Atlantic Mariculture Ltd
MARINE BIOSECURITY PLAN

Site Name or Description of Operation: Oronsay East Seaweed Farm

Site/Operation Location(s): Oronsay Island, Loch Sunart

Plan period: October 2022 - ongoing

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Farm overview

Description of operation

Atlantic Mariculture is currently farming two species of seaweed that are native to this area: *Alaria esculenta* (winged kelp) and *Saccharina latissima* (sugar kelp). Atlantic Mariculture has had two successful pilot seasons at this site (under prior registered company name GreenSea Solutions, updated November 2022), and now intends to increase its farming capacity. The boundary of the entire farm site covers an area of just over 15ha, and the updated farm structure will consist of 15 longline arrays, each suspended by moorings at either end.

Atlantic Mariculture intend to deploy and seed the farm in February 2023. The farm unit is expected to produce up to 6kg/m (wet weight), and harvesting will be carried out over the course of 2-4weeks, finishing by July 2023. Harvested kelp will be brought to shore at Glenmore Jetty, by agreement with the local landowner. All seaweed will be processed in a facility close to the farm site, at Ardtoe Marine Laboratory, Acharacle. All farming and processing activity will take place within a 10-mile radius.

Other regular interactions with the seaweed farm will consist of a minimum of twice-weekly checks of the structure in addition to checks preceding and following storm events.

Location

Loch Sunart is a fjordic loch located in Highland Lochaber on the West Coast of Scotland. The Loch is broadly aligned East to West and is around 31km in length, with an average width of 1.5km. At its deepest it is 124m. Oronsay East seaweed farm lies to the east of Oronsay Island in Loch Sunart, close to the western mouth of the loch.

Designated marine areas

Oronsay East seaweed farm is situated within Loch Sunart SAC (Figure 1) and the Loch Sunart to the Sound of Jura MPA (Figure 2). Qualifying marine interests for which the area is designated an SAC include rocky reefs (under Annex I) and presence of the otter populations (*Lutra lutra*) under Annex II. Qualifying marine interests for which the area is designated an MPA include populations of common skate (*Dipturus intermedius*).

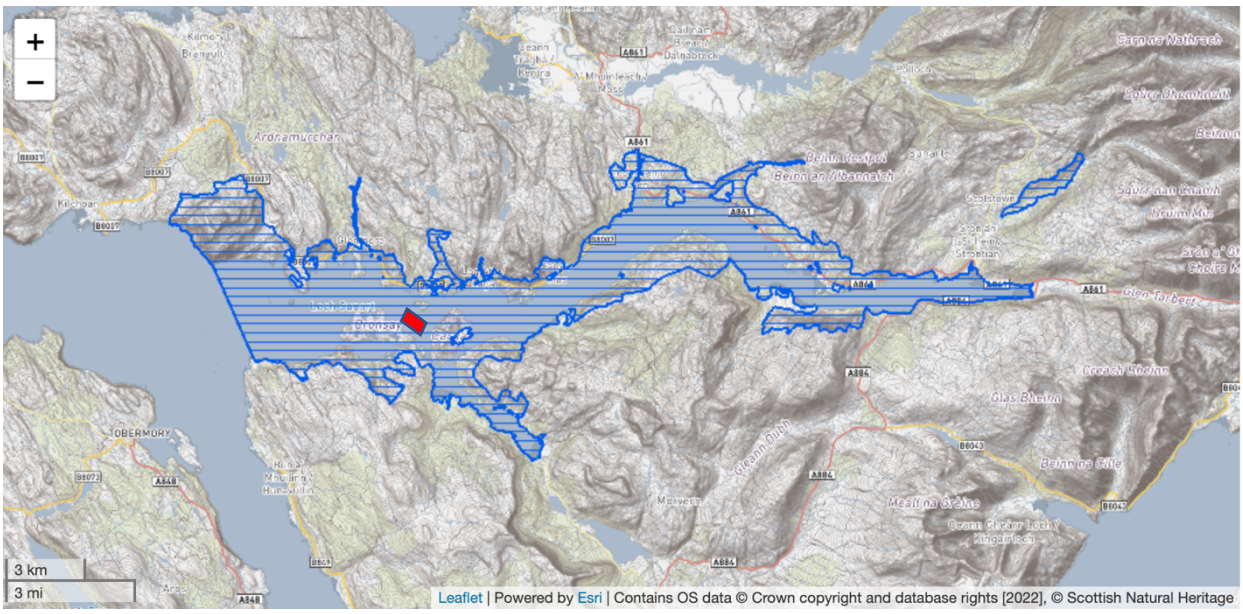

Figure 1. Oronsay East Seaweed Farm in relation to the Loch Sunart SAC

Any potential risk to reef structures will be mitigated by using drop-down cameras to ensure that seabed moorings are not placed on any designated benthic features. Regarding the risk of entanglement for marine mammals, Atlantic Mariculture will follow all guidelines provided by the Scottish Entanglement Alliance (www.scottishentanglement.org). Regular site checks will be carried out to ensure that no marine mammals have become entangled within the farm structure. Atlantic Mariculture will also continue to work closely with the Community Association of Lochs and Sounds (CAOLAS), who previously conducted an assessment dive at the site in 2020.

Figure 2. Oronsay East Seaweed Farm in relation to the Loch Sunart to the Sound of Jura MPA

Floating structures

The main structure of the farm will comprise 15x220m longline arrays. Each longline (growing rope) will be suspended at 2m below the surface from floating mooring buoys fixed to the seabed at two mooring points. Each longline will be supported and kept afloat by A3 buoys placed along the line at 12.5m distance. Each longline structure will require two 700KG anchors, both of which will be marked with a 600L grey can buoys. Two yellow special mark buoys will be positioned on the Northern and Eastern seaward corners of the farm boundary.

The farm structure will have the following floating elements:

- Floating mooring buoys
- Longline buoys
- Unlit yellow Special Mark buoys
- Growing ropes
- Spacer bars (to prevent longline entanglement)
- Mooring lines/chain

Subsurface structures

2x700KG concrete anchors will be used to moor each longline structure. Following the installation of the main structural components of the farm, the longlines will be seeded on land, transported by boat and deployed onto the site.

Seeding

Atlantic Mariculture is obtaining seed for the farm site from Hortimare B.V., the established Dutch marine seed provider. The seed will be propagated at Hortimare's facility in the Netherlands, using fertile sorus tissue collected by Atlantic Mariculture from breeding kelp populations within a 10-mile radius of the farm site. Sorus collection data will be logged systematically, with information on collection time and precise location.

Hortimare B.V. will assist Atlantic Mariculture with the seeding of the farm structure in February 2023. The growing ropes will be seeded directly with the seed mix as opposed to wrapping seeded twine along each rope. This method of seeding allows for the seedlings to establish better on the rope, lowering the risk of plant debris due to poorly attached holdfasts. Hortimare have developed a mechanised seeding technique that allows for the precise insertion of the seeded material onto the growing ropes, lowering the risk of seed attrition from the ropes upon submersion.

Hortimare follow a strict seeding protocol to mitigate biosecurity risks at all stages of the seed propagation and deployment, details of which can be provided upon request.

Non-Native Species (NNS) on the West Coast of Scotland

Species	Description	Habitat and Ecology
Key NNS recorded on west coast of Scotland		
Sargassum muticum	Wireweed is native to Japan and is considered invasive by SNH.	Grows on hard substrata in shallow waters and can also tolerate estuarine conditions. It can out-compete local species because it is fast-growing, can reproduce within the first year of life and being monoecious can fertilise itself (Pizzolla 2008).
Didemnum Vexillum	The carpet sea squirt is native to Japan and is considered invasive by SNH.	The species forms large leathery patches colonising artificial structures, rocks, boulders and even tide pools. It is usually found in low energy environments where water motion is limited. It is capable of covering extensive areas of the substratum (Gibson-Hall & Bilewitch 2018).
Caprella mutica	The Japanese skeleton shrimp is considered invasive by SNH.	Often found on biogenic reefs and in areas of human activity on natural and artificial substrate such as hydroids, mooring ropes and buoys. Fully benthic lifecycle with limited dispersal potential although can disperse along coasts on drifting algae.
Schizoporella japonica	This encrusting bryozoan was originally described from Japan, but is now well established in the Pacific coast of North America and European waters.	In the invaded range, the species has been found just below the waterline on floating structures, such as plastic fenders, mooring buoys, or the vertical walls of pontoons and is a typical fouling species (CABI 2019a).
Bugula neritina	The native locale of this bryozoan is unknown and was widespread when surveys of the species first started.	*B. neritina* colonies are typically found in harbours and embayments, intertidal to 5 m, attached to any available hard substrate (CABI 2019b).
Styela clava	This solitary sea squirt is native to the north-west Pacific and considered invasive by SNH.	*Styela clava* is found in shallow water on hard surfaces and occurs abundantly in sheltered warm water docks and harbour installations (Neish 2007).
Other well-established NNS across Scotland		
Codium fragile subsp. *Tomentosoides*	Known as green sea-fingers, this spongy green seaweed can displace native seaweeds and is considered invasive by SNH.	Occurs on rock and coralline algae in pools and on open rock, often found on man-made structures. Reproduction likely occurs towards the end of the summer / beginning of autumn.

Species	Description	Habitat and Ecology
Austrominius modestus	This barnacle is native to Australasia but introduced into Britain in the 1940s.	*A. modestus* inhabits a wide range of habitats including estuaries and harbours, occurring at a range of shore heights, tidal ranges and salinity regimes (CABI 2019c).
Undaria pinnatifida	*Undaria pinnatifida* is native to northeast Asia and one of only two seaweeds included in the Invasive Species Specialist Group list of the 100 most invasive species of the world.	The species inhabits rocky substrates from the low intertidal to 18 m depth, and is widespread at depths of 1–3 m (Epstein & Smale 2017).

Site Features Affecting Biosecurity

Salinity, temperature, freshwater input, and tidal range

Loch Sunart exhibits typical fjordic hydrography with a brackish (low salinity) surface layer and generally higher salinity waters with increasing depth. Tides are semi-diurnal, with 4m spring and 1m neap tidal ranges (Gillibrand, et al. 1995).

Annual precipitation in this area is typically upwards of 2000mm, with historical data records indicating that run-off due to rainfall is expected to be highest during autumn and winter months, from September to April (Edwards and Sharples, 1986).

Anchors

Standard concrete anchors offer a large surface area for colonisation due to their size. However, concrete anchors often lack structural complexity and take time to become bio fouled because of chemical leaching. Once a community has become established, concrete anchors are quite indistinguishable from surrounding substrate. Concrete anchors are typically coupled with a chain riser, which can also become heavily bio fouled

Rope spacers

Where required, spacer bars will be made from metal and are suspended approximately 2m below the surface of the water. This could provide a suitable structure for settlement of NNS.

Buoys

Floating buoys which mark each anchor and longline will be partially submerged and provide a manmade substrate for NNS settlement and will be in close proximity to the harvesting vessel. However, buoys may be easily cleaned during site visits to prevent the build-up of biofouling organisms.

Increase kelp yield and benthic shading

There is limited literature available on the impact of benthic shading in European waters. Benthic shading, caused by high kelp yields farmed intensively without sufficient line spacing, has been known to impact benthic habitats in tropical latitudes where red seaweeds are grown in much shallower waters. It is unlikely that there will be any negative impacts of benthic shading from the cultivation of brown kelp in Scottish waters.

Plant waste attrition

Sugar and winged kelp are both robust examples of brown macroalgae, and at the point of harvest it is expected that there will have been negligible (<1%) plant mass lost during the growing period. Atlantic Mariculture has a zero-waste policy both in their marine and land-based operations and intend to use the entirety of the kelp plant, from holdfast to tip, in their food and fertiliser products.

Site activities affecting biosecurity

Maintenance of farm site

The farm structure will require maintenance throughout the growing season. This may include the disposal of biofouling which has colonised equipment.

Seeding lines

Seeding lines could present a risk of introducing NNS into the marine environment as seaweed cultures are generally grown offsite and transported to the farm. Growing ropes will be constructed from spun polyester, which is resistant to UV light and salt water, but may become heavily fouled with a range of species after a long period of submersion. It should be noted that any submerged material that has not been antifouled, would be suitable for NNS settlement. Furthermore, any material with limited cleaning or eradication potential possesses an increasing risk as time passes and more biofouling organisms are established.

Work vessels

The hull of the work vessels have the potential to accumulate biofouling and increase the risk of NNS. However, antifouling, cleaning and eradication measures are available that reduce this risk. Additionally, the vessels used will be a small, newly refurbished barges based in Loch Moidart that will not have travelled from other countries, regions or water bodies, thereby reducing the risk of NNS introduction.

Biosecurity Control Measures - Instructions for site users

Activity type	Recommended biosecurity measures
Arrival of vessel with moorings, lines, anchors	• Carry out regular biofouling inspections, antifouling treatments, and inspection • If the level of biofouling is ranked at level 3 or higher (see Biofouling Visual Assessment table – Appendix A) the materials/structure should not be introduced until biofouling is removed. Removal must be in a controlled manner with all removed material contained and not released to the marine environment • Removal of biofouling must be in a controlled manner with all removed material contained and not released to the marine environment
Introduction of new construction materials/structures to the marine environment	• Visual inspection prior to introduction and clean if required
Introduction of seed stock to farm	• Stringent visual inspection of seed prior to deployment. • Use a reputable seed supplier with no historic INNS issues • Source a local supplier if possible • Harvest fertile material for seedstock from within 5 miles of farm site • If any INNS are found seed should not be used
Movement of site workers	• Apply Check, Clean, Dry procedure for all clothing and equipment: https://thegreenblue.org.uk/check-clean-dry/
Harvesting	• Harvest should be checked for epiphytes and especially NNS • Harvested kelp you should be stored correctly for onward transport to processing facility
Departure/removal of barges/ vessels/ lines or moorings	• Use the Biofouling Visual Assessment table (Appendix A) prior to vessel departure or removing subsea equipment. • Removal must be in a controlled manner with all removed material contained and not released to the marine environment
Training	• Training will be given to key staff in the identification of NNS and using the Biofouling Visual Assessment Table (Appendix A). These references should be printed off and placed in a biosecurity plan folder along with this Biosecurity Plan.

Contingency Plan

Issue	Action	Responsibility	Equipment
Fragmentation or dispersal of NNS into the water column.	Remove debris from the water column and dispose to landfill. Use the same procedures in place for routine cleaning.	Seaweed farm staff	Hand nets or boat hook.
Workboat is ranked at class 3 or above in the visual inspection (see Table 5).	The vessel is not allowed entry to worksite. It should be removed from water at home port, cleaned and antifouled. Inspect surrounding berths.	Seaweed farm staff	Laminated copy of Biofouling Visual Assessment table (Appendix A) to be available on site.
Rafted material with NNS dislodged	Remove from water and allow to air dry or dispose to landfill.	Seaweed farm staff	Hand nets or boat hook.
New non-native species found.	Inform Marine Scotland and SNH. Follow Marine Scotland and SNH instructions. The GB Non-native Species Secretariat should also be informed so they can update species distribution and abundance databases for NNS. Relevant details are located on their website: http://www.nonnativespecies.org	Seaweed farm staff	Copy of Marine Scotland contact available onsite.

Appendix A

Biofouling visual assessment table (from Payne *et al.* 2014)

Rank	Description	Visual estimate of biofouling cover
0	No visible fouling. Hull/structure entirely clean, no biofilm on visible submerged parts of the hull.	Nil
1	Slime fouling only. Submerged hull/structure areas partially or entirely covered in biofilm, but the absence of any plants or animals.	Nil
2	Light fouling. Hull/structure covered in biofilm and one to two very small patches of one type of plant or animal.	1–5 % of visible submerged surfaces
3	Considerable fouling of hull/structure. Presence of biofilm, and fouling still patchy, but clearly visible and comprised of either one or more types of plant and/or animal.	6–15 % of visible submerged surfaces
4	Extensive fouling of hull/structure. Presence of biofilm and abundant fouling assemblages consisting of more than one type of plant or animal.	16–40 % of visible submerged surfaces
5	Very heavy fouling of hull/structure. Many different types of plant and / or animal covering most of visible hull surfaces.	41–100 % of visible submerged surfaces