



**For the Love of the Sea Limited
A Community Benefit Society**

**An application for Câr-Y-Môr's 3 hectare seaweed &
shellfish IMTA site in Ramsey Sound,
Environmental Impact statement and Document to inform a
Habitats Regulation Assessment**

An assessment for Natural Resources Wales, to support a licence application

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Recommended citation:

Car y Mor 2021. Car y Mor seaweed and shellfish farm: Environmental statement. St. Davids.

Acknowledgements

Câr-Y-Môr members who have all voluntarily carried out required field work and drafted this application including this Environmental Impact assessment and statement and consulted many in the local community, stakeholders, other seaweed and shellfish farmers in the UK. These members include Marine Scientists, Marine engineers, fishermen, tour boat operators, fish farmers, accountants and many other supporters in the community.

Other assistance and advice:

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1 Non-technical summary

Table 1 Definitions & acronyms

Integrated Multi-Trophic Aquaculture (IMTA)	New concept of aquaculture where the main objective is promoting long term bio mitigative solutions while cultivating species at different trophic levels. The IMTA used by Câr-Y-Môr involves two trophic levels of extractive species - ie Seaweeds and Bivalves.

2 Introduction

2.1 Background to 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 one hundred committed members. The Society is managed by nine directors, with combined experience in aquaculture and fisheries, marine conservation, community engagement, business development and management skills. Câr-Y-Môr also owns Solva Seafoods, having bought this business in 2020 to create local jobs and develop a trading record, and as a future route to sell seaweed and shellfish grown on the farms.

Câr-y-Môr has started Wales's regenerative ocean farming in the St Davids Peninsula, with two trial sites at St Justinians and Porthlysgi, growing kelp, mussels, native oysters and scallops. This farming method uses no fertiliser, pesticides or freshwater, and provides a sustainable nutritious food source. Câr-Y-Môr's long term goal is to continue ocean farming alongside development of an education centre - ultimately to inspire others to replicate this ocean farming method across Wales. Regenerative ocean farms across Wales will enhance local marine biodiversity and the well-being of local communities, stimulate sustainable ocean jobs creation and give young people a route into an integrated Welsh seafood sector.

2.2 Overview of project

Câr-Y-Môr, following a year of successfully running the two trial farms now wishes to apply for a three hectare marine licence to expand its farming operation 500 meters north of the existing Carn ar wig trial site. The site proposed is the St Justinians site. The site is located 1km South of St Justians's lifeboat station, and approximately 200 m from the coast. The current trial site (Carn ar Wig) is 0.5 hectares in size, with coordinates from 52.8667777, -5.3157286, to 51.8675266, -5.3141348, on a south west to north east bearing. The proposed commercial site is three hectares in size, which is 0.6% of Ramsey Sound (470 hectares). A detailed description of the location is given in section 3.2.

The proposed commercial site will grow many species of local seaweed - e.g sugar kelp (*Saccharina latissima*), oarweed (*Laminaria digitata*), laver (*Porphyra sp.*) and dulse (*Palmaria palmata*), and three local species of shellfish - scallop (*Pecten maximus*), oyster (*Ostrea edulis*) and mussels (*Mytilus sp.*)

2.3 Justification of project

Câr-y-Môr's ocean farming method is inspired by <https://www.greenwave.org/> and based on Integrated Multi-Trophic Aquaculture (IMTA) principles, and essentially co-locates seaweed and shellfish cultivation. The seaweed and shellfish both support each other as they grow, with the seaweed taking up inorganic nutrients and the shellfish taking up organic nutrients. The benefits to this farming method are numerous and include:

- potential enhancement of local marine biodiversity
- provision of a habitat for many marine species
- a carbon-neutral farming method which requires no freshwater, land space or fertiliser
- sequestration of excess nutrients in the water column

- provision of storm surge protection
- provision of a sustainable food source, high in protein and nutrients
- stimulation of sustainable ocean-based jobs in rural coastal communities.

Câr-y-Môr's venture provides even more benefits, due to being a registered Community Benefit Society and through its proposed education programme. Through development of an education centre in the future, and the scale-up of the seaweed and shellfish farming, Câr-y-Môr will be able to provide a template for others on how food can be produced in the ocean in a sustainable way for all. Through the community being involved in the project throughout the planning and operational stages, numerous other benefits include:

- improved well-being and connection to the ocean
- a place to come together to give back after the difficulties of the pandemic
- making St Davids more resilient to future challenges by becoming more self-sustaining
- improved understanding of the natural world, marine conservation issues and how to grow and produce food in a sustainable way.

With so much compelling logic many people ask why has this sort of ocean farming not started in Wales years ago? There must be some negative impact no one is mentioning?? Câr-y-Môr believes that negative impacts are minimal and positive benefits of the farm will be many. Ocean farming can alternatively be described as 'zero input organic ranching within small fields in our ocean, growing seaweed and shellfish'. Yet, as there are no fences, it is an open resource for all marine life to pass through, benefitting from the new marine ecosystem the local community has created.

2.4 National perspective

Câr-y-Môr's ocean farm venture is in line with Welsh national policy:

- Future Generations Act: The farm fits under the aims for a 'Prosperous Wales', a 'Resilient Wales' and a 'Globally Responsible Wales'. The farm will create sustainable skilled ocean-based jobs, whilst providing a nutritious and low-carbon food source, promoting biodiversity and encouraging appreciation of the marine environment.
- One Planet Development: Though the farm is not an official One Planet Development, it will create a means for local people to grow food in a sustainable, low-carbon way, supporting the local community and environment.
- Welsh National Marine Plan: Under the Marine Plan, aquaculture projects should be supported where they contribute to the objectives of the plan, and comply with relevant policies etc (AQU_01a), and public authorities are encouraged to collaborate to understand opportunities for sustainable aquaculture (AQU_01b). CYM's proposed ocean farm fits within these policies, and will also provide an opportunity for research and development of sustainable aquaculture.

3 Stakeholder engagement and community participation

Stakeholder engagement has been undertaken prior to the submission of this application, and will continue throughout the application process and thereafter. The most notable example is the Pioneer Share Offer, which has to date received over £85,000 in funding from 60 people investing in this Society. After the article in the guardian newspaper this month https://www.theguardian.com/environment/2021/jul/13/welsh-caviar-should-we-all-start-eating-laver?CMP=Share_iOSApp_Other - several further enquiries have been received. During the trial sites' application process, extensive stakeholder consultation was undertaken, resulting in the community being fully supportive of the venture.

The St David's peninsula is a small close-knit community, with the main areas of employment in the area being Milford Haven, the fishing industry and the tourist industry. Nearly 40 million tourists visit St Davids every year, with the summer months busy with boat trips to Ramsey Island and fishing trips out to sea. The area is also popular with wildlife watchers, as harbour porpoises and bottlenose dolphins can often be seen in the Ramsey Sound. The Ramsey Sound itself is of interest to marine renewable energy development. The proposed site is within the Ramsey Sound, and in a busy area of water with activities including lobster fishing, renewable energy development, boating etc. Therefore, stakeholder engagement and community participation is of the utmost importance. The following stakeholders have been identified (with many letters of support available):

Governmental and non-governmental agencies:

- Welsh Government Fisheries Office
- Local MP - Stephen Crabb
- Local AM - Paul Davies
- Pembrokeshire County Council
- Natural Resources Wales
- Maritime Coastguard Agency
- MOD
- Trinity House
- RNLI
- Pembrokeshire Coastal Forum
- Trinity House
- RSPB
- The National Trust
- The Pembrokeshire National Coastal Park Authority

Industry and tourism:

- The fishing industry
- Boat trip operators
- Marine Renewable Energy developers
- Sailing, kayaking, diving and coastering clubs and operators (including TYF)
- Anglers and associations

Conservation groups:

- Welsh Wildlife Trust
- Marine Conservation Society

General:

- Neighbouring land-owners and occupiers

Workshops are planned in St Davids and Solva to discuss this application as soon as it is finalised. Further these will be also offered via an online platform to present the plans to the community members and stakeholders. Information will be also available by a physical newsletter and distributed to those who may not have access to online platforms.

3.1 Existing trial plots

The two existing trial farms are located at Carn ar Wig and Porthlysgi in Ramsey Sound near St. Davids, West Pembrokeshire - see figure 1.

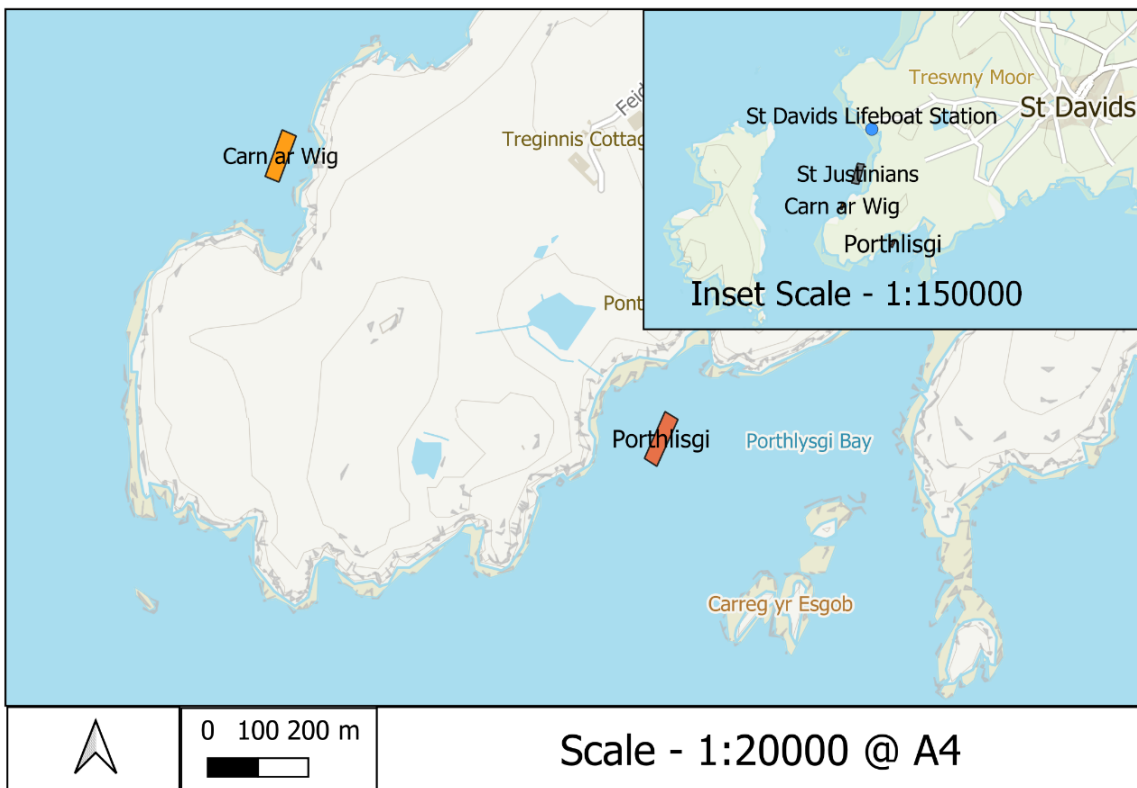


Figure 1. Existing trials sites at Carn ar Wig and Porthlysgi are marked in orange .

Table 1. Coordinates of the two respective existing trial pots

Carn ar Wig	
Longitude	Latitude
-5.315736	51.868074

-5.315337	51.867964
-5.315830	51.867141
-5.316227	51.867242

Porthlysgi Bay	
Longitude	Latitude
-5.304682	51.863036
-5.304309	51.862895
-5.304918	51.862058
-5.305277	51.862199

The cultivation method is longline culture and cultivated species include sugar kelp (*Saccharina latissima*) oarweed (*Laminaria digitata*), laver (*Porphyra sp.*), dulse (*Palmaria palmata*), scallop (*Pecten maximus*), oyster (*Ostrea edulis*) and mussels (*Mytilus sp.*)

The current supporting infrastructure for the trial sites include 300 kg anchors, ground chain, riser chains, trinity house buoys and flotation buoys, seaweed growing lines, lantern nets, mussel growing ropes and oyster growing cages (1m by 1m) on the seabed.

Trials on different flotation buoys have concluded that less flotation is required and is optimal as it reduces the visual impact, windage on the structure and movement and stress on the underwater stock especially in stormy conditions - smaller and less floats will be used in the future trials at these sites.

Port Health is presently sampling the mussels and scallops on the trial sites for classifying the shellfish beds for harvesting. So far, all results have been A grade.

Management and harvesting of the trial sites has been carried out throughout, with seaweed harvested for development of trial products and to develop drying methods.

At the end of the 5 year trial license period (2025), the society will either renew the licenses for more trials or decommission them as required by the license. The society has marine

contractors as members who will carry out this work removing all infrastructure with minimal disturbance to the sea bed.

3.2 The Proposed three hectare Seaweed and Shellfish (IMTA) farm

3.2.1 Proposed site

The proposed three hectare site (Labelled St Justinians) is 500 meters north east of the Carnarwig trial site. This location has been chosen as the preferred choice due to high suitability of the surrounding marine environment, the successful tests at the trial farms, and the accessibility. The site is located in Ramsey Sound in a shallow open bay on the east side of the sound (Table 1). The minimum depth is 10m at chart datum. The surrounding sea is (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 'pristine' with no local significant freshwater input. Another three hectare area close to the Porthlysgi trial site was considered (Survey results included as an alternative location). However the St Justinians site is preferred and is therefore the proposed 3 hectare site. Figure 2 below illustrates the location of the proposed site, whilst Table 2 provides coordinates.

Table 2. Coordinates of the proposed site 200m North and 150m West of the coast

St Justinians Proposed Site	
Longitude	Latitude
-5.312440965606 686	51.873328536407 63
-5.313735008239 7505	51.870701623644 26
-5.312190055847 1715	51.870542637926 84
-5.311006965606 687	51.873197535712 96

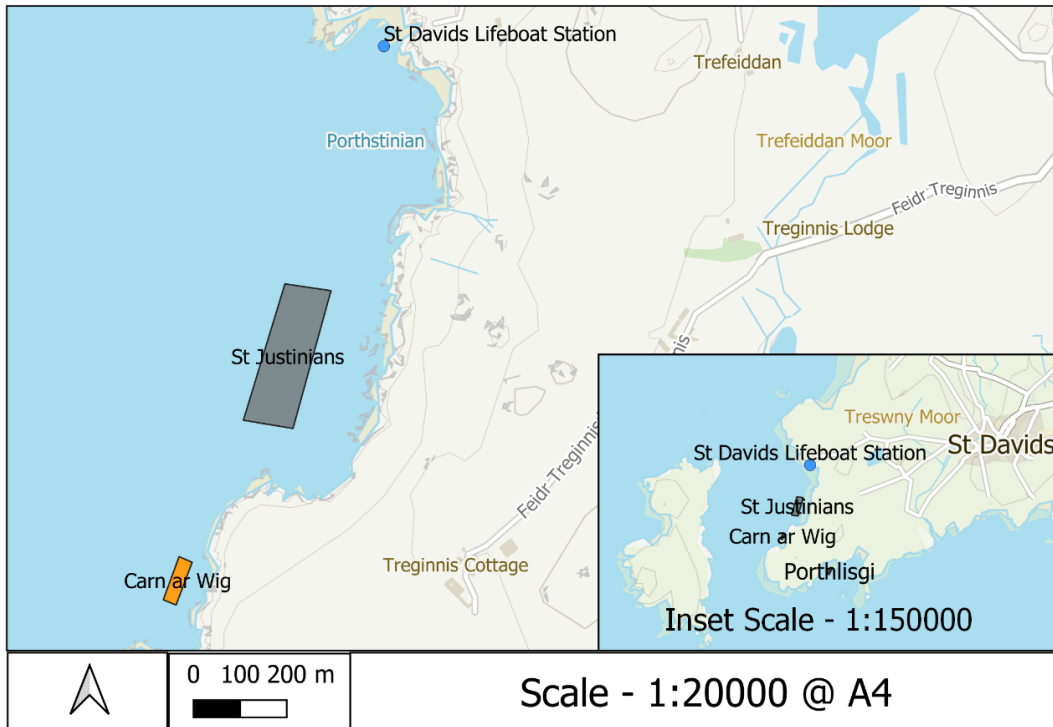


Figure 2. Proposed area (grey) 100 meters wide and 300 meters long - labelled St Justinians.

3.2.2 Proposed physical farm structures

The proposed site will follow the typical Integrated Multi-Trophic Aquaculture (IMTA) structure - 3D suspended method of growing seaweed, shellfish, and other marine organisms, which can withstand rough sea conditions. Within the proposed site it is proposed to have two phases of deployment - Phase 1 in the October 2021 and Phase 2 in October 2022 - All details below in Figures 3, 4 and 5 which show views of the seabed, sea surface and side underwater view

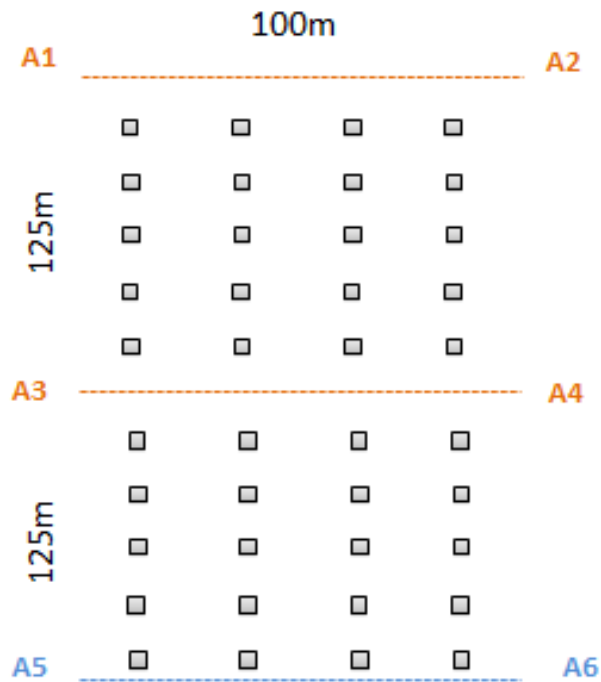


Figure 3. PROPOSED FARM : Plan view of sea bed (Standard trot mooring design).

During Phase 1 four 300 kg anchors are proposed to be deployed (A1, A2, A3 and A4), joined by two lengths of 100 m of 35 mm ground chain (A1 to A2, and A3 to A4), During Phase 2 two 300 kg anchors are proposed to be deployed (A5 & A6) joined by one length of 100 m of 35 mm ground chain (A5 to A6). The grey squares represent seabed native oyster cages (1m by 0.8m by 0.5m) - 20 in Phase 1 and 20 in Phase 2.

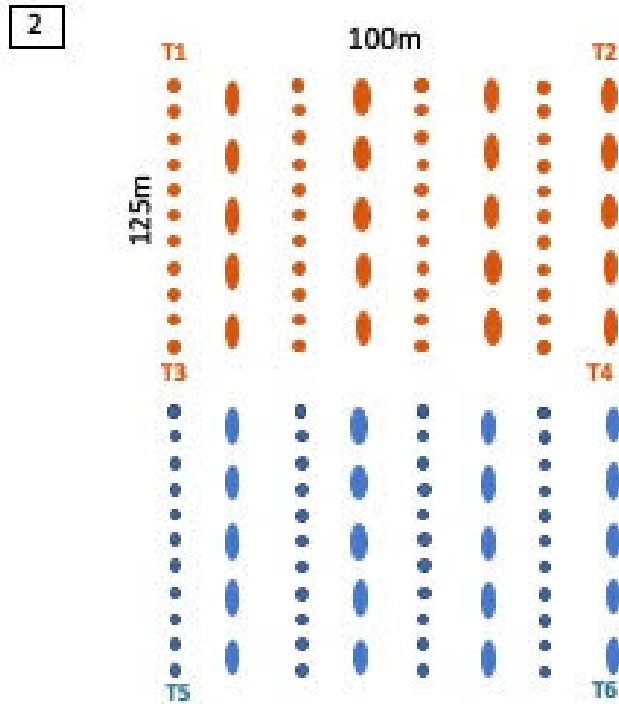


Figure 4. PROPOSED FARM : Plan view of sea surface (from a boat/coast view)

Phase 1 four trinity house special marks buoys are represented by T1-T4.

44 orange circles represent 4 seaweed lines each with 11 fifteen inch A floats .

20 orange shapes represent 4 shellfish lines each with 5 pencil floats (250 litre)

Phase 2 two trinity house special marks buoys are represented by T5-T6.

44 blue circles represent 4 seaweed lines each with 11 fifteen inch A floats .

20 blue shapes represent 4 shellfish lines each with 5 pencil floats (250 litre)

Please note as discussed in 3.1, the trials on different flotation buoys have concluded that less flotation is required and is optimal as it reduces the visual impact, windage on the structure and movement and stress on the underwater stock especially in stormy conditions. Therefore, smaller and fewer floats are proposed to be used on each of the new farm lines. For example, the existing 150 litre mussel floats, kindly donated to the Society for the trial sites, will be replaced by 15 inch (38 cm) A floats.

Figure 5 below illustrates the underwater side view of the proposed far, detailing kelp, scallops, oysters and mussels.

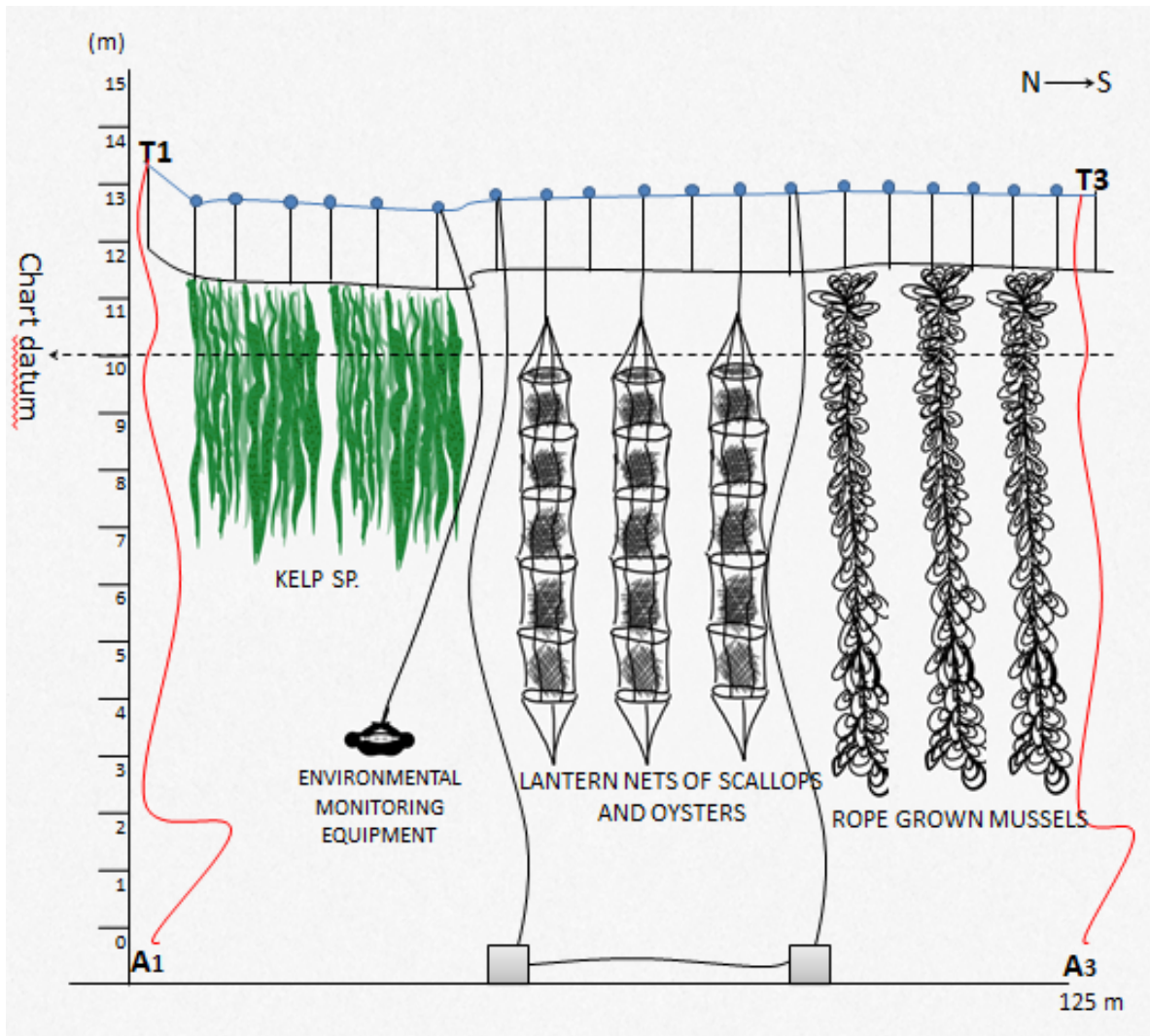


Figure 5. PROPOSED FARM: Underwater view of side elevation showing all different structures planned to be used on the lines
 The vertical red lines represent the riser chain (16mm). Examples of Seaweed and bivalves that will be suspended and grown off the header lines (2 metres below the surface.)

3.2.3 Source of seaweed spores and shellfish spat

The seaweed seed supplying Car-Y-Mor has been cultivated from wild seaweeds collected from an area within 25km of th Car-Y-Mor’s existing farms. The seed material selected for has been selected from a number of different locations within this 25km area to ensure that the cultivars will have a good genetic diversity and are adapted to the local marine conditions. Samples of seaweed seed selected for cultivation will also be sent to Dr. Niall McKeon at Aberystwyth University to create a record of the DNA of the cultivars grown on the farm. This will form the basis of ongoing DNA mapping work that Car-Y-Mor will carry out going forward.

Collected seed material is then transported to a seaweed Hatchery at Penmon Point in Anglesey (run by Plant Ecology Beyond Land CIC). At this facility the seed material will be

cleaned and spore release will be stimulated. The released spores will then be inoculated onto seaweed culture twine (sourced from Korary - Japan) and cultured for 5-7 weeks in controlled conditions in filter-sterilised fresh seawater, collected directly from the foreshore at Penmon Point (Rolin et al., 2017).

Alternatively, sporophytes may be directly seeded onto the main long-line header rope aided by a biological emulsion-binder before being deployed the same day. This second method will be carried out on a trial basis.

3.2.4 Installation & maintenance

The gear will be positioned and maintained by experienced local marine operators Robust Boats in collaboration with John Arnolds of 360 Aquaculture, who have experience growing rope grown mussels. The sites will be continually remotely monitored and periodically inspected by divers and/or by boat to record and evaluate any environmental impact, the suitability of the gear and the health of the shellfish and seaweed. A monitoring project is also being conducted by WWF and Plant Ecology Beyond Land CIC (PEBL), the results of which will be analysed to further monitor and mitigate any potential impacts of the ocean farm on the surrounding environment. Further detail on maintenance and monitoring activities are outlined in section 5.10 and 5.11 respectively.

3.2.5 Land-based facilities & support vessels

The seaweed and shellfish from the farm will be harvested by boat, then processed at the Robust Boats land-based facility, according to required regulations. The seaweed and shellfish will be transported from the St Justinians site in clean plastic buckets, straight to the processing facility by van, which is located less than 10 minute drive from the port. As the harvesting will only take place a few times a year, limited additional traffic will be created by transportation of equipment.

3.2.6 Proposed schedule

Proposed start date is October 2021, when Phase I of the infrastructure will be deployed. Seaweed seed will then be out-planted onto the farm beginning of November 2021. Phase II will be deployed in October 2022 subject to the Phase I being successful and no negative impact recorded by remote and human monitoring. The farm will be regularly maintained to ensure continued life as outlined in section 5.10.

3.2.7 Management, harvesting and processing

The harvesting of seaweed and shellfish is undertaken from the specially-designed boat by Câr Y Môr members. Seaweed is washed and dried in a polytunnel. Shellfish is processed according to regulatory requirements.

3.2.8 Method of removal of structures and anchors

Local marine contractors (members) will be responsible for removal of structures and anchors at the end of the life of the farm. This includes Steve Rees who is a local experienced mooring contractor, and will use appropriate equipment to remove the moorings, according to correct procedures to minimise disturbance to the seabed.

3.2.9 Costs markets and economic sustainability

A spatial assessment of the Potential for Aquaculture in Welsh waters considers that aquaculture is considered to be a key area for development in the UK, due to its potential to contribute to the sustainability and security of the UK food supply and economic development. The Welsh Government's Marine and Fisheries Strategic Action Plan states that it is committed to the sustainable development of aquaculture (marine and freshwater) and aims to double annual shellfish and finfish aquaculture output by 2020 (Welsh Government, 2013).

The long-term trend for the aquaculture industry is expected to be one of continued growth despite recent declines in the level of activity in some areas due to the economic downturn. Aquaculture is considered to be a key area for development by UK administrations due to its potential to contribute to the sustainability and security of the UK food supply and economic development (Radulovich et al. 2015; Rebours et al. 2014).

One of the major objectives of Câr Y Môr is to integrate seaweed and shellfish farming into local livelihood strategies for socio-economic and community development. The farm development will allow Câr Y Môr to become a commercially viable, sustainable ocean farm, and a template for others.

4 Surrounding environment description

4.1 Survey results

As there was almost no pre-existing data on the distribution of seabed habitats in the areas proposed for the seaweed/shellfish farm, a mini ROV (Chasing M2 with 4K video, operated by Martin Charlton, Pembrokeshire Marine Services Ltd.) was used to survey both areas in April 2021. The following sections provide a description of the habitats and communities present, the biotopes assigned (from the national marine habitat classification), maps of the habitat distribution and selected images captured from the video.

4.1.1 Priority site: St Justinians (south) (Carn ar Wig)

St. Justinians is on the mainland side of Ramsey Sound, which is well known for the very strong tidal currents that flow through it. The proposed site for the seaweed/shellfish farm is to the south of St. Justinians itself, within a bay that lies out of the strongest flows but is still exposed to moderately strong currents. The site is moderately sheltered from wave action, from the south and north. The adjacent coast is steep with high cliffs and there are a number of sea caves around the bay. The shores are predominantly rocky and steep with limpet/barnacle communities, but the lower shores are dominated by algae. The shallow subtidal close to the shores is also mainly rocky, but also fairly silty, particularly in the shallower parts of the bay, away from the headlands, where tidal flows reduce. Further out into the bay the rocky habitats continue, including rugged bedrock rock ridges and boulders that are increasingly tide-swept with distance from the shore and increasing depth. In the middle of the bay that rocky seabed gives way to a level seabed of cobbles, pebbles and coarse sediment, which is strongly tide-swept. Silty bedrock and boulders extend further out from the shore at the south end of the bay. At the inner south end of the bay, where tidal currents are weakest and the seabed is very gradually sloping, the shallow subtidal is predominantly sedimentary and very silty.

4.1.1.1 Seabed communities

Note: The surveys were not intended as a thorough survey of all habitats around St. Justinians and Porthlysgi. The descriptions below cover the main seabed areas under and immediately adjacent to the proposed seaweed/shellfish farm.

All depths are given from chart datum (bcd = below chart datum).

The following communities were present at the St Justinians site:

Seabed type	Description
<p>Infralittoral silty bedrock and boulders with red algae and sponges</p>	<p>Inshore rocky reef, extends out from the shore for approximately 200m and the areas surveyed were predominantly silty broken bedrock and boulders, at 6 to 11m. Much of the rock is low lying but there are also many steep sided ridges and outcrops standing more than 2m high, with broken slate in the gullys between them. Kelp <i>Laminaria hyperborea</i> was common on the top of the higher rock outcrops and will be abundant in the areas closer to shore. Much of the rock is very angular with vertical sides, fissures and overhangs. Upward facing surfaces were colonised by patchy algal turf, particularly <i>Calliblepharis ciliata</i>, <i>Delesseria sanguinea</i>, <i>Heterosiphonia plumosa</i> and <i>Cryptopleura ramosa</i>. A wide variety of other red and brown algae were also present in lower abundances, including <i>Callophyllis laciniata</i>, <i>Phyllophora</i>, <i>Phycodrys rubens</i> and <i>Carpomitra costata</i>. Sponges were common, including large colonies of <i>Cliona celata</i> and the orange sponge <i>Amphilectus fucorum</i>. Cup corals <i>Caryophyllia smithii</i> were also common. Occasional spider crabs <i>Maja squinado</i> and velvet swimming crabs <i>Necora puber</i> were present. Large sea urchins <i>Echinus esculentus</i>, the sea cucumber <i>Aslia lefevrei</i> and the fan worm <i>Bispira volutacornis</i> were occasional. Communities on the vertical surfaces were similar to those of the circalittoral rock that is described below. [Biotope code: IR.HIR.KFaR.FoR].</p>

<p>Circalittoral bedrock ridges & boulders with cup corals & sponges</p>	<p>The deepest areas of rocky seabed, at 10 to 13m, which are also the furthest out from the shore and therefore most exposed to tidal currents, also comprise steep angular bedrock ridges and boulders, but are too deep for many algae. These animal dominated communities were characterised by a wide variety of sponges, large numbers of cup corals <i>Caryophyllia smithii</i> and various other anthozoa. The sponges included erect species <i>Axinella dissimilis</i> and <i>Stelligera/Raspailia</i>, as well as <i>Dysidea fragilis</i>, <i>Amphilectus fucorum</i> and <i>Cliona celata</i>. A low turf of Crissid bryozoa covered much of the vertical surfaces and hydroids, including <i>Nemertesia ramosa</i> and <i>Sertularia argentea</i>, and the ascidian <i>Morchellium argus</i>, were occasional. [Biotope code: CR.HCR.XFa.ByErSp].</p>
<p>Scoured pebbles and cobbles with scallops</p>	<p>Moving out into the main channel, where the tidal currents are much stronger, the seabed is mostly level and consists of pebbles and cobbles with an in-fill of coarse sand and gravel. The strong currents mobilise the sand and gravel, which scour the hard substrata and greatly limit the growth of any soft-bodied marine life. Few conspicuous species were evident in the ROV images, with only pink encrusting coralline algae abundant on the cobbles, frequent calcareous tubes of keel worms and frequent scallops <i>Pecten maximus</i> lying in hollows between the stones. Occasional ross corals <i>Pentapora foliacea</i> were also present, but mostly in a relatively flattened form. The hydroid <i>Abietinaria abietina</i>, which is also resistant to sand scour, was occasional. A few boulders were seen, creating some texture to the seabed, but these were also scoured with just a few additional species where the boulder provided some shelter. [Biotope code: SS.SCS.CCS.PomB].</p>
<p>Circalittoral silty cobbles and boulders with ross coral</p>	<p>In some areas, particularly at the south end of the bay, slightly tucked out of the stronger</p>

	<p>currents, at 11 to 12m, there are areas of silty cobbles and low lying boulders that are intermediate between the more rugged bedrock inshore and the tideswept cobbles and pebbles offshore. Ross coral <i>Pentapora foliacea</i> was particularly abundant in this habitat, while a variety of sponges and hydroids were present on the boulders. [Biotope code: CR.MCR.EcCr.FaAlCr]</p>
<p>Mobile sand and gravel</p>	<p>Sandy sediments, comprising mixed coarse sands and gravel, with waves and ripples, are found at the south end of the bay, 6.5 to 11m. They are very mobile in the deeper areas, with very little conspicuous life except occasional scallops <i>Pecten maximus</i>, but become increasingly silty and more stable in the shallows of the inner bay. Occasional crabs <i>Carcinus maenas</i> and small fish are present, but other conspicuous life is mainly barnacles and algae attached to stones. Occasional boulders are present and colonised by a red algal turf, particularly <i>Calliblepharis ciliata</i>. [Biotope code: SS.SCS.ICS.SSh]</p>

4.1.2 Alternative site: Porthlysgi

In case of unforeseen circumstances whereby the priority site at St. Justinian's is not available, we have identified Porthlysgi Bay as an alternative location for the proposed site. Porthlysgi Bay, situated as it is on the south-west coast of the St. David's peninsula, is exposed to large seas. The surrounding shores are rocky and dominated by the limpet/barnacle communities that are characteristic of much of the open coast of Pembrokeshire. The subtidal seabed fringing the bay is also predominantly rocky with algal dominated communities of kelp and red algae. However, the rock does not extend far into the bay as sands and gravel predominate across the whole of the central area. Some of these sediments are very mobile, comprising coarse sands, gravels and pebbles that may be formed into waves by some of the large sea swells that roll into the bay during storms. But most of the seabed is characterised by fine silty sands – mostly rippled, indicating mobility from tidal currents and wave action, with very little conspicuous marine life. In the more sheltered areas, i.e. some areas at the back of the bay and also in the deepest areas of the outer bay, the fine sands are less mobile, with a higher silt content and burrowing fauna is more evident. Finally, where the sediment meets the fringing rock there are areas of low lying boulders and cobbles that are, to varying extents, influenced by sand scour or smothering.

4.1.2.1 Seabed communities

Note: The survey was not intended as a thorough survey of all habitats of Porthlysgi Bay so the descriptions below cover the main seabed areas under and immediately adjacent to the proposed seaweed/shellfish farm.

All depths are given from chart datum (bcd = below chart datum).

Seabed type	Description
<p>Infralittoral bedrock, with kelp park and red algal turf</p>	<p>The ROV survey collected only brief footage of the subtidal bedrock that fringes Porthlysgi Bay and was confined to the deeper areas below 6m. The areas viewed were silty bedrock ridges with kelp park and red algal turf. 6.5m to 9.5m. Conspicuous fauna sparse, except for occasional boring sponges (<i>Cliona celata</i>) and cup corals (<i>Caryophyllia smithii</i>). Red algal turf included <i>Heterosiphonia plumosa</i>, <i>Calliblepharis ciliata</i>, <i>Delesseria sanguinea</i> and other foliose species. Coarse sand, pebbles and cobbles covering floor of troughs between ridges. Kelp on the tops of ridges included <i>Laminaria hyperborea</i>, <i>Saccharina latissima</i> & <i>Saccorhiza polyschides</i>. Some high ridges present, some with steep / vertical sides, with bryozoan turf. [Biotope code: IR.MIR.KR.Lhyp.Pk].</p>
<p>Infralittoral boulders, cobbles and low lying bedrock strongly influenced by sand</p>	<p>Where the bedrock habitats described above meet 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</p>

	<p>habitat described above. Encrusting coralline algae and tubes of the keel worm <i>Spirobranchus</i> are particularly common. Other animals included occasional hermit crab <i>Pagurus bernhardus</i> and netted whelk <i>Tritia reticulata</i>. [Biotope code: IR.HIR.KSed.XKScrR].</p> <p>A variant of this habitat, with boulders and cobbles in silty sediment, was also present in deeper water (14.5m) at the centre of the Bay.</p>
<p>Coarse sediment waves</p>	<p>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 below. [Biotope code: SS.SCS.CCS].</p>
<p>Rippled fine sand</p>	<p>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 <i>Pecten maximus</i>. Rarely, small lumps of silty rock with sparse life, incl. hermit crabs, <i>Pagurus bernhardus</i>, spiny starfish <i>Marthasterias glacialis</i> and small pieces of red algae. One burrowing sea cucumber seen in deeper areas. This habitat gradually merged into the muddy sand habitat, described below, and the coarse sediment habitat described above. [Biotope code: S.SSa.IFiSa.IMoSa].</p>

Muddy sand with burrowing fauna	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 (<i>Arenicola marina</i>) and signs of other burrowing species (likely including heart urchins <i>Echinocardium cordatum</i> and razor clams <i>Ensis</i> spp.). Rare burrowing anemones <i>Cerianthus lloydii</i> . [Biotope code: SS.SSa.IMuSa].
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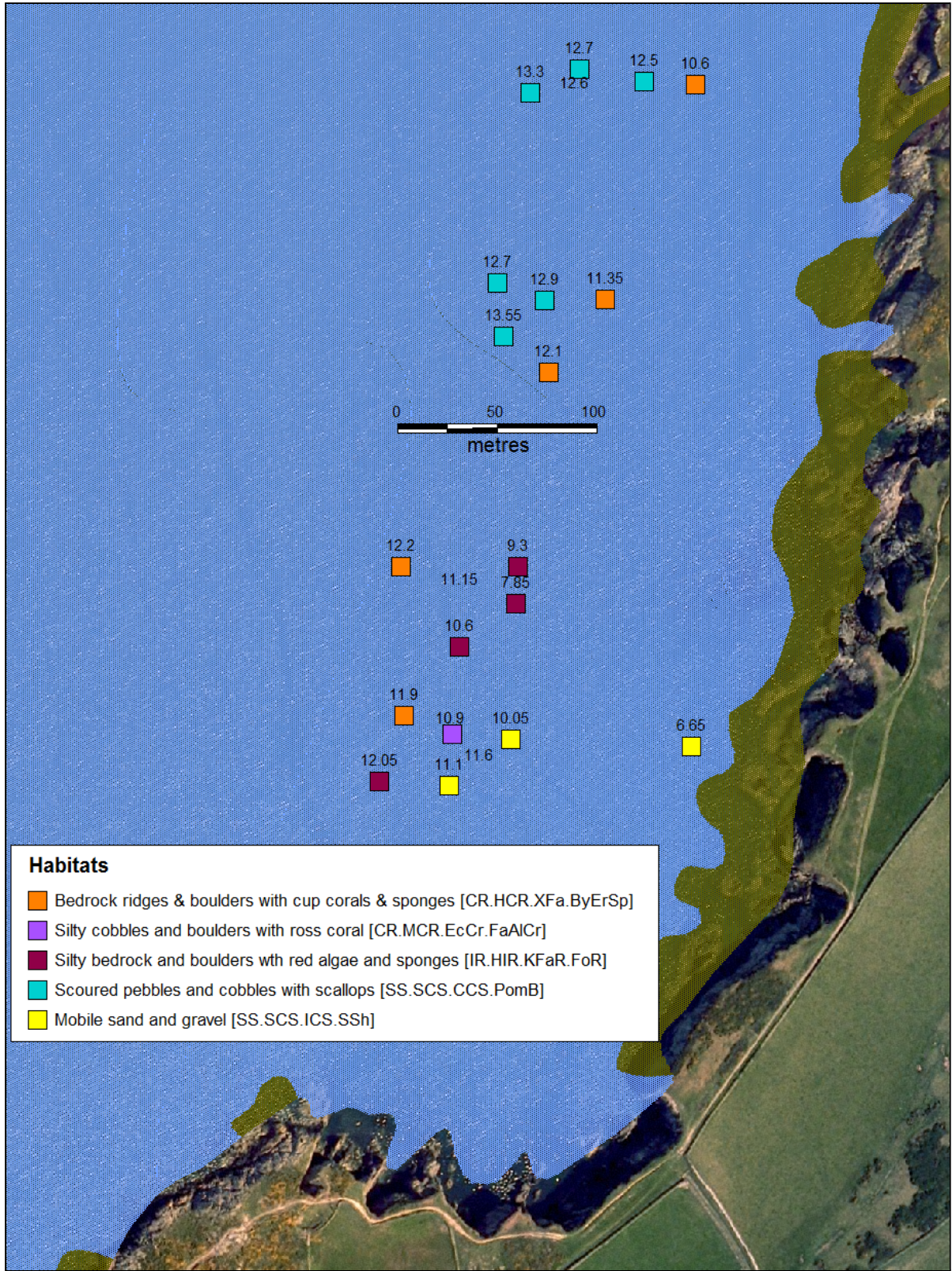
4.1.3 National classification

The following table shows the biotopes from national classification (<https://mhc.jncc.gov.uk/>).

Site	Code	Description
St.Justinians	IR.HIR.KFaR.FoR	Foliose red seaweeds on exposed lower infralittoral rock
	CR.MCR.EcCr.FaAlCr	Faunal and algal crusts on exposed to moderately wave-exposed circalittoral rock
	CR.HCR.XFa.ByErSp	Bryozoan turf and erect sponges on tide-swept circalittoral rock
	SS.SCS.CCS.PomB	<i>Pomatoceros triqueter</i> with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles
	SS.SCS.ICS.SSh	Sparse fauna on highly mobile sublittoral shingle (cobbles and pebbles)
Porthlysgi	IR.MIR.KR.Lhyp.Pk	<i>Laminaria hyperborea</i> park and foliose red seaweeds on moderately exposed lower infralittoral rock
	IR.HIR.KSed.XKScrR	Mixed kelps with scour-tolerant and opportunistic foliose red seaweeds on scoured or sand-covered infralittoral

		rock
	SS.SCS.CCS	Circa littoral coarse sediment
	S.SSa.IFiSa.IMoSa	Infralittoral mobile clean sand with sparse fauna
	SS.SSa.IMuSa	Infralittoral muddy sand

The following figures illustrate the seabed habitats at each site, based on the national classification system.



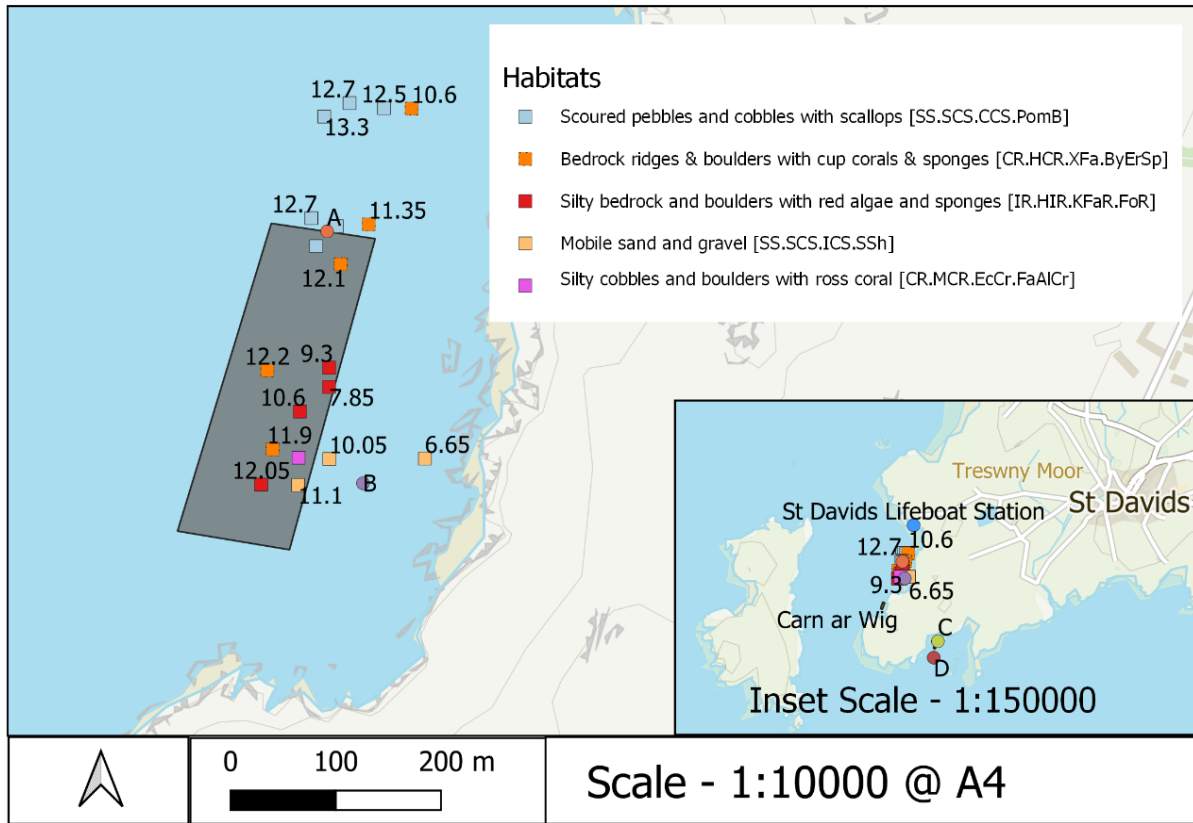


Figure 6. Seabed habitats at St Justinians, 9 April 2021

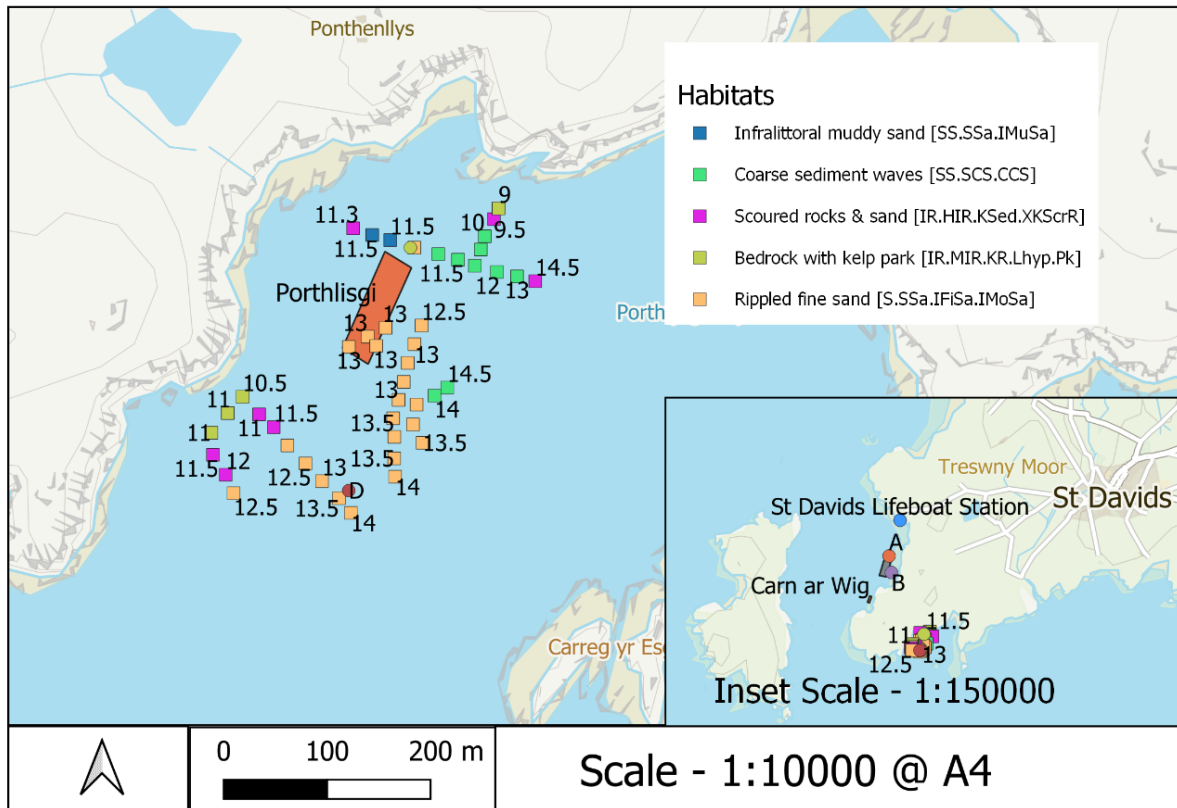


Figure 7. Seabed habitats at Porthlysgi, 20 April 2021

4.1.4 Seabed imagery

The following images have been selected to illustrate the seabed character at each site.

Table 2. Selected photographs to illustrate the character of the habitats at St Justinians, 20 April 2021.

<p>1. Infralittoral bedrock with kelp park</p>	<p>2. Infralittoral bedrock with red algae and sponges</p>
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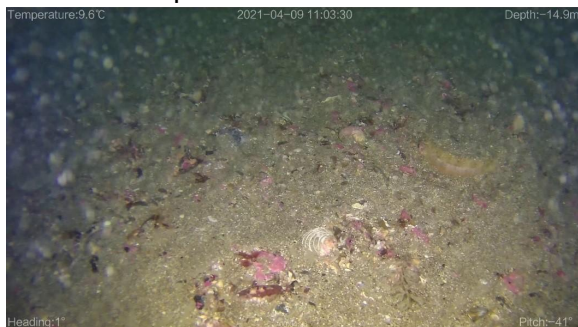


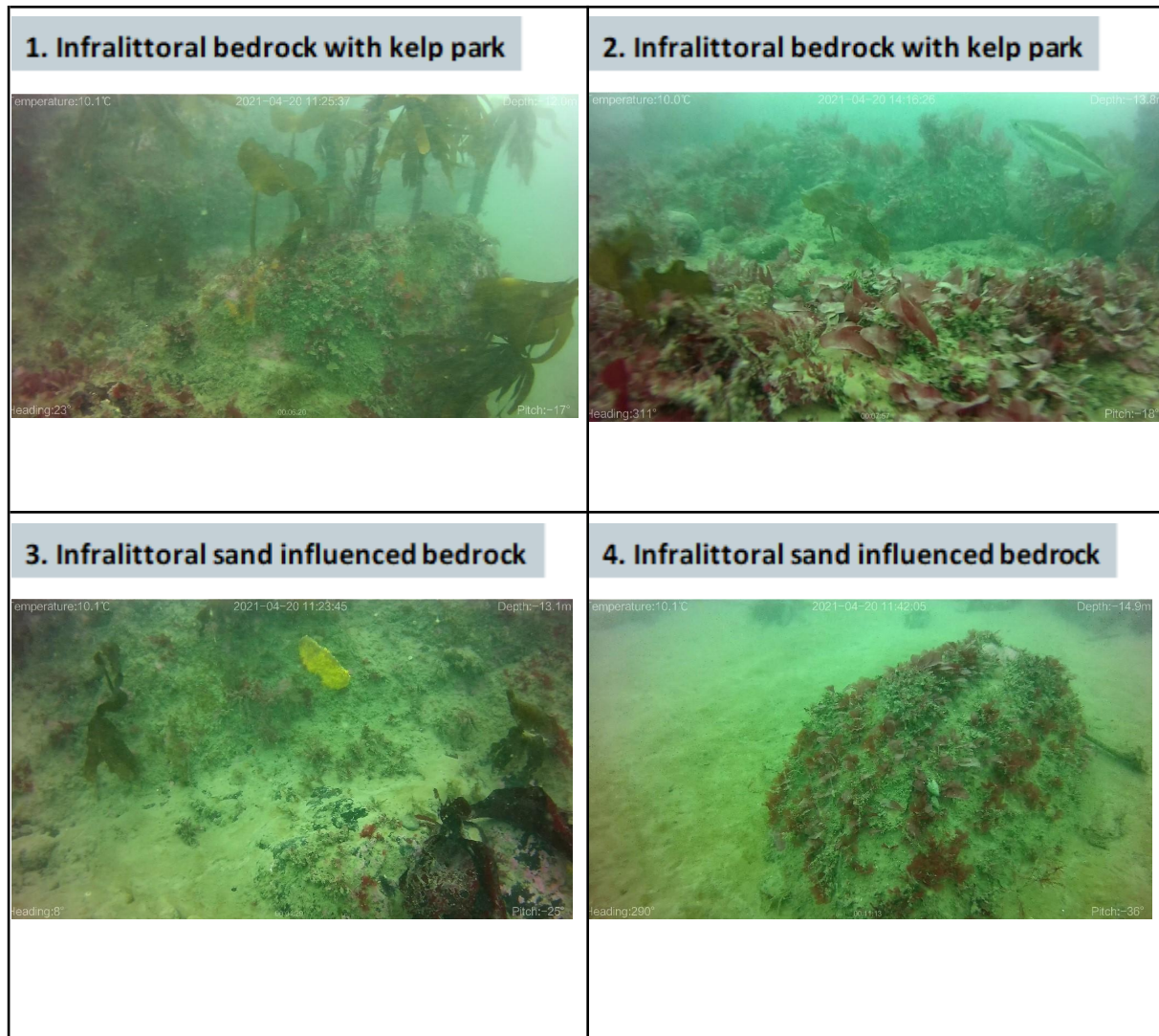






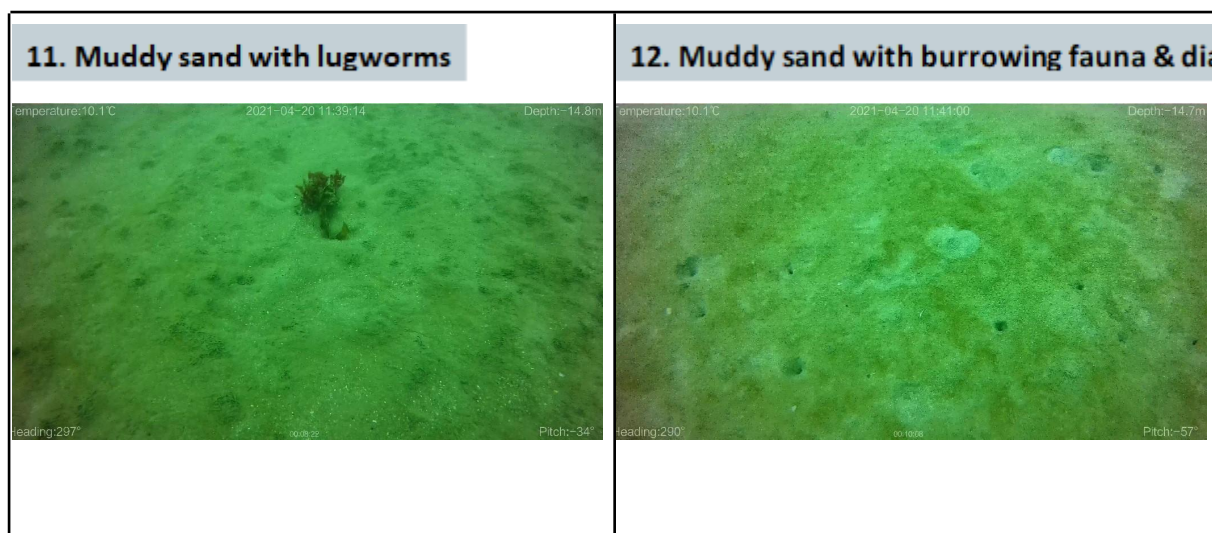
<p>3. Infralittoral bedrock with <i>Cilonia</i> sponge</p>  <p>Temperature: 9.6°C 2021-04-09 12:36:42 Depth: -10.1m Heading: 63° Pitch: -56°</p>	<p>4. Infralittoral bedrock with red algae and sponges</p>  <p>Temperature: 9.6°C 2021-04-09 12:45:13 Depth: -11.5m Heading: 172° Pitch: -47°</p>
<p>5. Circalittoral boulders with sponges and hydroids</p>  <p>Temperature: 9.6°C 2021-04-09 11:50:43 Depth: -12.6m Heading: 60° Pitch: -51°</p>	<p>6. Circalittoral boulders with sponges</p>  <p>Temperature: 9.6°C 2021-04-09 12:26:51 Depth: -13.5m Heading: 344° Pitch: -65°</p>
<p>7. Tide scoured cobbles and pebbles</p>  <p>Temperature: 9.6°C 2021-04-09 11:11:34 Depth: -14.5m Heading: 347° Pitch: -49°</p>	<p>8. Tide scoured sand and cobbles with scallops</p>  <p>Temperature: 9.6°C 2021-04-09 11:03:30 Depth: -14.9m Heading: 1° Pitch: -41°</p>
<p>9. Tide scoured cobbles and boulders</p>  <p>Temperature: 9.6°C 2021-04-09 11:19:32 Depth: -13.6m Heading: 128° Pitch: -51°</p>	<p>10. Silty boulders and cobbles with Ross</p>  <p>Temperature: 9.6°C 2021-04-09 13:42:54 Depth: -13.2m Heading: 169° Pitch: -38°</p>



Table 2. Selected photographs to illustrate the character of the habitats at Porthlysgi, 20 April 2021.



<p>5. Sand scoured boulders</p>  <p>temperature:10.0°C 2021-04-20 14:13:05 Depth:-16.8m Heading:330° Pitch:-23°</p>	<p>6. Sand influenced boulders and cobbles</p>  <p>temperature:10.0°C 2021-04-20 14:11:51 Depth:-17.2m Heading:324° Pitch:-56°</p>
<p>7. Coarse sand & gravel waves</p>  <p>temperature:10.1°C 2021-04-20 11:19:51 Depth:-14.5m Heading:21° Pitch:-28°</p>	<p>8. Scallop on ridge of sand & gravel</p>  <p>temperature:10.1°C 2021-04-20 11:31:48 Depth:-14.5m Heading:301° Pitch:-41°</p>
<p>9. Rippled fine & coarse sand</p>  <p>temperature:10.0°C 2021-04-20 13:07:55 Depth:-17.5m Heading:85° Pitch:-35°</p>	<p>10. Rippled fine sand</p>  <p>temperature:10.0°C 2021-04-20 12:25:19 Depth:-16.6m Heading:19° Pitch:-24°</p>



4.2 Nature conservation designations & ownership

The proposed site is within the following protected sites:

- Pembrokeshire Marine / Sir Benfro Forol SAC (Natura 2000 site code UK0013116)
- West Wales Marine / Gorllewin Cymru Forol SAC (Natura 2000 site code UK0030397)

Other potential relevant protected sites include:

- Ramsey and St Davids Peninsula Coast Special Protection Area (SPA)
- St. Davids Peninsula Coast and Ramsey Sites of Special Scientific Interest (SSSIs)
- Ramsey National Nature Reserve (NNR)
- Heritage Coast
- Ramsey RSPB Reserve

The water body from the high tide mark up to 12 nm belongs to The Crown Estate. The coastline adjacent is the Tregennis Peninsula, managed by the National Trust.

4.3 Physical environment

The complex bathymetry of Ramsey Sound includes a deep trench (~70 m) running north-south, a rocky reef called The Bitches extending west-east from Ramsey Island into the Sound and during a low spring tide, a semi-submerged rock pinnacle in the centre of the channel called Horse Rock, approximately 50 m in diameter. The tidal range at the sites is 5 m during springs with a peak spring velocity of 3 m/s. The UK Meteorological Office Wave Watch III Hindcast shows waves are predominantly from the south-west with wave heights of 4–5 m (User Manual and System Documentation of WAVEWATCH III TM Version 3.14).

Tidal velocities within Ramsey Sound are dominated by the semidiurnal lunar tide (M2), which has a period of approximately 12.4 h. The area therefore experiences a strong, semi-diurnal tidal regime with a range of approximately 1.6–5 m from mean neap to mean spring, and includes zones of high turbulence. Charted tidal streams indicate current speeds of up to 6 knots (~3 m s⁻¹). (Evans et al. 2015).

Careful consideration has been taken to the siting of the proposed sites for the cultivation project and measurements have been taken to validate to ensure that there is ample water flow to limit the potential negative impacts. The remainder of this section discusses some of the considerations with siting of seaweed cultivation projects.

The largest risk is that the placement of the cultivation project alters the natural hydrodynamics of the area and could result in significant changes to marine chemistry. This is a larger risk in areas important for water exchange, such as the entrance to enclosed water bodies (Campbell et al. 2018). However this proposed site is in a bay within Ramsey Sound which is definitely NOT an enclosed water body, having a high tidal flow rate continually passing through. Due to the high flow speeds and the very turbulent nature of the flow field, the area is of a medium-high suspended sediment transport (>1m²s⁻¹) (Haverson et al. 2018).

The more local tidal flow rates at both surveyed sites have been validated with a Valeport 801 Electromagnetic Flow Meter (Valeport.co.uk) provided by IBERS from Aberystwyth University. Measurements were taken approx 1 metre below surface held (on pole) from port side of aluminium landing craft 'Grafter' (anchored). The measurements were taken on 27/05/2021, the High tide at Milford was at 07:27 at 7.4 metres, the Low tide Milford at 13:50 at 0.6 metres. Table 1 shows the flow rates at different locations around the St Justinians site. Further details on onitoring of the flow rates at the proposed sites is outlined in section 5.11.

Site	Position	Stn	Latitude	Longitude	Time	Relation to tide	Metres/second	Knots
St Justinians	A	North (yellow buoy)	51.87326	-5.311671	07:38	¼ hour after HW Milford Haven	0.728	1.41
St Justinians	A	North (yellow buoy)	51.87325	-5.311593	10:10	2 ¾ hours after HW Milford Haven	0.464	0.90
St Justinians	A	North (yellow buoy)	51.87343	-5.311485	13:15	½ hour before LW Milford Haven	0.064	0.12
St Justinians	A	North (yellow buoy)	51.87325	-5.311593	15:39	1 ¾ hours after LW Milford Haven	0.140	0.27
St Justinians	B	South (inshore)	51.87111	-5.311176	08:00	½ hour after HW Milford Haven	0.111	0.22
St Justinians	B	South (inshore)	51.87113	-5.311031	09:56	2 ½ hours after HW Milford Haven	0.084	0.16
St Justinians	B	South (inshore)	51.87114	-5.311072	13:26	½ hour before LW Milford Haven	0.070	0.14

s								
Porthlysg i	C	North east (inshore)	51.86 307	-5.30432 4	08:4 4	1 ¼ hours after HW Milford Haven	0.069	0.13
Porthlysg i	C	North east (inshore)	51.86 323	-5.30438 6	14:0 4	¼ hour after LW Milford Haven	0.032	0.06
Porthlysg i	D	South west (offshore)	51.86 096	-5.30519 7	09:0 7	1 ¾ hours after HW Milford Haven	0.059	0.11
Porthlysg i	D	South west (offshore)	51.86 104	-5.30500 2	14:1 5	½ hour after LW Milford Haven	0.081	0.16

Table 1. Flow rate measurements around the St Justinians proposed site. Measurements are averages from 1 minute of recording, automatically calculated by meter.

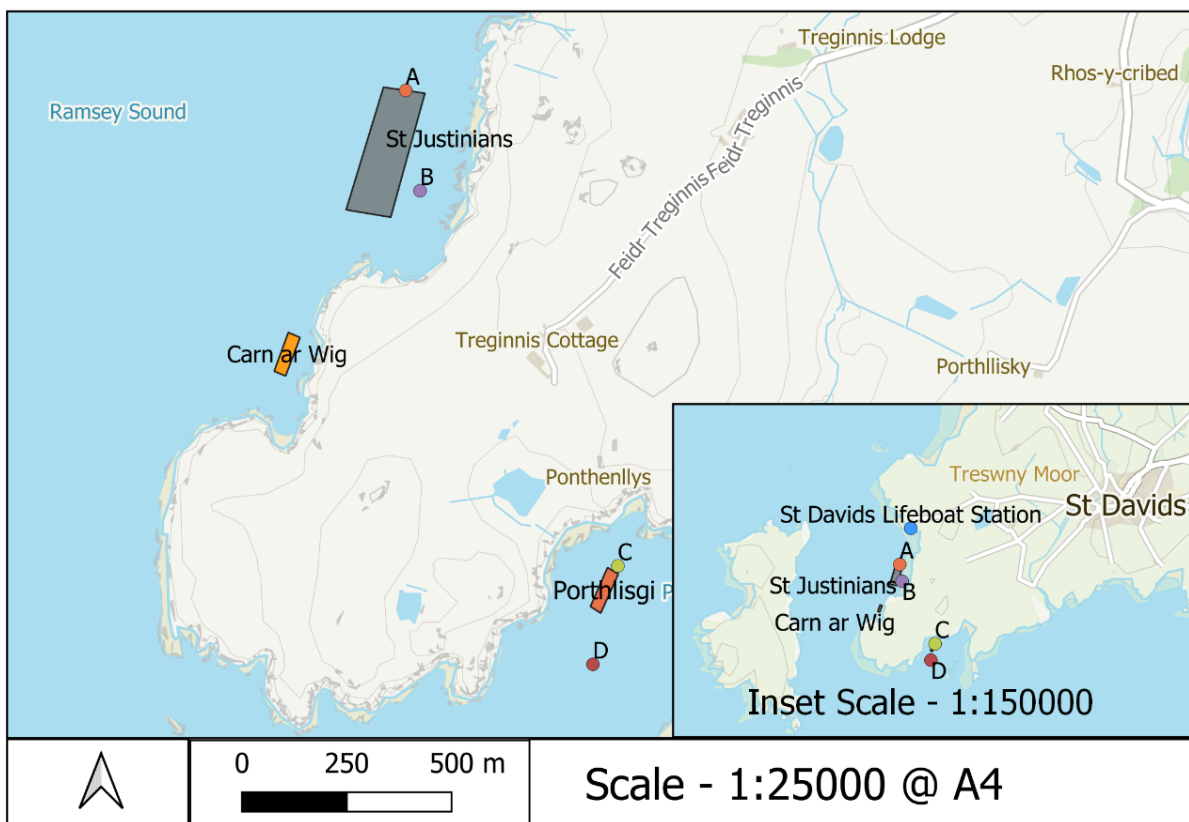


Figure 2. Plot of trial sites, proposed site, and flow meter measurement locations

4.4 Other users & infrastructure

4.4.1 Fisheries & angling

Ramsey Sound itself is exploited by fishermen using primarily potting, occasional rod and line and possibly fixed netting techniques. There are known to be a number of fishing boats which fish Ramsey Sound using the above mentioned techniques, but only one full-time, who is a

member of the Society. The others with smaller boats are hobby or summer fisherman. Some, but not all, of the fishermen who fish the Sound are members of the South West Wales Fisheries Community (SWWFC). All are aware of the trial farms and often fish around them as they are attracting more marine life. Similarly the tourist fishing boats visit the trial farms to fish and explain to the anglers about the farming. (The main tourist fishing boat is also a member of the society as is another fisherman from neighbouring Porthgain harbour).

4.4.2 Navigation

Please see attached Navigational Risk Assessment.

4.4.3 Tourism & Recreation

Pembrokeshire is a popular tourist destination with a variety of activities taking place, from coastering, to wildlife watching, to mackerel fishing. Ramsey Island is an RSPB nature reserve, popular with bird watchers and other people with an interest in wildlife. Thousand Island Exhibitions offer boat trips to the island. Over boat trips in the area include sea fishing and wildlife watching around the island. Several of Car Y Mor's supporters and members work in the tourist sector. Several of the boats point out Car Y Mor for tourist interest.

Recreation in the area includes diving, kayaking, coastering, fishing and walking. Some local divers have undertaken dives around Car Y Mor to check the underwater infrastructure.

4.4.4 Marine Renewable Energy

Ramsey sound has been the focus of much work over many years to create renewable energy. In 2015, a tidal turbine was installed in the deep central channel at the north end of the Sound by Tidal Energy Limited (TEL). Unfortunately, the turbine didn't work as planned and the project ceased.

A tidal turbine (12m high) was settled on the seabed in the deep central channel at the north end of Ramsey Sound in 2015 by Tidal Energy Limited (TEL). However, this project did not continue due to technical issues. Cambrian Offshore South West Ltd. (CO) was set up in 2019 to deliver the Ramsey Sound Regeneration project, which will see the regeneration of a tidal energy deployment site, including a grid connected, subsea tidal turbine, sub-station and associated infrastructure. CO have confirmed that existing infrastructure and future plans will have no conflict with Car-Y-Mor's proposed site. Moreover, CO strongly supports the proposed activities and is currently exploring a collaborative project to purchase and safeguard the disused lifeboat stations at St Justinians for both businesses, the RSPB and the tour and fishing boat operators.

5 Potential impacts, risks and mitigation measures

5.1 Screening Assessment for Appropriate Assessment - for preparation of Habitats Regulation Assessment

Table 5.1 Screening Assessment

Screening assessment

The screening assessment indicates the possible pathways through which the proposal may impact upon the relevant European site features. Each designated feature (taken from the official Natural 2000 designation documents) is recorded in the left hand column below.

The assessment in the right hand column below is made in view of the conservation objectives for the European sites concerned, as set out in NRW's extant advice under Regulation 37 of the Conservation of Habitats and Species Regulations 2017 in relation to the Pembrokeshire Marine SAC (NRW 2017) and West Wales Marine SAC (JNCC, 2019).

Colour coding is used as follows:

= There is no impact pathway from the proposal to the designated feature

= There is an impact pathway in principle, but significant effects can be ruled out

= There is an impact pathway and significant effects cannot be ruled out

As well as the above colour coding, the following numbers are used to describe the type of impact pathway considered to be present:

1 = Direct capture, damage or harm to a designated species feature.

2 = Damage to a designated habitat feature (including through direct physical impact, pollution, changes in thermal regime, hydrodynamics, light etc).

3 = Damage to the habitat of designated species features (including through direct physical impact, pollution, changes in thermal regime, hydrodynamics, light etc)

4 = Damage to a designated habitat feature via removal of, or other detrimental impact on, typical species.

5 = Removal of prey species of a designated species feature

6 = Damage to habitat of prey species.

Note that several impact pathways may be relevant to the same designated feature.

Conservation objectives are found in annex 1.		
European Marine Site and Conservation Features	Assessment of likelihood of significant effect	
	Relevant conservation objectives <i>*Insert relevant conservation objectives from NRW Reg 35 advice document</i>	Potential impact pathway <i>*For each row assign appropriate colour and number(s) (as above) and give short explanation as required</i>
Pembrokeshire Marine / Sir Benfro Forol SAC		
Allis shad <i>Alosa alosa</i>	Range Populations Typical species	There will be no interaction between the project and this species feature due to the methods and equipment deployed will not capture, harm the species or its habitat.
Twaite shad <i>Alosa fallax</i>	Range Populations Typical species	There will be no interaction between the project and this species feature due to the methods and equipment deployed will not capture, harm the species or its habitat.
Sea lamprey <i>Petromyzon marinus</i>	Range Populations Typical species	There will be no interaction between the project and this species feature due to the methods and equipment deployed will not capture, harm the species or its habitat.
River lamprey <i>Lampetra fluviatilis</i>	Range Populations Typical species	There will be no interaction between the project and this species feature due to the methods and equipment deployed will not capture, harm the species or its habitat.

<p>Otter <i>Lutra lutra</i></p>	<p>Range</p> <p>Populations</p> <p>Typical species</p>	<p>There is an impact pathway in principle, but significant effects can be ruled out due to the small scale and location of the activity</p>
<p>Grey Seal <i>Halichoerus grypus</i></p>	<p>Range</p> <p>Populations</p> <p>Typical species</p>	<p>1, 3, 6</p>
<p>Shore dock <i>Rumex rupestris</i></p>	<p>Range</p> <p>Populations</p> <p>Typical species</p>	<p>There will be no interaction between the project and this species feature due to the disparity in the locations of the activity and the feature.</p>
<p>Sandbanks which are slightly covered by sea water all the time</p>	<p>Structure and function</p> <p>Range</p> <p>Typical species</p>	<p>There will be no interaction between the project and this species feature due to the disparity in the locations of the activity and the feature.</p>
<p>Estuaries</p>	<p>Structure and function</p> <p>Range</p> <p>Typical species</p>	<p>There will be no interaction between the project and this species feature due to the disparity in the locations of the activity and the feature.</p>
<p>Mudflats and sandflats not covered by sea water at low tide</p>	<p>Structure and function</p> <p>Range</p> <p>Typical species</p>	<p>There will be no interaction between the project and this species feature due to the disparity in the locations of the activity and the feature.</p>

Coastal lagoons	Structure and function Range Typical species	There will be no interaction between the project and this habitat feature due to the disparity in the locations of the activity and the feature.
Large shallow inlets and bays	Structure and function Range Typical species	2, 4
Reefs	Structure and function Range Typical species	2
Atlantic salt meadows (<i>Glaucopuccinelliet alia maritimae</i>)	Structure and function Range Typical species	There will be no interaction between the project and this habitat feature due to the disparity in the locations of the activity and the feature.
Submerged or partially submerged sea-caves	Structure and function Range Typical species	There will be no interaction between the project and this habitat feature due to the disparity in the locations of the activity and the feature.
West Wales Marine/ Gorllewin Cymru Forol SAC		
Harbour porpoise <i>Phocoena phocoena</i>	Range Populations Typical species	1, 3, 6

If ALL rows in the right hand column of the table above are blue or green, it can be concluded that the proposal is not likely to have a significant effect on any European site, and no further consideration under the Habitats Directive/Regulations is required in order to determine the application. Otherwise, an appropriate assessment is required.

*Brief explanation is given within green cells.

Four features have been identified as yellow (There is an impact pathway and significant effects cannot be ruled out), this proposal shall go forward to the AA stage.

5.2. Appropriate Assessment

The following tables contain the appropriate assessment for the proposal. The two left hand columns list the designated features and the impact pathways identified from the TLSE where likely significant effects are anticipated or cannot be ruled out. Any features recorded in the TLSE as blue or green are not considered in the appropriate assessment.

Table 5.2 considers the potential impact in the absence of any additional conditions or restrictions intended to mitigate adverse effects.

Feature (from Table 5.1)	Impact pathway (s) (from Table 5.1) / Description of impacts	Assessment in view of conservation objectives	Can adverse effect be ruled out (Y or N)
Pembrokeshire Marine SAC			
Reefs	(2): Damage to a designated habitat feature (including through direct physical impact, pollution, changes in thermal regime, hydrodynamic,, light etc).	<p>The anchors and chains proposed will be lowered to the seabed and although there may be an initial impact on the reef feature from the deployment of the anchor and/or chain this will be minimal and so have no adverse effect on the reef feature.</p> <p>During the operation phase of the trial there will be no contact onto the seabed or reef feature from ropes or the lantern nets. The oyster baskets will contact the seabed, but the area of impact will be small, just slightly greater than the actual size of the basket (1m x 0.5m). The baskets will be lowered gently to the seabed to avoid any damage to the baskets.</p> <p>The baskets will be similar in size and shape to lobster and crab pots and studies have shown that potting has no significant effect on reef features</p>	Y

		<p>(Stephenson <i>et al.</i>, 2017; Walmsley <i>et al.</i>, 2015). The slow descent and the small area of possible impact will have no adverse effect on the reef feature for the European site.</p> <p>Studies have shown that dropper line diameter (Plew <i>et al.</i>, 2005) and dropper line and larger-scale spacing (i.e., long-line and raft) as well as farm size and configuration may influence current velocities (Boyd & Heasman, 1998; Smith <i>et al.</i>, 2006; Aure <i>et al.</i>, 2007; Duarte <i>et al.</i>, 2008; Stevens <i>et al.</i>, 2008). Mussel farms can increase flow and retention of water in an embayment (Lo <i>et al.</i>, 2008). Increased retention and flushing can modify deposition regimes within farms and influence seabed communities, this could include shell deposits below the ropes (de Jong, 1994; Lloyd, 2003).</p> <p>The scale of this multi-species farm would have little or no impact on the seabed communities in this area within the SAC as there are continual and significant tidal currents that vary throughout the tide cycles. This will always prevent any possible detritus accumulation and smothering of existing marine life.</p>	
<p>Grey Seal <i>Halichoerus grypus</i></p>	<p>(1): Direct capture, removal of prey species of a designated species feature</p>	<p>Seals are known to get entangled in ropes in the marine environment. These are mainly where the rope becomes slack in the water column and could entangle the seal. There are a number of rope grown mussel farms and seaweed farms in bays in Scotland where seals are known to feed and there have been no reports of any entangled in the ropes that hang from the rafts. An MSC assessment of the Shetland and Scottish Mainland rope grown fishery states that “<i>since the entanglement of marine mammals in mussel ropes has never happened since rope culture started, it can be considered a highly unlikely event</i>” (Cappell & Keus, 2017). Considering the scale of the farming in Scotland relative to this small scale proposed site it can be considered that the proposal will not have an adverse effect on the Grey seal population in the SAC.</p> <p>Grey Seals are highly mobile species which are not bound by location and actively hunt for prey within the entire European Marine Site. The small scale of the activity (0.6% of the area of Ramsey Sound and 0.002% of the SAC) will not have a significant effect on overall integrity of grey seal populations.</p>	<p>Y</p>

<p>Grey Seal <i>Halichoerus grypus</i></p>	<p>(3): Damage to the habitat of designated species features (including through direct physical impact, pollution, changes in thermal regime, hydrodynamics, light etc)</p>	<p>The main habitats of the Grey seals within the SAC are the intertidal areas used for hauling out, moulting and pupping. Grey seals also use sub-tidal and water column habitats for feeding. This proposal will not impact on any intertidal habitats and although there will be a small loss of subtidal habitat due to the baskets and anchors, the small scale and footprint of the activity will not adversely affect the habitat requirements of the Grey sea. In fact to the contrary the trial sites have already demonstrated that seals benefit from the marine life these multi species farms create</p>	<p>Y</p>
<p>Grey Seal <i>Halichoerus grypus</i></p>	<p>(6): Damage to habitat of prey species.</p>	<p>Grey seal diet varies by location and season; they largely consume demersal or benthic fish species (Hall, 2002; Prime & Hammond, 1990). Individual prey preferences also exist as well as temporal and geographical variations in diet and differences in prey between age groups (Prime & Hammond, 1990; Hauksson & Bogason, 1997; Beck <i>et al.</i>, 2005; Tucker <i>et al.</i>, 2007; Brasseur <i>et al.</i>, 2010).</p> <p><i>Trisopterus</i> species (Bib, Norway Pout and Poor Cod), plaice and whiting appeared to be the main prey species of the Grey seal with an increase in flatfish showing in the eastern Irish Sea (Kiely <i>et al.</i> 2000). Information by the Sea Mammal Research Unit (SMRU) indicates that the diet of seals mainly consists of sandeel, cod, haddock, saithe, whiting, herring, garfish, sea scorpions and dragonets. Plaice and sole also formed part of their prey in the North Sea (SMRU).</p> <p>The small scale and footprint of the proposed activity will not adversely affect the habitat of any of the prey species of the Grey seal. To the contrary they create nursery areas for many of these species</p>	<p>Y</p>
<p>Large shallow inlets and bays</p>	<p>(2): Damage to a designated habitat feature (including through direct physical impact, pollution, changes in thermal regime,</p>	<p>The physical extent of the Large shallow inlet and bay of the SAC will not be diminished by the small scale and footprint of the proposal. There may be a small loss of habitat due to the footprint of the baskets and anchors, but this would not be considered to have an adverse effect on the Large shallow inlet and bay feature.</p>	<p>Y</p>

	hydrodynamics, light etc).		
Large shallow inlets and bays	(4): Damage to a designated habitat feature via removal of, or other detrimental impact on, typical species.	<p>The growing of mussels on ropes and other shellfish in baskets can have an impact on the seabed through deposition from the shellfish and shell deposits. The main concern with suspended culture is a predicted increase in sedimentation beneath the lantern nets and longlines, caused by reduced flow because of the suspension structure, and increased levels of faeces and pseudofaeces from the mussels and associated epibiota. Generally investigations into the effects of suspended culture on sedimentation rates have shown that the effect is minimal and that the risk of adverse effects is low (Grant <i>et al.</i>, 1995; Jeffs <i>et al.</i>, 1999; Crawford, 2001; Crawford <i>et al.</i>, 2001; Crawford, 2003; Crawford <i>et al.</i>, 2003; Danovaro <i>et al.</i>, 2004) although there are examples of suspended mussel culture having adverse effects on the local ecosystem (Freire <i>et al.</i>, 1990; Stenton-Dozey <i>et al.</i>, 1999). Hartstein and Stevens (2005) showed that there was no significant difference in sedimentation rates between a farm and control sites in Marlborough Sound, New Zealand. They did however; find a significant difference in the total organic matter (TOM) between farm sites and control sites in sheltered bays. Highlighting that local hydrodynamics are important in identifying impacts by rope grown shellfish farms.</p> <p>Studies have shown that dropper line diameter (Plew <i>et al.</i>, 2005) and dropper line and larger-scale spacing (i.e., long-line and raft) as well as farm size and configuration may influence current velocities (Boyd & Heasman, 1998; Smith <i>et al.</i>, 2006; Aure <i>et al.</i>, 2007; Duarte <i>et al.</i>, 2008; Stevens <i>et al.</i>, 2008). Mussel farms can increase flow and retention of water in an embayment (Lo <i>et al.</i>, 2008). Increased retention and flushing can modify deposition regimes within farms and influence seabed communities, this could include shell deposits below the ropes (de Jong, 1994; Lloyd, 2003).</p> <p>The scale and location of this proposal would have little or no impact on the seabed communities in this area within the SAC where there is significant and continual tidal currents.</p>	Y

West Wales Marine/ Gorllewin Cymru Forol SAC			
<p>Harbour porpoise</p> <p><i>Phocoena phocoena</i></p>	<p>(1): Direct capture, removal of prey species of a designated species feature</p>	<p>Marine mammals are known to get entangled in ropes in the marine environment. These are mainly where the rope becomes slack in the water column and could entangle the mammal. There are a number of rope grown mussel farms in bays in Scotland where marine mammals are known to feed and there have been no reports of any entangled in the ropes that hang from the buoys and headlines. An MSC assessment of the Shetland and Scottish Mainland rope grown fishery states that “<i>since the entanglement of marine mammals in mussel ropes has never happened since rope culture started, it can be considered a highly unlikely event</i>” (Cappell & Keus, 2017). Considering the scale of the farming in Scotland and the scale of this proposal it can be considered that it will not have an adverse effect on the Harbour porpoise population in the SAC. Furthermore the porpoises within Ramsey sound keep to the deep fast flowing central channel as this is where their prey lives.</p>	<p>Y</p>
<p>Harbour porpoise</p> <p><i>Phocoena phocoena</i></p>	<p>(3): Damage to the habitat of designated species features (including through direct physical impact, pollution, changes in thermal regime, hydrodynamics, light etc)</p>	<p>Adequately defining the potential habitats of cetaceans is problematic. This is due to their highly mobile nature and their distribution being driven mainly by the corresponding distribution and availability of their various prey species. In the absence of prey data, relationships between quantifiable habitat characteristics such as depth, water temperature, seabed sediment type etc. are often used as proxies of prey distribution (NRW and JNCC, 2015).</p> <p>Different environmental variables were modelled against observed densities of Harbour porpoise within different Management Units (MUs) around Europe. In all MUs the coarseness of the seabed sediment was important, with porpoises showing a preference for coarser sediments (such as sand/gravel) rather than fine sediments (e.g. mud).</p> <p>The water column is also considered to be an important if obvious habitat for Harbour porpoise with the site.</p> <p>Impacts to these potential habitats could be caused by disturbance to the seabed and water column by the proposal through loss of seabed habitat and</p>	<p>Y</p>

		<p>disturbance during the lifting and relaying of the ropes and baskets.</p> <p>The small scale and location of the proposed site within the small bay is not noted as an important area for Harbour porpoise and therefore due to the location and scale of the proposal it can be considered that there will be no adverse effect on the habitat of the Harbour porpoise within the SAC.</p>	
<p>Harbour porpoise</p> <p><i>Phocoena phocoena</i></p>	<p>(6): Damage to habitat of prey species.</p>	<p>There are known to be a number of species eaten by Harbour porpoise within the SAC namely gobies, sandeel, whiting, herring and mackerel, and it can be supposed that they change their diet seasonally to target the prey availability.</p> <p>Other than the gobies and sandeels, the other species are pelagic. This small proposed farm is unlikely to affect the pelagic habitats - except to provide nursery beds and additional feeding areas. Gobies and sandeels are the species that could be impacted by any impact to the seabed habitat by the anchors, chains and oyster cages - however this will be minimal as any movement of these items will be with great care.</p> <p>Aspects of the ecology of some of the prey species may assist in interpreting seasonal differences in diet (Santos, 1998). Sandeels spend most of the autumn and winter (September to March) buried in the sand, with the exception of the spawning period between December and January (Macer, 1966; Reay, 1970; Langham, 1971; Winslade, 1974; Wright, 1996). This is consistent with the higher prevalence of sandeels in spring and summer diets than in autumn and winter diets of Scottish Harbour porpoises (Santos 1998). Although, arguably, echolocating porpoises should be able to detect sandeels in the sand it is perhaps energetically costly to catch them. The higher importance of whiting in the winter diet could relate to the lower availability of sandeels but is also consistent with trends in whiting abundance.</p>	<p>Y</p>

As all adverse effects can be ruled out (i.e. the right hand column is 'Y' for all features), no further consideration under the Habitats Directive/Regulations is required in order to determine the application.

5.2.1 In-combination assessment:

Other plans or projects which should be considered for potential in-combination effects with the proposal under consideration are those that fall into ALL of the following 3 categories:

(1) they have been subject to HRA and the HRA has either concluded no TLSE or no adverse effect on site integrity, but residual effects remain.

(2) their residual effects (net of any mitigation measures) could interact with the residual effects of the proposal under consideration, for example by magnifying the effects of the proposal, or making a habitat or species feature more sensitive to the effects of the proposal.

(3) they are one of the following:

- project started but not yet completed
- projects consented but not started
- ongoing projects subject to repeated authorisations (eg annual licences)
- applications lodged but not yet determined
- refusals subject to appeals procedures not yet determined
- projects not requiring consent, but which have been approved by the competent authority concerned
- proposals in adopted plans
- proposals in draft plans published for consultation
- allocations or other forms of proposals in adopted development plans
- allocations or other forms of proposals in draft development plans published for consultation.

5.2.2 Conclusion of Appropriate Assessment

Based upon the considerations presented in the sections above, we consider that there is strong evidence to suggest any risks to habitat features are reduced to an acceptable level, either resulting from the predicted effects of the plan or project on its own or when those predicted effects are considered in combination with the effects resulting from other relevant plans or projects.

5.3 Seabed habitats and species

The impact of aquaculture on the environment and effects of the environment on aquaculture production have become important issues in recent years. There is evidence that marine and freshwater aquaculture can cause environmental change, which in some cases may adversely affect the long-term viability of the aquaculture operation itself, or result in serious conflicts with other users of aquatic resources. These problems have led to a need to consider aquaculture as one component in the aquatic ecosystem and to plan aquaculture development in a way which makes efficient use of resources. There have been several recent reviews of impacts associated with finfish (Beveridge, 1984; NCC, 1989), mollusc (ICES, 1989; NCC, 1989) and crustacean (Phillips et al, 1990) culture but there is little information on seaweed culture. Further it must be highlighted that all aquaculture above is intensive monoculture - very often with feed and chemical inputs. However this proposed

farm is FUNDAMENTALLY different. It is extensive integrated multi trophic aquaculture (IMTA) farming multi species with zero inputs of feed and chemicals designed just to deliver positive impact on the marine environment

According to the Scottish government's seaweed cultivation policy (Marine Scotland, 2017), Câr Y Môr is referred to as a 'Small-medium' seaweed farm (0–50 × 200 m lines). The two trial farms have 2 * 100meter lines each and the proposed farm is planned to have 8 x 125 m lines. In this section we address these environmental implications in correlation to the scale of the seaweed and shellfish farm.

The main environmental impacts caused by seaweed and shellfish farming:

- Physical effects: Physical structures, physical shading, deposition of sediments and particulate organic matter (POM).
- Ecological effects: Loss of habitat, diseases.

5.3.1 Physical structures

Introduction of seaweed and shellfish lantern nets, ropes, anchors and other structures can disturb seabed habitats and cause sediments to become suspended. Each anchor will cover just 0.5 m² and the ground chain an area of 15 m² on the seabed. To minimise the impact, structures will also be placed carefully on the seabed to minimise disturbance, and will not be placed on or near any vulnerable habitats that have been identified.

5.3.2 Deposition of sediment and particulate organic matter (POM)

The installation of the seaweed and shellfish farm may disturb the sediments, enhancing sedimentation through suspension. Organic matter from the shellfish may also fall to the seabed, affecting the seabed habitats and increasing the risk of eutrophication. However, due to the fast currents in the area, deposition of organic matter is unlikely. Bivalve farms in intertidal high-energy and well flushed areas have been found to have a low impact on sediments, with high dispersal of organic particles (Gallardi et al. 2014; Campbell et al. 2018).

5.3.3 Ecological effects

Ecological effects of seaweed and shellfish farming can be both positive and negative. The main effects are outlined in Table 3 below.

Table 3. Potential physical issues associated with seaweed culture indicating positive and negative effects.

OPERATION AND ISSUES	POSITIVE EFFECTS	NEGATIVE EFFECTS
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Water quality	Enhanced oxygen, removal of nutrients, seaweed production	Reduced coastal phytoplankton, increased particulate matter in the water column (increased turbidity)
Benthos	Enhanced polyculture (e.g. with mollusc)	Changes in benthic species and production
Water column productivity	Enhanced production of invertebrates and finfish	Predators changes in community structure
	Shelter of fish fry	Competence
	Polyculture	

5.3.4 Loss of habitat - anchoring

Given the small footprint of the area, relevant to the protected SAC sites and the overall habitat in the area, the loss of habitat due to anchoring will be minimal. The affected species and habitats are common, and are not on the list of Welsh Biodiversity Action Plan (BAP) habitats and species. Anchors and ground chain placed will be done in areas with sandy sediment, devoid of many species. The anchors will be placed carefully to avoid any further sediment disturbance. Any sediment disturbance that does occur will quickly settle due to the high current speeds in the area. The loss of the habitat due to anchoring is also not permanent, as the anchors can be removed at the end of the ocean farm's life. The small area of seabed habitat affected could then recover.

5.3.5 Physical damage & smothering during installation and operation

During installation and maintenance of the farm, the highest risk is material dropping to the seabed and accumulating, such as seaweed detritus, shellfish shells, pseudo-faeces etc. However, due to the high currents in the area and locally, it is likely that any materials will be quickly transported away from the site, before settling on the seabed. Monitoring will also take place throughout the farm's operation, to ensure that deposition of excess material is not occurring, and to plan for changes to operation if this is the case.

There is also a risk of storm damage to the farm, affecting moorings and other equipment. Following learnings from the trial farm sites, equipment and set-up have now been fine-tuned to withstand storms and extreme weather conditions. Additional measures will be put in place, in the case of a storm, such as lowering the lines deeper in the water to protect from wave damage. These steps will greatly minimise the risk that equipment comes loose from the farm, resulting in marine pollution. Additionally the monitoring protocol is always to check

the farms during storm conditions from the coastal paths and afterwards by boat. Neighbours to the trial farms volunteer to take regular pictures and circulate to members - especially in bad weather. Many in the community are committed to safeguarding the sites.

Finally, the installation of anchors and lines has the potential to impact on fragile habitats. Erect sponges (*axinellids*) and ross coral (*Pentapora foliacea*) are common on rocky habitats in some parts of the proposed area. They are very vulnerable to physical damage from heavy objects or dragged lines and their recovery would be slow, due to slow growth rates. Video footage from the area shows that many of the ross coral are already partially broken, indicating damage from human activity (e.g. crab pots or fishing trawls / dredges). However, as video footage is now available to show the locations of these fragile habitats, great care would be taken to avoid such damage during the installation of the farm anchors and anchoring lines. Once in place, the farm would provide protection to these habitats by excluding any trawling activities.

5.3.6 Shading of the seabed from sunlight

The risk of shading of the seabed by seaweed and shellfish lines is minimal. Light is still able to penetrate through the lines, as sufficient distance is planned between the lines for work boat operation and to avoid any lines crossing. Furthermore, the seaweed will be harvested in the spring when it reaches its most dense stage, thus clearing the water column for several months of the year. Again, the seabed under the farm and water column surrounding will be monitored, for any changes in light availability and turbidity. There are no seagrass beds in the vicinity, thus shading is not considered a significant risk. Further due to the site being at minimum chart datum of 10 meters, the seabed under the sites is seen as an animal zone - the lower infralittoral zone and the upper circalittoral zone.

5.3.7 Marine mammals

Marine mammals present in the area include the grey seal (*Halichoerus grypus*), common dolphin (*Delphinus delphis*), bottlenose dolphin (*Tursiops truncatus*), harbour porpoises (*Phocoena phocoena*), Risso's dolphin (*Grampus griseus*), Short-beaked common dolphin (*Delphinus delphinus*) and even some visiting whales such as the Northern minke whale (*Balaenoptera acutorostrata*). Grey seal haul out sites are present in the Ramsey Sound. Grey seals are one of the key species that the Pembrokeshire Marine SAC is designated for, with a breeding population of around 5,000 individuals, and making up 4% of the UK grey seal population. Pupping season is in the autumn, from August at the earliest, to December at the latest. The Ramsey Sound population is mostly on the south east coast of the island.

There is a porpoise sensitive area within the Sound, identified under the Pembrokeshire Marine Code, with 'cautionary' areas to the north of the Sound, and 'extreme caution' areas to the south.

The potential impact on these marine mammals by the proposed St Justinian site:

- No impact on the Porpoises as they stay in the fast moving tidal areas through the centre of the sound feeding.
- From time to time, seals visit the trial farms as the farms have created a new marine ecosystem and the seals visit to feed on the fish. There will be no fishing nets and all ropes will be kept taught and moored so there are no

opportunities for entrapment. When divers are checking the trial farms, seals often come to investigate as they are very inquisitive creatures, so it is probable that some seals will visit the proposed farm motivated by curiosity or in order to feed.

- All other mammals mentioned do not visit the proposed site, as it is relatively shallow and close to the coast and out of the main current they all travel through for feeding.
- The fact that the trial farms have created a new marine ecosystem implies that a three hectare farm will probably create a haven for more juvenile marine life. This in turn will attract predators, including marine mammals. Unlike intensive fish farming, there are no predator nets or large net cages etc. - however there is still a minor risk of entrapment. No entrapment has been seen at the trial sites. A number of rope grown mussel farms in Scotland have been assessed for this risk, and no marine mammals have been found to become entangled. Instead, they have been found to feed in the area due to increased fish density.
- All volunteers and the local community are informed of the monitoring protocol of always checking from the coast path, by boat and underwater. These include regular checking of the anchoring lines to keep the lines taut at all times, checking of the farm after extreme weather and at regular intervals, and frequent maintenance. Furthermore, remote underwater cameras will be regularly used on the farms at different depths. If any entanglement risk to mammals are identified, the Society will be notified so actions can be taken immediately to reduce the risk.
- The potential impact of disturbing any mammals will be mitigated by reducing boat speed and any activity that frightens them, as a key objective of these farms is to improve marine ecosystems.

5.3.8 Seabirds

Seabirds are sensitive to changes in the quality of the marine environment, especially to changes in fish stocks and to oil pollution. None of these risks are conducted by Câr Y Môr.

However, the daily port traffic, for example Ramsey Island visitors, is described as a temporary disturbance for seabirds.

Ramsey Island is described as an important breeding site for seabirds as a consequence of the rat eradication (Bell et al. 2019). Câr Y Môr does not have any interaction with Ramsey Island. Ramsey Island is an important RSPB nature reserve for birds, with species present including the Manx shearwater (*Puffinus puffinus*), chough (*Pyrrhocorax*), guillemot (*Uria aalge*), Atlantic puffin (*Fratercula arctica*), European shag (*Phalacrocorax aristotelis*), Northern gannet (*Morus bassanus*), Razorbill (*Alca torda*), Common skoter (*Melanitta nigra*) and numerous other seabirds.

The potential impact on these birds by the proposed St Justinian site:

- Local bird watchers have been delighted by gannets visiting and feeding at the trial sites, so it's envisaged that the new site will also attract them in greater numbers;

- No nesting birds have been seen near either of the trial sites or near this proposed site. However, the society's monitoring protocol is for all members to report any future nesting birds near the farms so that disturbance can be minimised from any farm activities;
- As there will be no nets and all ropes will be kept taught and moored, there will be minimal opportunities for entrapment of the birds;
- The fact that the trial farms have created a new marine ecosystem implies that a three hectare farm will probably create a haven for more juvenile marine life, which in turn will attract more marine birds. Unlike intensive fish farming there are no predator nets or hundreds of square meters of net cages etc. - however there must still be a small risk of entrapment. None has been seen at the trial sites which is good news - but all volunteers and the local community are informed of the monitoring protocol of always checking from the coast path, by boat and underwater. Furthermore, remote underwater cameras will be regularly used on the farms at different depths. If any entanglement risk to birds is identified, all have been asked to notify the Society so actions can be taken to reduce the risk;
- The potential impact of disturbing any birds will be mitigated by reducing boat speed and any activity that frightens them.

5.3.9 Fish

Fish which are present as Annex II species include:

- Allis shad (*Alosa alosa*)
- Twaite shad (*Alosa fallax*)
- River lamprey (*Lampetra fluviatilis*)
- Seal lamprey (*Petromyzon marinus*)

Basking sharks (*Cetorhinus maximus*) are visitors to the Ramsey Sound. Cod (*Gadus morhua*), bass (*Micropterus salmoides*), whiting (*Merlangius merlangus*), herring (*Clupea harengus*), sole (*Clupea harengus*), plaice (*Pleuronectes platessa*), turbot (*Scophthalmus maximus*), rays (*Batoidea sp.*), pollock (*Pollachius sp.*), mackerel (*Scomber scombrus*), wrasse (*Labridae sp.*) and lobsters (*Nephropidae*) are also present in the area.

The potential impact on these fish and reptiles at the proposed St Justinian site:

- Local fishermen and boats running fishing trips have reported lots of juvenile fish at the trial sites, confirmed by gannets visiting and feeding at the trial sites;
- As there are no nets and all ropes are kept taught and moored, there are no opportunities for entrapment of these fish;
- The fact that the trial farms have created a new marine ecosystem implies that a three hectare farm will probably create a haven for more juvenile marine life which in turn will attract more marine birds;
- The potential impact of disturbing any fish will be mitigated by reducing boat speed and any activity that frightens them.

5.4 Surrounding environment

5.4.1 Plankton and water quality

There is a risk of removal of plankton and other organic material by filter feeding shellfish, removal of nutrients by seaweed and production of organic material by seaweed. The presence of seaweed in the water is also likely to have a marginal influence on the turbidity of the water due to particulates fragmenting from the cultivars. Due to the fast tidal flow of the area, these risks are likely to be minimal. Water quality and environmental monitoring will take place.

5.4.2 Tidal currents and wave exposure - effects from physical obstruction / sheltering

Due to the type of cultivation technique overall tidal flow is not likely to be affected, as the seaweed and shellfish are suspended above the sea floor. Studies at other sites show that total tidal exchange volume would likely remain unchanged, there would be a reduction in tidal flow at the surface where seaweed is suspended, however this would cause the maximum flow point to occur below the suspended seaweed body, This could have implications for the benthic and pelagic habitats present, which would experience altered flow dynamics resulting from changes to surface boundary conditions (Campbell et al. 2018). In the case of the potential site, this would increase the rate at which any debris from the site would be carried away.

5.4.3 Genetic profile & diversity

This endeavour will benefit from a specifically aligned genetic monitoring program in collaboration with Dr. Niall McKeon at Aberystwyth University. As these genetic assays are being implemented at the outset this represents a potential exemplar system with a cohesion among biodiversity (ecological and evolutionary) and socioeconomic considerations.

Native species will be introduced only at the farm, with spores from the trial sites for seaweed used to grow on kelp seedlings by Plant Ecology Beyond Land CIC in their controlled laboratory and hatchery at Penmon Point on Anglesey. Mussel and Scallop spat will be settled on site. Native oyster and scallop spat will be sourced from regulated and approved bonamia free hatcheries in the UK (Morecambe Bay). .

5.4.4 Pathogens and non-native invasive species

There is no evidence that seaweed diseases have been transferred as a result of seaweed culture, unlike other forms of finfish, crustacean and mollusc culture where there are many documented examples of translocation of pathogens as a result of movements of cultured animals (Welcomme, 1988; NCC, 1989).

The risks of introducing pathogens and invasive species with seedstock, juvenile shellfish or on equipment or footwear will be reduced by strict cleaning and checking procedures, and through regular inspections. No non-native species will be introduced.

No Pacific oysters are reported in Ramsey Sound – strict procedures will be followed to ensure none are introduced. Additionally, the Society's monitoring protocol encourages all involved to be vigilant for non native species using the sites as stepping stones. Regular plankton samples are taken and samples from settlement and growing ropes so if the site is

used as a stepping stone it has a good chance of being identified. Any non native species will be reported and removed.

5.4.5 Pollution & wildlife disturbance

There is a minimal risk of litter (ropes etc.), hydrocarbon spill (boat fuel and lubricants) and noise (boat & other human activity). Mitigation measures put in place will include regular maintenance of the farm to reduce equipment coming loose in storms, lowering of ropes during bad weather, regular inspections, use of approved boat fuel, appropriate oil safety plans on the boat used, the boat used minimally and at slow speeds steering clear of known seal haul out areas and bird nesting areas.

5.4.6 Visual impacts

Please see P17 Figure 4. PROPOSED FARM : Plan view of sea surface (from a boat/coast view)

Buoys on the water may result in a visual impact from the coast. As a result of trialling different buoys at the trial farms smaller and less floats are proposed to be used on each of the new farm lines thus minimising the visual impact. The buoys are the only equipment visible from the coast. Lights will not be used. The buoys on the seaweed lines will be white. An example of the visual impact of similar sized white buoys on a seaweed farm can be seen on a 150 hectare seaweed field in Brittany - please click on “production area” drop down for a photo on their website (<https://www.algolesko.com/home>).

Consultation will take place when setting up the site, to ensure that it is in line with local policy. Maintenance will take place to ensure the site is neat and as it should be. Information will be provided near the coast path and on line, to educate tourists and locals as to why the buoys are visible and the environmental benefits of the ocean farm. Trinity house navigation buoys, as deployed and maintained on the trial sites, will be required for safety.

5.5 Other users

5.5.1 Fisheries

Seaweed and shellfish farming provides structural complexity i.e. the arrangement and diversity of elements in space (Bergman et al. 2001), and provides a direct food source to some herbivores (Neish et al. 2017). Anecdotes suggest that seaweed farms can potentially increase fishery catches of some species in settings where natural submerged vegetation is scarce. Lobster fishing and crab fishing in the area could be impacted by reduced area for fishing, but local fishermen are supportive and continual stakeholder consultation will take place to ensure that this impact is minimised, and that all marine users are aware of the potential benefits of ocean farming to fish and shellfish populations.

5.5.2 Boating – tour and adventure boat trips, sea kayaking and sailing

The following tour and adventure boat trips: Falcon Boats, Blue Shark charters and Welsh Diving are currently active investors and members of Câr Y Môr. In their visits they provide the option to their clients to visit Câr Y Môr seaweed and shellfish installations. This will be a benefit to these operators.

5.5.3 Angling, coastering and SCUBA diving

This sector relates to recreational activities undertaken on or immersed in the sea including angling, surfing, windsurfing, sea kayaking, scuba diving and small sail boat activities.

With regard to future interactions with the seaweed and shellfish farm, in general, those activities are conducted in summer and are undertaken in safety areas. Hence, there will be no interaction between recreational activities and Câr Y Môr labour. It's worth noting that all such people are not only inquisitive but supportive of the trial farms. Free divers and scuba divers all enjoy diving at the farms and are amazed at the underwater life around them.

5.6 Cultural heritage

Pembrokeshire has a rich and diverse culture which has been shaped down the centuries by waves of invaders and settlers. Before the Norman Conquest, the whole area was Welsh speaking and ruled by Celtic chieftains. Entertainment was provided by bards who wandered from court to court recounting folktales. St Davids, or Dewisland, is surrounded by spectacular coastal scenery renowned for its beauty and abundance of wildlife. While many heritage features lie wholly within the marine environment, numerous features are also located in coastal areas. In addition, fishing and seaweed harvesting play a key role in food consumption and maintaining the machair. These include using natural fertilisers such as seaweed.

For centuries, coastal populations have harvested a wide variety of seaweeds and shellfish. Since they are a natural resource, they require careful management to sustainably and efficiently harvest. In some cases, harvesting and the management of seaweed and shellfish may be the responsibility of the processing industry or local fishers' organizations. These organisations, with the help of scientists, attempt to manage the resource and the ecosystem richness associated with it in sustainable ways. Historically, there was also often a gender component involved with women being the primary harvesters of seaweeds and though this has changed in many parts of the world, in others, women remain key to seaweed harvesting. Current harvesting methods, technologies, and cultural preferences have a strong connection with both historical uses and culture and society themselves. The wide variety of uses put to seaweeds today stands as testament to the ingenuity of humankind (A. Delaney et al., 2016). The ocean farm will continue this heritage.

5.7 Human health

Seaweeds may have an important role in modulating chronic disease. Rich in unique bioactive compounds not present in terrestrial food sources, including different proteins (lectins, phycobiliproteins, peptides, and amino acids), polyphenols, and polysaccharides, seaweeds are a novel source of compounds with potential to be exploited in human health applications. Purported benefits include antiviral, anticancer, and anticoagulant properties as well as the ability to modulate gut health and risk factors for obesity and diabetes. Though the majority of studies have been performed in cell and animal models, there is evidence of the beneficial effect of seaweed and seaweed components on markers of human health and disease status (Emma, 2014).

5.8 Use of natural resources

Seaweeds could become an important source for third generation biofuels production. In fact, macroalgae have an advantage over traditional biomass for biofuels production of not competing for land and freshwater with food crops. Furthermore, seaweeds have high

productivity, fast growth rate and high polysaccharide content (Kerrison et al. 2015). The latter is particularly important as seaweeds can be fermented to produce bio-ethanol or butanol, or used for generation of biomethane via anaerobic digestion.

5.9 Cumulative effects

Seaweed cultivation can have a positive effect through bioextraction of nitrogen and phosphorus from anthropogenic activities in the marine environment and aid management strategies at the water body level. Thus multiple ocean farms will aid improvements in water quality. There is potential for increased effects through cumulative interactions with the proposed site, the trial sites, and any new sites developed by alternative organisations. Each new cultivation site will have a responsibility to demonstrate that existing conservation objectives will not be undermined and any potential environmental risks identified at the consenting stage are kept within acceptable limits throughout the lifetime of the project. Seaweed cultivation offers the potential for positive ecosystem services if managed correctly (Sander W. K, 2020).

5.10 Maintenance

Regular inspection and maintenance of the farms is essential for the safety of all marine users and the efficient operation of the sea farm. The Community Benefit Societies membership includes divers, marine and mooring contractors including Robust Boats Ltd and Pembrokeshire Marine Services. This gives the society access to Commercial divers, ROVs and coded work boats. Further several members have decades of experience of working in the unique sea conditions found in Ramsey Sound. With these facilities and expertise the site will be regularly inspected and maintained and if any of the equipment or farms come to the end of their operational life these individuals will also ensure all is removed as they all have a vested interest in the community and the marine environment. With the experience of having operated the two existing farms, Car-Y-Mor has developed a maintenance schedule that ensures all of the infrastructure in and out of the water is maintained to ensure the safety of marine habitats and human users of the nearby sea. These maintenance checks also ensure the relevant regulations and standards are met.

5.11 Monitoring

5.11.1 Existing and ongoing monitoring

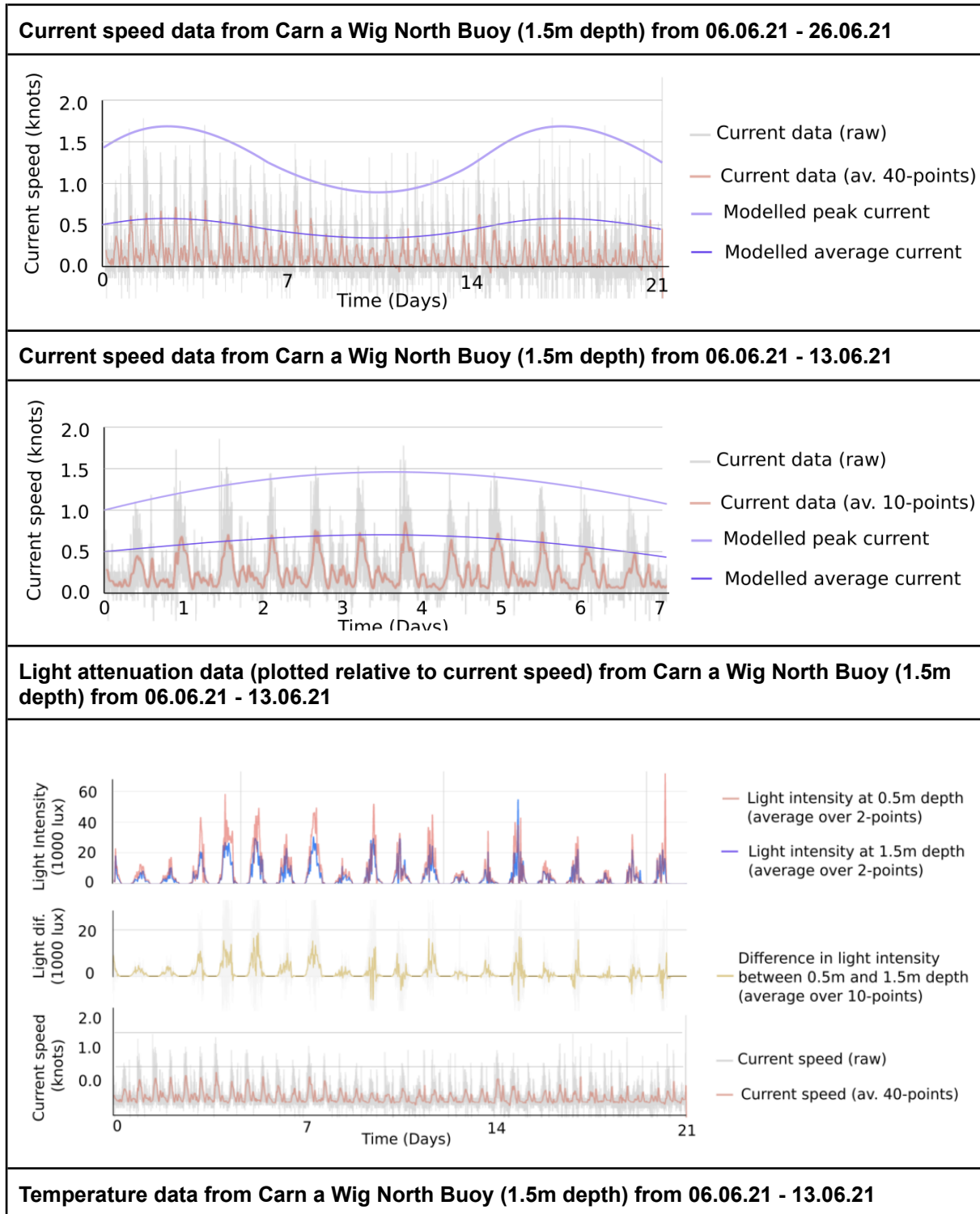
At the existing trial sites environment monitoring is actively being carried out by the shellfish centre at Bangor University (BU) and Plant Ecology Beyond Land CIC (PEBL). BU has been monitoring the variation of plankton, shellfish spat and salinity of the water column at the existing farms throughout the year. This monitoring has been active since February 2021. PEBL has been monitoring physical environmental parameters (Light, Temperature, Current speed) as well as imaging the growth of seaweeds at the farm.

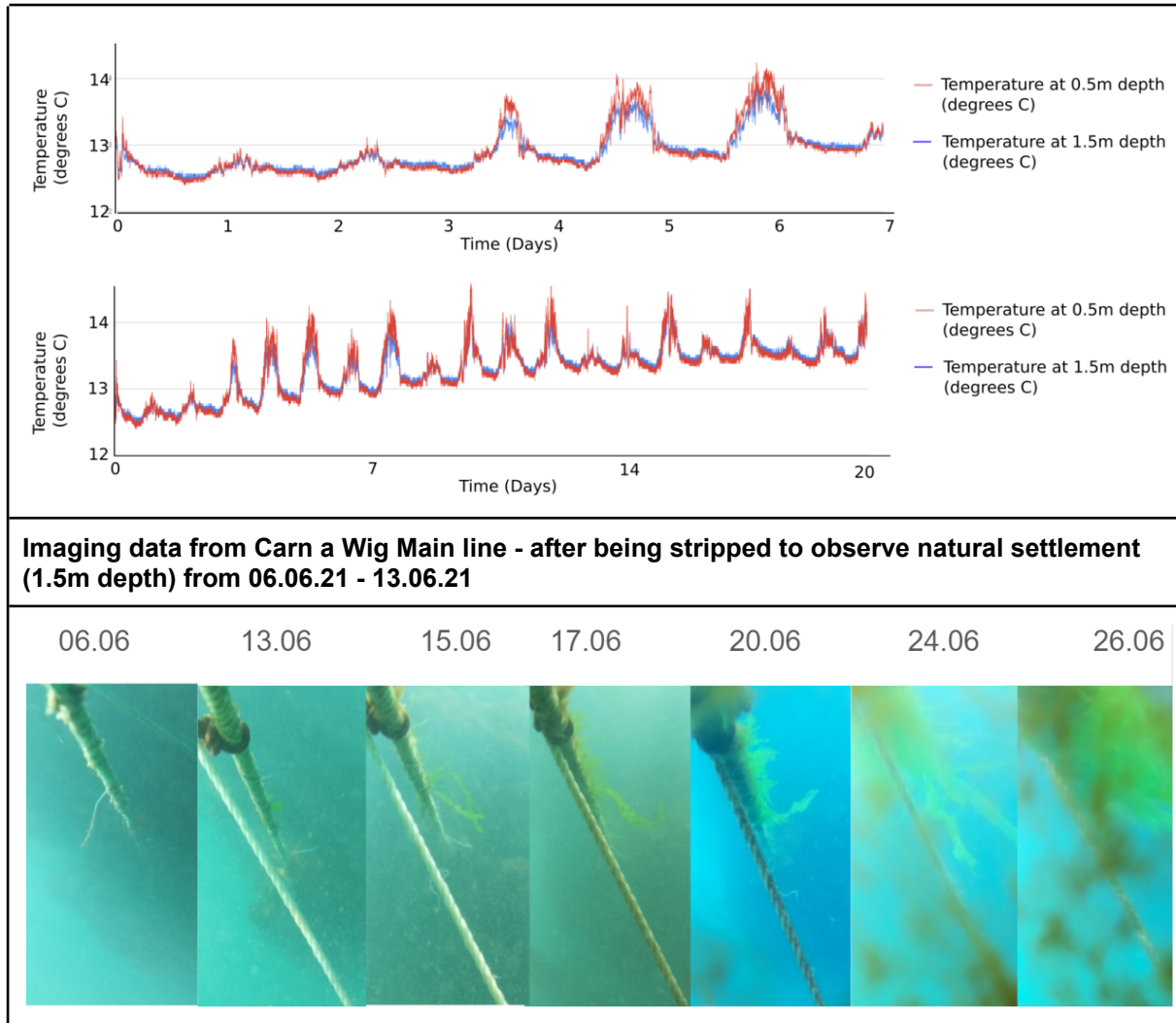
Table 4. Existing monitoring activities, their start/end date, the frequency of data gathering and the aim of each study is shown

Monitoring Activity	Start / Frequency	Description of activity	Aim of monitoring
Plankton	Feb'21 - ongoing / 14 day intervals	Collecting water samples at 6 locations at Carn A Wig and Porthliski sites and sending for analysis at BU	Determine the baseline of phytoplankton in the water column at the site
Mussel, Scallop, Oyster spat	Feb'21 - ongoing / 14 day intervals	Collecting water samples at 6 locations at Carn A Wig and Porthlisky sites and sending for analysis at BU	Determine the baseline concentration of spat in the water column at the site
Salinity (+Depth, Temp)	Feb'21 - ongoing / 14 day intervals	Measuring the salinity using a hand held probe submerged in a sample cup on the workboat	Determine reference conditions for the plankton and shellfish spat monitoring
Current speed at farm level	June'21 -ongoing / 10 min intervals	Deploying a tilt-current meter at 1.5m depth. Data is downloaded and battery is changed in 21 day intervals	Determine the baseline current speed in the farm area before infrastructure is added
Current speed at sea-bed	Aug'21 -ongoing / 10 min intervals	Deploying a tilt-current meter on the sea-bed (~12m depth). Download/ battery is changed in 21 day intervals	Determine the baseline current speed in the farm area before infrastructure is added
Light attenuation at farm level	June'21 -ongoing / 10 min intervals	Deploying two light sensors at 1.5m and 2.5m depth. Difference in light is monitored to give a value of light attenuation	Determine the baseline water transparency or concentration of particulate matter in the farm area before infrastructure is added
Temperature at farm level	June'21 -ongoing / 10 min intervals	Deploying two temperature sensors at 1.5m and 2.5m depth.	Determine mixing of water and any stratification events which might facilitate disease outbreaks in future shellfish cultivars
Imaging of Seaweeds	June'21 -ongoing / 12 hr intervals	Deploying a programmable underwater camera pointed at the main seaweed cultivation line which records images and HD video for 60 seconds 2x each day for up to 21 days	Determine level of natural settlement of cultivation line, health of species, growth rates, presence of other species

5.11.2 Preliminary monitoring data

Table 5. Preliminary data from some of the above mentioned monitoring activities is shown in the table below:





5.11.3 Future monitoring plans

The Society is collaborating with WWF, PEBL and Swansea University to carry out additional environmental monitoring work on the benefits this integrated multi trophic aquaculture delivers. This will involve;

- Regular inspections with Drop cams and ROVs to observe the benthic ecology for any changes in the presence of biodiversity.
- Tanking sediment samples (using sea-bed sample traps) to analyse the quantity of sediment depositing below the farm versus at a reference site nearby (and mapping sediment DNA to determine which quantity is wild sediment vs farm sediment)
- Taking shellfish and seaweed samples to determine uptake of Nitrates, Phosphate and Carbon due to presence of the farm
- Taking water samples and shellfish and seaweed samples to determine uptake of heavy metals

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Sander W. K. van den Burg, Christine Röckmann, Jennifer L. Banach and Luc van Hoof *Front. Mar. Sci.*, 20 February 2020 doi: 10.3389/fmars.2020.0006