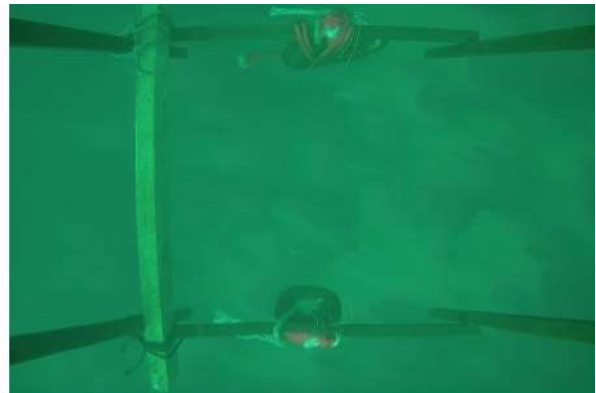
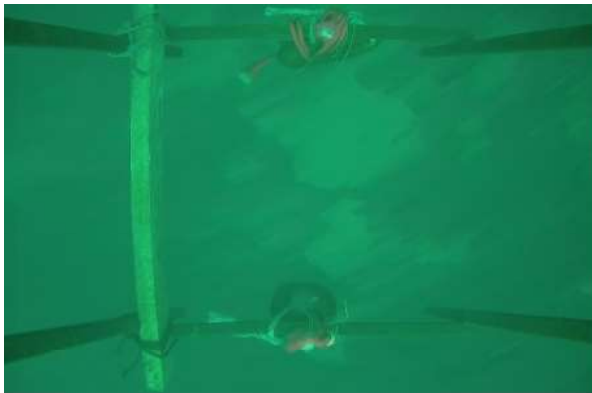
5.4.1. Carn Ar Wig North Proposed Farm

5.4.1.1. North West Anchor



The sonar data showed the proposed North West Anchor was likely to be sediment. The left image taken from the drop down video footage shows a sandy substrate with a very small covering of seaweeds. The right image also shows sandy substrate with a few small seaweeds.

5.4.1.2. North Transect Point 1



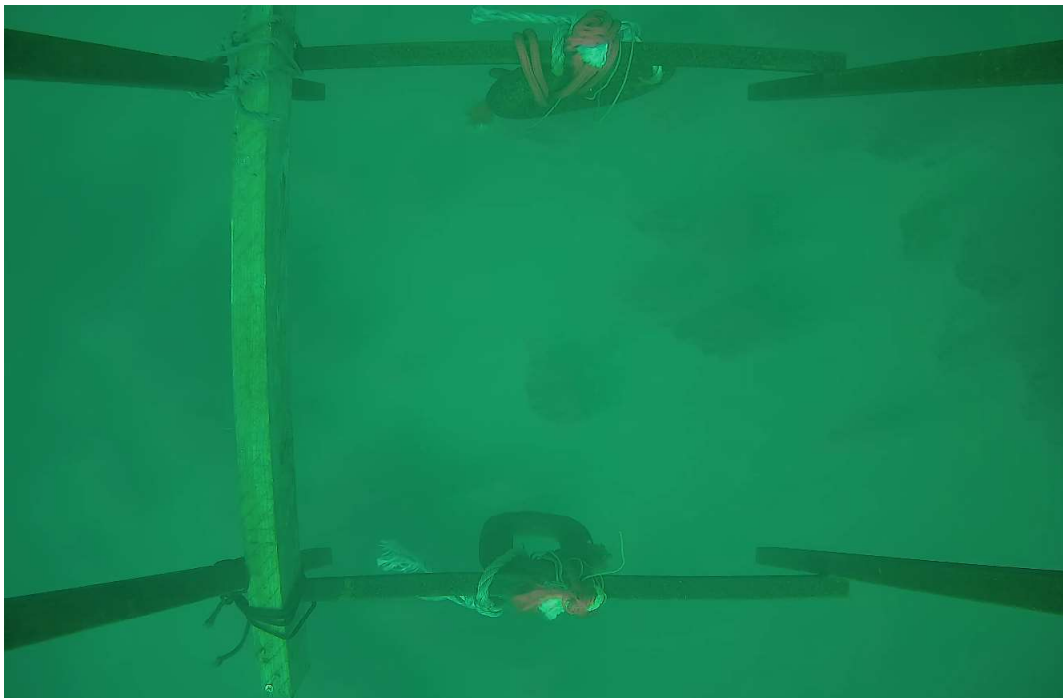
The sonar data showed the proposed North Transect Point 1 was likely to be rocky. The left image taken from the drop down video footage shows a sandy substrate with rocks covered with seaweeds. The right image also shows sandy substrate with rocks covered in seaweeds.

5.4.1.3. North Transect Point 2



The sonar data showed the proposed North Transect Point 2 was likely to be rocky. Both images taken from the drop down video footage show a rocky area with a dense covering of seaweeds.

5.4.1.4. North Transect Point 3



The sonar data showed the proposed North Transect Point 3 was likely to be sediment. The image above taken from the drop down video footage shows a sandy substrate with a very small covering of seaweeds.

5.4.1.5. North Transect Point 4



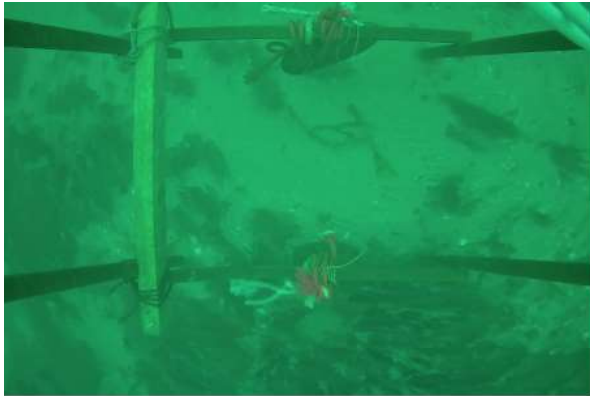
The sonar data showed the proposed North Transect Point 4 was likely to be sediment. Both images above taken from the drop down video footage shows a sandy substrate with a covering of some seaweeds.

5.4.1.6. North Transect Point 5



The sonar data showed the proposed North Transect Point 5 was likely to be rocky. The image above taken from the drop down video footage shows small rocks and pebbles with a few small boulders and a medium coverage of seaweeds.

5.4.1.7. North East Anchor



The sonar data showed the proposed North East Anchor was likely to be sediment. The left image taken from the drop down video footage shows a sandy substrate with a covering of small seaweed species. The right image also shows sandy substrate with a few small seaweeds.

5.4.2. Carn Ar Wig South Proposed Farm

5.4.2.1. South West Anchor



The sonar data showed the proposed South West Anchor was likely to be sediment. The image above taken from the drop down video footage shows a sandy substrate with a high coverage of small rocks and pebbles with a decent coverage of seaweeds.

5.4.2.2. South Transect Point 1



The sonar data showed the proposed South Transect Point 1 was likely to be sediment. The image above taken from the drop down video footage shows a sandy substrate with a very small covering of red seaweeds.

5.4.2.3. South Transect Point 2



The sonar data showed the proposed South Transect Point 2 was likely to be sediment. Both images taken from the drop down video footage shows a coarse substrate with a very small covering of seaweeds and some empty bivalve shells.

5.4.2.4. South Transect Point 3



The sonar data showed the proposed South Transect Point 3 was likely to be sediment. Both images taken from the drop down video footage shows a coarse substrate with a very small covering of seaweeds and some empty bivalve shells.

5.4.2.5. South Transect Point 4



The sonar data showed the proposed South Transect Point 4 was likely to be rocky. The top left image taken from the drop down video footage shows the rope between two oyster cages running along a large boulder with a dense coverage of mainly red seaweeds. The top right image shows an area of coarse sediment just past an oyster cage with a small covering of some seaweed species. The bottom image shows the rope between oyster cages leading to an oyster cage in the background with a small boulder to the left of the cage.

5.4.2.6. South Transect Point 5



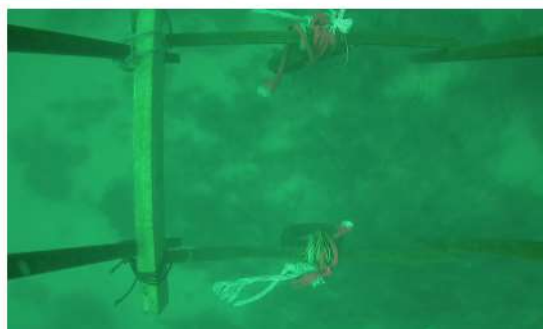
The sonar data showed the proposed South Transect Point 5 was likely to be sediment. The left image taken from the drop down video footage shows a coarse sediment with a moderate coverage of mainly red seaweeds. The right image shows an area of coarse sediment with a moderate covering of some seaweed species.

5.4.2.7. South East Anchor

The South East Anchor will be in the same position as the current South East Anchor as above.

5.4.3. Porthlysgi North Proposed Farm

5.4.3.1. North West Anchor



The sonar data showed the proposed North West Anchor was likely to be sediment. The top left image taken from the drop down video footage shows a rocky area with a dense coverage of seaweeds. The top

right image shows small areas of coarse sediment with rocks densely covered with seaweeds. The bottom image shows a higher percentage of coarse sediment but still small rocks and seaweed as the main habitat type.

5.4.3.2. North Transect Point 1



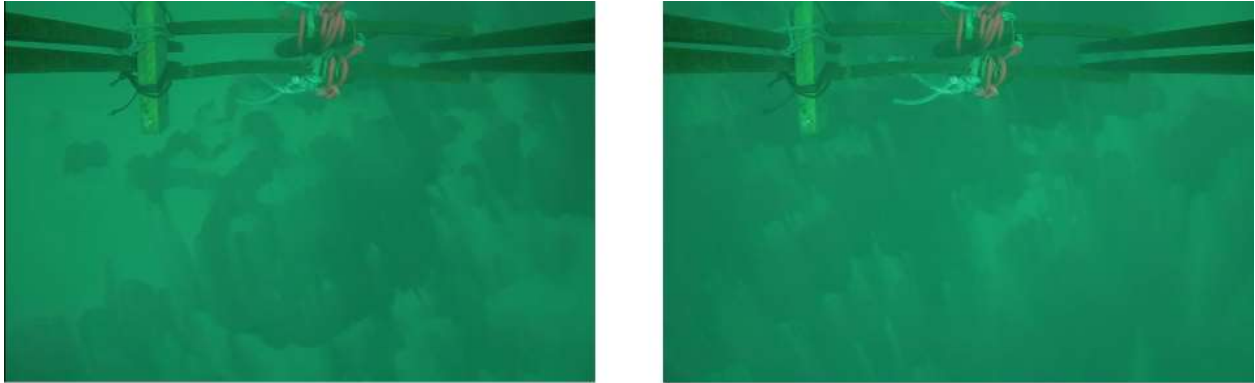
The sonar data showed the proposed North Transect Point 1 was likely to be rocky. The left image taken from the drop down video footage shows large rocks with a dense coverage of seaweeds. The right image again shows large rocks with some seaweed cover.

5.4.3.3. North Transect Point 2



The sonar data showed the proposed North Transect Point 2 was likely to be sediment. Both images taken from the drop down video footage show a sandy substrate with a few empty bivalve shells scattered sparsely around the area.

5.4.3.4. North Transect Point 3



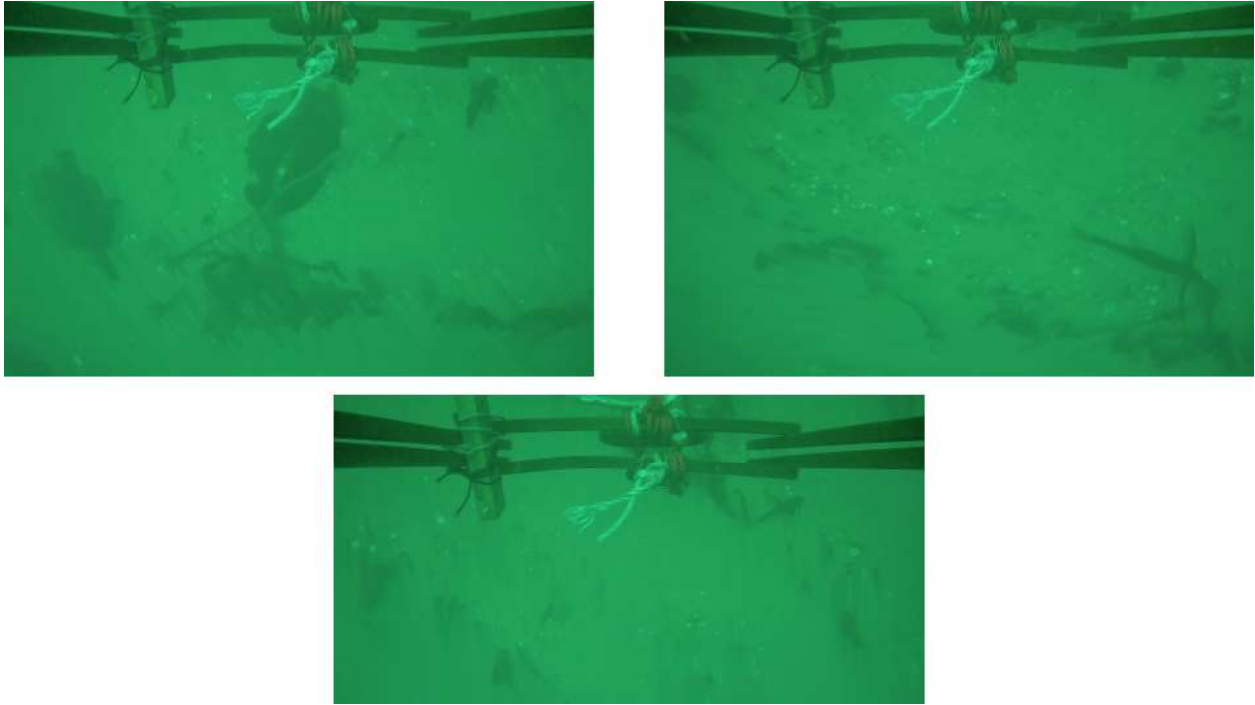
The sonar data showed the proposed North Transect Point 3 was likely to be rocky. The left image taken from the drop down video footage shows a sandy substrate with some rocks and seaweeds. The right image shows mainly rocks with a dense covering of seaweeds.

5.4.3.5. North Transect Point 4



The sonar data showed the proposed North Transect Point 4 was likely to be sediment. The image taken from the drop down video footage shows a sandy substrate with a few empty bivalve shells scattered sparsely around the area.

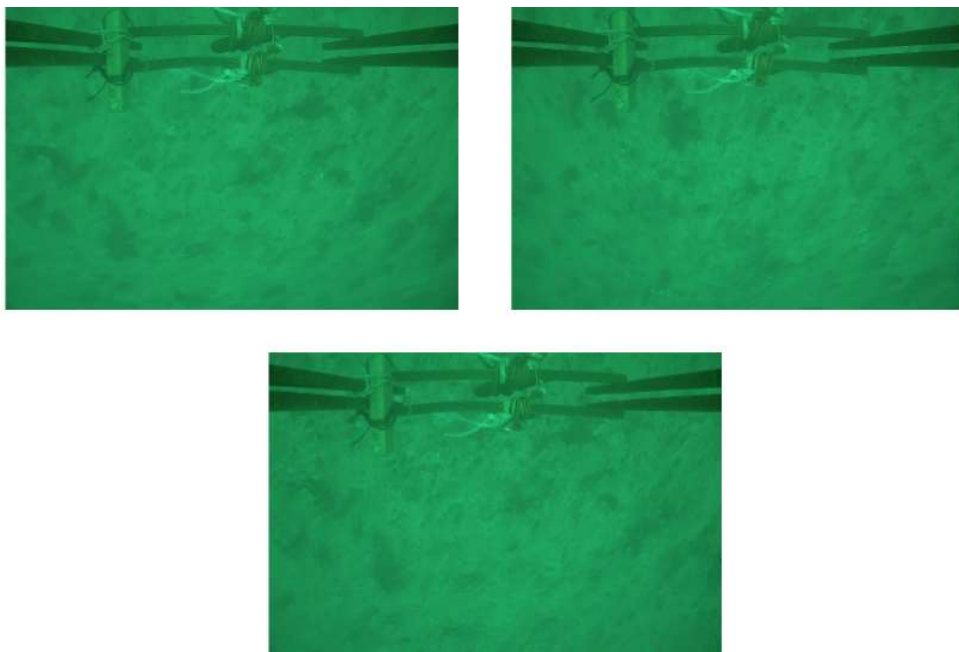
5.4.3.6. North East Anchor



The sonar data showed the proposed North East Anchor was likely to be sediment. All three images taken from the drop down video footage show a coarse substrate with a few empty bivalve shells scattered sparsely around the area and some kelp debris from the farm above.

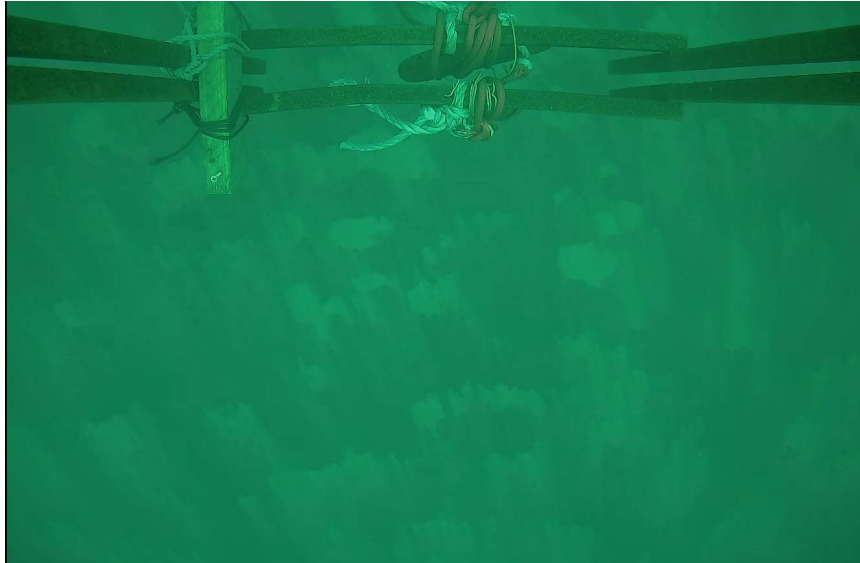
5.4.4. Porthlysgi South Proposed Farm

5.4.4.1. South West Anchor



The sonar data showed the proposed South West Anchor was likely to be sediment. All three images taken from the drop down video footage show a coarse substrate with a few small seaweed species sparsely covering the area.

5.4.4.2. South Transect Point 1



The sonar data showed the proposed South Transect Point 1 was likely to be sediment. The image taken from the drop down video footage shows rocks with a high density of seaweed covering the area.

5.4.4.3. South Transect Point 2



The sonar data showed the proposed South Transect Point 2 was likely to be rocky. Both images taken from the drop down video footage show a sandy substrate with a few empty bivalve shells sparsely covering the area.

5.4.4.4. South Transect Point 3



The sonar data showed the proposed South Transect Point 3 was likely to be sediment. The image taken from the drop down video footage shows small rocks on a coarse sediment with some seaweed coverage on the rocky areas.

5.4.4.5. South Transect Point 4



The sonar data showed the proposed South Transect Point 4 was likely to be sediment. The left image taken from the drop down video footage shows a coarse sediment with some small seaweed coverage. The right image shows a coarse sediment with almost no seaweed coverage and a few empty bivalve shells.

5.4.4.6. South Transect Point 5



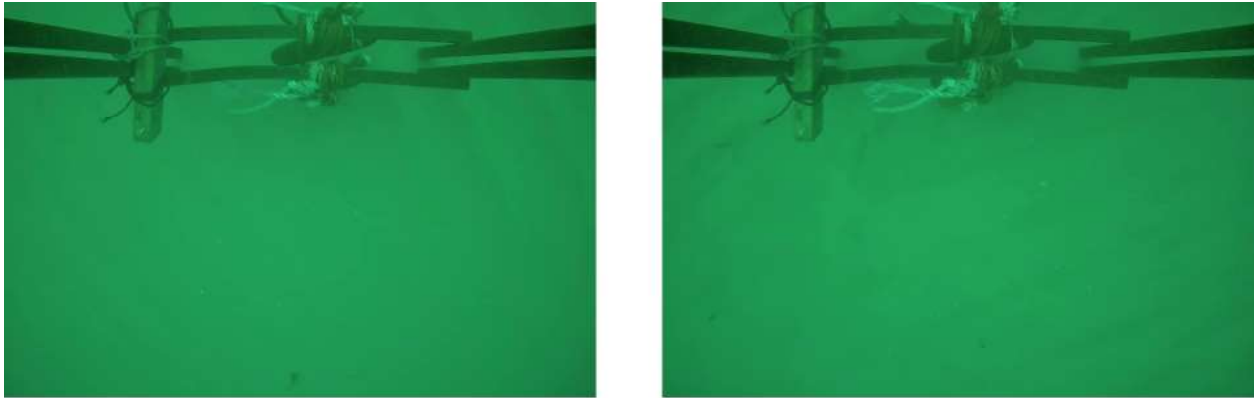
The sonar data showed the proposed South Transect Point 5 was likely to be sediment. Both images taken from the drop down video footage show sandy sediment with some small pieces of seaweed debris but nothing else.

5.4.4.7. South Transect Point 6



The sonar data showed the proposed South Transect Point 6 was likely to be sediment. The left image taken from the drop down video footage shows a coarse sediment with some empty bivalve shells. The right image shows a coarse sediment with a lower coverage of empty bivalve shells.

5.4.4.8. South East Anchor



The sonar data showed the proposed South East Anchor was likely to be sediment. Both images taken from the drop down video footage shows a sandy sediment with a few empty bivalve shells.

5.5. Comparison of Predicted Broadscale Habitat Maps, Side Scan Sonar, ROV Surveys and Ground Truthing with Diver & DDV Footage

The use of video footage has allowed for much more detailed designations of seabed habitats than the predicted maps allow. The current farm at Carn Ar Wig has a mixture of Sublittoral Mixed Sediment (SS.SMx) and Moderate Energy Circalittoral Rock (CR.MCR). Most of the farm is covered with sediments of various types with a substantial covering of green and red seaweeds and clusters of small to medium sized boulders which are dispersed across the farm area. The boulders show more red and green seaweeds growing on them with a few orange sponges being seen in the footage between the south west and north east anchors. Due to the presence of these boulders the area has been designated as circalittoral rock, although there are still plenty of areas of sediment. The video footage of the southern anchors shows these are placed in areas of mixed sediment and not placed on the boulders, however the footage for the northern anchors shows some SS.SMx but also CR.MCR, particularly for the North East anchor.

The proposed farm area for Carn Ar Wig is a mixture of the same habitats as the current area, with the CR.MCR giving way to SS.SMx along the North and West areas of the farm. This would be expected as the coastline is along the South and East edges of the farm and therefore rocky habitats would be more likely to occur here. To ensure the anchors are being placed in the areas of sediment described above, the anchors will be micro-sited by confirming the area of deployment and then using drop down video to ensure these areas are acceptable. The diver footage showed an area of CR.MCR over the proposed South West anchor which would need to be avoided. To avoid the areas containing most boulders, the

oyster cages will be deployed within the northern end of the farm and further west to stay within areas of mixed sediment.

The current farm at Porthlysgi has a mixture of Silty Fine Sand and Rippled Fine Sand. The ROV Report in 2021 described Rippled Fine Sand as covering extensive areas of seabed, at 12 to 14m, becoming less rippled and increasingly silty in the more sheltered areas at the back of the bay (less exposed to tidal currents) and with increasing depth. Very little conspicuous life except for occasional scallops *Pecten maximus*. Rarely, small lumps of silty rock with sparse life, incl. hermit crabs, *Pagurus bernhardus*, spiny starfish *Marthasterias glacialis* and small pieces of red algae. One burrowing sea cucumber seen in deeper area. This habitat gradually merged into the muddy sand habitat, described below, and the coarse sediment habitat described above. [Biotope code: S.SSa.IFiSa.IMoSa].

The ROV Report in 2021 described Silty Fine Sand as muddy fine sand in the most sheltered and least tide swept areas of the inner bay, 9.5 to 11.5m, with diatom film on the surface, lugworm casts (*Arenicola marina*) and signs of other burrowing species (likely including heart urchins *Echinocardium cordatum* and razor clams *Ensis* spp.). Rare burrowing anemones *Cerianthus lloydii*. [Biotope code: SS.SSa.IMuSa]. All diver footage of the current Porthlysgi farm showed various sediments as predicted by the sonar, except for the South West anchor which appeared to be situated on small boulders.

The proposed farm at Porthlysgi is covered by a variety of habitat types. The western and northern edges of the farm are fringed by cliffs which give way to rocky areas in the subtidal zone. The ROV survey characterised these areas as Bedrock with Kelp Park (IR.MIR.KR.Lhyp.Pk) and Scoured Rocks and Sand (IR.HIR.KSed.XKScrR). The Scoured Rocks and Sand habitat also extends slightly into the south-western corner of the farm before giving way to Rippled Fine Sand (S.SSa.IMuSa), which covers the main area of the proposed farm area. Towards the northern edge of the farm there is also a mixture of areas of Silty Fine Sand (SS.SSa.IMuSa) and Mobile Coarse Sediment Waves (SS.SCS.CCS). The ROV report describes Infralittoral bedrock, with kelp park and red algal turf as silty bedrock ridges with kelp park and red algal turf at a depth of 6.5m to 9.5m with conspicuous fauna sparse, except for occasional boring sponges (*Cliona celata*) and cup corals (*Caryophyllia smithii*). Red algal turf included *Heterosiphonia plumosa*, *Calliblepharis ciliata*, *Delesseria sanguinea* and other foliose species. Coarse sand, pebbles and cobbles covered the floor of troughs between ridges. Kelp on the tops of ridges included *Laminaria hyperborea*, *Saccharina latissima* & *Saccorhiza polyschides*. Some high ridges present, some with steep / vertical sides, with bryozoan turf. [Biotope code: IR.MIR.KR.Lhyp.Pk]. The ROV report describes Infralittoral boulders, cobbles and low lying bedrock strongly influenced by sand as where the bedrock meets the sand there are typically areas of mixed rock and sand habitat that can include fairly extensive areas of boulders and cobbles sticking out of the sand, approx. 10m. The rocks in these areas are, to a greater or lesser extent, scoured and smothered by sand, so that the assemblage of epibiota on the rocks is limited to a low diversity of species that are tolerant of such conditions. The most scoured rock surfaces are bare, while the least affected are colonised by a range of algae and animals similar to the kelp park habitat described above. Encrusting coralline algae and tubes of the keel worm *Spirobranchus* are particularly common. Other animals included occasional hermit crab *Pagurus bernhardus* and netted whelk *Tritia reticulata*. [Biotope code: IR.HIR.KSed.XKScrR]. The ROV Report describes Coarse sediment waves as an area of mobile sand, gravel, pebbles and cobbles, forming sand waves with very little

conspicuous life, at 9.5m to 11.5m in the middle of the bay. Coarsest sediment (mainly gravel & pebbles) on tops of ridges. Finer sand, with some silt, in troughs. Occasional scallops on ridge tops. This habitat gradually merged into the rippled fine sand habitat, described previously. [Biotope code: SS.SCS.CCS]. The DDV footage of the proposed farm for Porthlysgi confirmed that the western and north western edges of the site would be placed on or near various rocky habitats and these would need to be avoided during deployment.

Out of the total 44 ground truthing points used to verify the side scan sonar data, only 7 did not find a habitat matching what was to be expected. The sonar data for the current North West Anchor of Carn Ar Wig showed a likely habitat of sediment, whilst this is true from the images where a coarse substrate can be seen there are also small rocks in the area. It is possible these were too small for the resolution of the side scan sonar to pick up.

The current South West Anchor for Porthlysgi should have shown sediment as expected from the sonar data and all other ground truthing points showing sediment around the current farm area, however the images show the anchor resting on small boulders. It is unclear why this was not picked up on the sonar data.

The proposed South West anchor for Carn Ar Wig showed sediment as the likely habitat type according to the sonar but the images showed a sandy substrate with small rocks also present. Figure 23 shows an area of rock picked up on the sonar imaging slightly further south of the anchor so it is possible the diver footage strayed into this area, or that this area extends further north than shown on the sonar data.

The proposed North West anchor for Porthlysgi showed sediment as the likely habitat on the sonar data, however Figure 24 does show a large rocky area beginning just south of this point, and also another rocky area to the north-east of this point so it is likely that these areas extend further outside of the areas marked in Figure 24 and cover the proposed anchor site.

The proposed South Transect Points 1 and 3 for Porthlysgi show sediment as the likely habitat type according to the sonar data, but as with the North West anchor, Figure 25 shows several large rocky areas close to these transect points so it is likely these extend further south-east into the proposed farm area.

The proposed South Transect Point 2 for Porthlysgi showed an expected rocky area on the sonar imaging but the DDV footage shows definite sandy or coarse substrates across this whole area between the two South Anchors. As other points in this area were expected to be sediment but footage showed rocks present, it is also possible that this rocky area should have been slightly further north-west.

5.6. Recommendations for Farm Locations

Overall, monitoring of Carn Ar Wig has shown evidence of areas which could be classified as rock and would therefore be susceptible to the effects of shellfish farming infrastructure, for example scouring from chains or sustaining damage to communities that have colonised these areas by dropping oyster cages on top of them. However, video footage has shown no evidence of complex or sensitive communities which could be slow growing and sensitive to physical disturbance in these areas, with there being mostly a mix of red and green seaweed and occasionally some orange sponges seen (video

footage was too poor to determine species). Furthermore, whilst there are areas of boulders, there are also large areas of sediment and these become more prevalent to the north-west of the proposed farm area, and avoid the rocky habitats identified around the south west anchor.

After examination of all the habitat data above, the suggested action for Carn Ar Wig is moving the farm area further north-west by approximately 15m. All current infrastructure will be moved to ensure there is no longer any infrastructure on reef habitats and micro-siting using DDV footage will also be used to ensure the anchors are placed in suitable locations and the exact locations can be adjusted within the licensed area as needed. For both Carn Ar Wig and Porthlysgi this footage during deployment will be compiled into a Deployment Report which will be shared with NRW and The Crown Estate to provide evidence that the new farm sites are not placed on top of reef habitat.

New Proposed Carn Ar Wig Farm Coordinates:

North East Anchor	Longitude: -5.315138, Latitude: 51.868999
South East Anchor	Longitude: -5.315974, Latitude: 51.867356
North West Anchor	Longitude: -5.315646, Latitude: 51.869147
South West Anchor	Longitude: -5.317075, Latitude: 51.867665

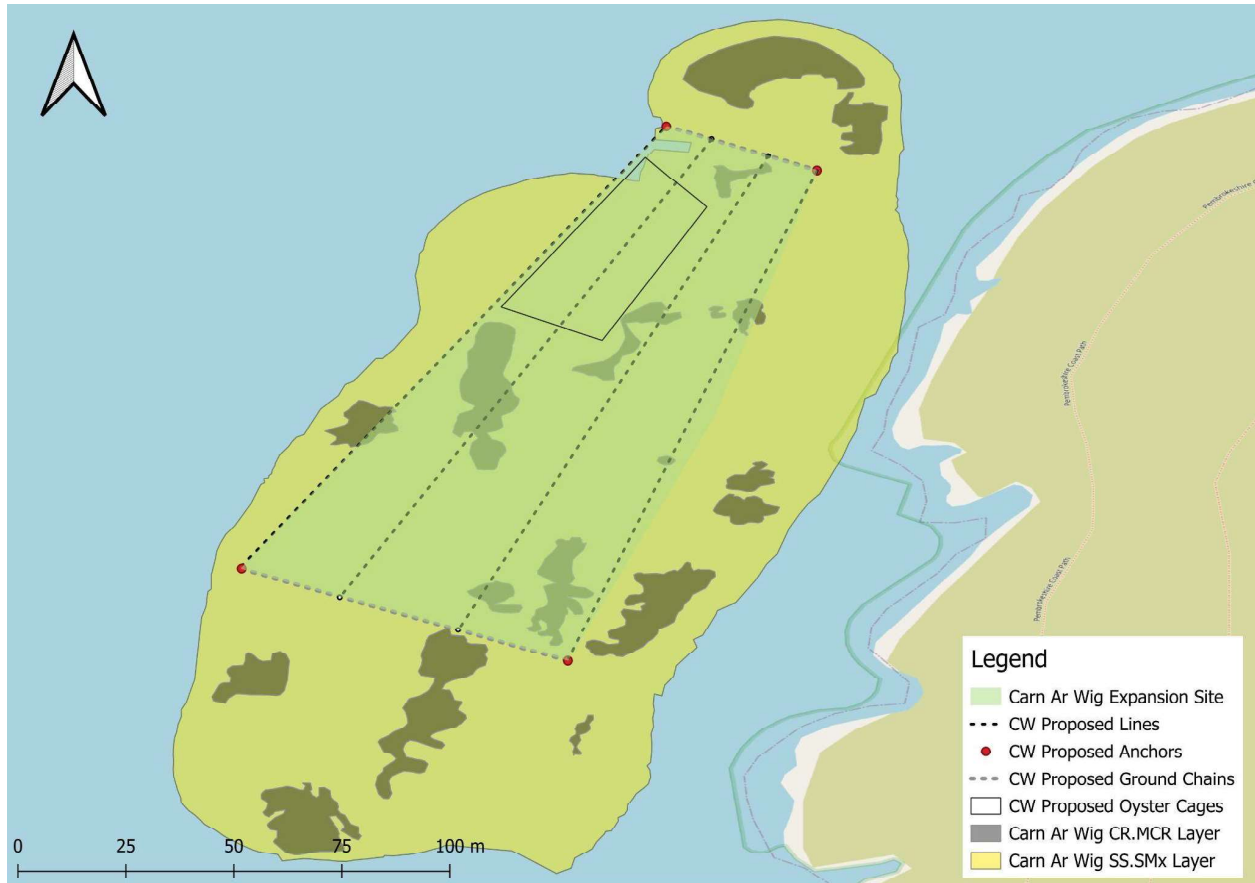


Figure 28. Updated Proposed Carn Ar Wig Farm Location. Showing the farm area in green and area where oyster cages would be deployed outlined in solid black.

The surveys conducted at Porthlysgi show the western edge of the farm and some of the south-western corner will be placed on bedrock habitats. Whilst there was no evidence of species of particular conservation concern, and these habitats are not considered rare or unusual, particularly in West Wales, they could still be considered under the classification of 'reefs' which is a protected feature for the Pembrokeshire Marine Special Area of Conservation (SAC). The management objectives of the SAC include protecting reef habitats from loss or degradation and this must be taken into consideration when deciding where farm infrastructure, particularly anchors, will be placed. Particularly for Porthlysgi Bay, there are moderately strong tidal currents and the further away from the coastline and into the bay the more there are sediment-based habitats. These conditions mean these habitats are already tide-swept and therefore are too mobile to have much macrophyte which means their sensitivity is low and their relative robustness to physical disturbance is characterised by a low diversity of common species.

In Version 4 of this report the following decisions were made using Figure 29 without the sonar habitat types overlaid: Taking these factors into consideration, the recommendation would be to move the farm approximately 20m to the right when looking at the farm head-on (Approximately a South-Easterly

direction). This would move the western edge of the farm away from the bedrock habitats and into the sediment-based habitats therefore reducing the potential risk of damaging reefs with farm infrastructure.

In this Version 5, the sonar habitat types have been overlaid onto Figure 29 below and show there would have still been some overlap of reef habitats with the farm infrastructure. Due to this, the farm coordinates have been adjusted again to ensure avoidance with these habitats as seen in Figure 30 and in the updated coordinates table below.

Updated New Proposed Porthlysgi Farm Coordinates:

North East Anchor	Longitude: -5.303021, Latitude: 51.862639
South East Anchor	Longitude: -5.305677, Latitude: 51.859996
North West Anchor	Longitude: -5.304358, Latitude: 51.863163
South West Anchor	Longitude: -5.307102, Latitude: 51.860495

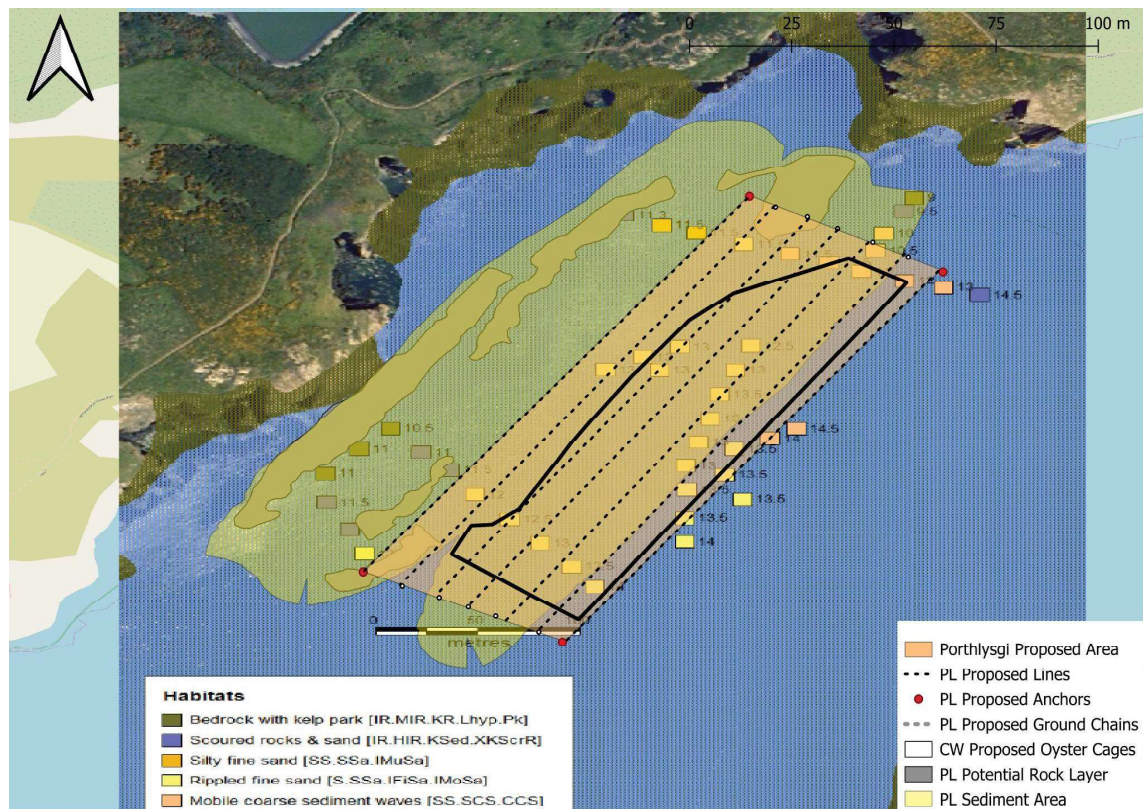


Figure 29. Updated Proposed Porthlysgi Farm Location. Showing the farm area in orange and area where oyster cages would be deployed outlined in solid black.

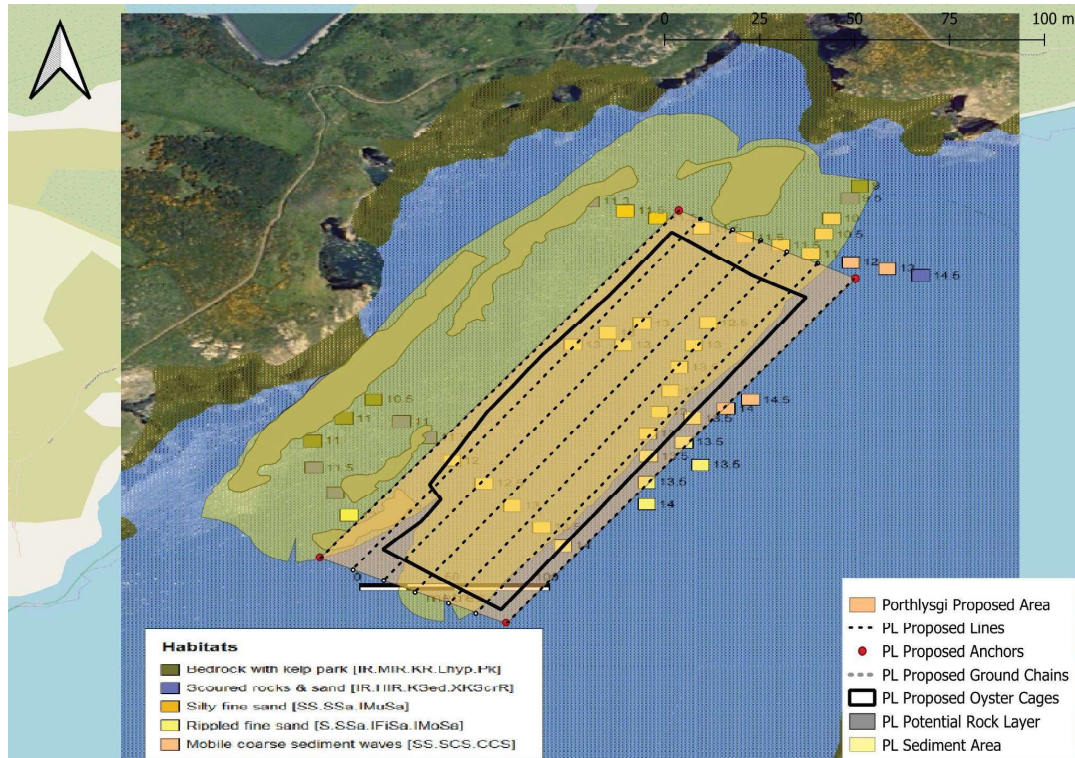


Figure 30. Final Updated Proposed Porthlysgi Farm Location. Showing the farm area in orange and area where oyster cages would be deployed outlined in solid black.

5.7. Shellfish Farm Infrastructure

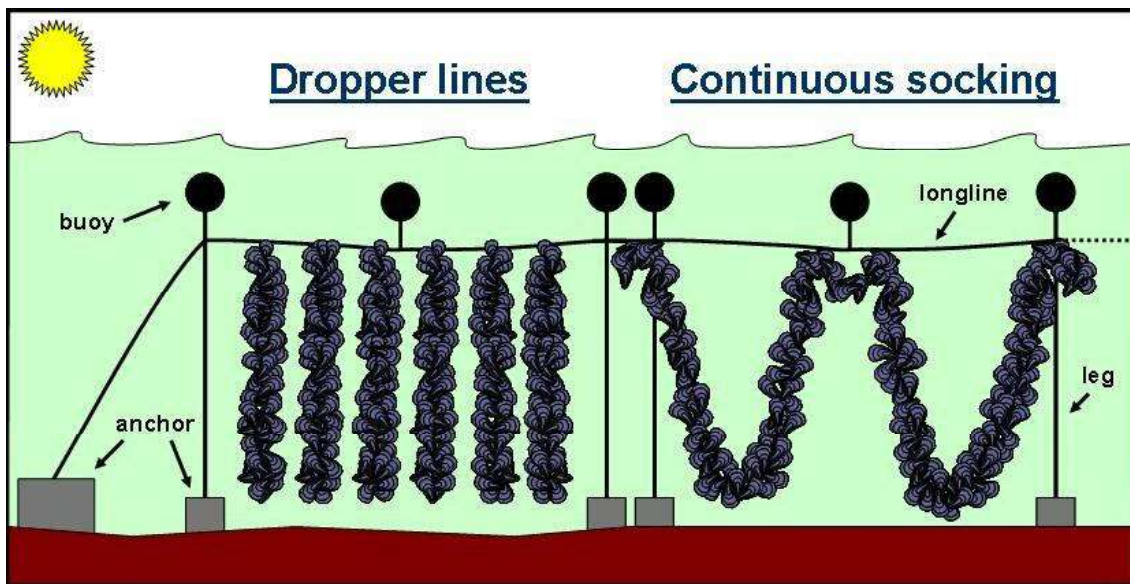


Figure 31. Mussel farming infrastructure examples. Showing both dropper lines and continuous socking methods.

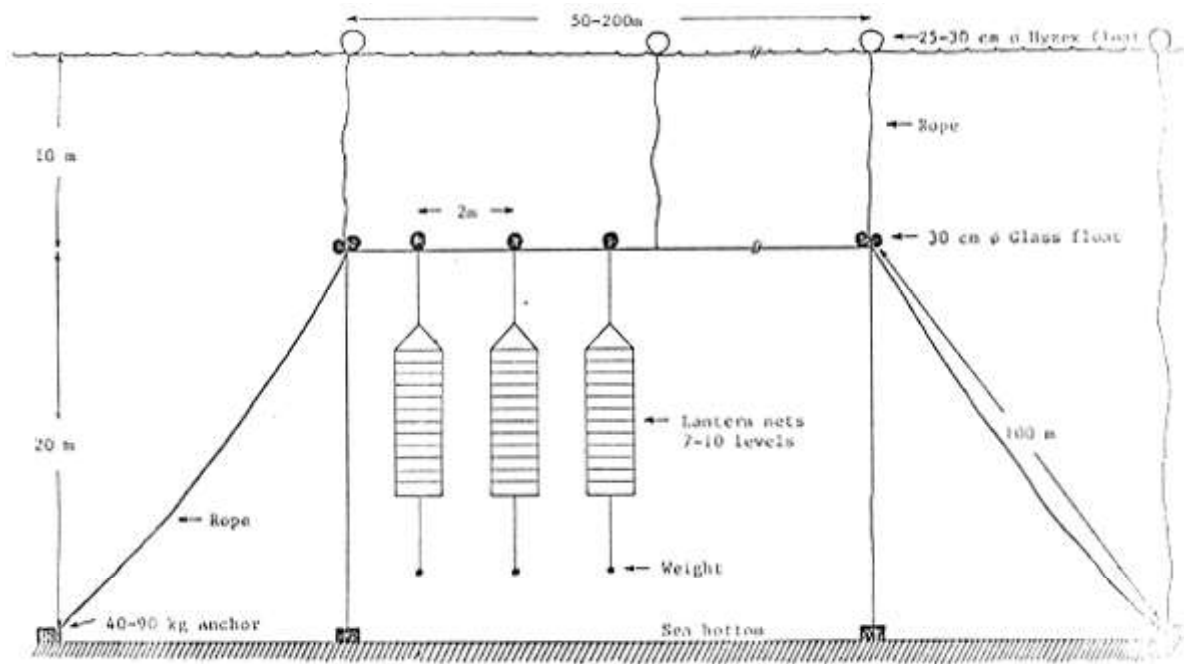


Figure 32. Shellfish farming infrastructure examples. Showing how lantern nets will be deployed onto the header lines. Used for *Mytilus edulis*, *Ostrea edulis* & *Aequipecten opercularis* species.

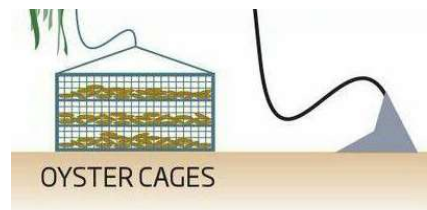


Figure 33. Shellfish farming infrastructure examples. Showing how cages used for *Ostrea edulis* will be placed on the seabed underneath the cultivation ropes above.

Both Carn Ar Wig and Porthlysgi will be used for growing mixed shellfish and therefore a range of methods will be used as shown in Figures 18-20 above. This will include mussels grown on spat ropes which will be continuous lines attached to the header rope via droppers; these will then be re-socked into dropper lines of socking mesh of various sizes. Mussels, oysters and scallops will be grown in lantern nets which will be tied on to the header ropes and if needed, weights will be added to the bottom to reduce the risk of tangling. Oysters will also be grown in cages which will be attached to each other via rope and individually weighted as well as attached to an anchor at each end of the line to ensure they do not move around on the seabed; buoys will also be placed at each anchor to allow retrieval and clearly mark from the surface where the cages are placed.

All farm infrastructure is subject to a maintenance routine to ensure shackles are tight, ropes are not worn and anchors, buoys and floats are securely attached to the farm. This also includes frequent checks on lantern nets and droppers for spat lines to reduce the risks of dragging along the seabed which would potentially cause damage to the seabed as well as damaging or destroying stock. As discussed, cages will only be placed in areas with sediment to ensure the risk to flora/fauna on the seabed is reduced.

Future monitoring will include diver maintenance of the farms every 6 months to check the condition of anchors and chains and report back any issues noted. The divers record each maintenance dive to allow easy reassessment of the condition of the infrastructure at a later date and therefore this footage can be used to compare how the seabed may have changed since the last dive was done. As these dives mainly focus on the outer areas of the farms where the anchors and chains are, an additional dive to capture footage from directly under the lines will be added to aid in assessing the potential smothering/shading effects the lines may have on the seabed beneath it. Câr-y-Môr is also involved in an ongoing monitoring project with PEBL CIC, looking at biodiversity at seaweed farms around the UK but also including the 2 shellfish farm sites. This will include data such as BRUV, benthic light and turbidity data and cetacean monitoring to provide a long term view of biodiversity on the farms.

6. Conclusions

Overall, Carn Ar Wig is a mixture of boulders and sediment habitats with the number of boulders decreasing to the North-West area of the proposed farm. The original farm location would have placed the south west anchor in an area of rocky habitat and so the decision has been made to move the farm location slightly north west into the sediment type habitat. Micrositing will be used to ensure the anchors are not placed in areas where there is a high number of boulders and further monitoring of the seabed will be conducted over the coming years to monitor the effects of farm infrastructure on the seabed and allow any adjustments to be made as needed.

Porthlysgi Bay is predominantly sandy sediment with some bedrock and boulders closer to the cliff areas in the north and west. The original farm location would have been within the vicinity of these potential rocky areas, therefore the decision has been made to adjust the farm location further into sedimentary habitats with lower sensitivities to the proposed farm activities. The farm will also be monitored as with Carn Ar Wig to assess the impacts of the farm on the bay and allow adjustments to be made if needed.

Oyster cages at both sites will be placed in areas of sediment to avoid damage to any rocky areas. Monitoring of the farm areas including effects of infrastructure such as anchors, chains and cages on the seabed and effects of shading/smothering from the shellfish cultivation itself will be done through analysis of diver footage and participation in ongoing biodiversity monitoring projects with external partners. This will ensure any potential changes to the seabed as a result of the farms can be monitored and changes implemented if necessary to safeguard the health of the seabed over the licensed period.