Seazou Aquaculture Ltd Seaweed Farm

Water Framework Directive Assessment

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Introduction

The following document outlines the Water Framework Directive Assessment for the proposed Seazou Aquaculture Ltd 25 hectare seaweed farm located off the coast of the Pennard Cliffs, to the east of Oxwich Bay, in the Bristol Channel south of the Gower Peninsular.

The location of the seaweed farm is shown in Figure 1 below. Please refer the Farm Overview document for further details of the seaweed farm and marine license application.

Figure 1: Seaweed farm location map

The Water Framework Directive Assessment includes:

1. A scoping report based using the template and guidance found at the following government website: https://www.gov.uk/guidance/water-framework-directive-assessment-estuarine-and-coastal-waters.An

2. Based on the results of the scoping report, two impact assessments have been undertaken for each of the receptors identified in the scoping as being at risk from the proposed seaweed farm activities.

Water Framework Directive Assessment:
Scoping for activities in estuarine and coastal waters

Use this template to record the findings of the scoping stage of your Water Framework Directive (WFD) assessment for an activity in an estuary or coastal water.

If your activity will:

- take place in or affect more than one water body, complete a template for each water body
- include several different activities or stages as part of a larger project, complete a template for each activity as part of your overall WFD assessment

The WFD assessment guidance for estuarine and coastal waters will help you complete the table.

Your activity	Description, notes or more information
Applicant name	Seazou Aquaculture Ltd
Application reference number (where applicable)	
Name of activity	Seazou Aquaculture Ltd Seaweed Farm
Brief description of activity	The creation of a 25-hectare seaweed farm located off the coast of the Pennard Cliffs, to the east of Oxwich Bay, in the Bristol Channel south of the Gower Peninsular. The farm will include 3 rows of 15 x 100m long submerged seaweed longline arrays suspended from weighted mooring anchors at either end.
Location of activity (central point XY coordinates or national grid reference)	SS 54622 86183
Footprint of activity (ha)	25 hectares, 500m x 500m
Timings of activity (including start and finish dates)	June 2024 – TBC. The duration of the activity will be dependent on the duration of the marine license.

Extent of activity (for example size, scale frequency, expected volumes of output or discharge)	The 25-hectare, 6,000m seaweed farm will produce one harvest a year of up to 90 tonnes of wet seaweed.
Use or release of chemicals (state which ones)	No

Water body[1]	**Description, notes or more information**
WFD water body name	Bristol Channel Outer North
Water body ID	GB611008590001
River basin district name	Western Wales
Water body type (estuarine or coastal)	Coastal
Water body total area (ha)	2314293857.46118
Overall water body status (2015)	Moderate
Ecological status	Moderate
Chemical status	High
Target water body status and deadline	Good by 2027
Hydromorphology status of water body	Not high
Heavily modified water body and for what use	Natural
Higher sensitivity habitats present	Yes, however the location and footprint of the seaweed farm does not impact any higher sensitivity habitats.
Lower sensitivity habitats present	Yes, however the location and footprint of the seaweed farm does not impact any lower sensitivity habitats.
Phytoplankton status	Good

History of harmful algae	No history of harmful algae as the Centre for Environment, Fisheries and Aquaculture Science (CEFAS) do not currently have a Harmful Algal Blooms (HABS) surveillance and monitoring site within the Bristol Channel Outer North water body. (Ref: https://www.cefas.co.uk/data-and-publications/habs/)
WFD protected areas within 2km	No

[1] *Water body information can be found in the Environment Agency's catchment data explorer and the water body summary table. Magic maps provide additional information on habitats and protected areas. Links to these information sources can be found in the WFD assessment guidance for estuarine and coastal waters.*

Specific risk information

Consider the potential risks of your activity to each of these receptors: hydromorphology, biology (habitats and fish), water quality and protected areas. Also consider invasive non-native species (INNS).

Section 1: Hydromorphology

Consider if hydromorphology is at risk from your activity.

Use the water body summary table to find out the hydromorphology status of the water body, if it is classed as heavily modified and for what use.

Consider if your activity:	Yes	No	Hydromorphology risk issue(s)
Could impact on the hydromorphology (for example morphology or tidal patterns) of a water body at high status	Requires impact assessment	Impact assessment not required	No risk of impacting a waterbody with a high hydromorphology status.
Could significantly impact the hydromorphology of any water body	Requires impact assessment	Impact assessment not required	The seaweed farm may impact the morphological conditions of the seabed as the seeded ropes will be fixed to the seabed using weighted anchors. The weighted anchors can cause damage to the seabed upon deployment. Please refer to the impact assessment for risk mitigation. The seaweed farm will be located well beyond the low water mark and will therefore not impact tidal patterns. However, during operation of the seaweed farm some changes in hydrodynamics, current flow and sediment dynamics around the facility may result in changes in nearby sedimentation rates. Please refer to the impact assessment for risk mitigation.

			Shading or smothering by the seaweed farm could potentially reduce benthic productivity. Please refer to the impact assessment for risk mitigation.
Is in a water body that is heavily modified for the same use as your activity	Requires impact assessment	Impact assessment not required	Not located in a water body that is heavily modified.

Record the findings for hydromorphology and go to section 2: biology.

Section 2: Biology

Habitats

Consider if habitats are at risk from your activity.

Use the water body summary table and Magic maps, or other sources of information if available, to find the location and size of these habitats.

Higher sensitivity habitats [2]	Lower sensitivity habitats [3]
chalk reef	cobbles, gravel and shingle
clam, cockle and oyster beds	intertidal soft sediments like sand and mud
intertidal seagrass	rocky shore
maerl	subtidal boulder fields
mussel beds, including blue and horse mussel	subtidal rocky reef
polychaete reef	subtidal soft sediments like sand and mud
saltmarsh	
subtidal kelp beds	
subtidal seagrass	

[2] *Higher sensitivity habitats have a low resistance to, and recovery rate, from human pressures.*

[3] *Lower sensitivity habitats have a medium to high resistance to, and recovery rate from, human pressures.*

Consider if the footprint[4] of your activity is:	Yes	No	Biology habitats risk issue(s)
0.5km^2 or larger	Yes to one or more – requires impact assessment	No to all – impact assessment not required	Yes
1% or more of the water body's area			No
Within 500m of any higher sensitivity habitat			No. There are a number of honeycomb worm (Sabellaria alveolata) reefs along the coastline adjacent to the seaweed farm's location, however they are more than 500m away.
1% or more of any lower sensitivity habitat			No

[4] *Note that a footprint may also be a temperature or sediment plume. For dredging activity, a footprint is 1.5 times the dredge area.*

Fish

Consider if fish are at risk from your activity, but only if your activity is in an estuary or could affect fish in or entering an estuary.

Consider if your activity:	Yes	No	Biology fish risk issue(s)
Is in an estuary and could affect fish in the estuary, outside the estuary but could delay or prevent fish entering it or could affect fish migrating through the estuary	Requires impact assessment	Go to next section	Activity is not in or outside an estuary.
Could impact on normal fish behaviour like movement, migration or spawning (for example creating a physical barrier, noise, chemical change or a change in depth or flow)	Requires impact assessment	Impact assessment not required	n/a
Could cause entrainment or impingement of fish	Requires impact assessment	Impact assessment not required	n/a

Record the findings for biology habitats and fish and go to section 3: water quality.

Section 3: Water quality

Consider if water quality is at risk from your activity.

Use the water body summary table to find information on phytoplankton status and harmful algae.

Consider if your activity:	Yes	No	Water quality risk issue(s)
Could affect water clarity, temperature, salinity, oxygen levels, nutrients or microbial patterns continuously for longer than a spring neap tidal cycle (about 14 days)	Requires impact assessment	Impact assessment not required	Increased sedimentation of organic matter from seaweeds and associated organisms could also increase benthic production in local area. Please refer to the impact assessment for risk mitigation. Possible risk of impacting water clarity during removal of biofouling from the ropes and buoys. Please refer to the impact assessment for risk mitigation. Possible risk of vessel oil or fuel spillage during the construction, operation and maintenance of the seaweed farm. Please refer to the impact assessment for risk mitigation.
Is in a water body with a phytoplankton status of moderate, poor or bad	Requires impact assessment	Impact assessment not required	No, phytoplankton status is good.
Is in a water body with a history of harmful algae	Requires impact assessment	Impact assessment not required	No history of harmful algae.

Consider if water quality is at risk from your activity through the use, release or disturbance of chemicals.

If your activity uses or releases chemicals (for example through sediment disturbance or building works) consider if:	**Yes**	**No**	**Water quality risk issue(s)**
The chemicals are on the Environmental Quality Standards Directive (EQSD) list	Requires impact assessment	Impact assessment not required	No use of release of chemicals.
It disturbs sediment with contaminants above Cefas Action Level 1	Requires impact assessment	Impact assessment not required	Activity does not disturb sediment with contaminants.

If your activity has a mixing zone (like a discharge pipeline or outfall) consider if:	**Yes**	**No**	**Water quality risk issue(s)**
The chemicals released are on the Environmental Quality Standards Directive (EQSD) list	Requires impact assessment[5]	Impact assessment not required	No use of release of chemicals.

[5] *Carry out your impact assessment using the Environment Agency's surface water pollution risk assessment guidance, part of Environmental Permitting Regulations guidance.*

Record the findings for water quality go on to section 4: WFD protected areas.

Section 4: WFD protected areas

Consider if WFD protected areas are at risk from your activity. These include:

- special areas of conservation (SAC)
- special protection areas (SPA)
- shellfish waters
- bathing waters
- nutrient sensitive areas

Use Magic maps to find information on the location of protected areas in your water body (and adjacent water bodies) within 2km of your activity.

Consider if your activity is:	Yes	No	Protected areas risk issue(s)
Within 2km of any WFD protected area[6]	Requires impact assessment	Impact assessment not required	The activity is within 2km of the following WFD protected area. - A special area of conservation (SAC)_Limestone Coast of South West Wales_ UK0014787

[6] *Note that a regulator can extend the 2km boundary if your activity has an especially high environmental risk.*

Record the findings for WFD protected areas and go to section 5: invasive non-native species.

Section 5: Invasive non-native species (INNS)

Consider if there is a risk your activity could introduce or spread INNS.

Risks of introducing or spreading INNS include:

- materials or equipment that have come from, had use in or travelled through other water bodies
- activities that help spread existing INNS, either within the immediate water body or other water bodies

Consider if your activity could:	Yes	No	INNS risk issue(s)
Introduce or spread INNS	Requires impact assessment	Impact assessment not required	Yes, there is a risk of introducing INNS for the following reasons: 1. The seaweed ropes will be seeded in a facility located outside of the waterbody. 2. Biofouling on the craft used to construct, operate and maintain the seaweed farm The risk will be low, please refer to the impact assessment for risk mitigation.

Record the findings for INNS and go to the summary section.

Summary

Summarise the results of scoping here.

Receptor	Potential risk to receptor?	Note the risk issue(s) for impact assessment
Hydromorphology	Yes	Increased sedimentation of organic matter from seaweeds and associated organisms could also increase benthic production in local area. Possible risk of impacting water clarity during removal of biofouling from the ropes and buoys. Possible risk of vessel oil or fuel spillage during the construction, operation and maintenance of the seaweed farm.
Biology: habitats	Yes	The footprint of the proposed activity is 0.5km2 and therefore an impact assessment is required.
Biology: fish	No	n/a
Water quality	Yes	Increased sedimentation of organic matter from seaweeds and associated organisms could also increase benthic production in local area. Possible risk of impacting water clarity during removal of biofouling from the ropes and buoys. Possible risk of vessel oil or fuel spillage during the construction, operation and maintenance of the seaweed farm.
Protected areas	Yes	The proposed activity is within 2km of a Special Area of Conservation.
Invasive non-native species	Yes	There is a risk of introducing INNS for the following reasons: 1. The seaweed ropes will be seeded in a facility located outside of the waterbody. 2. Biofouling on the craft used to construct, operate and maintain the seaweed farm

If you haven’t identified any receptors at risk during scoping, you don’t need to continue to the impact assessment stage and your WFD assessment is complete.

If you’ve identified one or more receptors at risk during scoping, you should continue to the impact assessment stage.

Include your scoping results in the WFD assessment document you send to your activity’s regulator as part of your application for permission to carry out the activity.

Impact Assessment

The following section outlines the impact assessments carried out for each of the receptors identified in the scoping as being at risk from the proposed seaweed farm activities. The following receptors have been identified in the scoping:

- Hydromorphology
- Biology: Habitats
- Water Quality
- Protected Areas
- Invasive Non Native Species (INNS)

Impact Assessment (1)

As per the government guidance for completing a water framework directive assessment, the impact assessment will firstly review the pressures-activity matrix to help identify ways the activity could affect the 'at risk' receptors. The assessment will then consider is there is a pathway linking the pressure to the receptor. If there is no pathway then no further assessment is required. If there is a pathway then the impact assessment will describe how the risk will be mitigated.

In addition, the impact assessment will assess for deterioration, assess for protected areas, assess for invasive non-native species (INNS), assess whether the activity jeopardises the good status of the water body, assess whether the activity jeopardises existing mitigation measures in a heavily modified water body and assess whether the activity meets the conditions of Article 4.7.

The Impact Assessment (1) is provided in tabular form in Appendix A.

Impact Assessment (2)

In addition to the impact assessment defined in the government guidance for completing a water framework directive assessment, an additional impact assessment has been undertaken. The second impact assessment follows the AWAA Aquaculture Activity Assessment process defined by Natural Resources Wales. The assessment follows the following process.

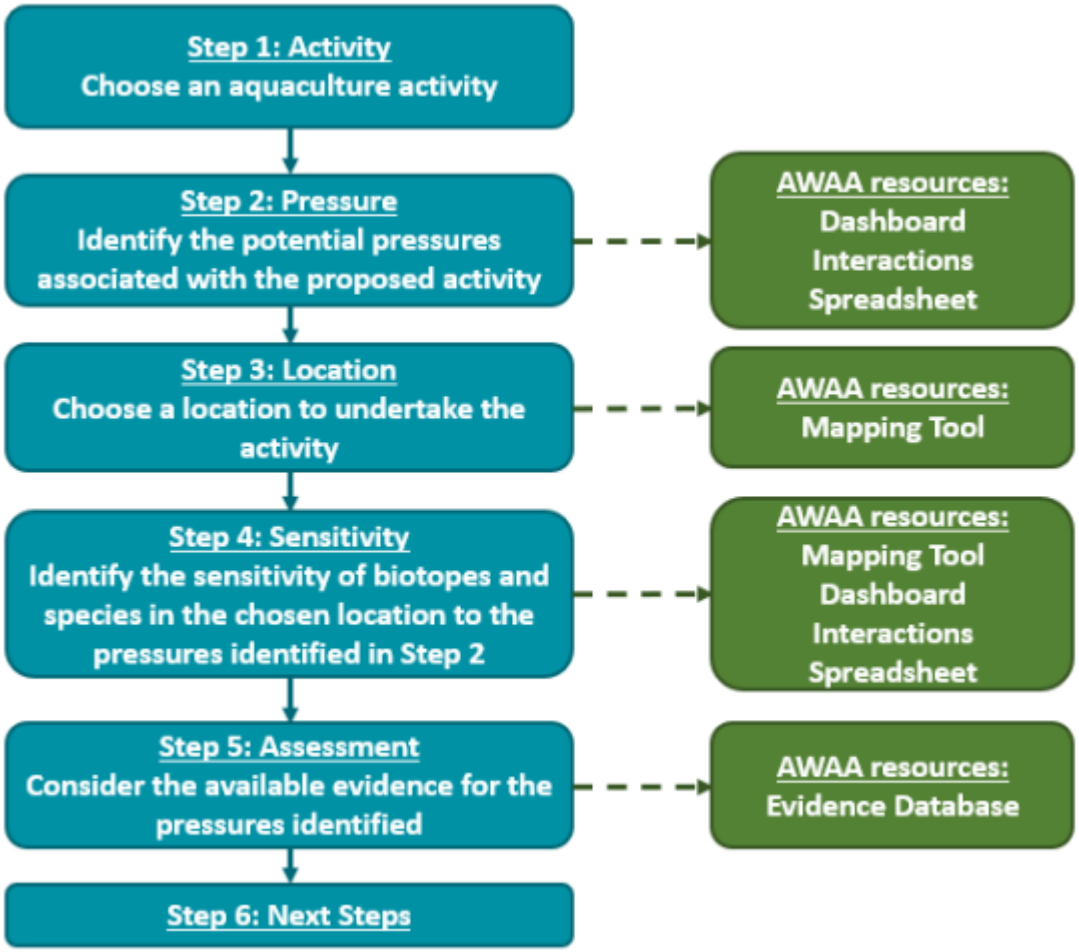


Figure 1: Step by step process for using the AWAA Aquaculture Activity Assessment resources

The AWAA mapping tool allows the user to identify the sensitive biotopes and species overlapping or nearby the proposed seaweed farm location and therefore determine whether the biotopes and species have the potential to be exposed to the pressures occurring from the aquaculture activities.

The location of the proposed seaweed farm does not coincide with any sensitive biotopes or species or any Maritime Protected Areas, however, an assessment has still been undertaken for each pressure identified and mitigation measure have been proposed to reduce any residual risks.

The mitigation proposed for the seaweed farm are as follows:

- The design of the seaweed farm, including the layout of the seaweed line and the arrangement of weighted anchors, will be done in conjunction with the engineers at the Kelson Marine Engineering.
- A carefully planned construction, operation and maintenance plan that minimised impact from the seaweed farm on the water body and local habitats.
- The biosecurity plan for the seaweed farm and associated cultivation facility.

The Impact Assessment (2) is provided in tabular form in Appendix B, and the associated AWAA maps are provided in Appendix C.

Summary

The impact assessment has identified possible pathways between environmental pressures and the various water framework directive receptors and sensitive biotopes and species and has illustrated mitigation measure to keep the risk of impact from the activities associated with the proposed seaweed farm to an acceptable level.

Appendix A – Impact Assessment (1)

Water Frame Directive Assessment

	Receptor	Impact
1	Hydromophology	Yes - Impact Assessment Required
2(i)	Biology - Habitats	Yes - Impact Assessment Required
2(ii)	Biology - Fish	No
3	Water Quality	Yes - Impact Assessment Required
4	WFD Protected Areas	Yes - Impact Assessment Required
5	Invasive Non Native Species	Yes - Impact Assessment Required

Impact Assessment 1 - Pressure Activity Matrix Review

Extracted from the Pressure Activity Matrix						Impact Assessment	
APJoinMasterID	CategoryTitle	ActivityTitle	PressureTitle	APJustificationDesc	RPPTitle	Impacted Receptor	Mitigation
2083	Production of living resources	Seaweed aquaculture: Suspended rope/net culture	Above water noise	Disturbance to species and their displacement from the site can arise from the construction and the operation of aquaculture farms, for instance from noise and light during management activities or from predation control [2834]. Aquaculture, like most maritime activities, generates sound as a by-product of ongoing operations, and sound may be associated with constructing, maintaining, and decommissioning aquaculture facilities. In some cases, intense sounds have been intentionally produced to deter predator attacks. As a result, noise can displace animals from their habitat or interrupt normal movement or migration patterns, adversely affect foraging and reproductive behaviour, and increase the risk of predation [3151].	medium-high	No impact to receptor	
2071	Production of living resources	Seaweed aquaculture: Suspended rope/net culture	Abrasion/disturbance of the substrate on the surface of the seabed	A variety of permanent anchors/moorings exist for aquaculture facilities. The selection of permanent mooring depends on the surrounding topography, the access to nearby land or harbours, the type of seabed available to keep the mooring stable, and the exposure of the site to weather, storms and drift ice. Types of moorings used include: deadweight moorings, such as train wheels, concrete blocks, railway ties and drag anchors, such as heavy chains; lightweight moorings such as spiral or helix anchors, and hydraulically driven expansion anchors. Hold-fast moorings, such as steel bolts, or tether moorings using external installations such as windmill structures, unused oil rig infrastructure and marine pilings (poles) are also becoming more common to tether shellfish culture infrastructure [4944]. Some aquaculture sites require extensive underwater infrastructure capable of abrading surrounding surfaces. Proper siting and design of aquaculture infrastructures, avoiding their location on especially sensitive habitats and considering the best technical solution for each type of area (e.g. adapting mooring structures to the conditions of the seabed substrate) can help avoid and minimise these potential adverse effects [2834]. Anchors cause damage to the seabed upon deploying the anchor and the subsequent dragging and locking in and also through the chain causing abrasion and scour whilst at anchor and upon recovery. Mooring chains from swinging moorings may scour the seabed as the mooring slackens and rotates with the tide [3223]. Small vessel anchors have been found to cause surface 'scars' of typically 1-4 m2 [5175]. Scouring over a 6 m radius around a mooring has been recorded on intertidal mudflats caused by anchor chains [5179],[4981].	medium-high	Hydropmorphology	The design of the weights and anchors will be developed to avoid locating them on especially sensitive habitats and the best technical solution proposed for the given location. For example, one proposal for the weights / anchors would be to use reef cube type block which are formed from a non invasive material and will encourage the growth of marine life. Advice will be sort from the Scottish Association for Marine Science (SAMS) to develop a weight / anchoring design that will stabilise the seaweed farm whilst minimising impact to the seabed.
2080	Production of living resources	Seaweed aquaculture: Suspended rope/net culture	Barrier to species movement	This pressure refers to obstructions to species movement caused by physical barriers or prolonged exposure to noise, light, visual disturbance or changes in water quality. The likelihood of impact will depend on factors such as the spatial/temporal scale of the activity and its location in relation to migratory routes, and so the pressure will need to be considered on case-by-case basis to determine relevance to a given feature/site. Whilst it is considered that examples of the association between this sub-activity and pressure will be rare, potential causes include fixed equipment in confined water bodies/estuaries, or behavioural effects from the use of acoustic deterrents [3121],[3152],[4921],[4445]. However, the impacts from the latter may be better considered by the pressure 'Underwater noise changes'.	low	No impact to receptor	
2069	Production of living resources	Seaweed aquaculture: Suspended rope/net culture	Changes in suspended solids (water clarity)	Suspended sediments are likely to increase in the water column during the construction of seaweed aquaculture facilities and during the operation phase of harvesting the seaweed. This is most likely to occur when removing biofouling from the ropes or nets [2834],[3110].	low	Water Quality	The risk of increasing sediments in the water column whilst removing biofoul from the ropes and equipment will be low due to the scale of the seaweed farm. The risk will be mitigated through a carefully planned operations and maintenance (O&M) strategy. Typically only the perimeter lines and buoys will be cleaned in situ with the seaweed lines and seaweed line buoys being cleaned on land.
2081	Production of living resources	Seaweed aquaculture: Suspended rope/net culture	Collision ABOVE water with static or moving objects not naturally found in the marine environment (e.g., boats, machinery, and structures)	Pressure relates to vessels associated with this sub-activity and their movement as well as infrastructure. Marine birds are frequently attracted to or become disorientated by artificial light sources, which can result in collision and therefore injury or death [4399],[4378],[2826]. Bird collisions with vessels have been recorded with the risk being greatest at night for lighted ships near coastal areas and when the vessel is relatively close to large breeding aggregations of seabirds (rather than further offshore). However, there are relatively few sources of quantified information relating to seabird strikes on vessels. Nocturnal bird strikes on vessels tend to occur when bright, artificial light sources are used at times of poor visibility, typically during bad weather, often angled outwards or upwards from the vessel [4466],[4378],[4476],[2826].	low	No impact to receptor	
2082	Production of living resources	Seaweed aquaculture: Suspended rope/net culture	Collision BELOW water with static or moving objects not naturally found in the marine environment (e.g., boats, machinery, and structures)	During construction and operation of the aquaculture facility, vessels may be used; if so species can collide with the propeller or other parts of the hull causing collision injury or death. In general, the most lethal and serious injuries to mobile species such as marine mammals are caused by large ships (e.g. 80 m or longer) and vessels travelling at speeds faster than 14 knots. Most minor injuries, by contrast, involved collisions with vessels less than 45 m long. Collisions are rarely reported for vessels doing less than 10 km/hour [5120],[4987]. There is a paucity of information regarding collision risk of animals (e.g. birds, fish, marine mammals) with underwater structures, especially for birds. The response of birds will depend on their detection of a device and any associated structures. The risk of collision may be increased if the devices alter the characteristics of the current, especially if such changes create new foraging opportunities, since this may impact on the manoeuvrability and underwater swimming agility of birds [4959],[5075]. Collision risks are most likely to pose the greatest risk in areas of strong water movement, such as areas of strong tidal flow or wave motion [3098].	low	No impact to receptor	
2087	Production of living resources	Seaweed aquaculture: Suspended rope/net culture	Deoxygenation	This pressure is associated with sediment mobilisation as well as the deposition of organic matter. The spatial and temporal persistence of any change will depend on factors such as the gear type and intensity of the activity, levels of natural disturbance, temperature and the sediment type/composition, resulting in many changes being relatively short lived and localised [4891],[4899],[4351],[4446]. For fishing, the pressure may result from disturbance of the sediment in the wake of towed gears and resuspension of organic rich sediments [1419],[3186],[1436],[4350],[4407],[4351],[4446],[4899]. Further, organic matter at the surface may be buried within anaerobic subsurface layers [4450]. In fisheries where discards are spatially concentrated, particularly in areas of low current flow, discards (or damage to benthic organisms, including target species) may result in localised increases in organic matter and potentially hypoxia or anoxia of the seabed [3120],[3805]. More generally, shellfish farms can result in sediments that are characterised by suboxic to anoxic conditions due to the deposition of organic material and the associated communities may be affected by this surplus of organic matter [5135],[2834]. In highly energetic waters, faeces and pseudofaeces may be spread over some distance. The extent of impacts is determined from the quantity and quality of the input and environmental conditions at the location [4939].	low	No impact to receptor - this pressure is related to fishing activities	
2064	Production of living resources	Seaweed aquaculture: Suspended rope/net culture	Genetic modification & translocation of indigenous species	Biological interactions between the cultivated species and species occurring in the site must be taken into account, in particular the possible effects of direct competition or introduction of new diseases [2834],[3110].	medium-high	Biology - Habitat	The risk of creating competition between cultivated species and species occurring at the site and the risk of introducing new diseases will be mitigated through the biosecurity plan for the seaweed farm. Only natural occurring species of seaweed found within 50km radius of the site will be cultivated for growing on the farm.
2085	Production of living resources	Seaweed aquaculture: Suspended rope/net culture	Hydrocarbon & PAH contamination. Includes those priority substances listed in Annex II of Directive 2008/105/EC.	Pressure primarily relates to vessels associated with this sub-activity and their movement. The primary chemicals of environmental concern in vessel oil and fuel are polycyclic aromatic hydrocarbons (PAHs). Deliberate discharges of oil or oil/water mixtures from ships are prohibited within the North West European Waters Special Area, established by the International Maritime Organization under MARPOL Annex I in 1999. This includes all waters around the UK and its approaches. However, accidental discharges still occur. Information on accidental discharges of oil from ships and offshore platforms is compiled annually by the Advisory Committee on Protection of the Sea (ACOPS) on behalf of the Maritime and Coastguard Agency. Although the majority of incidents are minor, several incidents occur annually that lead to the actual or potential release of significant amounts of oil (typically from large shipping vessels and tankers) [3096],[3164],[3194],[4985].	low	Water Quality	The impact to the water quality from contamination will be mitigated through carefully planned construction methodologies and operations and maintenance (O&M) strategies. Deliberate discharges of oil or oil/water mixtures will not be prohibited. During operation, the risk is also minimised by the low intensity of the operations, with a vessel accessing the seaweed farm only a few times throughout the year: once to lay the seaweed ropes, once to do the seaweed harvest, and then periodically for general maintenance.
2079	Production of living resources	Seaweed aquaculture: Suspended rope/net culture	Introduction of light	The pressure is potentially associated with construction, maintenance, operational lighting, plus navigation and operational lighting on vessels and structures. Lighting can cause disorientation or displace sensitive species. Lighted vessels and structures in open waters may pose a collision risk to many species of birds. Birds drawn to light may become disoriented and collide with these structures, which may result in injury and death. Light from vessels may also be of concern where significant levels of activity occur in close proximity to sensitive bird habitats including coastal inshore waters [2843],[3083],[3088],[3195],[2797],[3107],[4399],[4334],[4337],[2834]. Large enclosures could also have an effect on current circulation and light penetration [2834]. Disturbance to species and their displacement from the site can arise from the construction and the operation of aquaculture farms, for instance from noise and light during management activities or the need to control predation on farms [2834].	low	Biology - Habitat	The risk is of impacting local habitats through the introduction of light or conversely shade will be mitigated through the design of the seaweed farm layout. Advice will be sort from the Scottish Association for Marine Science (SAMS) to develop a layout for the seaweed farm that optimises the production of seaweed whilst minimising the impact of shading onto the seabed.

2066	Production of living resources	Seaweed aquaculture: Suspended rope/net culture	Introduction of microbial pathogens	The import or rearing of cultivated stock can introduce a range of pathogens and parasites into the marine environment which could be deemed damaging [4420],[3110]. The risks are also high because aquaculture facilities play an intermediary role when new species are brought into a country before being stocked out. If quarantining controls are weak the risks of transfer of pathogens or contamination of material by alien invasive species are high [4341].	low	Biology - Habitat	The risk of introducing pathogens and parasites into the marine environment will be mitigated through the biosecurity plan for the seaweed farm.
2065	Production of living resources	Seaweed aquaculture: Suspended rope/net culture	Introduction or spread of invasive non-indigenous species (INIS)	Aquatic organisms may be transferred to new locations as biofouling and can be harmful and invasive in locations where they do not naturally occur. All craft have some biofouling, even if recently cleaned or anti-fouled [4978],[5177]. Thousands of marine species can be carried in ships' ballast water [3164]. Aquaculture is a key pathway for the introduction of invasive species [4400],[4338],[2834],[3117]. Other biological interactions between the farmed species and the species occurring in the site must be taken into account, in particular the possible effects of escapes, such as interbreeding or direct competition from alien species used in aquaculture [2834],[3110].	medium-high	Invasive Non Native Species	The risk of introducing invasive non-indigenous species will be mitigated through the biosecurity plan for the seaweed farm and associated cultivation facilities.
2077	Production of living resources	Seaweed aquaculture: Suspended rope/net culture	Litter	Marine litter is items made or used by people and deliberately discarded or unintentionally lost into the sea and on beaches. Despite international legislation such as Annex V of the International Convention for the Prevention of Pollution from Ships, 1973 [3140], maritime activity is still a major source of litter. Fishing is an important source of marine litter. For example, 14 % of the litter identified during the UK Beachwatch survey (2006) was fishing related [3160], net loss in UK fisheries has been estimated at 36 km per year [5103] and surveys across 32 sites in European waters (continental shelves to canyons) found that derelict fishing gear was the second most abundant item encountered (34 % of total) [4459]. Various types of litter result from fishing in general including galley waste, fish boxes, floats/buoys, nets, ropes, lines, pots, weights and micro-plastic particles resulting from disintegration of plastic gear [3160],[3118]. Impacts of such litter include entanglement of marine wildlife including mammals and birds, ingestion and ghost fishing [3202],[3160],[2752],[3096],[5123],[5103]. Ghost gears can also damage benthic habitats (through abrasion, 'plucking' of organisms or meshes closing around them, and the translocation of seabed features) [5103]. Alongside existing legislation, potential mitigation measures are discussed in various sources of literature [2752],[3160],[5103].	low	Water Quality	The impact to the water quality from marine litter will be mitigated through carefully planned construction methodologies and operations and maintenance (O&M) strategies. During operation, the risk is also minimised by the low intensity of the operations, with a vessel accessing the seaweed farm only a few times throughout the year: once to lay the seaweed ropes, once to do the seaweed harvest, and then periodically for general maintenance.
2058	Production of living resources	Seaweed aquaculture: Suspended rope/net culture	Organic enrichment	Increased sedimentation of organic matter from seaweeds and associated organisms could also increase benthic production in areas with low current velocity [3110]. The extent of impacts is determined from the quantity and quality of the input and environmental conditions at the location [4939].	low	Water Quality	The risk of an increase in bethnic production will be low based on the scale an intensity of the seaweed farm. Advice will be sort from the Scottish Association for Marine Science (SAMS) to develop a layout for the seaweed farm that optimises the production of seaweed whilst minimising impact to the water body.
2068	Production of living resources	Seaweed aquaculture: Suspended rope/net culture	Penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion	A variety of permanent anchors/moorings exist for aquaculture facilities. The selection of permanent mooring depends on the surrounding topography, the access to nearby land or harbours, the type of seabed available to keep the mooring stable, and the exposure of the site to weather, storms and drift ice. Types of moorings used include: deadweight moorings, such as train wheels, concrete blocks, railway ties and drag anchors, such as heavy chains; lightweight moorings such as spiral or helix anchors, and hydraulically driven expansion anchors. Hold-fast moorings, such as steel bolts, or tether moorings using external installations such as windmill structures, unused oil rig infrastructure and marine pilings (poles) are also becoming more common to tether shellfish culture infrastructure [4944]. Some aquaculture sites require extensive underwater infrastructure capable of abrading surrounding surfaces. Proper siting and design of aquaculture infrastructures, avoiding their location on especially sensitive habitats and considering the best technical solution for each type of area (e.g. adapting mooring structures to the conditions of the seabed substrate) can help avoid and minimise these potential adverse effects [2834]. Anchors cause damage to the seabed upon deploying the anchor and the subsequent dragging and locking in and also through the chain causing abrasion and scour whilst at anchor and upon recovery. Mooring chains from swinging moorings may scour the seabed as the mooring slackens and rotates with the tide [3223]. Small vessel anchors have been found to cause surface 'scars' of typically 1-4m2 [5175]. Scouring over a 6 m radius around a mooring has been recorded on intertidal mudflats caused by anchor chains [5179],[4981].	medium-high	Hydropmorphology	The design of the weights and anchors will be developed to avoid locating them on especially sensitive habitats and the best technical solution proposed for the given location. For example, one proposal for the weights / anchors would be to use reef cube type block which are formed from a non invasive material and will encourage the growth of marine life. Advice will be sort from the Scottish Association for Marine Science (SAMS) to develop a weight / anchoring design that will stabilise the seaweed farm whilst minimising impact to the seabed.
2075	Production of living resources	Seaweed aquaculture: Suspended rope/net culture	Physical change (to another seabed type)	Aquaculture developments often require supporting infrastructure. The introduction of these structures can change the hydrological and sedimentological regime in the immediate vicinity of these structures and may lead to the erosion of or deposition of material on the seabed which alters the predominant habitat type [2834],[3110]. Sublittoral benthic habitats such as sand/mud flats/banks may be impacted by smothering from sediments generated from excretory products or following harvesting, especially if hydraulic or physical dredges are used [2834]. Mobile fishing gear is one of the best known sources of anthropogenic degradation of seabed habitat and associated benthic communities. Whilst the physical damage caused by persistent interaction with dredges could result in loss of certain sensitive habitats such as seagrass, the change is unlikely to be permanent if the activity were to cease, although recovery rates may be slow in some cases [3137],[4448].	low	Hydropmorphology	The design of the weights and anchors will be developed to avoid locating them on especially sensitive habitats and the best technical solution proposed for the given location. For example, one proposal for the weights / anchors would be to use reef cube type block which are formed from a non invasive material and will encourage the growth of marine life. Advice will be sort from the Scottish Association for Marine Science (SAMS) to develop a weight / anchoring design that will stabilise the seaweed farm whilst minimising impact to the seabed.
2076	Production of living resources	Seaweed aquaculture: Suspended rope/net culture	Physical change (to another sediment type)	Aquaculture developments often require supporting infrastructure. The introduction of these structures can change the hydrological and sedimentological regime in the immediate vicinity of these structures and may lead to the erosion of or deposition of material on the seabed which alters the predominant habitat type [2834],[3110]. Sublittoral benthic habitats such as sand/mud flats/banks may be impacted by smothering from sediments generated from excretory products or following harvesting, especially if hydraulic or physical dredges are used [2834]. Mobile fishing gear is one of the best known sources of anthropogenic degradation of seabed habitat and associated benthic communities. Whilst the physical damage caused by persistent interaction with dredges could result in loss of certain sensitive habitats such as seagrass, the change is unlikely to be permanent if the activity were to cease, although recovery rates may be slow in some cases [3137],[4448].	low	Hydropmorphology	The design of the weights and anchors will be developed to avoid locating them on especially sensitive habitats and the best technical solution proposed for the given location. For example, one proposal for the weights / anchors would be to use reef cube type block which are formed from a non invasive material and will encourage the growth of marine life. Advice will be sort from the Scottish Association for Marine Science (SAMS) to develop a weight / anchoring design that will stabilise the seaweed farm whilst minimising impact to the seabed.
2074	Production of living resources	Seaweed aquaculture: Suspended rope/net culture	Physical loss (to land or freshwater habitat)	Coastal developments can result in the loss of marine habitat through land claim to freshwater or terrestrial habitat [2834]. In an aquaculture context this may be relevant in instances where shoreside construction of aquaculture supporting infrastructure such as jetties, piers, slipways or buildings occurs.	low	No impact to receptor	
2067	Production of living resources	Seaweed aquaculture: Suspended rope/net culture	Removal of non-target species	Bycatch of species may be associated with almost aquaculture activities depending on the species farmed and the methods used. Removal of non-target species could result from the collection of wild caught material to be used as brood stock or to be grown on. Birds, seals and other wild predators may be directly removed through shooting, entanglement in nets (incl. anti-predator nets) or lines [4487],[4414].	low	No impact to receptor.	The seaweed farm is not located in the vicinity of any sensitive habitats so the risk is low.
2047	Production of living resources	Seaweed aquaculture: Suspended rope/net culture	Removal of target species	Removal of target species would occur when the species is removed from the wild and then grown within an aquaculture operation. The species may be used as brood stock or for growing on [3110]. Such target species may themselves be features/sub-features of designated sites, or may be species forming part of the biotope or wider community composition associated with the designated feature.	medium-high	No impact to receptor	
2070	Production of living resources	Seaweed aquaculture: Suspended rope/net culture	Smothering and siltation rate changes (Light)	During construction of an aquaculture facility sedimentation may occur. During operation changes in hydrodynamics, current flow and sediment dynamics around the facility may result in changes in nearby sedimentation rates. Shading or smothering by large scale seaweed farming could potentially reduce benthic productivity in shallow inshore areas. Increased sedimentation of organic matter from seaweeds and associated organisms could also increase benthic production in areas with low current velocity [3110]. However, the influence of seaweed culture on benthic communities has not been well studied and so it is uncertain whether the activity would exert the pressure at the benchmark level; it is likely to depend on intensity/scale and hydrographic conditions.	low	Hydropmorphology	The impact to the hydromorpholgy of the water body around the seaweed farm will be mitigated through the design of the seaweed farm layout. Advice will be sort from the Scottish Association for Marine Science (SAMS) to develop a layout for the seaweed farm that optimises the production of seaweed whilst minimising impact to the water body.
2086	Production of living resources	Seaweed aquaculture: Suspended rope/net culture	Synthetic compound contamination (incl. pesticides, antifoulants, pharmaceuticals). Includes those priority substances listed in Annex II of Directive 2008/105/EC.	Pressure primarily relates to vessels associated with this sub-activity and their movement. The primary chemicals of environmental concern in vessel oil and fuel are polycyclic aromatic hydrocarbons (PAHs). Deliberate discharges of oil or oil/water mixtures from ships are prohibited within the North West European Waters Special Area, established by the International Maritime Organization under MARPOL Annex I in 1999. This includes all waters around the UK and its approaches. However, accidental discharges still occur. Information on accidental discharges of oil from ships and offshore platforms is compiled annually by the Advisory Committee on Protection of the Sea (ACOPS) on behalf of the Maritime and Coastguard Agency. Although the majority of incidents are minor, several incidents occur annually that lead to the actual or potential release of significant amounts of oil (typically from large shipping vessels and tankers). Antifouling compounds like tributyltin (TBT; banned on vessels under 25 m in the UK since 1987, however) and copper wash from ship coatings enter and persist in the marine environment, with highest concentrations generally found in heavily used shipping routes or within harbours [3096],[3164],[3155],[2788],[3194],[4985]. Pesticides, fertilisers and antibiotics are all used in marine aquaculture operations to a lesser or greater extent [4340],[3110]. Zostera and Posidonia beds, mud habitats, mussel beds and reefs have low tolerance and resistance to some synthetic compounds used in aquaculture [2834].	low	Water Quality	The impact to the water quality from contamination will be mitigated through carefully planned construction methodologies and operations and maintenance (O&M) strategies. Deliberate discharges of oil or oil/water mixtures will not be prohibited. During operation, the risk is also minimised by the low intensity of the operations, with a vessel accessing the seaweed farm only a few times throughout the year: once to lay the seaweed ropes, once to do the seaweed harvest, and then periodically for general maintenance.

2084	Production of living resources	Seaweed aquaculture: Suspended rope/net culture	Transition elements & organo-metal (e.g. TBT) contamination. Includes those priority substances listed in Annex II of Directive 2008/105/EC.	Pressure primarily relates to vessels associated with this sub-activity and their movement, but may also relate to the aquaculture facility itself. The primary chemicals of environmental concern in vessel oil and fuel are polycyclic aromatic hydrocarbons (PAHs). Deliberate discharges of oil or oil/water mixtures from ships are prohibited within the North West European Waters Special Area, established by the International Maritime Organization under MARPOL Annex I in 1999. This includes all waters around the UK and its approaches. However, accidental discharges still occur. Information on accidental discharges of oil from ships and offshore platforms is compiled annually by the Advisory Committee on Protection of the Sea (ACOPS) on behalf of the Maritime and Coastguard Agency. Although the majority of incidents are minor, several incidents occur annually that lead to the actual or potential release of significant amounts of oil (typically from large shipping vessels and tankers). Antifouling compounds like tributyltin (TBT; banned on vessels under 25 m in the UK since 1987, however) and copper wash from ship coatings enter and persist in the marine environment, with highest concentrations generally found in heavily used shipping routes or within harbours [3096],[3164],[3155],[2788],[3194],[4985].	low	Water Quality	The impact to the water quality from contamination will be mitigated through carefully planned construction methodologies and operations and maintenance (O&M) strategies. Deliberate discharges of oil or oil/water mixtures will not be prohibited. During operation, the risk is also minimised by the low intensity of the operations, with a vessel accessing the seaweed farm only a few times throughout the year: once to lay the seaweed ropes, once to do the seaweed harvest, and then periodically for general maintenance.
2078	Production of living resources	Seaweed aquaculture: Suspended rope/net culture	Underwater noise changes	Vessels and machinery used during the construction phase will increase noise levels. Vessel movement is an important source of underwater noise, with noise emitted typically varying with vessel size whereby larger vessels generate lower frequency sound. Although propeller cavitation is the main source of such noise, gear deployment/towing/hauling, turbulence around the hull and the use of fish finding sonars will also result in noise being transmitted underwater by fishing vessels. For example, the source levels associated with small sea going vessels are typically 160-180 dB (Peak) re 1 µPa-m (RMS) [3152]. Acoustic deterrents/harassing devices are an additional potential source of underwater noise [3152],[3096],[4921]. Underwater noise can result in disturbance particularly to mobile receptors such as fish, birds and mammals [3152],[4921],[2074],[3069],[3121],[4445],[4869]. Disturbance to species and their displacement from the site can arise from the construction and the operation of aquaculture farms, for instance from noise and light during management activities or the need to control predation on farms [2834].	low	No impact to receptor	
2063	Production of living resources	Seaweed aquaculture: Suspended rope/net culture	Visual disturbance	The movement of vessels (and associated gear), people and vehicles can create visual stimuli which can evoke a disturbance response in mobile species such as fish, marine mammals, seabirds and coastal birds. Disturbance to species and their displacement from the site can arise from the construction and the operation of aquaculture farms. However, the magnitude of the pressure will depend on the nature, scale, intensity and duration of the activity, plus other factors such as species present and age, weather conditions and degree of habituation to disturbance source [3134],[2497],[3202],[2825],[3269],[2707],[5106],[4977],[5117],[2834],[3110].	medium-high	No impact to receptor	
2072	Production of living resources	Seaweed aquaculture: Suspended rope/net culture	Water flow (tidal current) changes, including sediment transport considerations	Structures placed in the marine environment immediately interact with the local current regime. Suspended aquaculture structures or pens have the potential of altering flow rates [4891],[4887],[3110]. Artificial reefs may have directly negative impacts through changes in current velocities and direction [4980],[5018],[5021],[2293]. Structures added to the coastal environment as a result of coastal defence schemes, coastal developments, artificial reefs, etc., can change local flow conditions. In particular, cross shore structures such as groynes and harbour arms can intercept flow paths, causing flows to divert around or across the structures [4892],[4893],[4894],[4873],[5075],[4960],[3125],[4961]. Large enclosures could also have an effect on current circulation and light penetration. Model outputs show that suspended aquaculture can result in a 20 % reduction in current speed and water exchange rates [4887]. Risks can be managed, if necessary, by limiting the sizes of complexes and re-siting them regularly [4405].	low	Hydropmorphology	The impact to the hydromorpholgy of the water body around the seaweed farm will be mitigated through the design of the seaweed farm layout. Advice will be sort from the Scottish Association for Marine Science (SAMS) to develop a layout for the seaweed farm that optimises the production of seaweed whilst minimising impact to the water body.
2073	Production of living resources	Seaweed aquaculture: Suspended rope/net culture	Wave exposure changes	Structures placed in the marine environment immediately interact with the local current regime. Suspended aquaculture structures or pens have the potential of altering flow rates [4891],[4887],[3110]. Artificial reefs may have directly negative impacts through changes in current velocities and direction [4980],[5018],[5021],[2293]. Structures added to the coastal environment as a result of coastal defence schemes, coastal developments, artificial reefs, etc., can change local flow conditions. In particular, cross shore structures such as groynes and harbour arms can intercept flow paths, causing flows to divert around or across the structures [4892],[4893],[4894],[4873],[5075],[4960],[3125],[4961]. Large enclosures could also have an effect on current circulation and light penetration. Model outputs show that suspended aquaculture can result in a 20 % reduction in current speed and water exchange rates [4887]. Risks can be managed, if necessary, by limiting the sizes of complexes and re-siting them regularly [4405].	low	Hydropmorphology	The impact to the hydromorpholgy of the water body around the seaweed farm will be mitigated through the design of the seaweed farm layout. Advice will be sort from the Scottish Association for Marine Science (SAMS) to develop a layout for the seaweed farm that optimises the production of seaweed whilst minimising impact to the water body.

Impact Assessment (1) - Part 2

Assessment	Impact Assessment
Assess for deterioration	Based on the impact assessment performed above, and with the mitigation measures in place, it is not envisaged that the proposed seaweed farm will cause deterioration to any quality element with the Bristol Channel Outer North water body.
Assess for protected areas	The activity is within 2km of: - A special area of conservation (SAC)_Limestone Coast of South West Wales_ UK0014787 The limestone coast protected area is an onshore protected area and there is therefore no pathway between it and the seaweed farm activities.
Assess for invasive non native species	There is no risk of introducing or spreading any INNS. The seaweed farm will be growing kelp that is indigenous to the UK and the farm will be serviced by a fishing vessel that is moored in Tenby harbour and has been fishing around the Gower Peninsular for many years.
Jeopardising good status	The activities related to the seaweed farm will not jeopardise the good status of the Bristol Channel Outer North water body.
Jeopardising mitigation measure	The seaweed farm is not in a water body that is heavily modified.
Article 4.7 defence	N/A

Appendix B – Impact Assessment (2)

Water Frame Directive Assessment

	Receptor	Impact
1	Hydromophology	Yes - Impact Assessment Required
2(i)	Biology - Habitats	Yes - Impact Assessment Required
2(ii)	Biology - Fish	No
3	Water Quality	Yes - Impact Assessment Required
4	WFD Protected Areas	Yes - Impact Assessment Required
5	Invasive Non Native Species	Yes - Impact Assessment Required

Impact Assessment 2 - AWAA

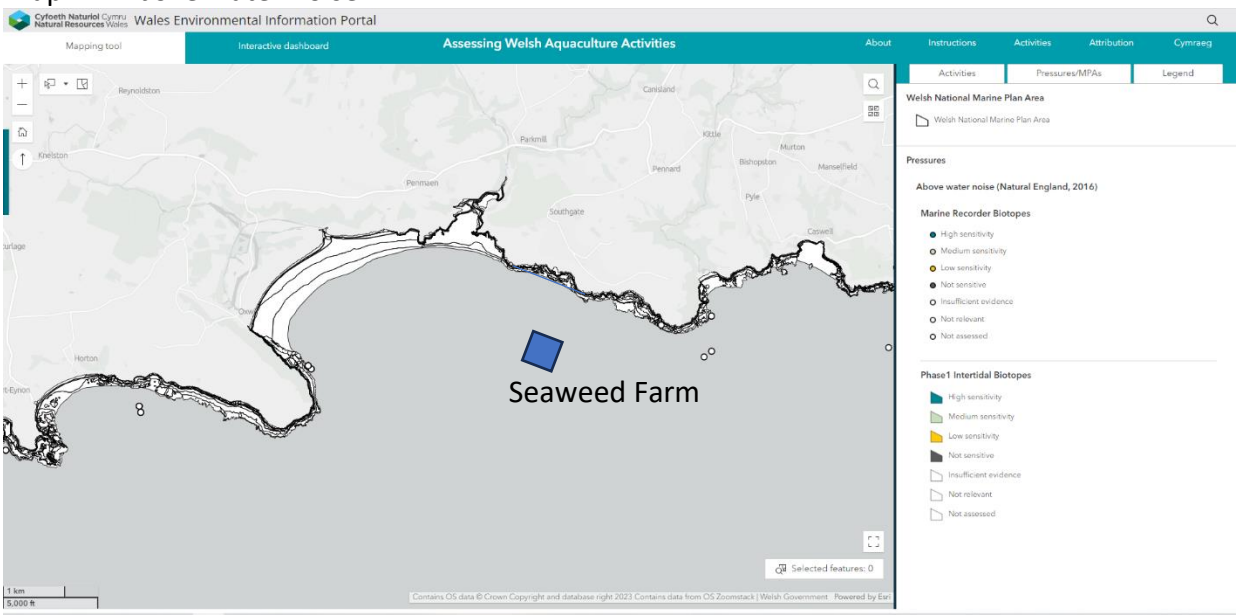
Refer to Impact Assesment 1 https://smnr-nrw.hub.arcgis.com/apps/73894fae28f64ed0b9b7344dcc667493/explore

	Pressure name	Description	Pathway from aquaculture activity	Impacted Receptor (taken from WFD Assessment scoping)	Biotopes or Protected Species impacted by pressure (taken from the AWAA Mapping Tool)	Mitigation
1	Above water noise (Pressure from Natural England, 2022)	Any loud noise made onshore or offshore by construction, vehicles, vessels, tourism, mining, blasting etc.	Above water noise generated by machinery or vessels could disturb birds and marine mammals	No WFD assessment receptors do not include birds and marine mammals	No - See Map 1	During construction of the seaweed farm the risk will ne mitigated through a carefully planned construction methodology. During operation the risk is minimised by the low intensity of the operations, with a vessel accessing the seaweed farm only a few times throughout the year: once to lay the seaweed ropes, once to do the seaweed harvest, and then periodically for general maintenance.
2	Abrasion/disturbance of the substrate on the surface of the seabed	Physical disturbance or abrasion at the surface of the substratum in sedimentary or rocky habitats	Scouring caused by anchoring to the seabed could cause abrasion	Yes - Hydromorphology	No - See Map 2	The design of the weights and anchors will be developed to avoid locating them on especially sensitive habitats and the best technical solution proposed for the given location. For example, one proposal for the weights / anchors would be to use reef cube type block which are formed from a non invasive material and will encourage the growth of marine life. Advice will be sort from the Scottish Association for Marine Science (SAMS) to develop a weight / anchoring design that will stabilise the seaweed farm whilst minimising impact to the seabed.
3	Barrier to species movement	The physical obstruction of species movements and including local movements	Infrastructure, such as lines and ropes suspended in the water column, may present a barrier to the movement of some species	No impact to WFD receptors	No - See Map 3	The risk is low as the AWAA mapping tool has not identified an sensitive species in the vicinity of the seaweed farm. Advice will be sort from the Scottish Association for Marine Science (SAMS) to develop seaweed farm layout that will help mitigate the risk of creating a barrier to the movement of species.
4	Changes in suspended solids (water clarity)	Changes in sediment and organic particulate matter and chemical concentrations can change water clarity (or turbidity)	Construction, operation and harvesting may stir up sediment and increase turbidity. Seaweed suspended in the water column may slow currents and lead to increased accretion	Yes - Water Quality	No - See Map 4	The risk of increasing sediments in the water column whilst removing biofoul from the ropes and equipment will be low due to the scale of the seaweed farm. The risk will be mitigated through a carefully planned operations and maintenance (O&M) strategy. Typically only the perimeter lines and buoys will be cleaned in situ with the seaweed lines and seaweed line buoys being cleaned on land.
5	Collision ABOVE water with static or moving objects not naturally found in the marine environment (Pressure from Natural England, 2022)	The injury or mortality of biota from both static and/or moving structures	Vessels and machinery used for construction and harvesting may present a collision hazard above the water	No impact to WFD receptors	No - See Map 5	The risk is low as the AWAA mapping tool has not identified an sensitive species in the vicinity of the seaweed farm. During operation the risk is minimised by the low intensity of the operations, with a vessel accessing the seaweed farm only a few times throughout the year: once to lay the seaweed ropes, once to do the seaweed harvest, and then periodically for general maintenance.
6	Collision BELOW water with static or moving objects not naturally found in the marine environment	Injury or mortality from collisions of biota with both static and/or moving structures	Vessels or infrastructure such as ropes and lines may suspended in the water column, or vessels may present a collision hazard below the water	No impact to WFD receptors	No - See Map 6	The risk is low as the AWAA mapping tool has not identified any sensitive species in the vicinity of the seaweed farm. During operation the risk is minimised by the low intensity of the operations, with a vessel accessing the seaweed farm only a few times throughout the year: once to lay the seaweed ropes, once to do the seaweed harvest, and then periodically for general maintenance.
7	Genetic modification & translocation of indigenous species	Genetic modification can be either deliberate (i.e. introductions) or a by product of other activities (i.e. mutations)	Transplanting of indigenous species from one location to another could lead to interbreeding and alter the gene pool	No impact to WFD receptors	No - See Map 7	The risk is low as the AWAA mapping tool has not identified any sensitive biotopes or species in the vicinity of the seaweed farm. Residual risk will be mitigated through the biosecurity plan for the seaweed farm. Only natural occurring species of seaweed found within 50km radius of the site will be cultivated for growing on the farm.
8	Hydrocarbon and polycyclic aromatic hydrocarbon (PAH) contamination	Increases in the levels of these compounds compared with background concentrations	Introduced to the environment via vessels or machinery oil or fuel leaks and spills	Yes - Water Quality	No - See Map 8	The risk is low as the AWAA mapping tool has not identified any sensitive biotopes or species in the vicinity of the seaweed farm. The impact to the water quality from contamination will be mitigated through carefully planned construction methodologies and operations and maintenance (O&M) strategies. Deliberate discharges of oil or oil/water mixtures will not be prohibited. During operation, the risk is also minimised by the low intensity of the operations, with a vessel accessing the seaweed farm only a few times throughout the year: once to lay the seaweed ropes, once to do the seaweed harvest, and then periodically for general maintenance.
9	Introduction of light or shading	Direct inputs of light from anthropogenic activities. Also shading from structures etc.	Infrastructure and seaweed suspended in the water column may cause shading of the seabed	No impact to WFD receptors	No - See Map 9	The risk is low as the AWAA mapping tool has not identified any sensitive biotopes or species in the vicinity of the seaweed farm. The risk will be mitigated through the design of the seaweed farm layout. Advice will be sort from the Scottish Association for Marine Science (SAMS) to develop a layout for the seaweed farm that optimises the production of seaweed whilst minimising impact to the water body.
10	Introduction of microbial pathogens (including metazoan parasites)	Untreated or insufficiently treated effluent discharges and run-off from terrestrial sources and vessels. Also, in shellfisheries where seed stock is imported, 'infected' seed could be introduced	Diseases or parasites from imported aquaculture stocks could spread quickly amongst high densities of stock and could spread to wild populations	Yes - Biology (Habitat)	No - See Map 10	The risk is low as the AWAA mapping tool has not identified any sensitive biotopes or species in the vicinity of the seaweed farm. The risk of introducing pathogens and parasites into the marine environment will be mitigated through the biosecurity plan for the seaweed farm.
11	Introduction or spread of invasive non-indigenous species (INIS)	The direct or indirect introduction of INIS	Introduction of INIS for aquaculture purposes or introduction of INIS on farmed seaweed. Spawning from farmed INIS stock could spread to surrounding areas	Yes - INNS	No - See Map 11	The risk is low as the AWAA mapping tool has not identified any sensitive biotopes or species in the vicinity of the seaweed farm. The risk of introducing invasive non-indigenous species will be mitigated through the biosecurity plan for the seaweed farm and associated cultivation facilities.
12	Litter	Any manufactured or processed solid material from anthropogenic activities discarded, disposed or abandoned	Rope, lines, plastic or other infrastructure may be lost to the marine environment	Yes - Water Quality	No - See Map 12	The risk is low as the AWAA mapping tool has not identified any sensitive biotopes or species in the vicinity of the seaweed farm. The impact to the water quality from marine litter will be mitigated through carefully planned construction methodologies and operations and maintenance (O&M) strategies. During operation, the risk is also minimised by the low intensity of the operations, with a vessel accessing the seaweed farm only a few times throughout the year: once to lay the seaweed ropes, once to do the seaweed harvest, and then periodically for general maintenance.
13	Nutrient enrichment	Increased levels of the elements nitrogen, phosphorus, silicon (and iron) in the marine environment compared to background concentrations	Seaweed detritus (e.g. broken fronds) may introduce nutrients to the surrounding area, however, reductions in nutrient enrichment have been recorded as seaweeds uptake nutrients	Yes - Water Quality	No - See Map 13	The risk is low as the AWAA mapping tool has not identified any sensitive biotopes or species in the vicinity of the seaweed farm. Advice will be sort from the Scottish Association for Marine Science (SAMS) to develop a layout for the seaweed farm that optimises the production of seaweed whilst minimising impact to the water body.

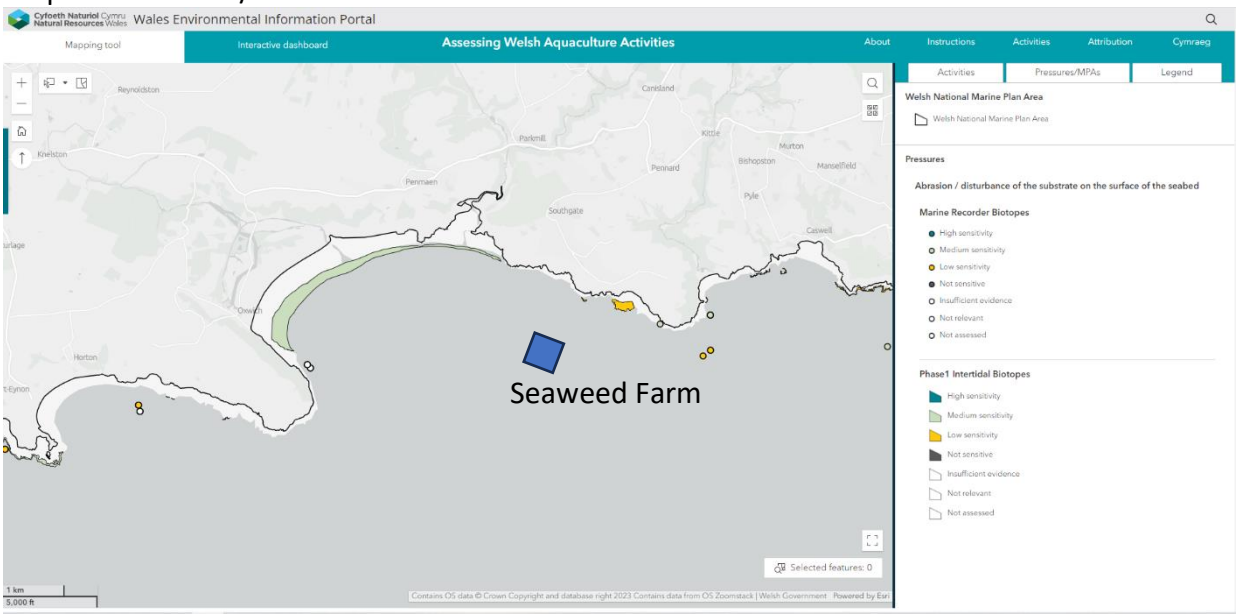
14	Organic enrichment	The degraded remains of dead biota and microbiota; faecal matter from marine animals; or flocculated colloidal organic matter	Introduction of organic matter from seaweed detritus (e.g. broken fronds) may be introduced to the surrounding area	Yes - Water Quality	No - See Map 14	The risk is low as the AWAA mapping tool has not identified any sensitive biotopes or species in the vicinity of the seaweed farm. Advice will be sort from the Scottish Association for Marine Science (SAMS) to develop a layout for the seaweed farm that optimises the production of seaweed whilst minimising impact to the water body.
15	Penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion	Physical disturbance of sediments where there is limited or no loss of substratum from the system	Penetration or sub-surface disturbance of the seabed from anchors or moorings	Yes - Hydromorphology	No - See Map 15	The risk is low as the AWAA mapping tool has not identified any sensitive biotopes or species in the vicinity of the seaweed farm. The design of the weights and anchors will be developed to avoid locating them on especially sensitive habitats and the best technical solution proposed for the given location. For example, one proposal for the weights / anchors would be to use reef cube type block which are formed from a non invasive material and will encourage the growth of marine life. Advice will be sort from the Scottish Association for Marine Science (SAMS) to develop a weight / anchoring design that will stabilise the seaweed farm whilst minimising impact to the seabed.
16	Physical change (to another seabed type)	The permanent change of one marine seabed type to another marine seabed type	Introduction of aquaculture infrastructure offers an artificial substrate for colonisation	Yes - Hydromorphology	No - See Map 16	The risk is low as the AWAA mapping tool has not identified any sensitive biotopes or species in the vicinity of the seaweed farm. The design of the weights and anchors will be developed to avoid locating them on especially sensitive habitats and the best technical solution proposed for the given location. For example, one proposal for the weights / anchors would be to use reef cube type block which are formed from a non invasive material and will encourage the growth of marine life. Advice will be sort from the Scottish Association for Marine Science (SAMS) to develop a weight / anchoring design that will stabilise the seaweed farm whilst minimising impact to the seabed.
17	Removal of non-target species	Removal of non-farmed species associated with management and harvesting activities	Wild species, particularly invertebrates which live around or on the farmed seaweed may be removed during harvesting. Nets or lines suspended in the water column could cause entanglements	No impact to WFD receptors	No - See Map 17	The risk is low as the AWAA mapping tool has not identified any sensitive biotopes or species in the vicinity of the seaweed farm. The risk of removal of non-native species will be mitigated as the seaweed will be harvested by hand.
18	Smothering and siltation rate changes ('Light' deposition)	When the natural rates of siltation are altered (increased or decreased)	Accumulation of broken fronds, particularly after storm events	Yes - Hydromorphology	No - See Map 18	The risk is low as the AWAA mapping tool has not identified any sensitive biotopes or species in the vicinity of the seaweed farm. The impact to the hydromorpholgy of the water body around the seaweed farm will be mitigated through the design of the seaweed farm layout. Advice will be sort from the Scottish Association for Marine Science (SAMS) to develop a layout for the seaweed farm that optimises the production of seaweed whilst minimising impact to the water body.
19	Synthetic compound contamination (incl. pesticides, antifoulants, pharmaceuticals)	Increases in the levels of these compounds compared with background concentrations	The use of antifoulants to reduce unwanted settlement on infrastructure or the addition of pesticides	Yes - Hydromorphology	No - See Map 19	The risk is low as the AWAA mapping tool has not identified any sensitive biotopes or species in the vicinity of the seaweed farm. The impact to the water quality from contamination will be mitigated through carefully planned construction methodologies and operations and maintenance (O&M) strategies. Deliberate discharges of oil or oil/water mixtures will not be permitted. During operation, the risk is also minimised by the low intensity of the operations, with a vessel accessing the seaweed farm only a few times throughout the year: once to lay the seaweed ropes, once to do the seaweed harvest, and then periodically for general maintenance.
20	Transition elements and organo-metal (e.g. Tributyltin (TBT)) contamination	The increase in transition elements levels compared with background concentrations, due to their input by air or directly at sea	Introduction from antifouling compounds on infrastructure	Yes - Hydromorphology	No - See Map 20	The risk is low as the AWAA mapping tool has not identified any sensitive biotopes or species in the vicinity of the seaweed farm. The impact to the water quality from contamination will be mitigated through carefully planned construction methodologies and operations and maintenance (O&M) strategies. Deliberate discharges of oil or oil/water mixtures will not be prohibited. During operation, the risk is also minimised by the low intensity of the operations, with a vessel accessing the seaweed farm only a few times throughout the year: once to lay the seaweed ropes, once to do the seaweed harvest, and then periodically for general maintenance.
21	Underwater noise changes	Increases over and above background noise levels at a particular location	Noise generated by vessels and machinery during construction, operation and harvesting	No WFD assessment receptors do not include birds and marine mammals	No - See Map 21	The risk is low as the AWAA mapping tool has not identified any sensitive biotopes or species in the vicinity of the seaweed farm. During construction of the seaweed farm the risk will ne mitigated through a carefully planned construction methodology. During operation the risk is minimised by the low intensity of the operations, with a vessel accessing the seaweed farm only a few times throughout the year: once to lay the seaweed ropes, once to do the seaweed harvest, and then periodically for general maintenance.
22	Visual disturbance	The disturbance of biota by anthropogenic activities, (e.g. increased vessel movements)	Visual disturbance to seabirds and marine mammals as a result of vessel movement	No WFD assessment receptors do not include birds and marine mammals	No - See Map 22	The risk is low as the AWAA mapping tool has not identified any sensitive biotopes or species in the vicinity of the seaweed farm. During construction of the seaweed farm the risk will ne mitigated through a carefully planned construction methodology. During operation the risk is minimised by the low intensity of the operations, with a vessel accessing the seaweed farm only a few times throughout the year: once to lay the seaweed ropes, once to do the seaweed harvest, and then periodically for general maintenance.
23	Water flow (tidal current) changes, including sediment transport considerations	Changes in water movement associated with tidal streams, prevailing winds and ocean currents	Infrastructure and suspended seaweed could reduce flow speeds, increase turbulence or alter water flow direction	Yes - Hydromorphology	No - See Map 23	The risk is low as the AWAA mapping tool has not identified any sensitive biotopes or species in the vicinity of the seaweed farm. The impact to the hydromorpholgy of the water body around the seaweed farm will be mitigated through the design of the seaweed farm layout. Advice will be sort from the Scottish Association for Marine Science (SAMS) to develop a layout for the seaweed farm that optimises the production of seaweed whilst minimising impact to the water body.
24	Wave exposure changes	Local changes in wavelength, height and frequency	Infrastructure and seaweed in the water column could reduce wave action and impact local coastal processes	Yes - Hydromorphology	No - See Map 24	The risk is low as the AWAA mapping tool has not identified any sensitive biotopes or species in the vicinity of the seaweed farm. The impact to the hydromorpholgy of the water body around the seaweed farm will be mitigated through the design of the seaweed farm layout. Advice will be sort from the Scottish Association for Marine Science (SAMS) to develop a layout for the seaweed farm that optimises the production of seaweed whilst minimising impact to the water body.

Appendix C – AWAA Mapping Tool Maps

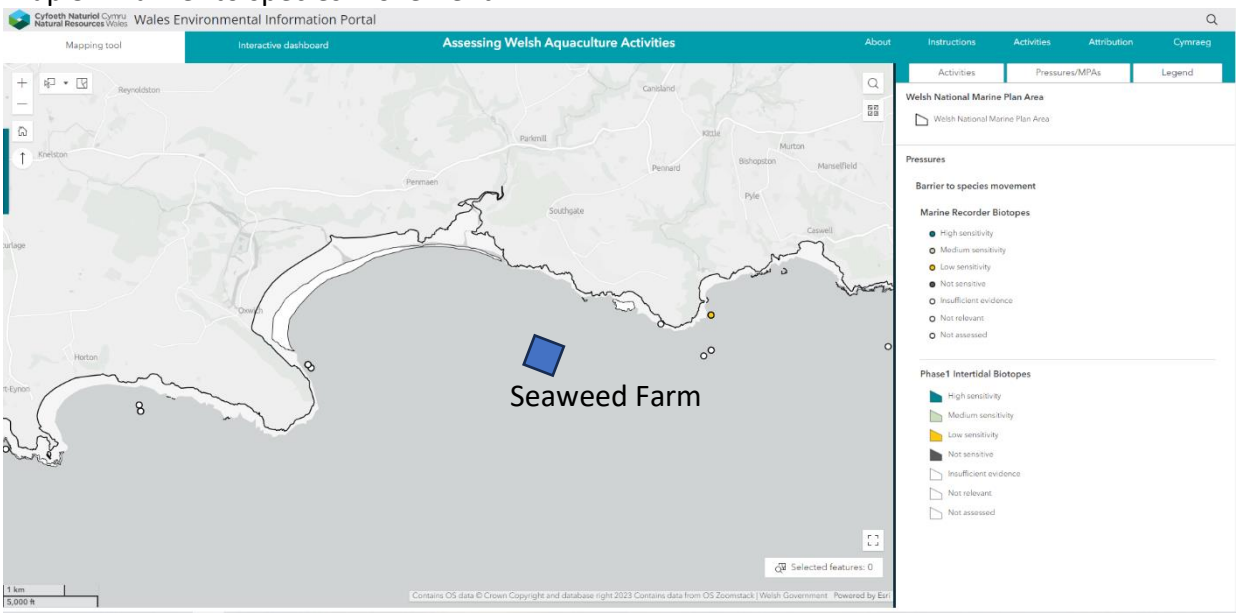
Map 1 – Above water noise



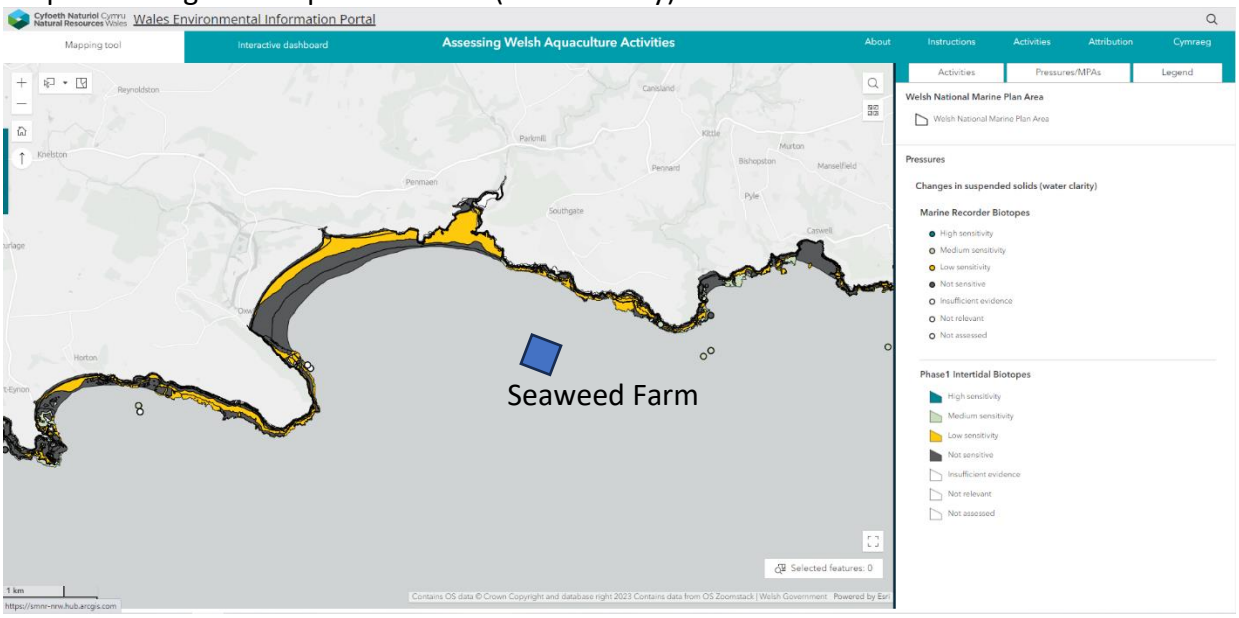
Map 2 – Abrasion / disturbance of the substrate on the surface of the seabed



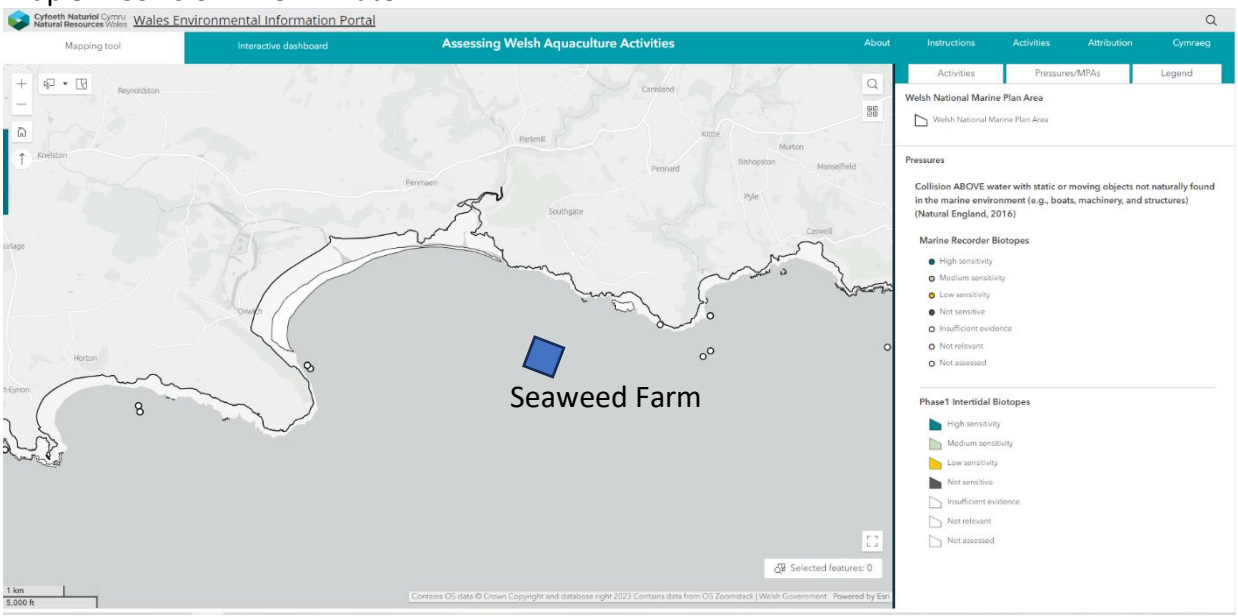
Map 3 – Barrier to species movement



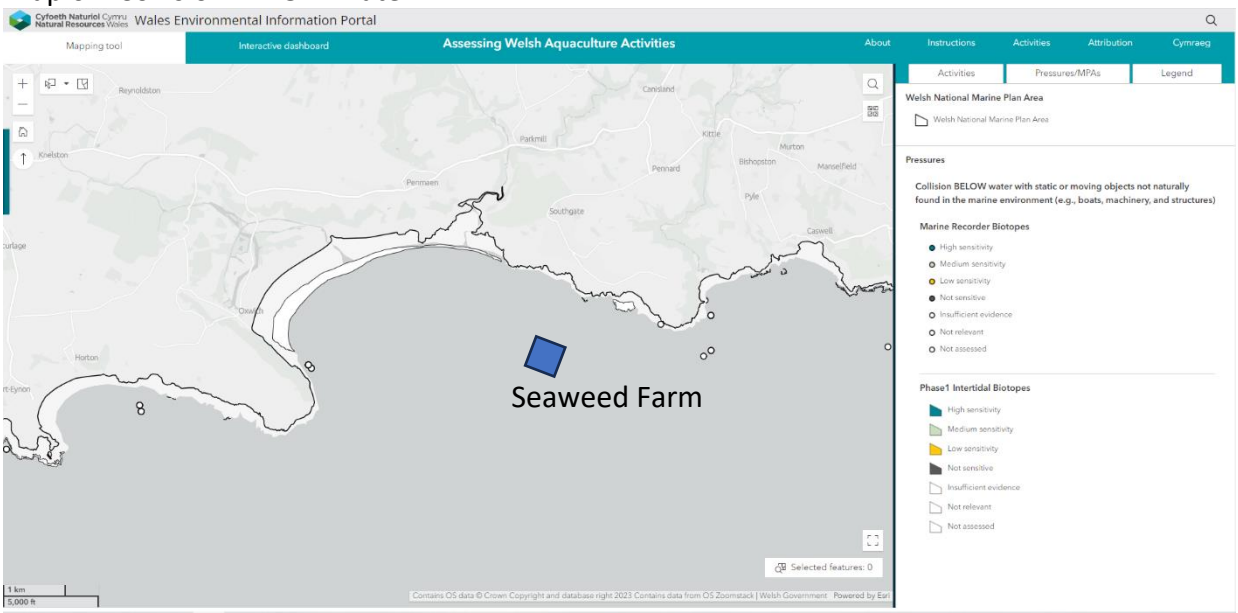
Map 4 – Changes in suspended solids (water clarity)



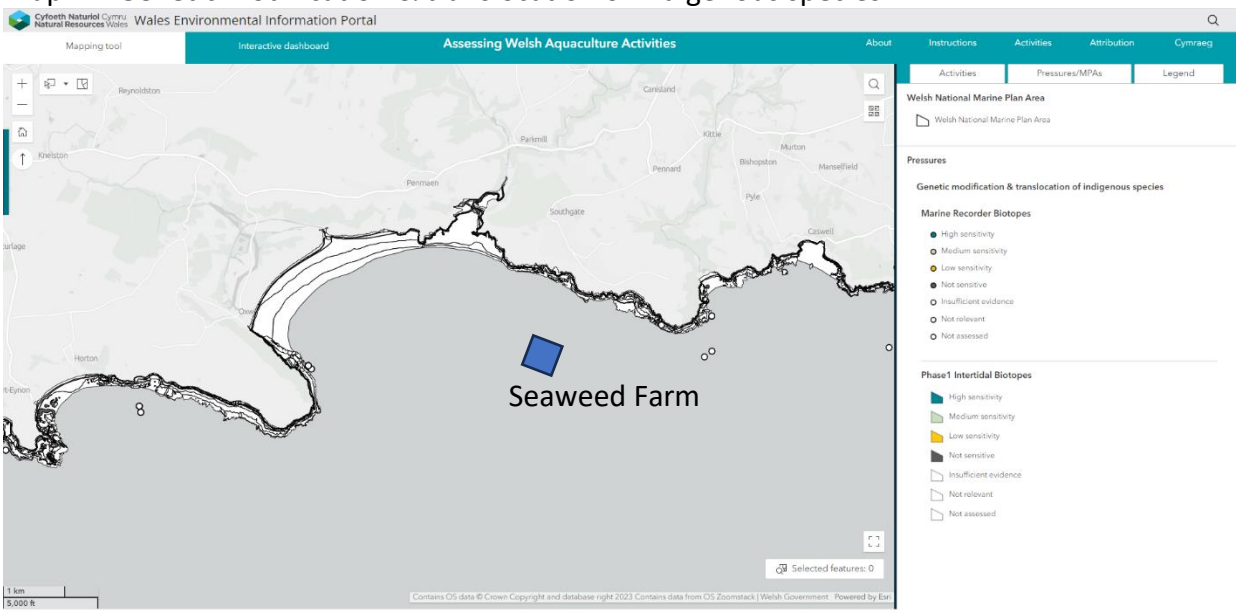
Map 5 – Collision ABOVE water



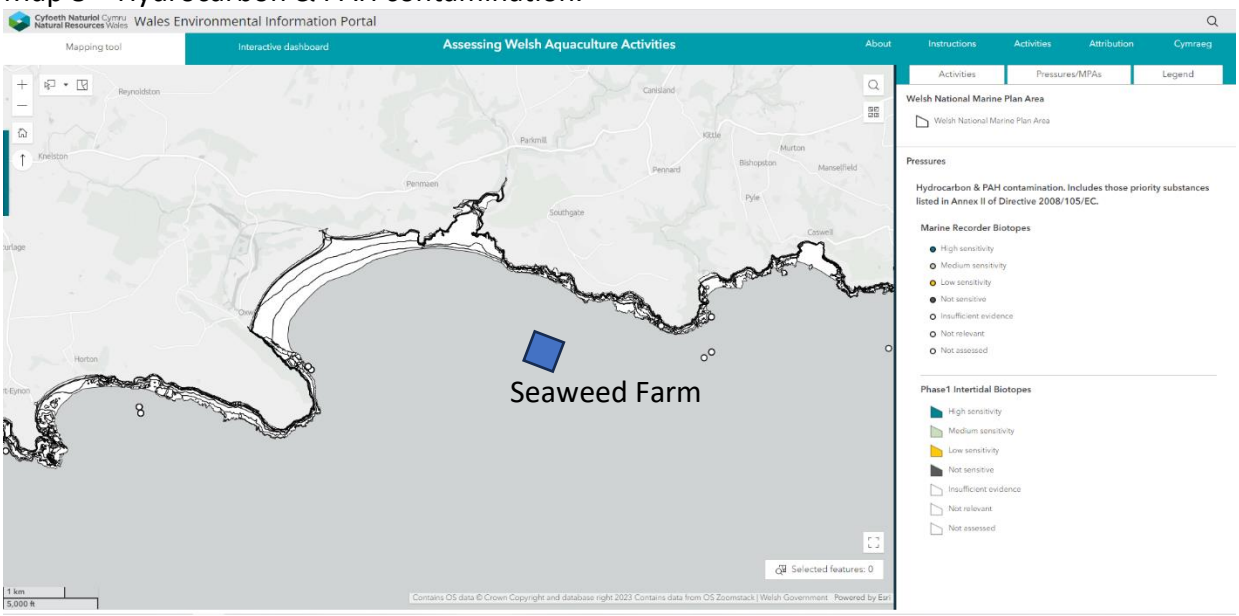
Map 6 – Collision BELOW water



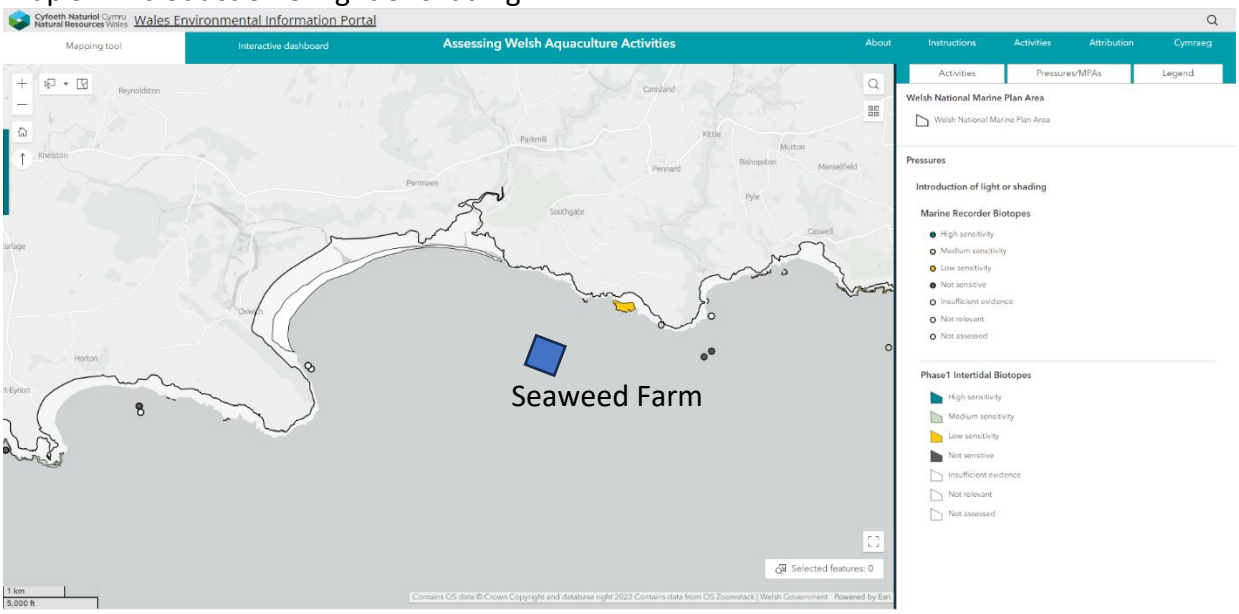
Map 7 – Genetic modification & translocation of indigenous species



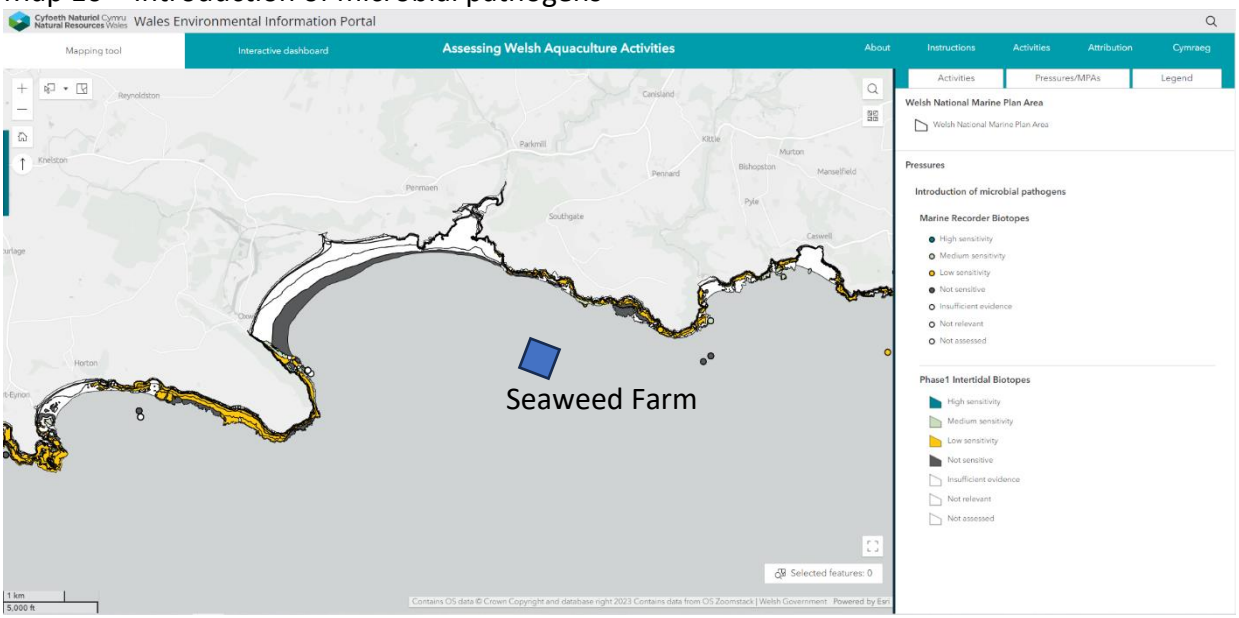
Map 8 – Hydrocarbon & PAH contamination.



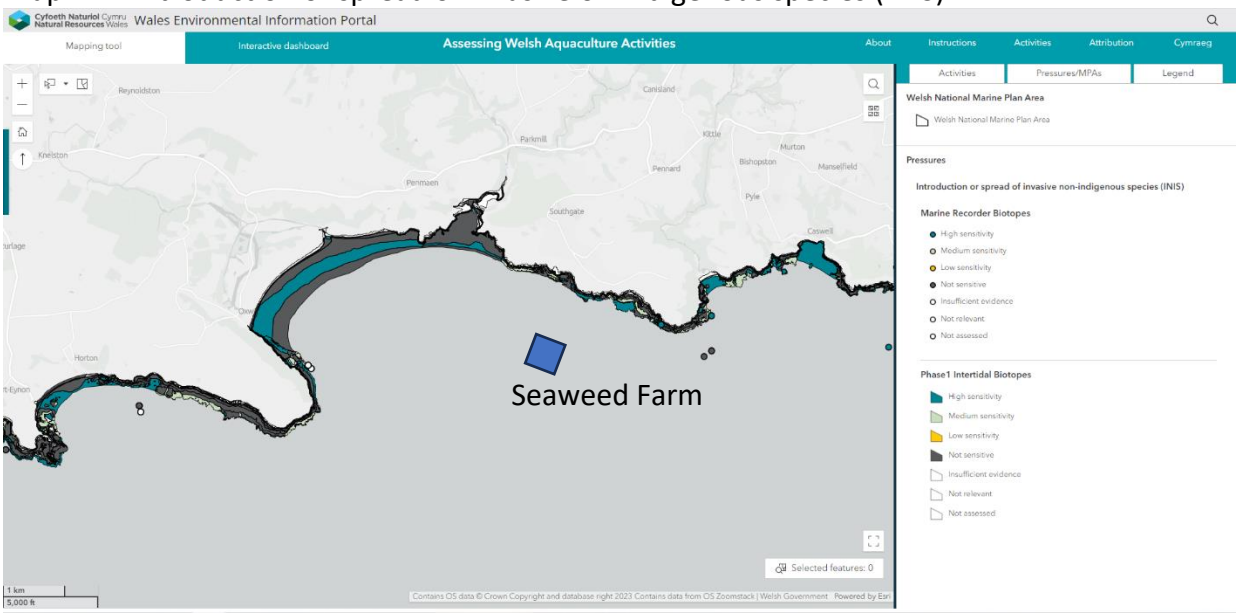
Map 9 – Introduction of light or shading



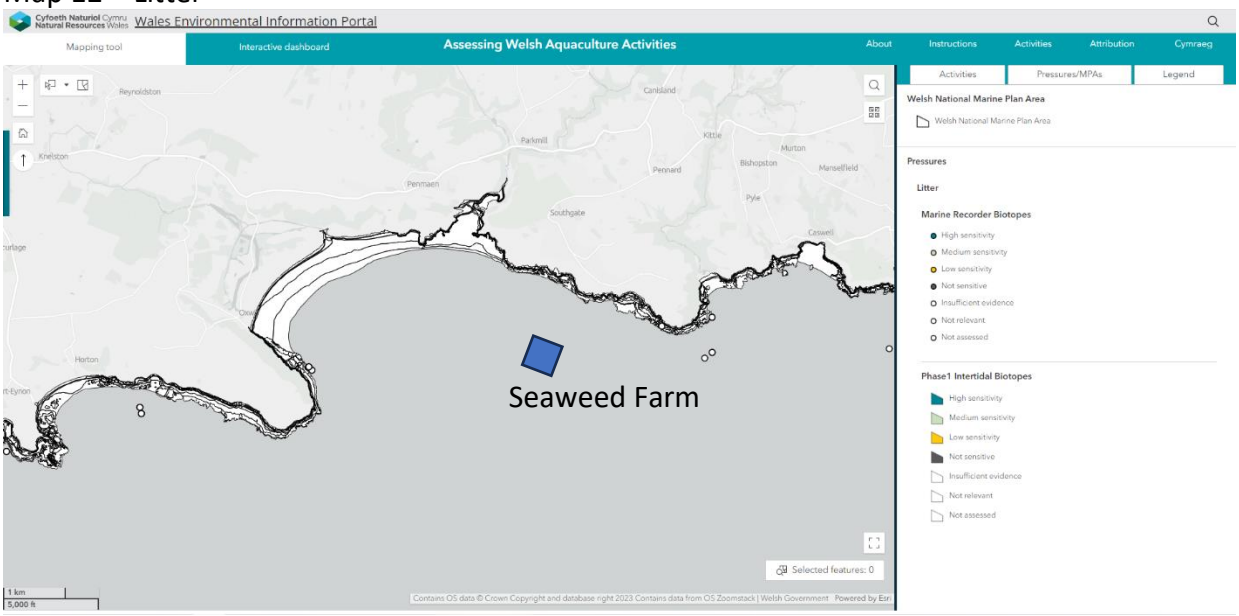
Map 10 – Introduction of microbial pathogens



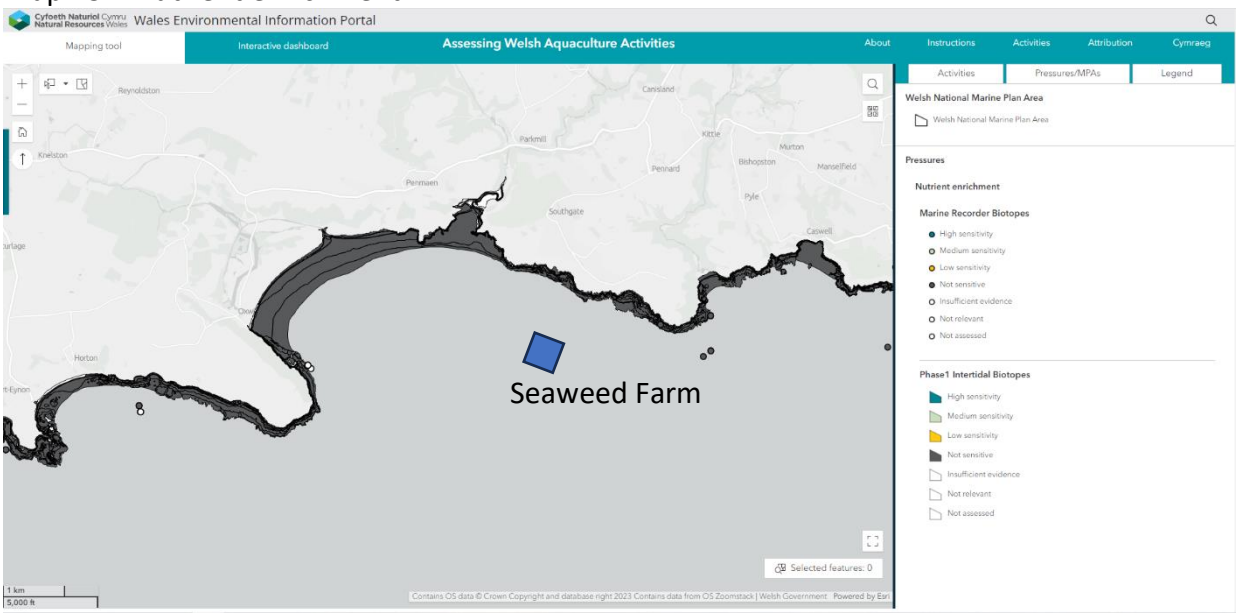
Map 11 – Introduction or spread of invasive on-indigenous species (INIS)



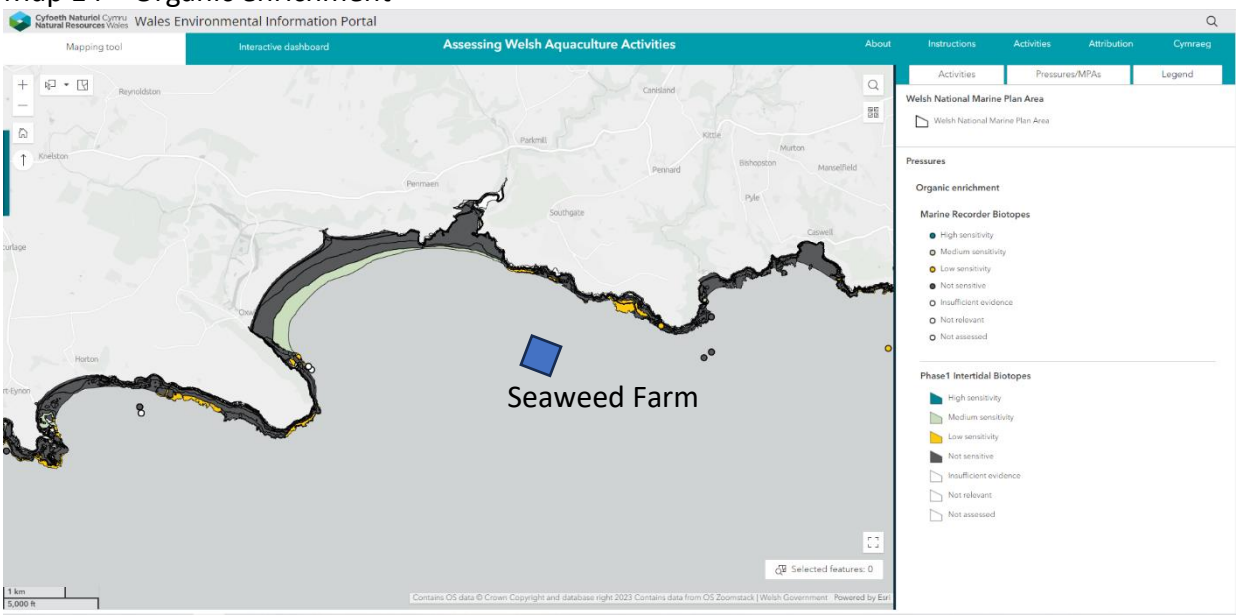
Map 12 – Litter



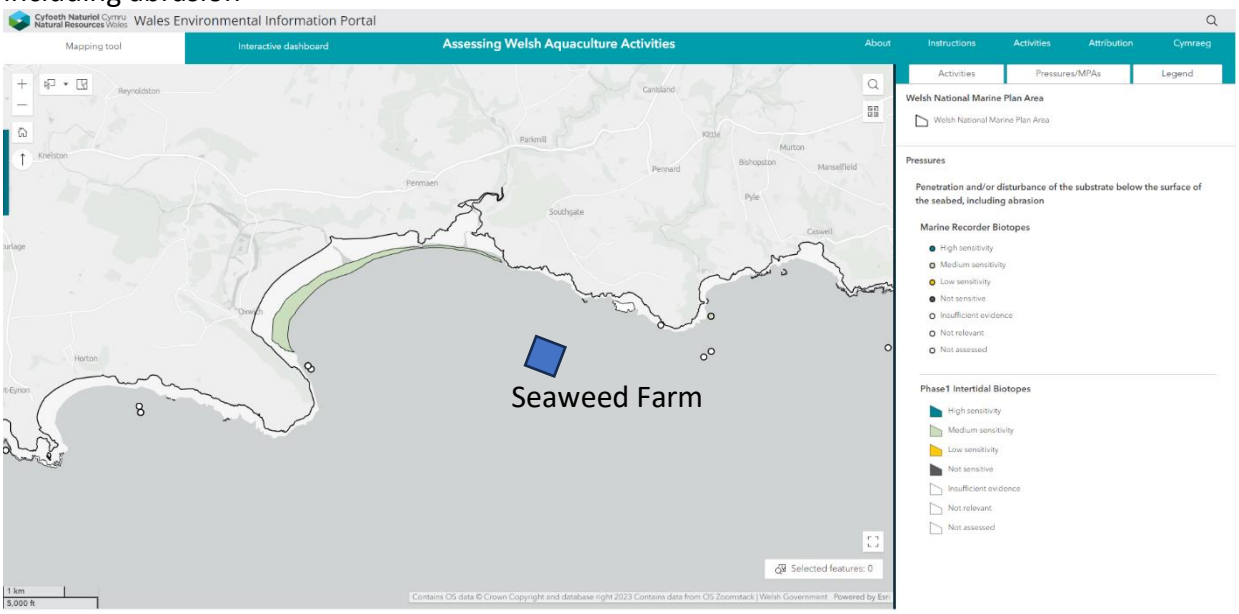
Map 13 – Nutrient enrichment



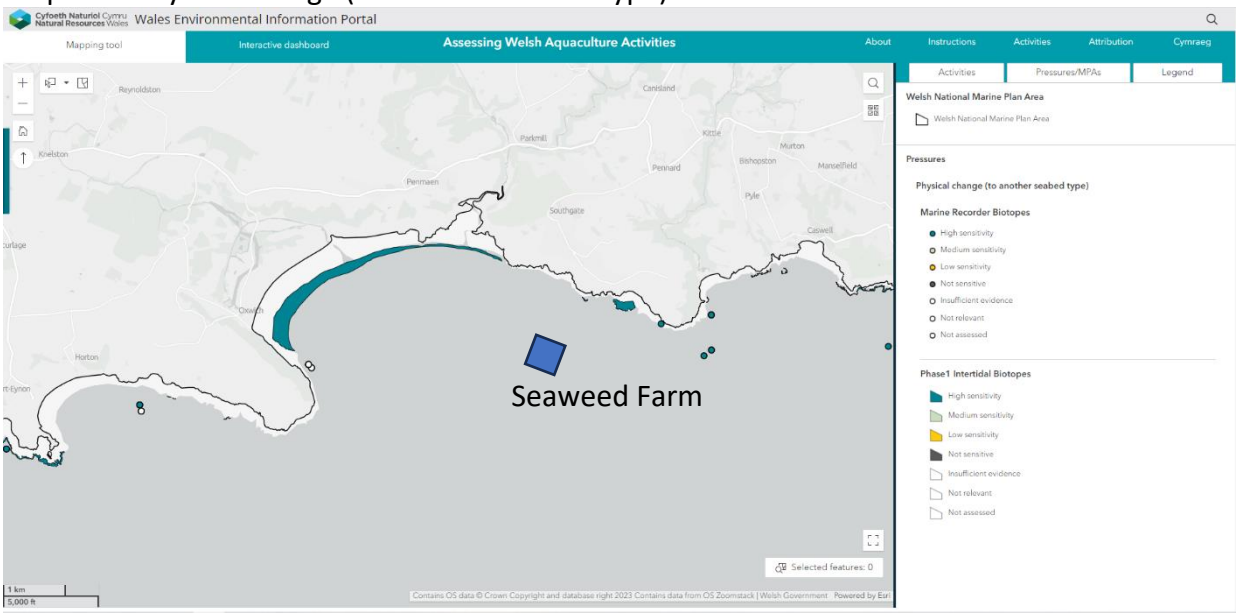
Map 14 – Organic enrichment



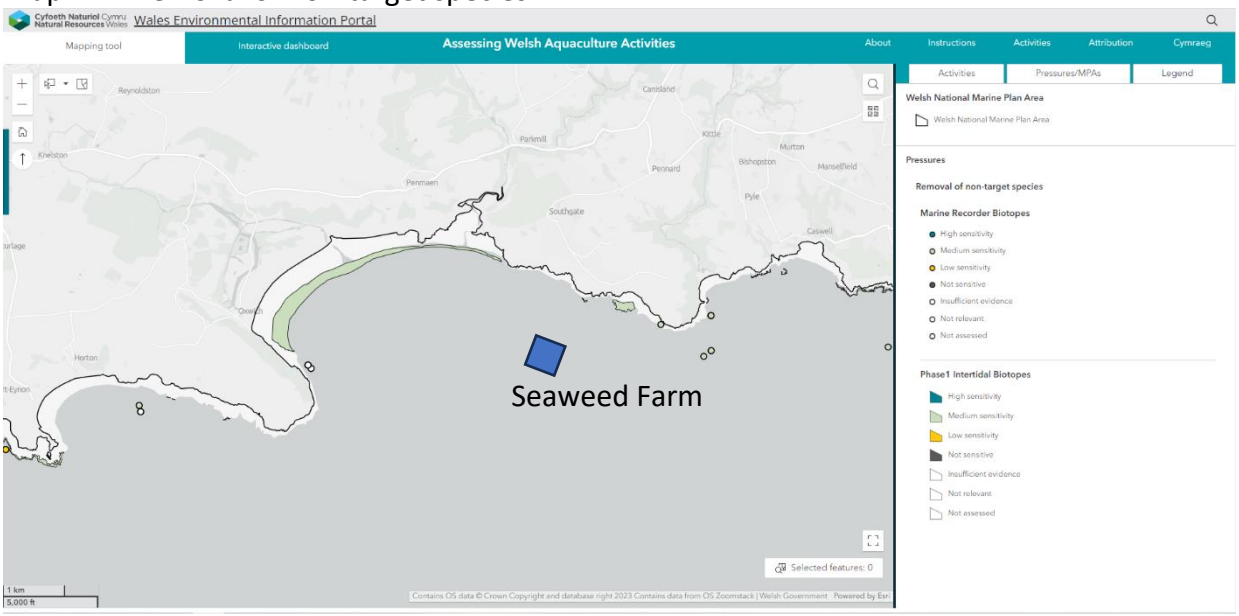
Map 15 – Penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion



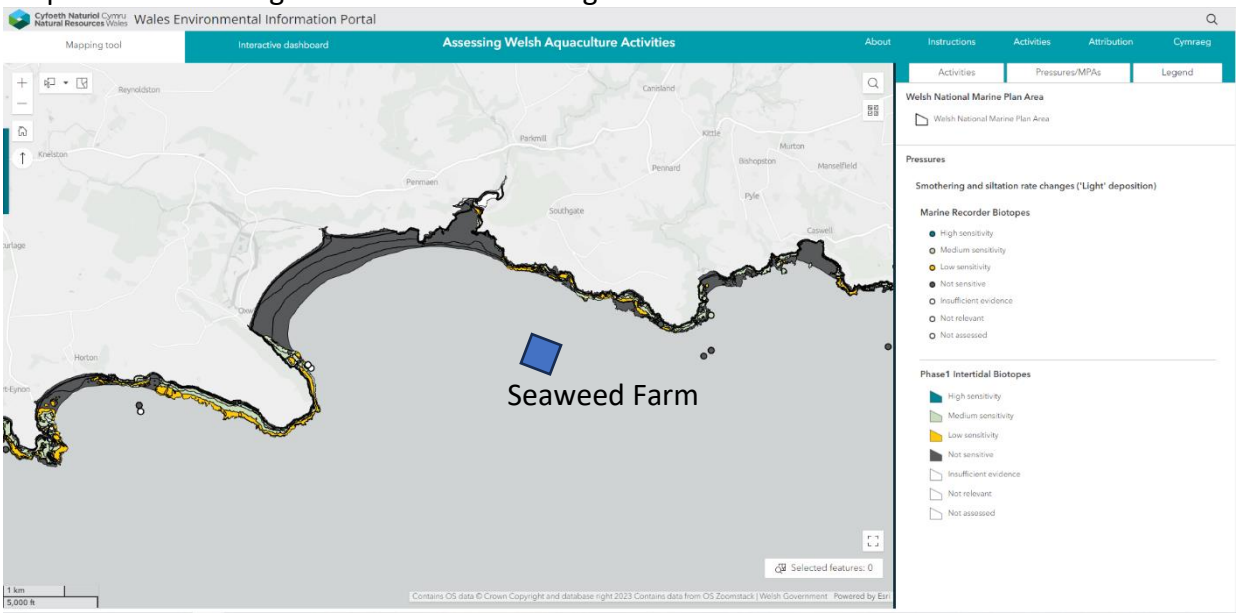
Map 16 – Physical change (to another seabed type)



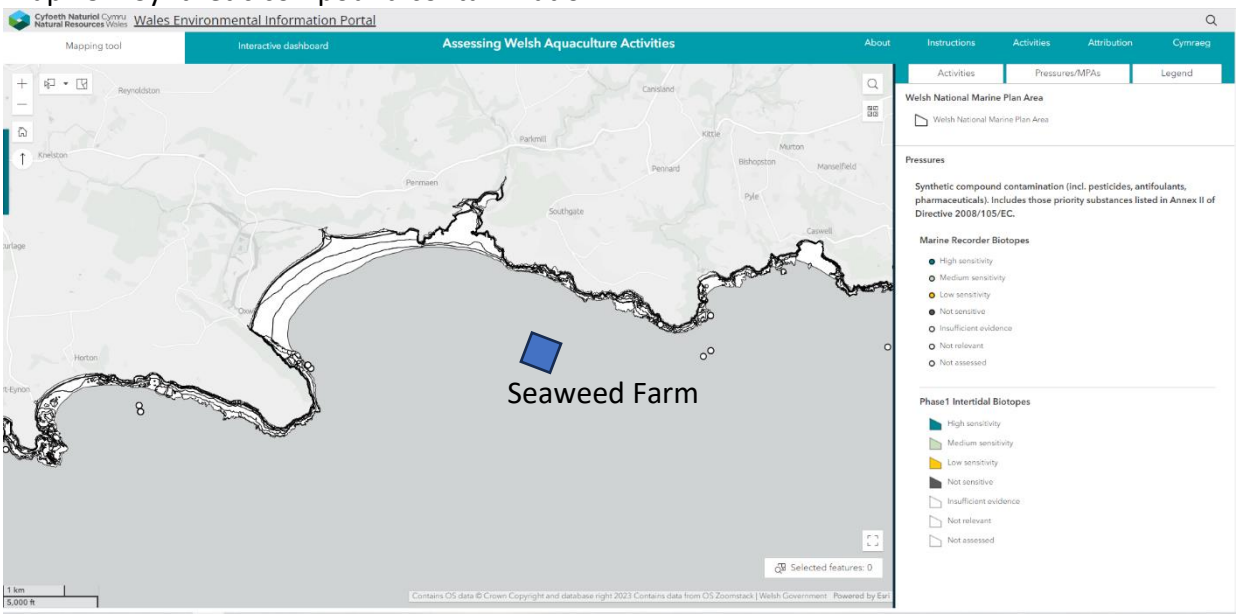
Map 17 – Removal of non-target species



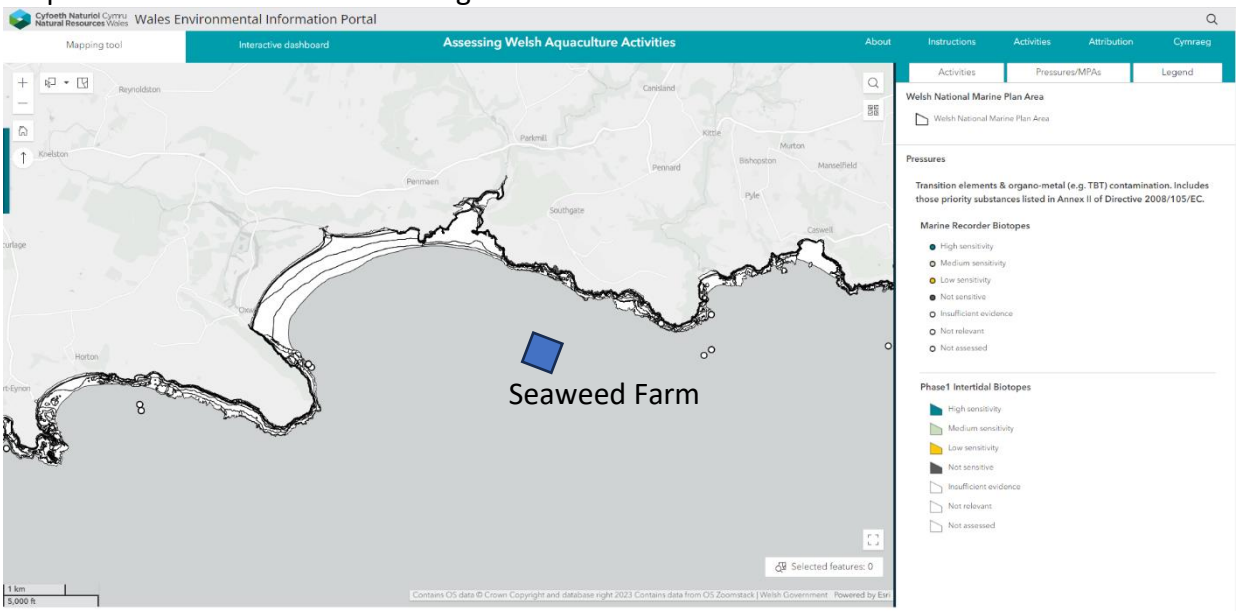
Map 18 – Smothering and siltation rate changes



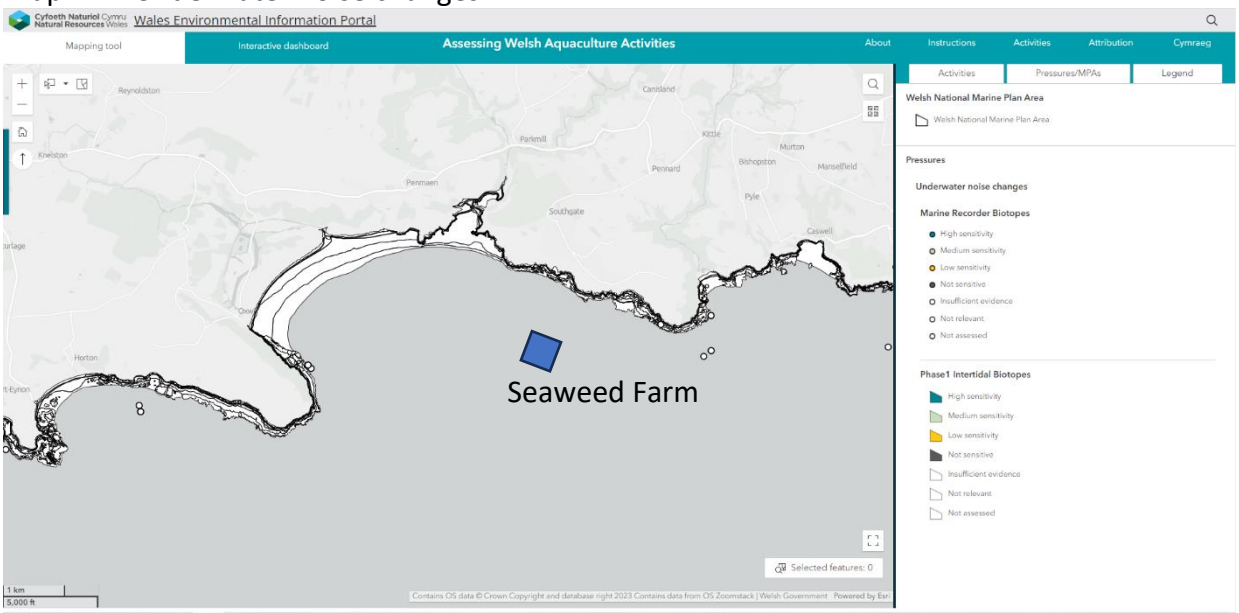
Map 19 – Synthetic compound contamination



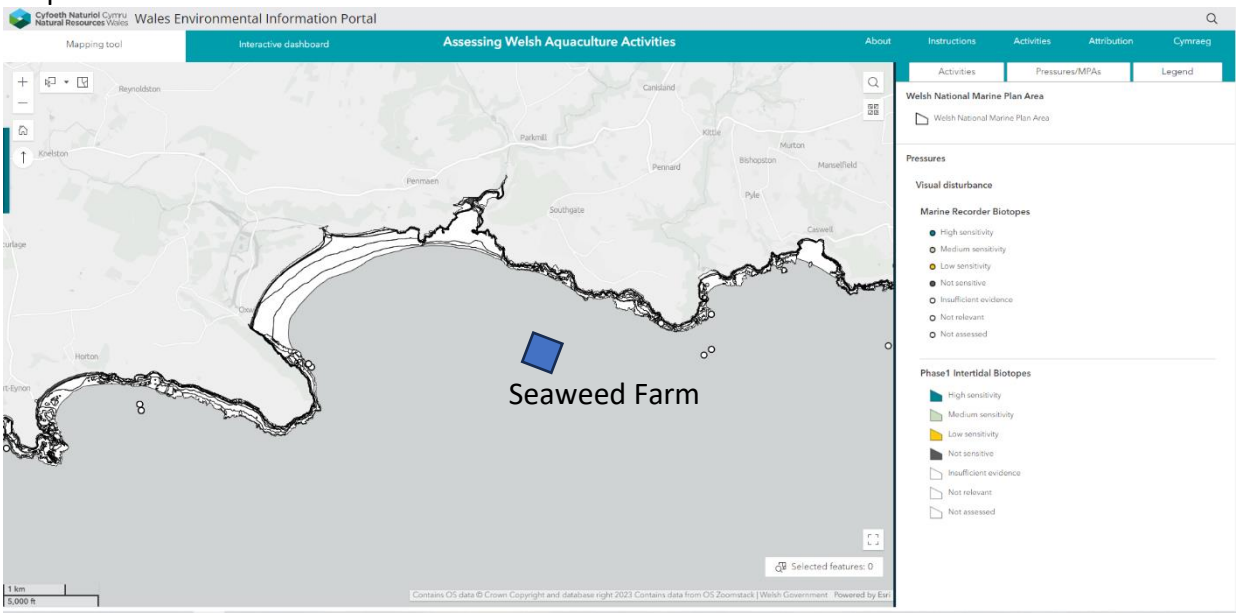
Map 20 – Transition elements & organo-metal contamination



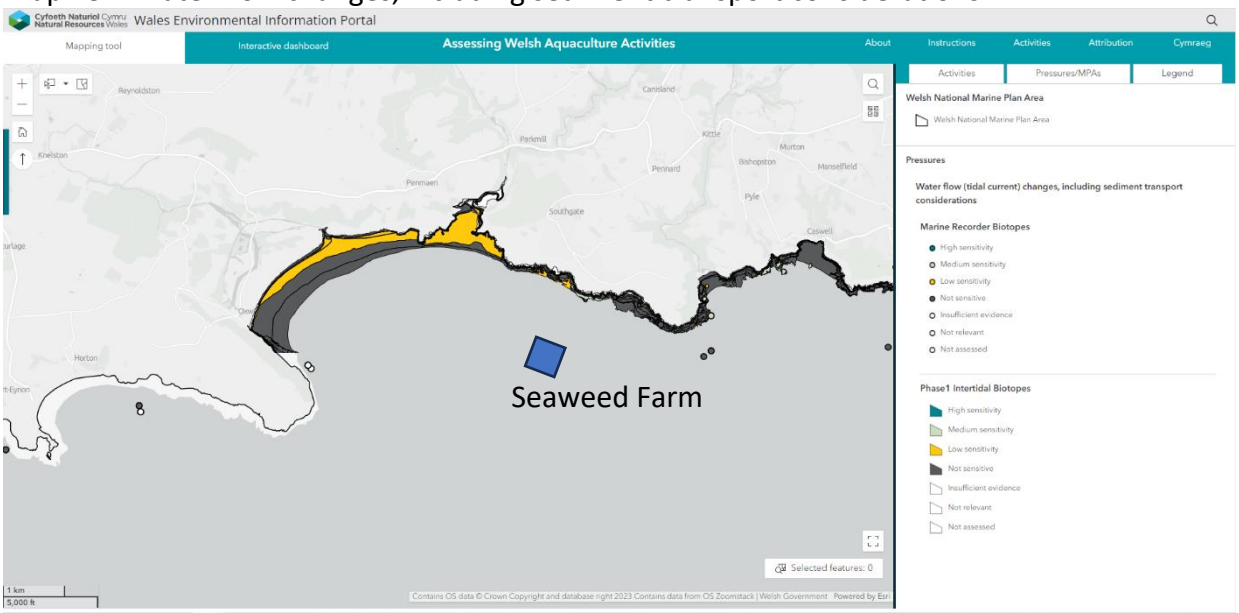
Map 21 – Underwater noise changes



Map 22 – Visual disturbance



Map 23 – Water flow changes, including sediment transport considerations



Map 24 – Wave exposure changes