Supporting Information for Screening for Appropriate Assessment Related to the Harvest of Seaweed

GREATMANS BAY

COMMERCIALLY CONFIDENTIAL

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Abbreviations

AA	Appropriate Assessment
AIMU	Assessments of Impacts of the Maritime Usage
GIS	Geographic Information System
JNCC	Joint Nature Conservation Committee
MUL	Maritime Usage Licence
MARA	Maritime Area Regulatory Authority
MU	Management Units
NPWS	National Parks and Wildlife Service
QI	Qualifying Interest
SAC	Special Areas of Conservation
SCI	Special Conservation Interest
SISAA	Supporting Information Screening for Appropriate Assessment
SPA	Special Protection Areas
SPR	Source Pathway Receptors
ZOI	Zone of Influence

1. Introduction

The Maritime Area Regulatory Authority ("MARA") was established under the Marine Area Planning Act 2021("MAPA"). The commencement date for MARA was July 17, 2023. Under Section 7 of MAPA, MARA has the authority to grant a Marine Usage Licence ("MUL") for the harvesting of seaweed.

Arramara Teoranta (Teo) is applying to MARA for a Maritime Usage Licence (MUL) to harvest the seaweed *Ascophyllum nodosum* and *Fucus spp*. (hereafter referred to as *Ascophyllum*) from the intertidal shoreline of Greatmans Bay, County Galway (Table 1 and Figure 1), targeting an annual harvest of up to 2,271 wet tonnes.

Arramara Teo has been sustainably harvesting *Ascophyllum* in the region for several decades, and the present MUL application aims to allow Arramara Teo to continue its harvesting activities. Arramara Teo has relied on local harvesters to obtain *Ascophyllum* and will continue to do so. This MUL application only applies to state-owned foreshore and excludes any portion of the foreshore for which a seaweed appurtenant right has been identified by Tailte Éireann, formerly the Property Registration Authority of Ireland. The Property Registration Authority of Ireland was contacted, and relevant information obtained. Biomass assessments also reflect this.

Arramara Teo believes a regulated, licensed industry is the only protection for Ireland's National seaweed resources.

	Geographic Descriptions and Coordinates of Arramara Teo's proposed MUL area
Harvest Allowance	The entire foreshore, including islands and ledges on the coastline of Greatmans Bay starting at 53.224315, -9.665211 in the townland of Maumeen and extending to 53.301741, -9.634923 in the townland of Lettermore. All ledges and foreshore of the townland of Carrowroe West. All ledges and foreshore of the following islands: Inishlay, Illauncurragilka, Glassillaun, Illaunroe and Rossroe Island.
Harvest Restriction	To ensure compliance with existing legal rights and to avoid any potential conflict with rights holders, harvesting operations will not take place where Appurtenant Rights have been registered with Tailte Éireann.

Table 1 - Geographic Descriptions and Coordinates; Greatmans Bay

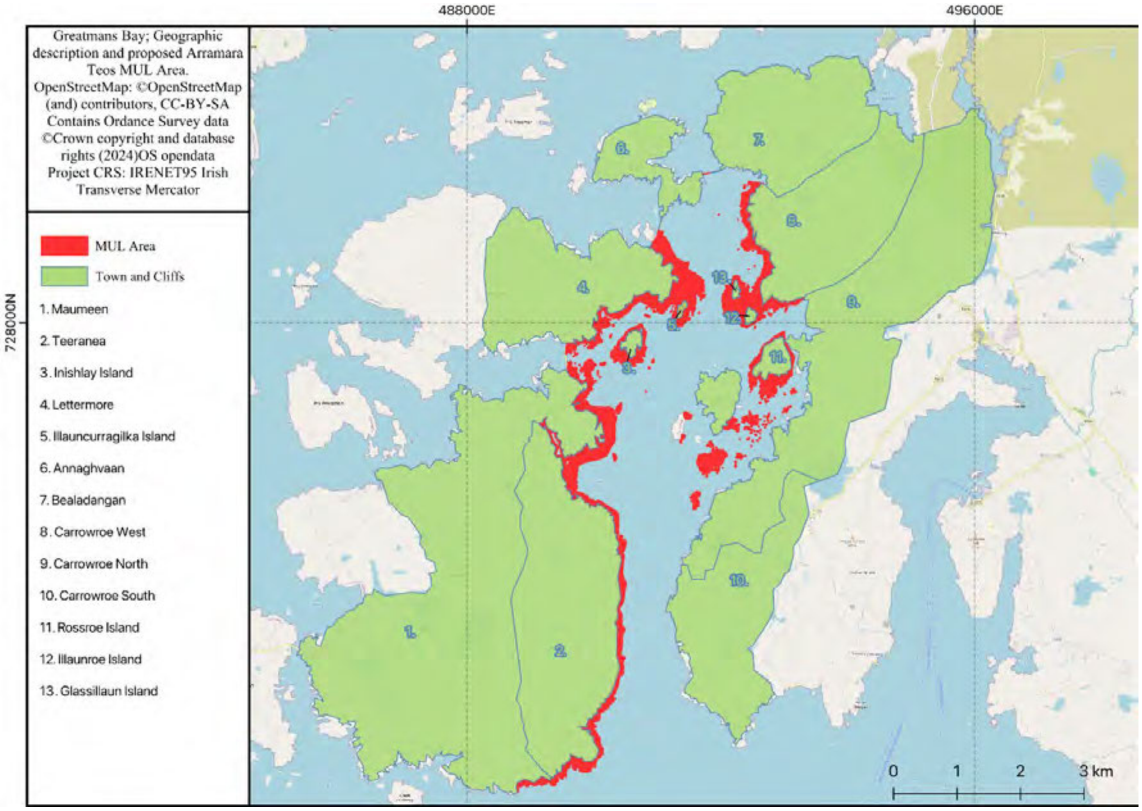

Figure 1 – Geographic description and proposed Arramara Teo MUL Area

1.1 Company Profile and Historical Context

The west of Ireland has supported human use of seaweeds for centuries. Initially taken as 'storm tossed' (seaweeds thrown ashore during North Atlantic storms), a variety of species have been used to build up otherwise sparse soils, to fertilise gardens and to supplement the diets of animals. As coastal communities became more familiar with the benefits of seaweed they began to harvest specific species for personal dietary, therapeutic and medicinal purposes.

Entrepreneurial and scientific knowledge grew, and commercial uses of certain species emerged. Commercial use within Arramara Teo evolved to where the harvesting of the species as responsibly and sustainably as possible became integral to sustaining the industry.

Founded in 1947 in *Cill Chiaráin* (Kilkieran), Connemara, County Galway, Arramara Teo has been acquiring and processing seaweed for over 78 years along the western coast of Ireland. It acquires seaweed from over 200 local harvesters and provides employment for 29 employees at its processing plant located in Kilkieran, County Galway. At its peak in 1979, the company processed 62,000 tonnes *(Guiry & Blunden, 1981)*. Since 1964, sustainable annual harvests of *Ascophyllum* and *Fucus* have ranged from 8,000 to 28,000 wet tonnes, with an average of 22,000 tonnes per year since 2008 *(Guiry & Morrison, 2013).*

Arramara Teo is now a subsidiary of Acadian Seaplants Ltd ("ASL"), a family company founded by Louis Deveau in 1980 and based in Nova Scotia, Canada. ASL acquired Arramara from Údarás na Gaeltachta in May 2014. Údarás na Gaeltachta had held 100% of the company shares on behalf of the State since 2006. Prior to 2006 the Department of Marine and Natural Resources owned 82% of shares while ISP

Alginates, a Scotland-based subsidiary of a multi-national corporation, held the remaining 18% of shares.

There is a deep tradition of hand-harvesting seaweeds along Ireland's west coast *(MacMonagail & Morrison, 2020; see Appendix A - Literature Review of Commercial Harvesting of Ascophyllum nodosum)*, although boat and rake harvesting has recently become more popular. Arramara Teo initially processed various seaweeds, including *Laminaria* and *Saccharina*, before focusing on *Ascophyllum* and *Fucus*, which remains its primary species processed in its Kilkieran factory for agricultural, horticultural, aquaculture, and alginate industries.

While Arramara Teo's operation is now solely based in the Connemara Gaeltacht region of Kilkieran, it had previously operated additional facilities near Newport, County Mayo and at Dungloe, County Donegal. These facilities were closed as efficiencies in resource management, logistics and production were realised. This indirectly allowed another Irish seaweed company to establish and grow in County Donegal, utilising the same species. Arramara Teo continued to acquire resources from harvesters across Counties Mayo, Galway and the northwest corner of County Clare and this continues to be the primary supply area for Arramara Teo today.

Over the past 78 years, Arramara Teo has emerged as Ireland's largest purchaser and processor of select intertidal seaweed species. During that time and in the absence of licensing, Arramara Teo has managed to gently guide resource management and harvest activity in its traditional harvesting procurement regions of Counties Galway, Mayo, Donegal and northern County Clare. This tactful evolution has resulted in a sustainable resource and an uninterrupted industry track record throughout Ireland's west coast.

In 2014, Arramara Teo submitted a licence application to harvest seaweed from the foreshore of Counties Mayo, Galway and Clare to the Marine Planning and Foreshore Division of the Department of Housing, Planning, Community and Local Government Ref (FS006108). While the application was being processed and prior to publication for public consultation the Department suspended the foreshore licencing process for all seaweed application in April 2015 pending consultation with the Attorney General on the status of existing seaweed rights on the foreshore. Arramara Teo views licensing as formalizing the responsibility to ensure the orderly, sustainable and continued development and growth of the *Ascophyllum* and *Fucus* harvest in Ireland as well as providing the justification for future investment.

1.2 Current Business Model

Arramara Teo has developed a thorough management plan for the harvest of *Ascophyllum.* This is based on years of experience harvesting in the region combined with expertise from the development and implementation of similar management plans for the harvest of *Ascophyllum* in Canada, United States, and Scotland. The main components of the management plan include:

- **A single licensee per region** - This ensures that the resource is not overharvested because of competitive pressure from multiple companies. It also allows for the licensee to exert some control over the quantity of resource removed on a yearly basis.

- **The implementation of area-based management** - The foreshore is divided into sectors that form the management unit. A biomass assessment is conducted within each sector to evaluate the available biomass of *Ascophyllum.* Based on these assessments, a yearly quota is established for each sector.

- **Harvest quotas per sector** - A maximum of 20% of the standing stock of *Ascophyllum* is harvested annually in any sector. This level of harvest is commonly used in Canada, United States, and Scotland. It has proven to be sustainable after more than two decades of continuous commercial harvesting, having no long-term impact on the biomass, length, or morphology of *Ascophyllum*.

Arramara Teo conducts biomass assessments and monitors the condition of the resource. Arramara Teo also employs a resource team who oversee the harvesting activities, work with the harvesters, and ensure that annual quotas are respected.

1.3 Harvest Management Plan

There is a long history of commercial harvesting of *Ascophyllum* in the region (*Guiry and Morrison, 2013*) and many of the *Ascophyllum* beds have been harvested for several decades.

Arramara Teo's current model is to buy *Ascophyllum* and *Fucus* from many different local independent harvesters along the West Coast of Ireland. Arramara remains committed to these harvesters' long history, tradition and culture of harvesting seaweed. As such, Arramara Teo will enter contract supply/service agreements with the harvesters for the supply of seaweed. The agreements will include, as part of our Harvest Management Plan, specific areas to cut and a schedule that fits the need of the harvester. In addition, Arramara is committed to training and supplying the harvesters with the necessary equipment to ensure seaweed is cut sustainably.

The purpose of the Harvest Management Plan is to ensure traditional harvesting activities are properly conducted allowing growth and development of the industry while maintaining excellent environmental stewardship of the *Ascophyllum* and *Fucus* resource and ecosystem. This objective has been accomplished by doing the following:

- Research the current harvesting methods to evaluate and quantify sustainability and identify improvements to the harvesting techniques to maximize the biomass.
- Strengthen the management approach to ensure a sustainable industry based on good quality biomass.
- Understand the resource using historical landings data.
- Develop biomass assessment using satellite/aerial imagery and ground-truthing surveys.
- Develop harvest strategies for each sector.
- Develop resource management protocols.
- Develop harvester support and training.

Arramara Teo's annual Harvest Management Plan is prepared based on information developed and maintained in the seaweed resource records of the company. From the data, the level of sustainable harvest is determined by using the following information:

- Detailed resource sector maps.
- Detailed data on actual seaweed volumes.
- History of previous harvest and regrowth rates.

- History of harvest rates and harvesting methods employed.
- Availability of harvesters.
- Demand for the seaweed to meet production forecasts.
- Relative cost of harvest delivered to the factory.

While annual harvest budgets are set by Arramara Teo, they are based on historical information and current projections from the harvesters cutting in the area. This planning allows for the orderly flow of raw material for production purposes. The harvest occurs year-round but at a very low intensity.

These harvesters employ two different methods to harvest *Ascophyllum*: the traditional harvest and the boat and rake method. Both are described in Section 2.3 – Harvesting Methods.

The harvesters cut and prepare their seaweed for transport. As the harvesters are independent contractors, they manage access to the seaweed that they cut. The harvester contacts Arramara Teo when they have enough seaweed to be picked up and transported to the factory in Kilkieran. Arramara Teo sends a resource manager to verify the quantity and quality of seaweed that has been cut and then arranges for the purchase and transport of the seaweed to the Arramara Teo factory for processing.

1.4 Statement of Authority

The authors of this report have extensive expertise and experience in seaweed ecology, sustainable harvesting practices, and industry operations. With decades of combined research, including published works on the ecology of commercially important seaweed species and the environmental impacts of seaweed harvesting, as well as training in Appropriate Assessment and the Habitats Directive (2024), the authors are well-equipped to develop this comprehensive Screening for Appropriate Assessment (SISAA) report. Their involvement in academic research and industry projects has allowed them to contribute to sustainable practices globally, making them authorities in seaweed management. Their experience developing sustainable harvest plans in Canada, the USA, and Scotland, as well as industry-leading sustainable harvest management practices, has provided them with the required knowledge and experience to develop this report.

1.5 Aim of this SISAA Report

This Supporting Information Screening for Appropriate Assessment (SISAA) report has been prepared per the current guidance documents, and it assesses the likely significant effects of the proposed seaweed harvesting operation on its own, or in combination with other plans or projects, on any European site. European sites are designated as Special Areas of Conservation (SAC) under the Habitats Directive or Special Protection Areas (SPA) under the Birds Directive. The Appropriate Assessment (AA) screening stage considers whether, based on objective scientific evidence, it can be concluded that there are no likely significant effects on any European site, given best scientific knowledge and the conservation objectives of the relevant European sites.

This SISAA report provides the information required to justify the determination made related to the likelihood of the proposed seaweed harvesting to likely significantly impact the surrounding Natura 2000 sites in the context of their conservation objectives.

1.6 Approach to Screening for Appropriate Assessment

This SISAA has been undertaken to inform the Screening for Appropriate Assessment, which will be carried out by MARA per Figure 2 below.

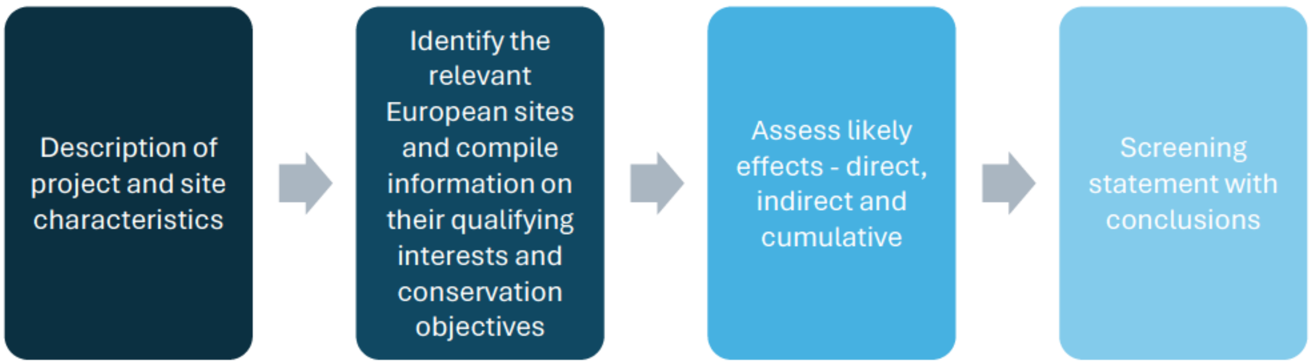

Figure 2 - Screening process adopted for Screening for Appropriate Assessment

By taking the ecological impact assessment in a step-by-step manner concerning the habitats and species of the conservation sites, together with their conservation objectives, this report seeks to inform the screening process required as the first stage of the process according to Article 6.3 of the EU Habitats Directive.

"Any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives... "

1.7 Description of Proposed Project

Arramara Teo is applying for an exclusive 10-year MUL to harvest *Ascophyllum* and *Fucus* from five bays in County Galway along the west coast of Ireland. Since each bay will potentially interact with different European sites, a separate SISAA report has been prepared for each bay.

This SISAA report covers the annual harvest of 2,271 tonnes of *Ascophyllum* and *Fucus* from the intertidal zone of Greatmans Bay in County Galway. The areas and harvest quantities only consider state-owned foreshore free from any appurtenant rights.

Biomass assessments have been conducted to map and quantify *Ascophyllum* and *Fucus* in each bay. Based on those assessments, management plans detailing the sustainable harvesting programs have been developed for each bay.

2. Resource Management

2.1 Overview

The accurate biomass assessments, scientific information collected, and experience gained by the company over the past several years has provided detailed information regarding the intricacies of developing a sustainable seaweed harvest fishery in Ireland. The commercial harvest of *Ascophyllum* and *Fucus* in Ireland has long been a traditional fishery working well with all stakeholders in all harvest areas. Arramara Teo has over 78 years of experience in harvesting, and these relationships of trust with harvesters is a guiding principle to a sustainable harvest. Arramara Teo will also continue to make the necessary investments in harvesting infrastructure, trucking, recruitment and training of harvesters.

Specifically, Arramara Teo has adopted a resource management model based on the well-accepted Area Based Management Model that is used in many jurisdictions globally. This includes the following seven components:

- Professional management team of resource scientists and resource managers
- Long tradition of trust with harvesters
- Monthly resource management meetings
- Harvester recruitment and training
- Harvester tools and infrastructure
- Harvesting plans
- Harvesting management and monitoring

Arramara Teo has been operating under this model; however, in an open fishery, the orderly management of the biomass is difficult to control when it is unknown how other harvesters are managing their operations. This makes sustainability of the resource challenging and could lead to overharvesting.

2.2 Resource Management Team

Arramara will continue to use its team of experienced and qualified resource management professionals to implement the sustainable harvest of the resource. The team is comprised of resource management personnel from Arramara Teo and Uist Asco operations throughout Ireland and Scotland and senior leaders from other parts of both organizations, providing over 50 years of combined experience. Monthly meetings are arranged for the Resource Management and Research teams to approach harvest management, planning, execution and problem solving. These meetings provide a forum for the exchange of ideas, experiences and challenges faced during the harvest season. The resource managers and the rest of the management team benefit from the feedback provided at these meetings.

The management of the harvest in Arramara Teo is led by resource managers. Each is assigned a specific geographic area and brings specific technical, harvesting, agriculture and cultural competencies to the team and are very familiar with all harvesting activities. They are well qualified to conduct their duties in a professional manner.

2.3 Harvesting Methods

Traditional Harvesting

Traditional harvesting involves using one to two local harvesters, also known as cutters, working within a specific section of the foreshore. The seaweed is cut on foot at low tide within a 20 m x 20 m section of bed using a knife or sickle (see Figure 3), leaving at least 25 cm attached to the substrate to ensure re-growth of the plant. This traditional harvesting is carried out in strict rotation to allow the *Ascophyllum* to regrow, with harvesters only returning after 3 to 5 years.

Using a fork, the seaweed is then gathered into bundles (called "*climíní*" in Connemara Irish) of approximately 2 to 3 tonnes, which are bound by 20-meter-long nets and ropes and left on the intertidal shoreline. These bundles float at high water and are towed by a small boat (3 to 4 metres in length, 20 to 30 HP outboard engine) to a suitable pier for collection by a lorry with a crane that lifts the *climíni* onto the lorry, where it is inspected by a resource team member before a haulier transports the seaweed to Arramara Teo for processing (usually in 20-tonne loads). Hauliers access the seaweed through the road networks and existing tracks.

Hand Harvesting using a Small Boat and Rake

The boat and rake method was introduced to Ireland in 2015 by Arramara Teo. It is an effective and sustainable method to harvest *Ascophyllum,* which has been used in Canada for over 40 years and has been recently implemented in the United States and Scotland. For the boat and rake method, harvesters manoeuvre their boat (maximum length 3 to 4 metres, 30 HP outboard engine) to the bed they wish to harvest on the rising tide. The boats are specifically designed to carry a load of 3 to 4 tonnes of seaweed. The harvester cuts the seaweed using a specially designed cutting rake that allows the harvester to target and trim the upper portion of individual plants and bring the cut portion into the boat. All rakes are equipped with a 15-cm rail to prevent cutting from occurring too close to the holdfast. Figure 3 shows an Arramara Teo boat and rake harvester.

Once full, the boats are unloaded at a landing site directly into a truck or stored into nets for collection within a few days after the initial cut. Harvesting from the boat allows harvesters to operate during high tide and store the seaweed in the boat rather than leaving it on the shore. Because their vessel is constantly moving with the tide and currents, harvesters gather *Ascophyllum* plants in a patchy and pruning fashion. This process leaves ample canopy for other intertidal inhabitants, allows for a rapid regeneration of seaweed shoots and minimizes the disturbance of the habitat architecture. Overall, our research finds the boat and rake method to be a highly sustainable practice.

Figure 3- Image of Traditional (left) and Boat and Rake (right) harvesters

2.4 Harvester Training and Recruitment

Harvester training and recruitment is extremely important to the success of Arramara Teo. Standard Operating Procedures for Harvesting of *Ascophyllum nodosum* provides all harvesters cutting seaweed for Arramara Teo good knowledge of the company expectations.

The total number of harvesters engaged is approximately 200. Annually harvesters are invited to the factory in Kilkieran for presentations and training to familiarize themselves with the seaweed industry including seaweed biology, weather, tides, safety guidelines, coastal geology, assessment, harvesting guidelines and regulations, compliance, reporting, and maintenance of harvesting tools. It is reiterated to all harvesters that training and proper safety is critical to the success of the any harvest season. Resource managers also conduct training of new harvesters in the field. This includes familiarization with assigned harvest areas, harvesting tool maintenance, harvesting technique and safety equipment.

Ongoing training is conducted through placement with experienced harvesters to provide knowledge concerning tides and currents, boat handling at the harvest sites, proper boat loading procedures and transportation of harvest safely to the landing site.

Harvester health and safety is the number one priority of all parties involved. Arramara Teo encourages all harvesters to obtain marine training. Compliance monitoring of harvesters and equipment is conducted on a regular basis by Resource Management and Safety personnel.

2.5 Boat Safety

All harvesters using Arramara Teo's boat and rake method are required to undergo boat safety training before use. This training takes approximately 8 to 10 business days to complete and is either company provided, or company supported. The following training and/or certifications are required:

- Certified National Power Boat Certificate
- VHF Certificate
- Hydraulic Equipment Handling/Maintenance Training
- Internal Arramara Safety training and Induction
- On water harvest training with an experienced harvester

In addition, all boats provided by Arramara are registered with the Marine Survey office in Ireland. Boats are classified as work boats and have P4 designation. Boats are maintained on a regular basis by an independent contractor. This contractor does all boat and motor maintenance for the fleet.

2.6 Harvest Management and Monitoring

The annual Harvest Plan is a key component of Arramara Teo's annual budgeting and planning process.

For the management of the *Ascophyllum* and *Fucus* resource, the coastline was divided into 21 bays. From the north, the first bay is in Broad Haven Bay, Sruwaddacon Co. Mayo. The last bay is in Shannon Estuary, Co. Clare.

Arramara Teo produces a Harvest Plan prior to the start of the annual harvest and an annual Harvest Report upon the completion of the annual harvest.

The annual Harvest Plan includes a complete list of the bays to be harvested, which are further divided into sectors to provide a higher resolution, the volumes to be harvested, planned meetings with harvesters, and the planned financial and human resources required to implement the harvest plan.

Arramara Teo collects data on its harvested resources. The data are used to track harvester remuneration and are also used by the resource manager to track landings. All harvests, by sector, are recorded to generate harvest landing reports.

The annual Harvest Report itemises the results of the annual harvest and will be presented to the relevant regulatory authorities. The Harvest Report includes following subject areas:

- Harvested quantities
- Harvest landings by bay
- Harvest landings by sector
- Assessment of the resource
- Future considerations

3. Sustainable Harvesting of *Ascophyllum* & *Fucus*

3.1 Quantitative *Ascophyllum nodosum* and *Fucus vesiculosus* Biomass Survey

Since 2014, Arramara Teo has developed an intensive assessment program to enhance its understanding of total and harvestable *Ascophyllum* biomass, which is essential for a viable fishery and effective management plan. The program incorporates scientific sampling, extensive ground-truthing, sector bed mapping using remote sensing, and harvest experience, resulting in high-resolution biomass data stored in a GIS database. This comprehensive dataset informs Arramara Teo of the current condition of resources on the West Coast of Ireland.

The field surveys, which are the most recent and detailed in Ireland, estimate *Ascophyllum* and *Fucus* density across harvesting sectors to calculate harvestable biomass. Sampling locations were chosen within main beds to ensure representativeness. Sampling was conducted within a four-hour window around low tide. A 30 m transect was set parallel to the shore at the midpoint of the *Ascophyllum/Fucus* zone, with ten 50 x 50 cm (0.25 m^2) quadrats randomly placed along the transect. Shoots were cut 25 cm from the holdfast, weighed using a digital hook scale, and recorded as density per unit area. Bed width measurements were also taken to calibrate satellite-based area data. (See Appendix C - Biomass assessments of *Ascophyllum nodosum* and *Fucus spp.*)

3.2 Available Biomass

Arramara Teo resource scientists have calculated the standing biomass of *Ascophyllum* and *Fucus* to be greater than 11,350 tonnes for Greatmans Bay. Arramara Teo is applying for an annual harvest of 2,271 tonnes (20% of the standing stock). The exact biomass to be harvested, as well as the size of the harvestable areas in the MUL and the total standing stock of the targeted seaweed, can be seen in Table 2. Further detail can be found in Section 3.4, which outlines in more detail how Arramara Teo will manage the resource to ensure that harvesting of the resource remains sustainable.

The seaweed will be harvested from the mid and low intertidal shores of sheltered and semi-exposed rocky shorelines from the Bay (see Table 1). Existing piers, landing sites and roads will be used for the collection and onward transport of the harvested seaweed.

Region	Sector	MUL Area (ha)	Intertidal Bed Area (ha)	Density Asco (kg/m^2)	Density Fucus (kg/m^2)	Density Asco and Fucus (kg/m^2)	Cover (%)	Asco Height (cm)	Number of transects	Proposed Annual Harvest (t)
Greatmans Bay	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Total	**272**	**137.2**						**36**	**2,271**

Table 2 - Sustainable harvest estimates and sectors within the MUL area

3.3 Implementing a Precautionary Approach to Harvest Management in Ireland: Area-Based Management

Ascophyllum and *Fucus* are not only the raw material for the industry but also form important habitats for diverse species (Kelly et al. 2001; MacMonagail et al. 2017). Area-based management is a spatial management strategy for conservation and management of marine resources. It divides an area into small geographic units or sectors which become the management units. The units vary in number and size depending on the quantity of the resource within a bay. Each unit has its harvest budget, which is determined by our biomass surveys. Area-based management can be used to customise harvest plans to respond to small-scale ecological concerns relevant to the resource or the habitat, such as protecting waterfowl breeding areas. It also allows yield to be optimised when there are changes in productivity or geographical differences in productivity within harvest areas over time.

Other advantages of area-based management are economic. The assignment of an exclusive license gives the company the security of raw material supply. This, in turn, permits investment of both human and monetary resources in research and development to reach the goals of the harvest plan and make a viable industry.

Area-based management for the harvest of *Ascophyllum* has been successfully used in Canada and in Maine, USA for several decades by Acadian Seaplants, the parent company of Arramara Teoranta. Acadian Seaplants has also implemented it in North Uist, Scotland, in 2020 to sustainably manage the harvest of *Ascophyllum* under the guidance of NatureScot. Arramara Teo proposes to use this same management strategy in the MUL area proposed in the West coast of Ireland.

3.4 Harvest Regulations

To minimise significant changes in the structure of the resource and its biomass, the management plan also includes conservative exploitation rates well below the annual growth of the resource. *Ascophyllum* generally produces 40% (and up to 70%) of its biomass annually (Lauzon-Guay et al. 2021, Cousens 1985, Vadas, Wright & Beal, 2004). A recent study has demonstrated that these approximations may be underestimating the real productivity of the species (Lauzon-Guay et al. 2022). Field studies in Ireland indicate that the growth rates are similar or higher than in Canada (MacMonagail, unpublished data). In Canada, up to 25% of the standing stock of *Ascophyllum* is removed annually by harvesters. This level of harvest has had no impact on the biomass or height of *Ascophyllum* after more than 20 years of continuous harvest (Lauson-Guay et al. 2021). As a precautionary approach, we propose a conservative annual exploitation rate of 20% in the proposed MUL area. Each sector may not be harvested to its maximum harvest potential depending on several factors, including the harvest method employed, availability of harvesters, demand for seaweed to meet production forecasts, the relative cost of harvest delivered to the factory and other practical constraints. The 20% represents the maximum that may be harvested within a year in any sector. In addition to the exploitation rate, our management plan controls cutting height (25 cm) and holdfast removal.

All these internal regulations are components of the precautionary approach and general conservation principles Acadian Seaplants and Arramara Teo apply everywhere they harvest *Ascophyllum.*

3.5 Resource Monitoring and Research

Over the last ten years, Arramara Teo has developed and implemented scientific surveys, biomass assessments, and research in Ireland.

3.6 Proposed Scientific Monitoring Plan

Arramara Teo proposes to follow the internationally recognised scientific monitoring methodologies developed and practised by Acadian Seaplants Limited in Canada, the USA, and Scotland.

The biomass of *Ascophyllum* within Greatmans Bay will be monitored through annual resource inspections and biomass sampling (Figure 4). Based on this monitoring, the Harvest Plan for the following year will be adjusted.

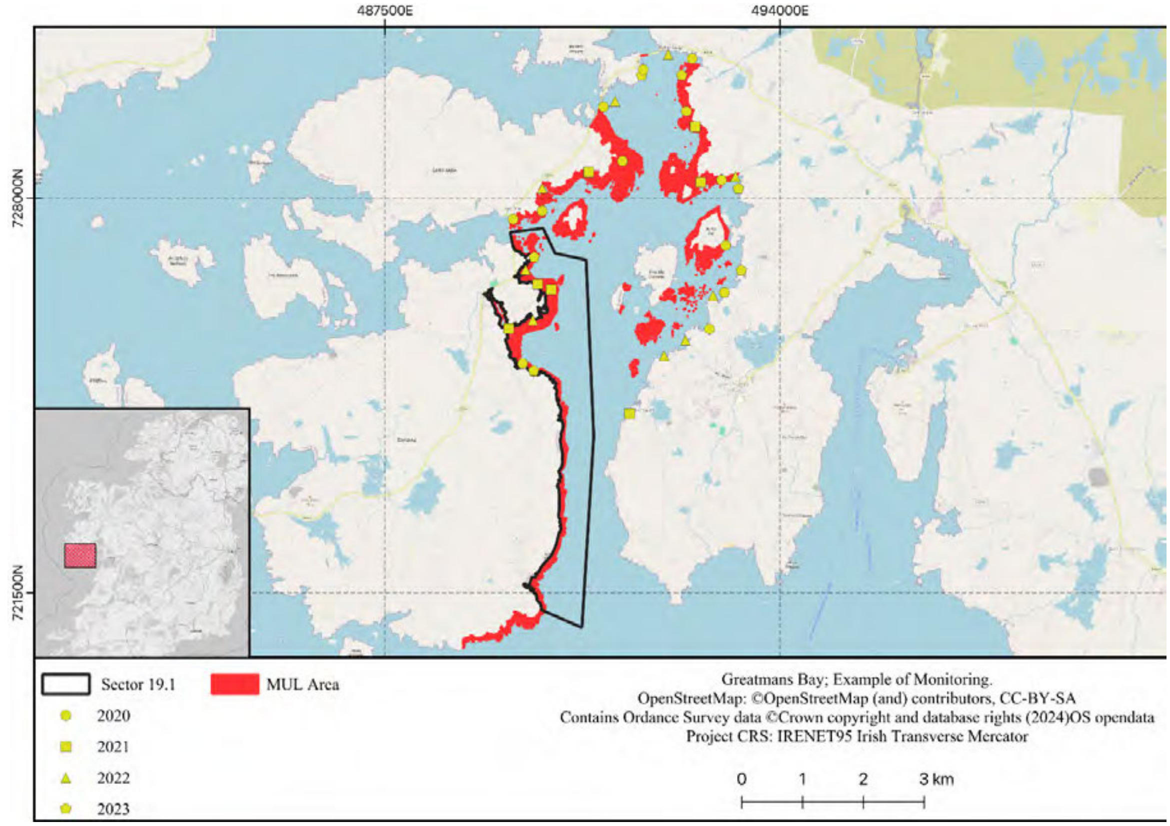

Figure 4 - Example showing annual monitoring sites; highlighting an individual sector

3.7 Description of the Receiving Environment

To describe the receiving environment of Greatmans Bay, several relevant data sources were utilised, including data provided by The National Parks and Wildlife Service (NPWS), the Marine Institute (MI), Coordination of information on the environment (CORINE), and other relevant datasets.

For Greatmans Bay, we present:

- Natura 2000 sites within the Zone of Influence (ZOI) and their relevant Qualifying Interests.
- Substrate.
- Description of the biota.
- The presence of significant populations of Annex I and Annex II species.

Intertidal transects were surveyed as part of these baseline characterisation assessments. See Appendix B - Ecology Assessment – Greatmans Bay. The Bay's ecology is described below in the context of the wider environment and of the Natura 2000 sites.

3.8 Ecological Assessment

Horizontal and vertical shore transects were sampled at Greatmans Bay. Vertical shore transects with multiple quadrats allowed a description of the extent of the biotopes present in the survey sites. Fauna and macroalgae (including epiphytic algae) were recorded along with substrate type, wave exposure, and width of the algal band on the shore. As the shores tended to be composed of hard substrates such as bedrock, boulders, cobble and gravel, it was not possible to collect cores for the fauna.

A description of Greatmans Bay, including a description of each biotope recorded, the fauna encountered, and the extent of the biotope, is also outlined in Appendix B - Ecology Assessment – Greatmans Bay. Descriptions of the biotopes are from the JNCC Marine Habitat Classification for Britain and Ireland (Connor *et al.* 2004).

3.9 Greatmans Bay

Greatmans Bay exhibits a shallow gradient and is part of the Kilkieran Bay and Islands SAC (IE002111). The substrate within Greatmans Bay varies from bedrock and boulders to mixed.

Algal distribution down the shore was *Pelvetia canaliculata*, *Fucus spiralis*, *F. vesiculosus*, *Ascophyllum nodosum* and *F. serratus*. *Ulva sp.* and *Ascophyllum nodosum ecad mackaii* were present. *F. spiralis*, *F. serratus*, *Vertebrata lanosa* and *F. vesiculosus* were recorded as epiphytic on *Ascophyllum nodosum* (Appendix C - Ecology Assessment – Greatmans Bay).

Fauna of the upper *Ascophyllum nodosum* band was *Spirorbis sp*., *Littorina obtusata*, *Melarhaphe neritoides, L. saxatilis*, *Gibbula umbilicalis*, *L. littorea*, *Actinia equina*, *Nucella lapillus*, barnacles, *Patella vulgata*, *Anurida maritima*, amphipods*, Mytilus edulis*, *Carcinus maenas* and bryozoans. Mid-band fauna were *Spirobis sp*., *L. obtusata*, *L. saxatilis*, *N. lapillus*, *P. vulgata*, *L. littorea*, hydroids*, Necora puber*, amphipods, *Osilinus lineatus*, *C. maenas*, *Gibbula sp.* and bryozoans. In the lower band were *L. obtusata*, *N. lapillus*, barnacles, *M. nerotoides*, *L. littorea*, *Spirobis sp*., *Pagurus sp*., *O. lineatus*, *Gibbula sp.*, tunicates and bryozoans.

Extensive maerl beds, in addition to eelgrass *Zostera marina,* can be found within the bay. Also present are areas of salt marsh, which are found as a thin fringe salt marsh along most stretches of coastline and in the lee of causeways built to connect islands, e.g. Gorumna Island, to the mainland (MERC Consultants, 2005). While the intertidal harvestable areas occur below the salt marsh, there are no access points through the salt marsh.

Otter *Lutra lutra*, a species listed in Annex II of the E.U. Habitats Directive, commonly occurs throughout Kilkieran Bay and Islands SAC (IE002111), of which Greatmans Bay is a part. There are common seal *Phoca vitulina* haul-out sites within the bay (Cronin et al. 2004), and there are also grey seal *Halichoerus grypus* breeding sites recorded from some of the outer islands of Kilkieran Bay in 2005 (O'Cadhla et al. 2007).

Activities which impact on Kilkieran Bay and Islands SAC (IE002111) are fish and shellfish aquaculture (medium influence), taking/removing flora (low influence) and landfill, land reclamation and drying out (low influence) (NPWS, 2001f).

Figures 5 to 9 are provided for additional context.

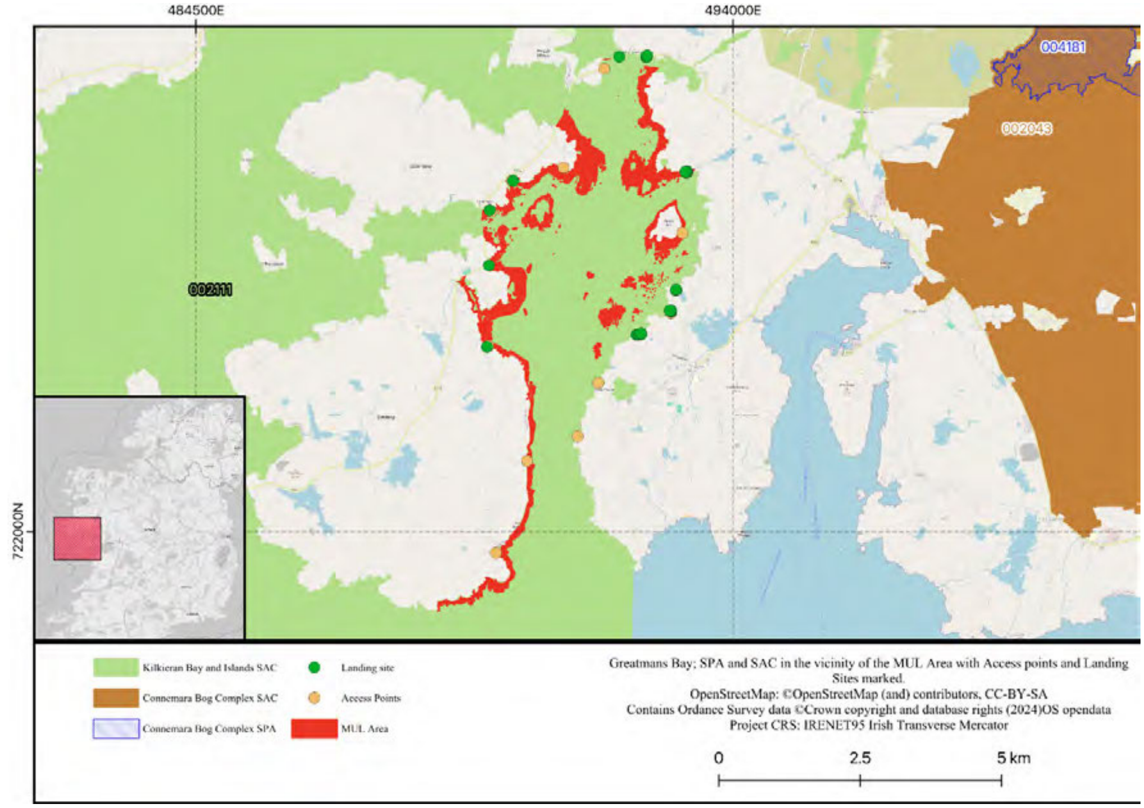

Figure 5 - Access Points, Landing Sites, SPA's and SAC's in the vicinity of Greatmans Bay

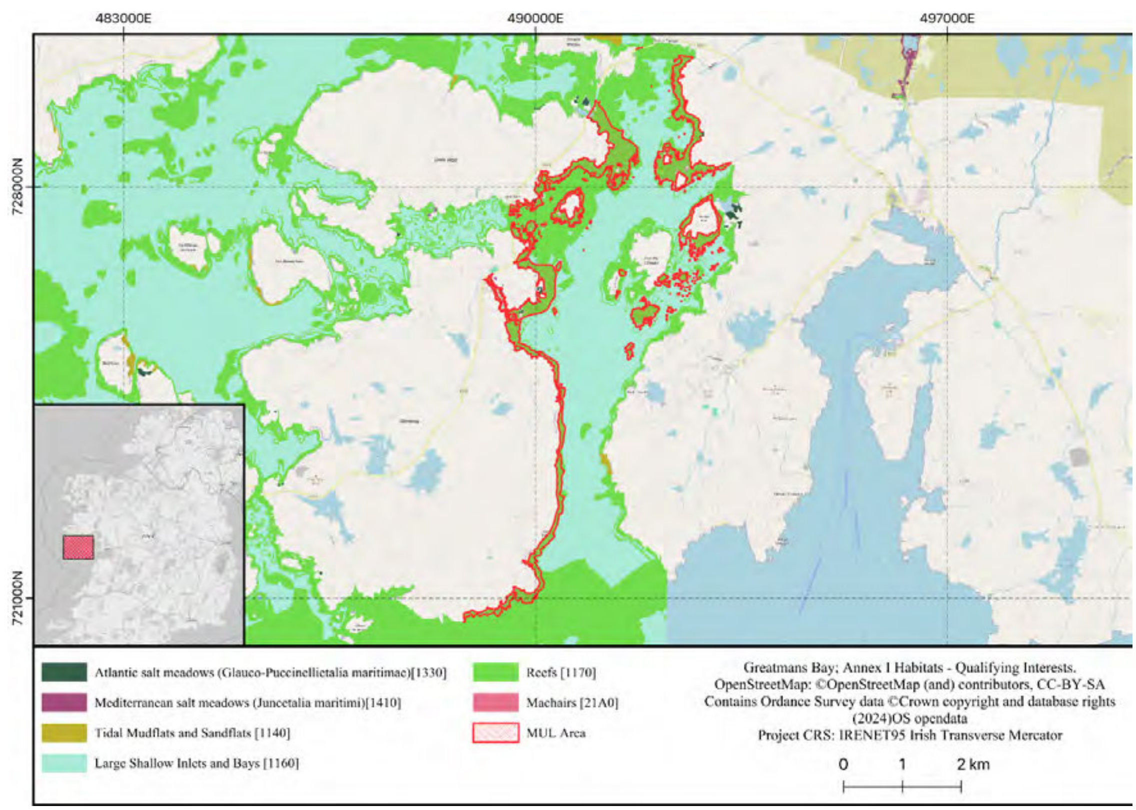

Figure 6 - Annex I Habitats in the vicinity of Greatmans Bay

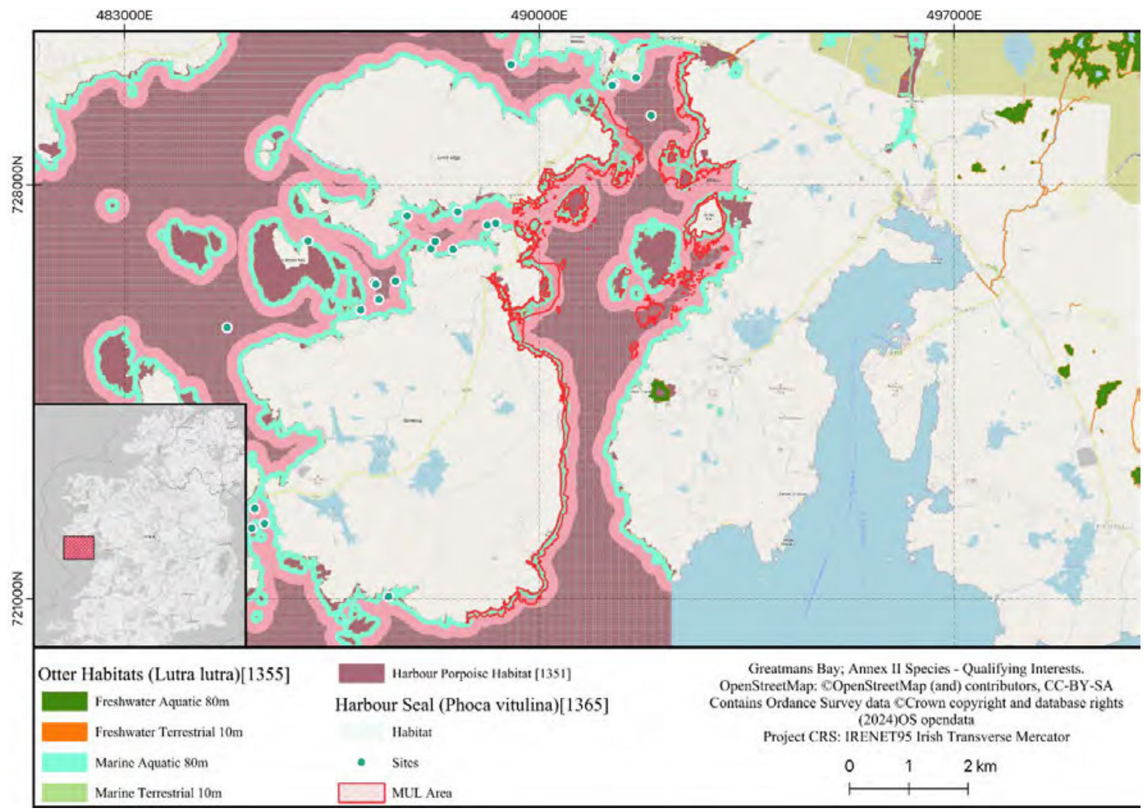

Figure 7 - Annex II Habitats in the vicinity of Greatmans Bay

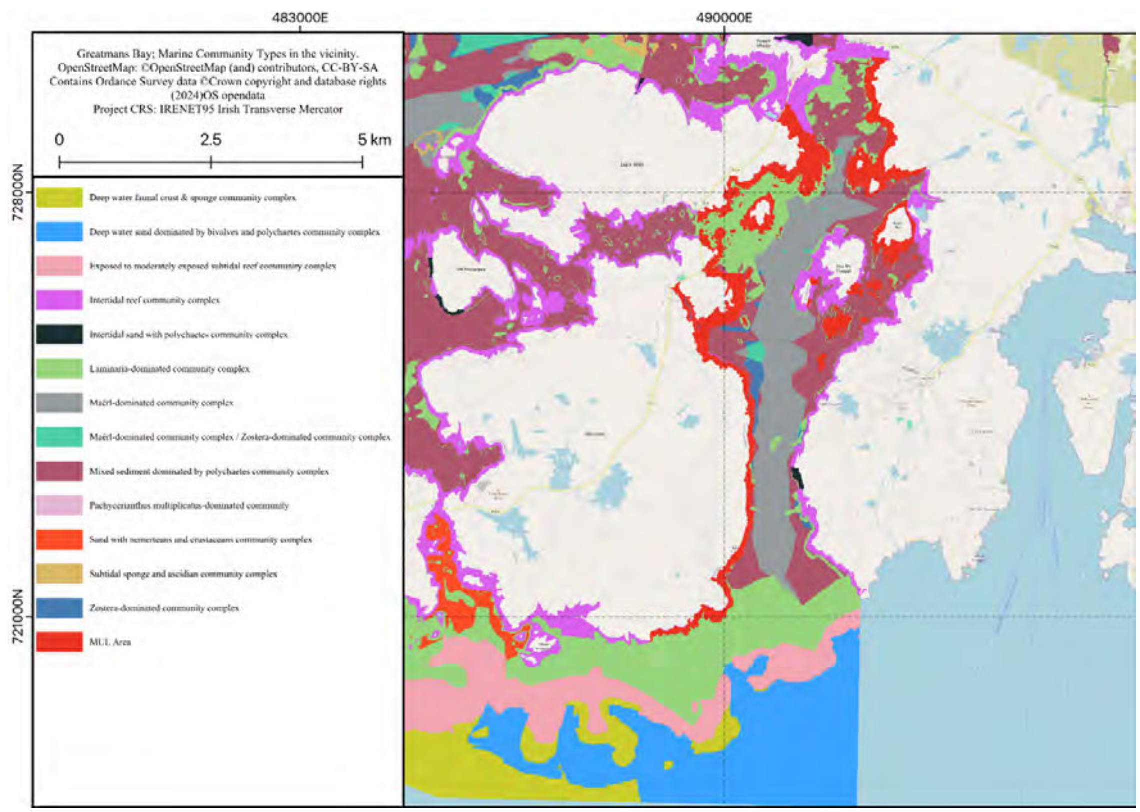

Figure 8 – Marine Community Types in the vicinity of Greatmans Bay

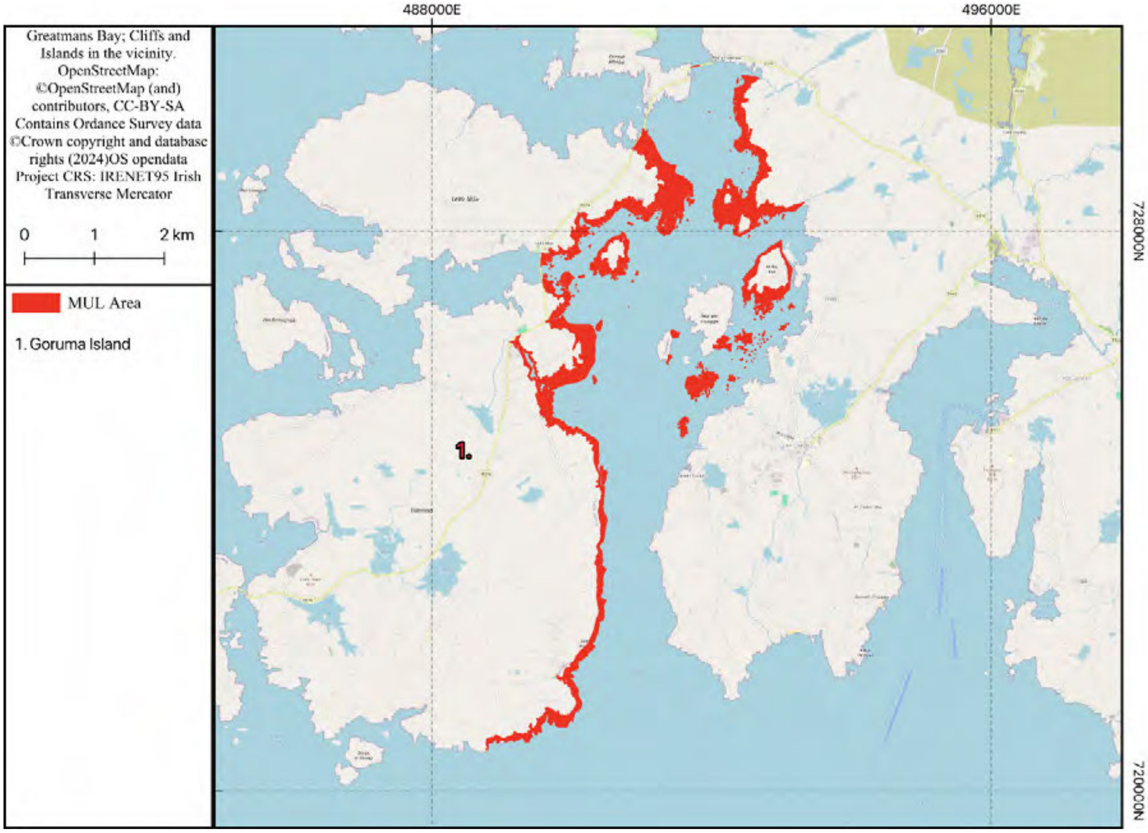

Figure 9 – Cliff Sites and Islands in the vicinity of Greatmans Bay

4. STAGE 1 Screening Appraisal for Appropriate Assessment

4.1 Site Selection Process

The potential for a Natura 2000 site to be significantly affected by seaweed harvesting under Arramara Teo's licence depends on whether Qualifying Interests (QIs)/Special Conservation Interests (SCIs) of a European site:

- May come into direct interaction with harvesters.
- Are sensitive to the sustainable harvest activities to the extent that the harvest is likely to have a significant negative effect on the specific objectives of the European site.

After an extensive search, Arramara Teo has identified relevant European sites based on the following:

- Receptors which the proposed harvesting may impact.
- Determine what impact harvesting could have on sensitive receptors.
- Determine an appropriate Zone of Influence (ZOI).
- Carry out appropriate screening of relevant conservation sites within the ZOI.

Of the SACs/SPAs within the ZOI of the MUL areas, the following QIs/SCIs (Table 3) are not deemed to be relevant to the seaweed harvesting activity as they are in no way connected to the intertidal environment and will not be directly or indirectly impacted by the harvesting activity:

Habitats	Qualifying Interests
1013	Geyer's whorl snail *Vertigo geyeri*
1014	Narrow-mouthed whorl snail *Vertigo angustior*
1065	Marsh fritillary butterfly *Euphydryas (Eurodryas, Hypodryas) aurinia*
1150	*Coastal lagoons
1230	Vegetated sea cliffs of the Atlantic and Baltic coasts
1303	Lesser horseshoe bat *Rhinolophus hipposideros*
1310	*Salicornia* and other annuals colonising mud and sand
1393	Shining sickle moss *Drepanocladus (Hamatocaulis) vernicosus*
1528	Marsh saxifrage *Saxifraga hirculus*
1833	Slender naiad *Najas flexilis*
3110	Oligotrophic waters containing very few minerals of sandy plains (*Littorelletalia uniflorae)*
3130	Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or of the *Isoëto-Nanojuncetea*
3140	Hard oligo-mesotrophic waters with benthic vegetation of *Chara spp.*
3150	Natural eutrophic lakes with Magnopotamion or Hydrocharition-type vegetation
3160	Natural dystrophic lakes and ponds
3180	*Turloughs
3260	Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation
4010	Northern Atlantic wet heaths with *Erica tetralix*

Table 3 - QIS not deemed to be relevant to the seaweed harvesting activity

Habitats	Qualifying Interests
4030	European dry heaths
4060	Alpine and Boreal heaths
5130	*Juniperus communis* formations on heaths or calcareous grasslands
6210	Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco Brometalia*) (*important orchid sites)
6410	Molinia meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae)*
6510	Lowland hay meadows *(Alopecurus pratensis, Sanguisorba officinalis*)
7130	Blanket bogs (* if active only)
7140	Transition mires and quaking bogs
7150	Depressions on peat substrates of the *Rhynchosporion*
7210	*Calcareous fens with Cladium mariscus and species of the *Caricion davallianae*
7220	*Petrifying springs with tufa formation (*Cratoneurion*)
7230	Alkaline fens
8110	Siliceous scree of the montane to snow levels (*Androsacetalia alpinae* and *Galeopsietalia ladani*)
8210	Calcareous rocky slopes with chasmophytic vegetation
8220	Siliceous rocky slopes with chasmophytic vegetation
8240	*Limestone pavements
8310	Caves not open to the public
8330	Submerged or partly submerged sea caves
91A0	Old sessile oak woods with Ilex and Blechnum in the British Isles
91E0	*Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae*)

Table 3 (cont'd) - QIS not deemed to be relevant to the seaweed harvesting activity

4.2 Determination of Zone of Influence: Establishing an Impact Pathway

This report evaluates the possibility of significant effects using the source-pathway-receptor model (Table 4). The "source" refers to elements of the proposed works that could potentially impact an ecological feature (receptor). The "pathway" is the route through which the source may alter the receptor. The "ecological receptor" refers to the Special Conservation Interests (SPAs) or Qualifying Interests (SACs) for which conservation objectives have been set for the European sites in question. An effect occurs when there is a linkage between the source, pathway, and receptor. The harvesting activity may result in the following:

- Removal of target species, such as *Ascophyllum* and *Fucus* biomass.
- Removal of non-target species, including associated flora like epiphytic *Vertebrata lanosa* and fauna such as *Littorina spp.*
- Uncovering of fauna, such as winkles and crabs, increasing their availability as prey.
- Desiccation of sediment from sunlight exposure, affecting infauna.
- Trampling of flora and fauna during the seaweed cutting process and collection/access/ Arramara Teo personnel.
- Disturbance of fauna by harvest activities.
- Potential pollution from boats.
- Increased turbidity.

Source	Pathway	Receptor	Potential Impact
Seaweed Harvesting (Physical removal of target species)	Water	Habitat structure (rocky intertidal zone)	Alteration of habitat structure; loss of habitat complexity
		Marine species (intertidal invertebrates, fish)	Loss of shelter and feeding grounds; disruption of food web
		Protected European Sites (e.g. habitats for which Natura 2000 sites are designated, such as reefs)	Degradation of habitat quality; potential loss of conservation status
Bycatch and non-target species (Removal of non-target seaweed and marine organisms)	Dispersal	Non-target seaweed species (e.g., other macroalgae)	Reduced abundance and diversity of seaweed communities
		Marine fauna (e.g., molluscs, crustaceans)	Disruption of populations and community structure
Physical disturbance (Trampling, boat anchoring, and movement)	Hydrodynamics	Intertidal and subtidal habitats (e.g., seagrass beds, maerl beds)	Direct damage to habitats; increased sedimentation and turbidity
		Nesting and breeding sites (e.g., seabirds, fish)	Disturbance to breeding sites and nesting areas
Increased turbidity (Disturbance of sediments due to harvesting activities (boat motor)	Water	Water quality (e.g., increased turbidity)	Reduced light penetration; impacts on photosynthetic organisms
		Photosynthetic organisms (e.g., phytoplankton, other algae)	Reduced primary productivity; changes in community composition
Potential pollution (Fuel spills from boats)	Water	Marine water quality (e.g., nutrient loading, chemical contamination)	Water pollution; potential eutrophication; toxic effects on marine life
		Sensitive species (e.g., benthic invertebrates, juvenile fish)	Bioaccumulation of toxins; sub-lethal and lethal effects
Noise and vibration (Disturbance from boat engines and harvesting equipment)	Water	Marine mammals (e.g., seals, dolphins)	Behavioural changes; displacement from habitat; hearing impairment
		Seabirds (e.g., nesting birds)	Disturbance leading to nest abandonment; reduced breeding success
Uncovering previously hidden fauna (Removal of seaweed canopy exposing underlying fauna)	Exposure	Exposed marine fauna (e.g., small crustaceans, juvenile fish, molluscs)	Increased vulnerability to predators; heightened environmental stress
Desiccation of sediment (Exposure of sediment to air and sun following seaweed removal)	Exposure	Sediment-dwelling organisms (e.g., burrowing invertebrates, microbial communities)	Drying out of sediment; potential mortality of moisture-dependent organisms; changes in sediment properties
Disturbance by harvesters, boats, and tractors	Air, Water	Marine fauna (e.g., seabirds, marine mammals, benthic organisms)	Direct physical disturbance; habitat avoidance; increased stress levels

Table 4 - Source Pathway – Receptor Matrix

4.3 Zone of Influence of Seaweed Harvesting Activities

A list of Natura 2000 sites potentially affected by the proposed seaweed harvesting has been compiled, focusing on those with marine/coastal Qualifying Interests (QIs) or Special Conservation Interests (SCIs). The Zone of Influence (ZOI) for this assessment was expanded to include designated Natura 2000 sites that could be impacted to account for all potential direct, indirect and cumulative effects. (See Table 5 and Figures 13 to 18).

- Any SAC near the Screening Area assigned for Annex I habitats that the proposed works might impact.
- Any SAC assigned for mobile Annex II species that may be present within the Screening Area and impacted by the works.
- Any SPA designated for birds, including SPAs with breeding seabirds identified as SCI species, that may occur within the Screening Area and be impacted by the proposed works. The indicative breeding season mean maximum foraging ranges from Woodward et al. (2019) have been applied to identify relevant species, where the mean maximum represents the highest range reported in each study, averaged across studies.

4.4 Habitats

The Appropriate Assessment (AA) Screening identified sensitive receptors within the ZOI using the Source-Pathway-Receptor (SPR) model. For habitats like mudflats, reefs, and large shallow inlets and bays, the ZOI is confined to the Bay.

4.5 Marine Mammals

The ZOl extends to their respective Management Units (MUs) for mobile species such as Common bottlenose dolphins and Harbour porpoises. See supplemental Annex IV Species at Risk Assessment Report. ZOI considerations for highly mobile species, like cetaceans, pinnipeds, and mustelids, are based on the latest empirical evidence of foraging ranges, ensuring comprehensive coverage of potential impacts.

- **Cetaceans**: The published Management Unit (MU) for Harbour porpoise (*Phocoena phocoena*) and Common bottlenose dolphin (*Tursiops truncatus*) (IAMMWG, 2023).
- **Pinnipeds:** Grey seal (*Halichoerus grypus*) foraging range is a maximum of 448 km, while the Harbour (common) seal (*Phoca vitulina*) maximum foraging range is 273 km (Carter et al. 2022).
- **Mustelids:** Otters regularly commute up to 500m across open water.

Using this approach, all proposed project components were examined to identify potential pathways and receptors that could be impacted, allowing for the establishment of a ZOI. This process included the following steps:

- They are identifying sources of potential impacts and their pathways from the proposed project site to European Sites.
- Consider sensitive receptors and their dependent ecosystems within the European sites.
- They identify and characterise project-related impacts and their likely direct, indirect and cumulative effects on the identified sensitive receptors.

Species/Habitat	Potential Impact	Zone of Influence (ZOI)	Associated Habitat
Benthic habitats			
Reefs, mudflats, etc.	Removal of material	Within the bay	
Cetaceans			
Harbour porpoise (*Phocoena phocoena*)	Underwater noise / physical disturbance	Celtic and Irish Sea MU (IAMMWG, 2023)	Harbour porpoises (*Phocoena phocoena*) are found year-round in Irish coastal waters, particularly in shallow bays, estuaries, and nearshore areas, where they feed on small fish and invertebrates. Sightings are common throughout the year, with notable concentrations in spring and late summer (*Berrow et al. 2008*).
Bottlenose dolphin (*Tursiops truncatus*)		Irish Sea and offshore Channel and SW England	Bottlenose dolphins (*Tursiops truncatus*) are present year-round in Irish waters, particularly in coastal areas, estuaries, and bays, where they are often seen in small groups. They are most frequently observed along the western and southern coasts, with higher activity noted during the warmer months from spring through autumn (*Ingram & Rogan, 2002*).
Mustelids			
European otter (*Lutra lutra*)	Underwater noise / physical disturbance	500m	The European otter (*Lutra lutra*) is found throughout Ireland, inhabiting a variety of aquatic habitats, including rivers, lakes, estuaries, and coastal areas. Otters are active year-round and are primarily nocturnal or crepuscular, with their activity influenced by food availability and seasonal water conditions. They are common along the west coast but are also distributed inland, favouring areas with dense vegetation for cover (*Bailey et al. 2013*).
Pinnipeds			
Grey seal (*Halichoerus grypus*)	Underwater noise / physical disturbance	448 km *(Carter et al. 2022)*	Grey seals (*Halichoerus grypus*) are present year-round in Irish coastal waters, with key habitats including rocky shorelines, islands, and estuaries. They haul out onshore to rest, breed, and moult, with the breeding season typically occurring from September to December. Grey seals are frequently observed along the west and southwest coasts, where they form colonies on isolated islands and undisturbed beaches (*Cronin et al. 2014*).
Harbour (common) seal (*Phoca vitulina*)		273 km *(Carter et al. 2022)*	Harbour seals (*Phoca vitulina*) are found year-round in Irish coastal waters, particularly in sheltered bays, estuaries, and intertidal areas. They come ashore, or haul out, regularly to rest, breed, and moult, with the pupping season typically occurring in June and July, followed by moulting in August. Harbour seals are most observed along Ireland's west and south coasts (*Duck & Morris, 2013*).

Table 5 - Zone of Influence of potentially impacted mobile species and habitats

Species/Habitat	Potential Impact	Zone of Influence (ZOI)	Associated Habitat
Marine Fish			
Sea lamprey (*Petromyzon marinus*)	Underwater noise / physical disturbance	35 km	Sea lamprey (*Petromyzon marinus*) migrate into Irish waters from the ocean to freshwater rivers for spawning, typically entering estuaries and coastal areas in late spring to early summer. The peak migration period occurs between April and July, after which they move into rivers to spawn in suitable gravel habitats (*King & Roche, 2008*).
River lamprey (*Lampetra fluviatilis*)			River lamprey (*Lampetra fluviatilis*) migrate from estuarine and coastal environments into freshwater rivers in Ireland to spawn. This migration generally occurs in late autumn and winter, with peak movement between November and February, when they seek suitable spawning grounds in gravelly riverbeds (*King & Linnane, 2004*).
Twaite shad (*Alosa fallax fallax*) *			Twaite shad (*Alosa fallax fallax*) is present in Irish waters as they migrate annually from marine environments to freshwater rivers to spawn. They typically enter estuaries and coastal waters in late spring, with peak migration occurring from April to June, before moving upriver to spawn in flowing, shallow river habitats (*Maitland & Hatton-Ellis, 2003*).
Allis shad (*Alosa alosa*)*			Allis shad (*Alosa alosa*) migrate into Irish waters from the sea to freshwater rivers to spawn. They typically enter estuaries and coastal areas in the spring, with peak migration between April and May, moving upstream to spawn in fast-flowing sections of rivers with gravel beds (*Aprahamian & Lester, 2001*).
Atlantic salmon (*Salmo salar*) **			Atlantic salmon (*Salmo salar*) migrate from oceanic habitats back to Irish freshwater rivers to spawn. They are typically present in Irish coastal and estuarine waters from spring through autumn, with peak migrations occurring between May and October. After entering coastal waters, they move upriver to reach spawning grounds in clean, gravel-bottomed streams (*McCarthy et al. 2008*).
Migratory Birds			
Sandwich Tern (*Thalasseus sandvicensis*)	Disturbance	34.3 km *(Woodward et al. 2019)*	Sandwich Terns (*Thalasseus sandvicensis*) typically forage in shallow coastal waters, including estuaries and lagoons, and sometimes over rocky intertidal zones where small fish are concentrated during tidal movements. They are known to exploit a variety of coastal habitats, adjusting their foraging strategies according to prey availability (Gochfeld et al. *2018*).
Lesser Black-backed Gull (*Larus fuscus*)		127 km *(Woodward et al. 2019)*	Lesser Black-backed Gulls *(Larus fuscus*) frequently forage along coastal areas, including rocky intertidal zones, estuaries, and beaches, where they scavenge and hunt for a variety of prey. They are highly adaptable and use the intertidal zone to exploit food resources exposed during low tide, including small invertebrates and fish (*Cramp et al. 1983*).

Table 5 (cont'd) - Zone of Influence of potentially impacted mobile species and habitats

Species/Habitat	Potential Impact	Zone of Influence (ZOI)	Associated Habitat
Migratory Birds			
Common Gull (*Larus canus*)	Disturbance	50 km *(Woodward et al. 2019)*	Common Gulls *(Larus canus*) are often found in coastal habitats, including rocky intertidal zones, mudflats, and sandy shores, where they forage for invertebrates, small fish, and other marine organisms. They frequently exploit these areas during low tide when food resources are more accessible (*Cramp et al. 1983*).
Arctic Tern (*Sterna paradisaea*)		25.7 km *(Woodward et al. 2019)*	Arctic Terns (*Sterna paradisaea*) frequently forage in shallow coastal waters, estuaries, and sometimes along rocky shorelines where tidal movements concentrate prey. They are adept at exploiting intertidal areas, especially during low tide, for small fish and invertebrates (*Hatch et al. 2020*).
Cormorant (*Phalacrocorax carbo*)		25.6 km *(Woodward et al. 2019)*	Cormorants (*Phalacrocorax carbo*) are commonly found along coastal zones, including rocky intertidal areas, where they forage for fish and other marine prey. They are highly adaptable and frequently dive in shallow coastal waters and around rocky outcrops, taking advantage of prey availability influenced by tidal movements (*Cramp & Simmons, 1977*).
Herring Gull (*Larus argentatus*)		58.8 km (Woodward et al. 2019)	Herring Gulls (*Larus argentatus*) frequently forage along coastal areas, including rocky intertidal zones, mudflats, and sandy shores. They are highly opportunistic and make use of intertidal zones during low tide, scavenging or hunting for invertebrates, fish, and other available prey (*Cramp & Simmons, 1983*).
Shag (*Phalacrocorax aristotelis*)		13.2 km (*Woodward et al. 2019)*	Shags (*Phalacrocorax aristotelis*) are closely associated with rocky coastal environments, frequently foraging in intertidal and shallow subtidal zones near rocky shores. They rely on these areas to hunt for fish and other marine prey, often diving close to the shore where prey is concentrated (*Cramp & Simmons., 1977*).

* Species not considered as it is not a QI of relevant SACs.

** Atlantic salmon (*Salmo solar*) is not considered further as salmon is an anadromous fish that spawns in rivers and is protected under Annex II of the EU Habitats Directive only when in freshwater.

Table 5 (cont'd) - Zone of Influence of potentially impacted mobile species and habitats

4.6 Migratory Birds

Arramara Teo has applied a targeted screening approach to assess potential impacts on migratory bird species. This approach considers the Source-Pathway-Receptor (SPR) model, which refines this radius by considering species-specific foraging mobility. Due to the localised and transient nature of the seaweed harvesting activities, migratory birds from SPAs whose foraging ranges, as described by Woodward et al. (2019), overlap with the Maritime Usage Licence (MUL) area have been included in this screening.

In this screening process, SPAs are evaluated for potential ecological connectivity to the MUL area if their Special Conservation Interest (SCI) species, related habitats, or wetlands are within the foraging range or directly overlap with the project site. This connectivity is based on established criteria:

- The presence of European sites within the search area (criteria 1).
- Sites associated with qualifying mobile species whose range (such as foraging, migratory, overwintering, breeding, or natural habitat range) may interact with the MUL area (criteria 2).

Woodward et al. (2019) provided a robust, species-specific mean-maximum foraging distance dataset, which Arramara Teo has employed conservatively to encompass the foraging ranges of relevant migratory seabirds. Using Woodward et al. (2019) for foraging distances, Arramara Teo has mapped foraging zones for breeding seabirds, ensuring that these zones cover all SPAs within the range of the project area. Specifically, foraging distances are vital for assessing potential connectivity with seabird colonies during the breeding season, as seabirds operate as central-place foragers, regularly returning to nesting sites to provide for their young. During this period, the predictable foraging behaviour of seabirds allows a clear measure of impact. In contrast, non-breeding season movements are more variable and dispersed, highlighting the need for seasonal context in assessing project interactions. For seabird species during the summer breeding months, the ZOI is considered to extend to all those SPAs within the foraging range of the proposed MUL area. For wintering species, which often have shorter foraging ranges than seabirds, the mean-maximum foraging range is applied as a precautionary step.

The following Natura 2000 sites (Table 6) were screened for inclusion in the project's ZOI, considering both direct overlaps and ecological corridors or foraging paths that could enable species movements to and from the project area. This approach, prioritising scientifically grounded screening criteria, ensures that potential impacts on migratory bird species are effectively assessed and mitigated where necessary.

Natura 2000 site	Qualifying Interest/ Special Conservation Interest	Source-Pathway-Receptor Connections rationale	Considered for screening Y/N
Kilkieran Bay and Islands SAC IE002111	Mudflats and sandflats not covered by seawater at low tide [1140]; Large shallow inlets and bays [1160]; Reefs [1170]; Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [1330]; Mediterranean salt meadows (*Juncetalia maritimi*) [1410]; Otter *Lutra lutra* [1355]; Harbour seal *Phoca vitulina* [1365]; Harbour porpoise *Phocoena phocoena* [1351]	**Mudflats and sandflats** - Seaweed harvesting is planned within the range of this habitat type, introducing the possibility of direct disturbance from manual harvesters as well as from boat and rake operations. Additionally, the potential for habitat fragmentation and water quality impacts associated with boat usage has been identified. A potential pathway for significant effects exists, necessitating mitigation measures to reduce these impacts; **Large shallow inlets and bays** - Seaweed harvesting is planned within the range of this habitat type, introducing the possibility of direct disturbance from manual harvesters, as well as from boat and rake operations. Additionally, the potential for habitat fragmentation and water quality impacts associated with boat usage has been identified. A potential pathway for significant effects exists, necessitating mitigation measures to reduce these impacts; **Reefs** - Seaweed harvesting is planned within the range of this habitat type, introducing the possibility of direct disturbance from manual harvesters, as well as from boat and rake operations. Additionally, the potential for habitat fragmentation and water quality impacts associated with boat usage has been identified. A potential pathway for significant effects exists, necessitating mitigation measures to reduce these impacts; **Atlantic salt meadows** - Seaweed harvesting is planned within the range of this habitat type, introducing the possibility of direct disturbance from manual harvesters, as well as from boat and rake operations. Additionally, the potential for habitat fragmentation and water quality impacts associated with boat usage has been identified. A potential pathway for significant effects exists, necessitating mitigation measures to reduce these impacts; **Mediterranean salt meadows** - Seaweed harvesting is planned within the range of this habitat type, introducing the possibility of direct disturbance from manual harvesters, as well as from boat and rake operations. Additionally, the potential for habitat fragmentation and water quality impacts associated with boat usage has been identified. A potential pathway for significant effects exists, necessitating mitigation measures to reduce these impacts; **Otter** - Seaweed harvesting is planned within the range of this species type, introducing the possibility of direct disturbance from manual harvesters, as well as from boat and rake operations. Additionally, the potential for habitat fragmentation and water quality impacts associated with boat usage has been identified. A potential pathway for significant effects exists, necessitating mitigation measures to reduce these impacts; **Harbour seal** - Harvesting within the foraging range of *Phoca vitulina* (Harbour seal) (up to 273km, Carter et al. 2022); **Harbour porpoise** - Seaweed harvesting within Harbour porpoise Management Unit (IAMMWG, 2023).	Y - Mudflats and sandflats; Y - Large shallow inlets and bays; Y - Reefs; Y - Atlantic salt meadows; Y - Mediterranean salt meadows; Y - Otter; Y - Harbour seal; Y - Harbour porpoise

Table 6 - Relevant Natura 2000 sites and SPR identification and Rationale

Natura 2000 site	Qualifying Interest/ Special Conservation Interest	Source-Pathway-Receptor Connections rationale	Considered for screening Y/N
Kilkieran Bay and Islands SAC IE002111	Coastal lagoons [1150]; Machairs (* in Ireland) [21A0]; Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or Isoeto-Nanojuncetea [3130]; Lowland hay meadows (Alopecurus pratensis, Sanguisorba officinalis) [6510]; Najas flexilis (c) [1833]	No Source-Pathway-Receptor link.	N - Coastal lagoons; N - Machairs; N - Oligotrophic to mesotrophic standing waters; N - Lowland hay meadows; N - Lowland hay meadows
Inishmore Island SAC IE000212	Reefs [1170]; Perennial vegetation of stony banks [1220]; Vegetated sea cliffs of the Atlantic and Baltic coasts [1230]; Embryonic shifting dunes [2110]; Shifting dunes along the shoreline with *Ammophila arenaria* (white dunes) [2120]; Machairs (* in Ireland) [21A0]; European dry heaths [4030]; Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites) [6210]; Lowland hay meadows (Alopecurus pratensis, Sanguisorba officinalis) [6510]; Limestone pavements [8240]	No Source-Pathway-Receptor link.	N - Reefs; N - Perennial vegetation; N - Vegetated sea cliffs; N - Embryonic shifting dunes; N - White dunes; N – Machairs; N - European dry heaths; N - Semi-natural dry grasslands; N - Lowland hay meadows; N - Limestone pavements
Connemara Bog Complex SAC IE002034	Otter *Lutra lutra* [1355]	**Otter** - Seaweed harvesting is planned within the range of this species type, introducing the possibility of direct disturbance from manual harvesters, as well as from boat and rake operations. Additionally, the potential for habitat fragmentation and water quality impacts associated with boat usage has been identified. A potential pathway for significant effects exists, necessitating mitigation measures to reduce these impacts.	**Y – Otter**

Table 6 (cont'd) - Relevant Natura 2000 sites and SPR identification and Rationale

Natura 2000 site	Qualifying Interest/ Special Conservation Interest	Source-Pathway-Receptor Connections rationale	Considered for screening Y/N
Connemara Bog Complex SAC IE002034	Reefs [1170]; Coastal lagoons [1150]; Oligotrophic waters containing very few minerals of sandy plains (*Littorelletalia uniflorae*) [3110]; Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or *Isoeto-Nanojuncetea* [3130]; Natural dystrophic lakes and ponds [3160]; Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation [3260]; Northern Atlantic wet heaths with *Erica tetralix* [4010]; European dry heaths [4030]; Molinia meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*) [6410]; Blanket bogs (* if active bog) [7130]; Transition mires and quaking bogs [7140]; Depressions on peat substrates of the *Rhynchosporion* [7150]; Alkaline fens [7230]; Old sessile oak woods with Ilex and Blechnum in the British Isles [91A0]; Euphydryas aurinia (Marsh Fritillary) [1065]; Salmo salar (Salmon) [1106]; Najas flexilis (Slender Naiad) [1833]	No Source-Pathway-Receptor link.	N - Reefs; N - Coastal lagoons; N - Oligotrophic waters; N - Oligotrophic to mesotrophic waters; N - Natural dystrophic lakes and ponds; N - Water courses; N - Northern Atlantic wet heaths; N - European dry heaths; N - Molinia meadows; N - Blanket bogs; N - Transition mires; N - Depressions on peat; N - Alkaline fens; N - Old sessile oak; N - Marsh Fritillary; N – Salmon; N - Slender Naiad
The Twelve Bens/Garraun Complex SAC IE002031	Oligotrophic waters containing very few minerals of sandy plains (Littorelletalia uniflorae) [3110]; Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or Isoeto-Nanojuncetea [3130]; Alpine and Boreal heaths [4060]; Blanket bogs (* if active bog) [7130]; Depressions on peat substrates of the Rhynchosporion [7150]; Siliceous scree of the montane to snow levels (Androsacetalia alpinae and Galeopsietalia ladani) [8110]; Calcareous rocky slopes with chasmophytic vegetation [8210]; Siliceous rocky slopes with chasmophytic vegetation [8220]; Old sessile oak woods with Ilex and Blechnum in the British Isles [91A0]; Margaritifera margaritifera (Freshwater Pearl Mussel) [1029]; Salmo salar (Salmon) [1106]; Lutra lutra (Otter) [1355]	No Source-Pathway-Receptor link.	N - Oligotrophic waters; N - Oligotrophic to mesotrophic standing waters; N - Alpine and Boreal heaths; N - Blanket bogs; N - Depressions on peat; N - Siliceous scree; N - Calcareous rocky slopes; N - Siliceous rocky slopes; N - Old sessile oak woods; N - Freshwater Pearl Mussel; N – Salmon; N - Otter
Slyne Head Islands SAC IE000328	Reefs [1170]; Grey seal *Halichoerus grypus* [1364]; *Tursiops truncatus* (Common bottlenose dolphin) [1349]	No Source-Pathway-Receptor link.	N - Reefs; N - Grey seal; N - Common bottlenose dolphin
West Connacht Coast SAC IE002998	Common bottlenose dolphin *Tursiops truncatus* [1349]; Harbour porpoise *Phocoena phocoena* [1351]	No Source-Pathway-Receptor link.	N - Common bottlenose dolphin; N - Harbour porpoise

Table 6 (cont'd) - Relevant Natura 2000 sites and SPR identification and Rationale

Natura 2000 site	Qualifying Interest/ Special Conservation Interest	Source-Pathway-Receptor Connections rationale	Considered for screening Y/N
Lough Carra/Mask Complex SAC IE001774	Oligotrophic waters containing very few minerals of sandy plains (Littorelletalia uniflorae) [3110]; Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or Isoeto-Nanojuncetea [3130]; Hard oligo-mesotrophic waters with benthic vegetation of Chara spp. [3140]; European dry heaths [4030]; Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites) [6210]; Calcareous fens with Cladium mariscus and species of the Caricion davallianae [7210]; Alkaline fens [7230]; Limestone pavements [8240]; Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae) [91E0]; Rhinolophus hipposideros (Lesser Horseshoe Bat) [1303]; Lutra lutra (Otter) [1355]; Hamatocaulis vernicosus (Slender Green Feather-moss) [6216]	No Source-Pathway-Receptor link.	N - Oligotrophic waters; N - Oligotrophic to mesotrophic standing waters; N - Hard oligo-mesotrophic waters; N - European dry heaths; N - Semi-natural dry grasslands; N - Calcareous fens; N - Alkaline fens; N - Limestone pavements; N - Alluvial forests; N - Lesser Horseshoe Bat; N – Otter; N - Slender Green Feather-moss
Lough Corrib SAC IE000297	Oligotrophic waters containing very few minerals of sandy plains (Littorelletalia uniflorae) [3110]; Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or Isoeto-Nanojuncetea [3130]; Hard oligo-mesotrophic waters with benthic vegetation of Chara spp. [3140]; Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation [3260]; Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites) [6210]; Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae) [6410]; Active raised bogs [7110]; Degraded raised bogs still capable of natural regeneration [7120]; Depressions on peat substrates of the Rhynchosporion [7150]; Calcareous fens with Cladium mariscus and species of the Caricion davallianae [7210]; Petrifying springs with tufa formation (Cratoneurion) [7220]; Alkaline fens [7230]; Limestone pavements [8240]; Old sessile oak woods with Ilex and Blechnum in the British Isles [91A0]; Bog woodland [91D0]; Margaritifera margaritifera (Freshwater Pearl Mussel) [1029]; Austropotamobius pallipes (White-clawed Crayfish) [1092]; Petromyzon marinus (Sea Lamprey) [1095]; Lampetra planeri (Brook Lamprey) [1096]; Salmo salar (Salmon) [1106]; Rhinolophus hipposideros (Lesser Horseshoe Bat) [1303]; Lutra lutra (Otter) [1355]; Najas flexilis (Slender Naiad) [1833]; Hamatocaulis vernicosus (Slender Green Feather-moss) [6216]	No Source-Pathway-Receptor link.	N - Oligotrophic waters; N - Oligotrophic to mesotrophic standing waters; N - Hard oligo-mesotrophic waters; N - Water courses; N - Semi-natural dry grasslands; N - Molinia meadows; N - Active raised bogs; N - Degraded raised bogs; N - Depressions on peat; N - Calcareous fens; N - Petrifying springs; N - Alkaline fens; N - Limestone pavements; N - Old sessile oak woods; N - Bog woodland; N - Freshwater Pearl Mussel; N - White-clawed Crayfish; N - Sea Lamprey; N - Brook Lamprey; N – Salmon; N - Lesser Horseshoe Bat; N – Otter; N - Slender Naiad; N - Slender Green Feather-moss

Table 6 (cont'd) - Relevant Natura 2000 sites and SPR identification and Rationale

Natura 2000 site	Qualifying Interest/ Special Conservation Interest	Source-Pathway-Receptor Connections rationale	Considered for screening Y/N
St. John's Point SAC IE000191	Large shallow inlets and bays [1160]; Reefs [1170]; Vegetated sea cliffs of the Atlantic and Baltic coasts [1230]; Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites) [6210]; Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae) [6410]; Alkaline fens [7230]; Limestone pavements [8240]; Submerged or partially submerged sea caves [8330]; Euphydryas aurinia (Marsh Fritillary) [1065]; *Tursiops truncatus* (Common bottlenose dolphin) [1349]	No Source-Pathway-Receptor link.	N - Large shallow inlets and bays; N – Reefs; N - Vegetated sea cliffs; N - Semi-natural dry grasslands; N - Molinia meadows; N - Alkaline fens; N - Limestone pavements; N - Submerged sea caves; N - Marsh Fritillary; N - Bottlenose dolphin
Slyne Head Peninsula SAC IE002074	Coastal lagoons [1150]; Large shallow inlets and bays [1160]; Reefs [1170]; Annual vegetation of drift lines [1210]; Perennial vegetation of stony banks [1220]; Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [1330]; Mediterranean salt meadows (*Juncetalia maritimi*) [1410]; Embryonic White dunes [2110]; White dunes along the shoreline with *Ammophila arenaria* (white dunes) [2120]; Machairs (* in Ireland) [21A0]; Oligotrophic waters containing very few minerals of sandy plains (*Littorelletalia uniflorae*) [3110]; Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or Isoeto-Nanojuncetea [3130]; Hard oligo-mesotrophic waters with benthic vegetation of Chara spp. [3140]; European dry heaths [4030]; Juniperus communis formations on heaths or calcareous grasslands [5130]; Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites) [6210]; Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae) [6410]; Lowland hay meadows (Alopecurus pratensis, Sanguisorba officinalis) [6510]; Alkaline fens [7230]; Petalwort *Petalophyllum ralfsii* [1395]; *Tursiops truncatus* (Common bottlenose dolphin) [1349]; Najas flexilis (Slender Naiad) [1833]	No Source-Pathway-Receptor link.	N - Coastal lagoons; N - Large shallow inlets and bays; N - Reefs; N - Annual drift lines; N - Perennial vegetation of stony banks; N - Atlantic salt meadows; N - Mediterranean salt meadows; N - Embryonic dunes; N - White dunes; N - Machairs; N - Oligotrophic waters; N - Oligotrophic to mesotrophic standing waters; N - Hard oligo-mesotrophic waters; N - European dry heaths; N - Juniperus communis formations; N - Semi-natural dry grasslands; N - Molinia meadows; N - Lowland hay meadows; N - Alkaline fens; N – Petalwort; N - Common bottlenose dolphin; N - Slender Naiad
Inishkea Islands SAC IE000507	Machairs (* in Ireland) [21A0]; Grey seal *Halichoerus grypus* [1364]; Petalwort *Petalophyllum ralfsii* [1395]	No Source-Pathway-Receptor link.	N - Machairs; N - Grey seal; N - Petalwort

Table 6 (cont'd) - Relevant Natura 2000 sites and SPR identification and Rationale

Natura 2000 site	Qualifying Interest/ Special Conservation Interest	Source-Pathway-Receptor Connections rationale	Considered for screening Y/N
Galway Bay Complex SAC IE000268	***Phoca vitulina* (Harbour seal) [1365]**	**Harbour seal** - Harvesting within the foraging range of *Phoca vitulina* (Harbour seal) (up to 273km, Carter et al. 2022).	**Y - Harbour seal**
	Mudflats and sandflats not covered by seawater at low tide [1140]; Coastal lagoons [1150]; Large shallow inlets and bays [1160]; Reefs [1170]; Perennial vegetation of stony banks [1220]; Vegetated sea cliffs of the Atlantic and Baltic coasts [1230]; Salicornia and other annuals colonising mud and sand [1310]; Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [1330]; Mediterranean salt meadows (*Juncetalia maritimi*) [1410]; Turloughs [3180]; Juniperus communis formations on heaths or calcareous grasslands [5130]; Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites) [6210]; Calcareous fens with Cladium mariscus and species of the Caricion davallianae [7210]; Alkaline fens [7230]; Limestone pavements [8240]; *Lutra lutra* (Otter) [1355]	No Source-Pathway-Receptor link.	N - Mudflats and sandflats; N - Coastal lagoons; N - Large shallow inlets and bays; N - Reefs; N - Perennial vegetation; N - Vegetated sea cliffs; N – Salicornia; N - Atlantic salt meadows; N - Mediterranean salt meadows; N – Turloughs; N - Juniperus communis formations; N - Semi-natural dry grasslands; N - Calcareous fens; N - Alkaline fens; N - Limestone pavements; N - Otter
Duvillaun Islands SAC IE000495	Grey seal *Halichoerus grypus* [1364]; *Tursiops truncatus* (Common bottlenose dolphin) [1349]	No Source-Pathway-Receptor link.	N - Grey seal; N - Common bottlenose dolphin
Blasket Islands SAC IE002172	Reefs [1170]; Vegetated sea cliffs of the Atlantic and Baltic coasts [1230]; European dry heaths [4030]; Submerged or partially submerged sea caves [8330]; Harbour porpoise *Phocoena phocoena* [1351]; Grey seal *Halichoerus grypus* [1364]	No Source-Pathway-Receptor link.	N - Reefs; N - Vegetated sea cliffs; N - European dry heaths; N - Submerged sea caves; N - Harbour porpoise; N - Grey seal
Inishbofin and Inishshark SAC IE000278	Coastal lagoons [1150]; Oligotrophic waters containing very few minerals of sandy plains (Littorelletalia uniflorae) [3110]; Northern Atlantic wet heaths with Erica tetralix [4010]; European dry heaths [4030]; Grey seal *Halichoerus grypus* [1364]	No Source-Pathway-Receptor link.	N - Coastal lagoons; N - Oligotrophic waters; N - Northern Atlantic wet heaths; N - European dry heaths; N - Grey seal
Rockabill to Dalkey SAC IE003000	Reefs [1170]; Harbour porpoise *Phocoena phocoena* [1351]	No Source-Pathway-Receptor link.	N - Reefs; N - Harbour porpoise

Table 6 (cont'd) - Relevant Natura 2000 sites and SPR identification and Rationale

Natura 2000 site	Qualifying Interest/ Special Conservation Interest	Source-Pathway-Receptor Connections rationale	Considered for screening Y/N
Clew Bay Complex SAC IE001482	**Harbour seal *Phoca vitulina* [1365]**	**Harbour seal** - Harvesting within the foraging range of *Phoca vitulina* (Harbour seal) (up to 273km, Carter et al. 2022).	**Y - Harbour seal**
	Mudflats and sandflats not covered by seawater at low tide [1140]; Coastal lagoons [1150]; Large shallow inlets and bays [1160]; Annual vegetation of drift lines [1210]; Perennial vegetation of stony banks [1220]; Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [1330]; Embryonic shifting dunes [2110]; Shifting dunes along the shoreline with Ammophila arenaria (white dunes) [2120]; Machairs (* in Ireland) [21A0]; Old sessile oak woods with Ilex and Blechnum in the British Isles [91A0]; Otter *Lutra lutra* [1355]	No Source-Pathway-Receptor link.	N - Mudflats and sandflats; N – Coastal lagoons; N - Large shallow inlets and bays; N - Annual vegetation of drift lines; N - Perennial vegetation of stony banks; N - Atlantic salt meadows; N - Embryonic dunes; N - White dunes; N – Machairs; N - Old sessile oak woods; N - Otter
Lower River Shannon SAC IE002165	Sandbanks which are slightly covered by sea water all the time [1110]; Estuaries [1130]; Mudflats and sandflats not covered by seawater at low tide [1140]; Coastal lagoons [1150]; Large shallow inlets and bays [1160]; Reefs [1170]; Perennial vegetation of stony banks [1220]; Vegetated sea cliffs of the Atlantic and Baltic coasts [1230]; Salicornia and other annuals colonising mud and sand [1310]; Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [1330]; Mediterranean salt meadows (*Juncetalia maritimi*) [1410]; Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation [3260]; Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae) [6410]; Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae) [91E0]; Margaritifera margaritifera (Freshwater Pearl Mussel) [1029]; Petromyzon marinus (Sea Lamprey) [1095]; Lampetra planeri (Brook Lamprey) [1096]; *Lampetra fluviatilis* (River Lamprey) [1099]; Salmo salar (Salmon) [1106]; *Tursiops truncatus* (Common bottlenose dolphin) [1349]; *Lutra lutra* (Otter) [1355]	No Source-Pathway-Receptor link.	N - Sandbanks; N - Estuaries; N - Mudflats and sandflats; N - Coastal lagoons; N - Large shallow inlets and bays; N – Reefs; N - Perennial vegetation; N - Vegetated sea cliffs; N – Salicornia; N - Atlantic salt meadows; N - Mediterranean salt meadows; N - Water courses; N - Molinia meadows; N - Alluvial forests; N - Freshwater Pearl Mussel; N - Sea Lamprey; N - Brook Lamprey; N - River Lamprey; N – Salmon; N - Bottlenose dolphin; N - Otter

Table 6 (cont'd) - Relevant Natura 2000 sites and SPR identification and Rationale

Natura 2000 site	Qualifying Interest/ Special Conservation Interest	Source-Pathway-Receptor Connections rationale	Considered for screening Y/N

Roaringwater Bay and Islands SAC IE000101	Large shallow inlets and bays [1160]; Reefs [1170]; Vegetated sea cliffs of the Atlantic and Baltic coasts [1230]; European dry heaths [4030]; Submerged or partially submerged sea caves [8330]; Harbour porpoise *Phocoena phocoena* [1351]; Otter *Lutra lutra* [1355]; Grey seal *Halichoerus grypus* [1364]	No Source-Pathway-Receptor link.	N - Large shallow inlets and bays; N - Reefs; N - Vegetated sea cliffs; N - European dry heaths; N - Submerged sea caves; N - Harbour porpoise; N – Otter; N – Grey seal
Belgica Mound Province SAC IE002327	Reefs [1170]; *Tursiops truncatus* (Common bottlenose dolphin) [1349]; *Phocoena phocoena* (Harbour porpoise) [1351]	No Source-Pathway-Receptor link.	N – Reefs; N – Common Bottlenose dolphin; N – Harbour porpoise
Codling Fault Zone SAC IE003015	Submarine structures made by leaking gases [1180]; *Phocoena phocoena* (Harbour porpoise) [1351]	No Source-Pathway-Receptor link.	N - Submarine structures; N – Harbour porpoise
Inishkea Islands SAC IE000507	Machairs (* in Ireland) [21A0]; Grey seal *Halichoerus grypus* [1364]; Petalwort *Petalophyllum ralfsii* [1395]	No Source-Pathway-Receptor link.	N - Machairs; N - Grey seal; N - Petalwort
Glengarriff Harbour and Woodland SAC IE000090	***Phoca vitulina* (Harbour seal) [1365]**	**Harbour seal -** Harvesting within the foraging range of *Phoca vitulina* (Harbour seal) (up to 273km, Carter et al. 2022).	**Y – Harbour seal**
	Old sessile oak woods with Ilex and Blechnum in the British Isles [91A0]; Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae) [91E0]; Geomalacus maculosus (Kerry Slug) [1024]; Rhinolophus hipposideros (Lesser Horseshoe Bat) [1303]; *Lutra lutra* (Otter) [1355]	No Source-Pathway-Receptor link.	N - Old sessile oak; N - Alluvial forests; N - Kerry Slug; N - Lesser Horseshoe Bat; N – Otter
Blackwater Bank SAC IE002953	Sandbanks which are slightly covered by sea water all the time [1110]; *Phocoena phocoena* (Harbour porpoise) [1351]	No Source-Pathway-Receptor link.	N – Sandbanks; N - Harbour porpoise
Carnsore Point SAC IE002269	Mudflats and sandflats not covered by seawater at low tide [1140]; Reefs [1170]; *Phocoena phocoena* (Harbour porpoise) [1351]	No Source-Pathway-Receptor link.	N - Mudflats and sandflats; N – Reefs; N - Harbour porpoise
Murlough UK0016612	Harbour seal *Phoca vitulina* [1365]	No Source-Pathway-Receptor link.	N - Harbour seal
The Maidens UK0030384	Grey seal *Halichoerus grypus* [1364]	No Source-Pathway-Receptor link.	N - Grey seal

Table 6 (cont'd) - Relevant Natura 2000 sites and SPR identification and Rationale

Natura 2000 site	Qualifying Interest/ Special Conservation Interest	Source-Pathway-Receptor Connections rationale	Considered for screening Y/N

Kenmare River SAC IE002158	**Harbour seal *Phoca vitulina* [1365]**	**Harbour seal** - Harvesting within the foraging range of *Phoca vitulina* (Harbour seal) (up to 273km, Carter et al. 2022).	**Y - Harbour seal**
	Large shallow inlets and bays [1160]; Reefs [1170]; Perennial vegetation of stony banks [1220]; Vegetated sea cliffs of the Atlantic and Baltic coasts [1230]; Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [1330]; Mediterranean salt meadows (*Juncetalia maritimi*) [1410]; White dunes along the shoreline with *Ammophila arenaria* (white dunes) [2120]; Fixed coastal dunes with herbaceous vegetation (grey dunes) [2130]; European dry heaths [4030]; Juniperus communis formations on heaths or calcareous grasslands [5130]; Calaminarian grasslands of the Violetalia calaminariae [6130]; Submerged or partially submerged sea caves [8330]; Vertigo angustior (Narrow-mouthed Whorl Snail) [1014]; Rhinolophus hipposideros (Lesser Horseshoe Bat) [1303]; Phocoena phocoena (Harbour Porpoise) [1351]; Otter *Lutra lutra* [1355]	No Source-Pathway-Receptor link.	N - Large shallow inlets and bays; N - Reefs; N - Perennial vegetation of stony banks; N - Vegetated sea cliffs; N - Atlantic salt meadows; N - Mediterranean salt meadows; N - White dunes; N - Grey dunes; N - European dry heaths; N - Juniperus communis formations; N - Calaminarian grasslands; N - Submerged sea caves; N - Narrow-mouthed Whorl Snail; N - Lesser Horseshoe Bat; N - Harbour Porpoise; N - Otter
Inishmore Island SAC IE000213	Reefs [1170]; Perennial vegetation of stony banks [1220]; Vegetated sea cliffs of the Atlantic and Baltic coasts [1230]; Embryonic White dunes [2110]; White dunes along the shoreline with *Ammophila arenaria* (white dunes) [2120]; Fixed coastal dunes with herbaceous vegetation (grey dunes) [2130]; Dunes with *Salix repens ssp. argentea* (*Salicion arenariae)* [2170]; Humid dune slacks [2190]; Machairs (* in Ireland) [21A0]; European dry heaths [4030]; Alpine and Boreal heaths [4060]; Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites) [6210]; Lowland hay meadows (Alopecurus pratensis, Sanguisorba officinalis) [6510]; Limestone pavements [8240]; Submerged or partially submerged sea caves [8330]; Vertigo angustior (Narrow-mouthed Whorl Snail) [1014]; *Phocoena phocoena* (Harbour porpoise) [1351]	No Source-Pathway-Receptor link.	N - Coastal lagoons; N - Reefs; N - Perennial vegetation; N - Vegetated sea cliffs; N - Embryonic White dunes; N - White dunes; N - Grey dunes; N - Salix dunes; N - Humid dunes; N – Machairs; N - European dry heaths; N - Alpine and Boreal heaths; N - Semi-natural dry grasslands; N - Lowland hay meadows; N - Limestone pavements; N - submerged sea caves; N -Narrow-mouthed Whorl Snail; N – Harbour porpoise

Table 6 (cont'd) - Relevant Natura 2000 sites and SPR identification and Rationale

Natura 2000 site	Qualifying Interest/ Special Conservation Interest	Source-Pathway-Receptor Connections rationale	Considered for screening Y/N
Slaney River Valley SAC IE000781	***Phoca vitulina* (Harbour seal) [1365]**	**Harbour seal** - Harvesting within the foraging range of *Phoca vitulina* (Harbour seal) (up to 273km, Carter et al. 2022).	**Y – Harbour seal**
	Estuaries [1130]; Mudflats and sandflats not covered by seawater at low tide [1140]; Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [1330]; Mediterranean salt meadows (*Juncetalia maritimi*) [1410]; Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation [3260]; Old sessile oak woods with Ilex and Blechnum in the British Isles [91A0]; Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae) [91E0]; Margaritifera margaritifera (Freshwater Pearl Mussel) [1029]; *Petromyzon marinus* (Sea Lamprey) [1095]; *Lampetra planeri* (Brook Lamprey) [1096]; *Lampetra fluviatilis* (River Lamprey) [1099]; *Alosa fallax fallax* (Twaite Shad) [1103]; Salmo salar (Salmon) [1106]; *Lutra lutra* (Otter) [1355]	No Source-Pathway-Receptor link.	N – Estuaries; N – Mudflats; N – Atlantic salt meadows; N – Mediterranean salt meadows; N - Water courses; N - Old sessile oak; N - Alluvial forests; N - Freshwater Pearl Mussel; N – Sea Lamprey; N – Brook Lampreys; N – River Lampreys; N – Twaite Shad; N – Salmon; N - Otter
Bunduff Lough and Machair/Trawalua/Mullaghmore SAC IE000625	Mudflats and sandflats not covered by seawater at low tide [1140]; Large shallow inlets and bays [1160]; Reefs [1170]; White dunes along the shoreline with *Ammophila arenaria* (white dunes) [2120]; Fixed coastal dunes with herbaceous vegetation (grey dunes) [2130]; Humid dune slacks [2190]; Machairs (* in Ireland) [21A0]; Juniperus communis formations on heaths or calcareous grasslands [5130]; Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites) [6210]; Alkaline fens [7230]; Euphydryas aurinia (Marsh Fritillary) [1065]; *Phocoena phocoena* (Harbour porpoise) [1351]; *Petalophyllum ralfsii* (Petalwort) [1395]	No Source-Pathway-Receptor link.	N - Mudflats and sandflats; N - Large shallow inlets and bays; N - Reefs; N - White dunes; N - Grey dunes; N - Humid dune slacks; N – Machairs; N - Juniperus communis formations; N - Semi-natural dry grasslands; N - Alkaline fens; N - Marsh Fritillary; N - Harbour porpoise; N – Petalwort
Lambay Island SAC IE000204	**Harbour seal *Phoca vitulina* [1365]**	**Harbour seal** - Harvesting within the foraging range of *Phoca vitulina* (Harbour seal) (up to 273km, Carter et al. 2022).	**Y - Harbour seal**
	Reefs [1170]; Vegetated sea cliffs of the Atlantic and Baltic coasts [1230]; *Phocoena phocoena* (Harbour porpoise) [1351]; Grey seal *Halichoerus grypus* [1364]	No Source-Pathway-Receptor link.	N - Reefs; N - Vegetated sea cliffs; N - Harbour porpoise; N - Grey seal

Table 6 (cont'd) - Relevant Natura 2000 sites and SPR identification and Rationale

Natura 2000 site	Qualifying Interest/ Special Conservation Interest	Source-Pathway-Receptor Connections rationale	Considered for screening Y/N
Ballysadare Bay SAC IE000622	**Harbour seal *Phoca vitulina* [1365]**	**Harbour seal** - Harvesting within the foraging range of *Phoca vitulina* (Harbour seal) (up to 273km, Carter et al. 2022).	**Y - Harbour seal**
	Estuaries [1130]; Mudflats and sandflats not covered by seawater at low tide [1140]; Embryonic White dunes [2110]; White dunes along the shoreline with *Ammophila arenaria* (white dunes) [2120]; Fixed coastal dunes with herbaceous vegetation (grey dunes) [2130]; Humid dune slacks [2190]; Vertigo angustior (Narrow-mouthed Whorl Snail) [1014]	No Source-Pathway-Receptor link.	N - Estuaries; N - Mudflats and sandflats; N - Embryonic dunes; N - White dunes; N - Grey dunes; N - Humid dune slacks; N - Narrow-mouthed Whorl Snail
Cummeen Strand/Drumcliff Bay (Sligo Bay) SAC IE000627	**Harbour seal *Phoca vitulina* [1365]**	**Harbour seal** - Harvesting within the foraging range of *Phoca vitulina* (Harbour seal) (up to 273km, Carter et al. 2022).	**Y - Harbour seal**
	Estuaries [1130]; Mudflats and sandflats not covered by seawater at low tide [1140]; Embryonic White dunes [2110]; White dunes along the shoreline with *Ammophila arenaria* (white dunes) [2120]; Fixed coastal dunes with herbaceous vegetation (grey dunes)* [2130]; Juniperus communis formations on heaths or calcareous grasslands [5130]; Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites) [6210]; Petrifying springs with tufa formation (Cratoneurion) [7220]; Vertigo angustior (Narrow-mouthed Whorl Snail) [1014]; Petromyzon marinus (Sea Lamprey) [1095]; Lampetra fluviatilis (River Lamprey) [1099]	No Source-Pathway-Receptor link.	N - Estuaries; N - Mudflats and sandflats; N - Embryonic dunes; N - White dunes; N - Grey dunes; N - Juniperus communis formations; N - Semi-natural dry grasslands; N - Petrifying springs; N - Narrow-mouthed Whorl Snail; N - Sea Lamprey; N - River Lamprey
Donegal Bay (Murvagh) SAC IE000133	**Harbour seal *Phoca vitulina* [1365]**	Harbour seal - Harvesting within the foraging range of Phoca vitulina (Harbour seal) (up to 273km, Carter et al. 2022).	Y - Harbour seal
	Mudflats and sandflats not covered by seawater at low tide [1140]; Fixed coastal dunes with herbaceous vegetation ('grey dunes') [2130]; Dunes with *Salix repens* ssp. *argentea* (*Salicion arenariae*) [2170]; Humid dune slacks [2190]	No Source-Pathway-Receptor link.	N - Mudflats and sandflats; N - Grey dunes; N – Salix dunes; N - Humid dune slacks

Table 6 (cont'd) - Relevant Natura 2000 sites and SPR identification and Rationale

Natura 2000 site	Qualifying Interest/ Special Conservation Interest	Source-Pathway-Receptor Connections rationale	Considered for screening Y/N
Horn Head and Rinclevan SAC IE000147	Embryonic White dunes [2110]; White dunes along the shoreline with *Ammophila arenaria* (white dunes) [2120]; Fixed coastal dunes with herbaceous vegetation (grey dunes)* [2130]; Dunes *with Salix repens ssp. argentea* (*Salicion arenariae*) [2170]; Humid dune slacks [2190]; Machairs (* in Ireland) [21A0]; Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or Isoeto-Nanojuncetea [3130]; Vertigo geyeri (Geyer's Whorl Snail) [1013]; Grey seal *Halichoerus grypus* [1364]; Petalwort *Petalophyllum ralfsii* [1395]; Najas flexilis (Slender Naiad) [1833]	No Source-Pathway-Receptor link.	N - Embryonic dunes; N - White dunes; N - Grey dunes; N - Salix dunes; N - Humid dunes; N – Machairs; N - Oligotrophic to mesotrophic standing waters; N - Geyer's Whorl Snail; N - Grey seal; N - Petalwort; N - Slender Naiad
Slieve Tooey/Tormore Island/Loughros Beg Bay SAC IE000190	Vegetated sea cliffs of the Atlantic and Baltic coasts [1230]; Atlantic salt meadows (Glauco-Puccinellietalia maritimae) [1330]; Mediterranean salt meadows (Juncetalia maritimi) [1410]; Embryonic White dunes [2110]; White dunes along the shoreline with *Ammophila arenaria* (white dunes) [2120]; Fixed coastal dunes with herbaceous vegetation (grey dunes) [2130]; Decalcified fixed dunes with *Empetrum nigrum* [2140]; Atlantic decalcified fixed dunes (*Calluno-Ulicetea*) [2150]; Dunes with Salix repens ssp. argentea (Salicion arenariae) [2170]; Humid dune slacks [2190]; Alpine and Boreal heaths [4060]; Blanket bogs (* if active bog) [7130]; Vertigo angustior (Narrow-mouthed Whorl Snail) [1014]; Otter *Lutra lutra* [1355]; Grey seal *Halichoerus grypus* [1364]	No Source-Pathway-Receptor link.	N - Vegetated sea cliffs; N - Atlantic salt meadows; N - Mediterranean salt meadows; N - Embryonic dunes; White dunes; N – Grey dunes; N - Decalcified dunes; N - Atlantic decalcified dunes; N – Salix dunes; N – Humid dunes; N - Alpine and Boreal heaths; N - Blanket bogs; N - Narrow-mouthed Whorl Snail; N - Otter; N - Grey seal
Killala Bay/Moy Estuary SAC IE000458	**Harbour seal *Phoca vitulina* [1365]**	**Harbour seal** - Harvesting within the foraging range of *Phoca vitulina* (Harbour seal) (up to 273km, Carter et al. 2022).	**Y – Harbour seal**
	Estuaries [1130]; Mudflats and sandflats not covered by seawater at low tide [1140]; Annual vegetation of drift lines [1210]; Vegetated sea cliffs of the Atlantic and Baltic coasts [1230]; Salicornia and other annuals colonising mud and sand [1310]; Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [1330]; Embryonic White dunes [2110]; White dunes along the shoreline with *Ammophila arenaria* (white dunes) [2120]; Fixed coastal dunes with herbaceous vegetation (grey dunes) [2130]; Humid dune slacks [2190]; Vertigo angustior (Narrow-mouthed Whorl Snail) [1014]; Sea Lamprey *Petromyzon marinus* [1095]	No Source-Pathway-Receptor link.	N - Estuaries; N - Mudflats and sandflats; N - Annual vegetation of drift lines; N - Vegetated sea cliffs; N – Salicornia; N - Atlantic salt meadows; N - Embryonic dunes; N - White dunes; N - Fixed dunes; N - Humid dunes; N - Narrow-mouthed Whorl Snail; N - Sea Lamprey

Table 6 (cont'd) - Relevant Natura 2000 sites and SPR identification and Rationale

Natura 2000 site	Qualifying Interest/ Special Conservation Interest	Source-Pathway-Receptor Connections rationale	Considered for screening Y/N
Saltee Islands SAC IE000707	Mudflats and sandflats not covered by seawater at low tide [1140]; Large shallow inlets and bays [1160]; Reefs [1170]; Vegetated sea cliffs of the Atlantic and Baltic coasts [1230]; Submerged or partially submerged sea caves [8330]; Grey seal Halichoerus grypus [1364]	No Source-Pathway-Receptor link.	N - Mudflats and sandflats; N - Large shallow inlets and bays; N - Reefs; N - Vegetated sea cliffs; N - submerged sea caves; N - Grey seal
Rutland Island and Sound SAC IE002283	**Harbour seal *Phoca vitulina* [1365]**	**Harbour seal** - Harvesting within the foraging range of *Phoca vitulina* (Harbour seal) (up to 273km, Carter et al. 2022).	**Y - Harbour seal**
	Coastal lagoons [1150]; Large shallow inlets and bays [1160]; Reefs [1170]; Annual vegetation of drift lines [1210]; Embryonic shifting dunes [2110]; Shifting dunes along the shoreline with *Ammophila arenaria* (white dunes) [2120]; Fixed coastal dunes with herbaceous vegetation (grey dunes) [2130]; Humid dune slacks [2190]	No Source-Pathway-Receptor link.	N - Coastal lagoons; N - Large shallow inlets and bays; N - Reefs; N - Annual vegetation of drift lines; N - Embryonic dunes; N - White dunes; N - Grey dunes; N - Humid dunes
Pembrokeshire Marine/ Sir Benfro Forol UK0013116	Grey seal *Halichoerus grypus* [1364]	No Source-Pathway-Receptor link.	N - Grey seal
Cardigan Bay/ Bae Ceredigion UK0012712	Grey seal *Halichoerus grypus* [1364]	No Source-Pathway-Receptor link.	N - Grey seal
Pen Llyn a`r Sarnau/ Lleyn Peninsula and the Sarnau SAC UK0013117	Grey seal *Halichoerus grypus* [1364]	No Source-Pathway-Receptor link.	N - Grey seal
North Anglesey Marine / Gogledd Môn Forol UK0030398	Harbour porpoise *Phocoena phocoena* [1351]	No Source-Pathway-Receptor link.	N - Harbour porpoise
Bristol Channel Approaches / Dynesfeydd Môr Hafren UK0030396	Harbour porpoise *Phocoena phocoena* [1351]	No Source-Pathway-Receptor link.	N - Harbour porpoise
North Channel UK0030399	Harbour porpoise *Phocoena phocoena* [1351]	No Source-Pathway-Receptor link.	N - Harbour porpoise
West Wales Marine / Gorllewin Cymru Forol UK0030397	Harbour porpoise *Phocoena phocoena* [1351]	No Source-Pathway-Receptor link.	N - Harbour porpoise

Table 6 (cont'd) - Relevant Natura 2000 sites and SPR identification and Rationale

Natura 2000 site	Qualifying Interest/ Special Conservation Interest	Source-Pathway-Receptor Connections rationale	Considered for screening Y/N
West of Ardara/Maas Road SAC IE000197	**Harbour seal *Phoca vitulina* [1365]**	**Harbour seal** - Harvesting within the foraging range of *Phoca vitulina* (Harbour seal) (up to 273km, Carter et al. 2022).	**Y - Harbour seal**
	Estuaries [1130]; Mudflats and sandflats not covered by seawater at low tide [1140]; Large shallow inlets and bays [1160]; Annual vegetation of drift lines [1210]; Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [1330]; Mediterranean salt meadows (*Juncetalia maritimi*) [1410]; Embryonic shifting dunes [2110]; Shifting dunes along the shoreline with *Ammophila arenaria* (white dunes) [2120]; Fixed coastal dunes with herbaceous vegetation (grey dunes) [2130]; Decalcified fixed dunes with *Empetrum nigrum* [2140]; Atlantic decalcified fixed dunes (*Calluno-Ulicetea*) [2150]; Dunes *with Salix repens ssp. argentea* (*Salicion arenariae*) [2170]; Humid dune slacks [2190]; Machairs (* in Ireland) [21A0]; Oligotrophic waters containing very few minerals of sandy plains (Littorelletalia uniflorae) [3110]; Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or Isoeto-Nanojuncetea [3130]; Northern Atlantic wet heaths with Erica tetralix [4010]; European dry heaths [4030]; Alpine and Boreal heaths [4060]; Juniperus communis formations on heaths or calcareous grasslands [5130]; Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (* important orchid sites) [6210]; Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae) [6410]; Lowland hay meadows (Alopecurus pratensis, Sanguisorba officinalis) [6510]; Blanket bogs (* if active bog) [7130]; Depressions on peat substrates of the Rhynchosporion [7150]; Alkaline fens [7230]; Vertigo geyeri (Geyer's Whorl Snail) [1013]; Margaritifera margaritifera (Freshwater Pearl Mussel) [1029]; Euphydryas aurinia (Marsh Fritillary) [1065]; Salmo salar (Salmon) [1106]; Lutra lutra (Otter) [1355]; Petalophyllum ralfsii (Petalwort) [1395]; Najas flexilis (Slender Naiad) [1833]	No Source-Pathway-Receptor link.	N - Estuaries; N - Mudflats and sandflats; N - Large shallow inlets and bays; N - Annual vegetation of drift lines; N - Atlantic salt meadows; N - Mediterranean salt meadows; N - Embryonic shifting dunes; N - White dunes; N - Grey dunes; N - Decalcified fixed dunes; N - Atlantic decalcified fixed dunes; N - Salix dunes; N - Humid dunes; N - Machairs; N - Oligotrophic waters; N - Oligotrophic to mesotrophic standing waters; N - Northern Atlantic wet heaths; N - European dry heaths; N - Alpine and Boreal heaths; N - Juniperus communis formations; N - Semi-natural dry grasslands; N - Molinia meadows; N - Lowland hay meadows; N - Blanket bogs; N - Depressions on peat; N - Alkaline fens; N - Geyer's Whorl Snail; N - Freshwater Pearl Mussel; N - Marsh Fritillary; N – Salmon; N - Otter; N – Petalwort; Slender Naiad

Table 6 (cont'd) - Relevant Natura 2000 sites and SPR identification and Rationale

Natura 2000 site	Qualifying Interest/ Special Conservation Interest	Source-Pathway-Receptor Connections rationale	Considered for screening Y/N
Anse de Vauville FR2502019	Harbour porpoise *Phocoena phocoena* [1351]	No Source-Pathway-Receptor link.	N - Harbour porpoise
Banc et récifs de Surtainville FR2502018	Harbour porpoise *Phocoena phocoena* [1351]	No Source-Pathway-Receptor link.	N - Harbour porpoise
Chausey FR2500079	Harbour porpoise *Phocoena phocoena* [1351]	No Source-Pathway-Receptor link.	N - Harbour porpoise
Baie du Mont Saint-Michel FR2500077	Harbour porpoise *Phocoena phocoena* [1351]	No Source-Pathway-Receptor link.	N - Harbour porpoise
Estuaire de la Rance FR5300061	Harbour porpoise *Phocoena phocoena* [1351]	No Source-Pathway-Receptor link.	N - Harbour porpoise
Baie de Lancieux, Baie de l'Arguenon, Archipel de Saint Malo et Dinard FR5300012	Harbour porpoise *Phocoena phocoena* [1351]	No Source-Pathway-Receptor link.	N - Harbour porpoise
Cap d'Erquy-Cap Fréhel FR5300011	Harbour porpoise *Phocoena phocoena* [1351]	No Source-Pathway-Receptor link.	N - Harbour porpoise
Baie de SaintBrieuc – Est FR5300066	Harbour porpoise *Phocoena phocoena* [1351]	No Source-Pathway-Receptor link.	N - Harbour porpoise
Tregor Goëlo Est FR5300010	Harbour porpoise *Phocoena phocoena* [1351]	No Source-Pathway-Receptor link.	N - Harbour porpoise
Côte de Granit rose-Sept-Iles FR5300009	Harbour porpoise *Phocoena phocoena* [1351]	No Source-Pathway-Receptor link.	N - Harbour porpoise
Nord Bretagne DH FR2502022	Harbour porpoise *Phocoena phocoena* [1351]	No Source-Pathway-Receptor link.	N - Harbour porpoise
Baie de Morlaix FR5300015	Harbour porpoise *Phocoena phocoena* [1351]	No Source-Pathway-Receptor link.	N - Harbour porpoise
Abers - Côte des legends FR5300017	Harbour porpoise *Phocoena phocoena* [1351]	No Source-Pathway-Receptor link.	N - Harbour porpoise
Ouessant-Molène FR5300018	Harbour porpoise *Phocoena phocoena* [1351]	No Source-Pathway-Receptor link.	N - Harbour porpoise
Côtes de Crozon FR5302006	Harbour porpoise *Phocoena phocoena* [1351]	No Source-Pathway-Receptor link.	N - Harbour porpoise
Chaussée de Sein FR5302007	Harbour porpoise *Phocoena phocoena* [1351]	No Source-Pathway-Receptor link.	N - Harbour porpoise

Table 6 (cont'd) - Relevant Natura 2000 sites and SPR identification and Rationale

Natura 2000 site	Qualifying Interest/ Special Conservation Interest	Source-Pathway-Receptor Connections rationale	Considered for screening Y/N
Récifs du talus du golfe de Gascogne FR5302016	Harbour porpoise *Phocoena phocoena* [1351]	No Source-Pathway-Receptor link.	N - Harbour porpoise
Récifs et landes de la Hague FR2500084	Harbour porpoise *Phocoena phocoena* [1351]	No Source-Pathway-Receptor link.	N - Harbour porpoise
Baie du Mont Saint Michel FR2510048	Harbour porpoise *Phocoena phocoena* [1351]	No Source-Pathway-Receptor link.	N - Harbour porpoise
Connemara Bog Complex SPA IE004181	**Cormorant (*Phalacrocorax carbo*) [A017]**; Merlin (*Falco columbarius*) [A098]; Golden Plover (*Pluvialis apricaria*) [A140]; **Common Gull (*Larus canus*) [A182]**	Seaweed harvesting is planned within the range of the pelagic bird species **Common Gull** and **Cormorant**. A potential pathway for significant effects exists, necessitating mitigation measures to reduce these impacts.	**Y - Common Gull; Y - Cormorant**
Inishglora and Inishkeeragh SPA IE004084	Shag (*Gulosus aristotelis*) [A017]; Storm Petrel (*Hydrobates pelagicus*) [A014]; Cormorant (*Phalacrocorax carbo*) [A017]; Barnacle Goose (*Branta leucopsis*) [A045]; **Lesser Black-backed Gull (*Larus fuscus*) [A183]**; Herring Gull (*Larus argentatus*) [A184]; Arctic Tern (*Sterna paradisaea*) [A194]	Seaweed harvesting is planned within the range of the pelagic bird species **Lesser Black-backed Gull**. A potential pathway for significant effects exists, necessitating mitigation measures to reduce these impacts.	**Y - Lesser Black-backed Gull**
Lough Mask SPA IE004062	Tufted Duck (*Aythya fuligula*) [A061]; Black-headed Gull (*Chroicocephalus ridibundus*) [A179]; Common Gull (*Larus canus*) [A182]; **Lesser Black-backed Gull (*Larus fuscus*) [A183]**; Common Tern (*Sterna hirundo*) [A193]; Greenland White-fronted Goose (*Anser albifrons flavirostris*) [A395]; Wetland and Waterbirds [A999]	Seaweed harvesting is planned within the range of the pelagic bird species **Lesser Black-backed Gull**. A potential pathway for significant effects exists, necessitating mitigation measures to reduce these impacts.	**Y - Lesser Black-backed Gull**
Inishmore SPA IE004152	Kittiwake (*Rissa tridactyla*) [A188]; **Arctic Tern (*Sterna paradisaea*) [A194]**; Little Tern (*Sterna albifrons*) [A195]; Guillemot (*Uria aalge*) [A199]	Seaweed harvesting is planned within the range of the pelagic bird species **Arctic Tern**. A potential pathway for significant effects exists, necessitating mitigation measures to reduce these impacts.	**Y - Arctic Tern**
Slyne Head to Ardmore Point Islands SPA IE004159	Barnacle Goose (*Branta leucopsis*) [A045]; **Sandwich Tern (*Sterna sandvicensis*) [A191]; Arctic Tern (*Sterna paradisaea*) [A194]**; Little Tern (*Sterna albifrons*) [A195]	Seaweed harvesting is planned within the range of the pelagic bird species **Arctic Tern** and **Sandwich Tern**. A potential pathway for significant effects exists, necessitating mitigation measures to reduce these impacts.	**Y - Arctic Tern; Y - Sandwich Tern**

Table 6 (cont'd) - Relevant Natura 2000 sites and SPR identification and Rationale

Site Code	Special Area of Conservation (SAC)	Distance to the nearest point of MUL area (km)
IE002111	Kilkieran Bay and Islands SAC	The MUL area is located within Kilkieran Bay and Islands SAC
IE002034	Connemara Bog Complex SAC	Located ~3 km west of Greatmans Bay at the nearest point to the MUL area
IE000268	Galway Bay Complex SAC	Located ~33 km southeast of Greatmans Bay at the nearest point to the MUL area
IE001482	Clew Bay Complex SAC	Located ~51 km north of Greatmans Bay at the nearest point to the MUL area
IE002158	Kenmare River SAC	Located ~151 km southwest of Greatmans Bay at the nearest point to the MUL area
IE000204	Lambay Island SAC	Located ~240 km east of Greatmans Bay at the nearest point to the MUL area
IE000622	Ballysadare Bay SAC	Located ~123 km northeast of Greatmans Bay at the nearest point to the MUL area
IE000627	Cummeen Strand/Drumcliff Bay (Sligo Bay) SAC	Located ~126 km northeast of Greatmans Bay at the nearest point to the MUL area
IE000133	Donegal Bay (Murvagh) SAC	Located ~171 km northeast of Greatmans Bay at the nearest point to the MUL area
IE000458	Killala Bay/Moy Estuary SAC	Located ~96 km northeast of Greatmans Bay at the nearest point to the MUL area
IE002283	Rutland Island and Sound SAC	Located ~195 km northeast of Greatmans Bay at the nearest point to the MUL area
IE000197	West of Ardara/Maas Road SAC	Located ~180 km northeast of Greatmans Bay at the nearest point to the MUL area
IE000781	Slaney River Valley SAC	Located ~225 km southeast of Greatmans Bay at the nearest point to the MUL area
IE000090	Glengarriff Harbour and Woodland SAC	Located ~162 km south of Greatmans Bay at the nearest point to the MUL area
IE004181	Connemara Bog Complex SPA	Located ~6 km north of Greatmans Bay at the nearest point to the MUL area
IE004062	Lough Mask SPA	Located ~28 km northwest of Greatmans Bay at the nearest point to the MUL area
IE004084	Inishglora and Inishkeeragh SPA	Located ~104 km northwest of Greatmans Bay at the nearest point to the MUL area
IE004152	Inishmore SPA	Located ~11 km southwest of Greatmans Bay at the nearest point to the MUL area
IE004159	Slyne Head to Ardmore Point Islands SPA	Located ~10 km northwest of Greatmans Bay at the nearest point to the MUL area

Table 7 - List of Irish Special Areas of Conservation and Special Protection Areas within ZOI (Figure 10 & 11)

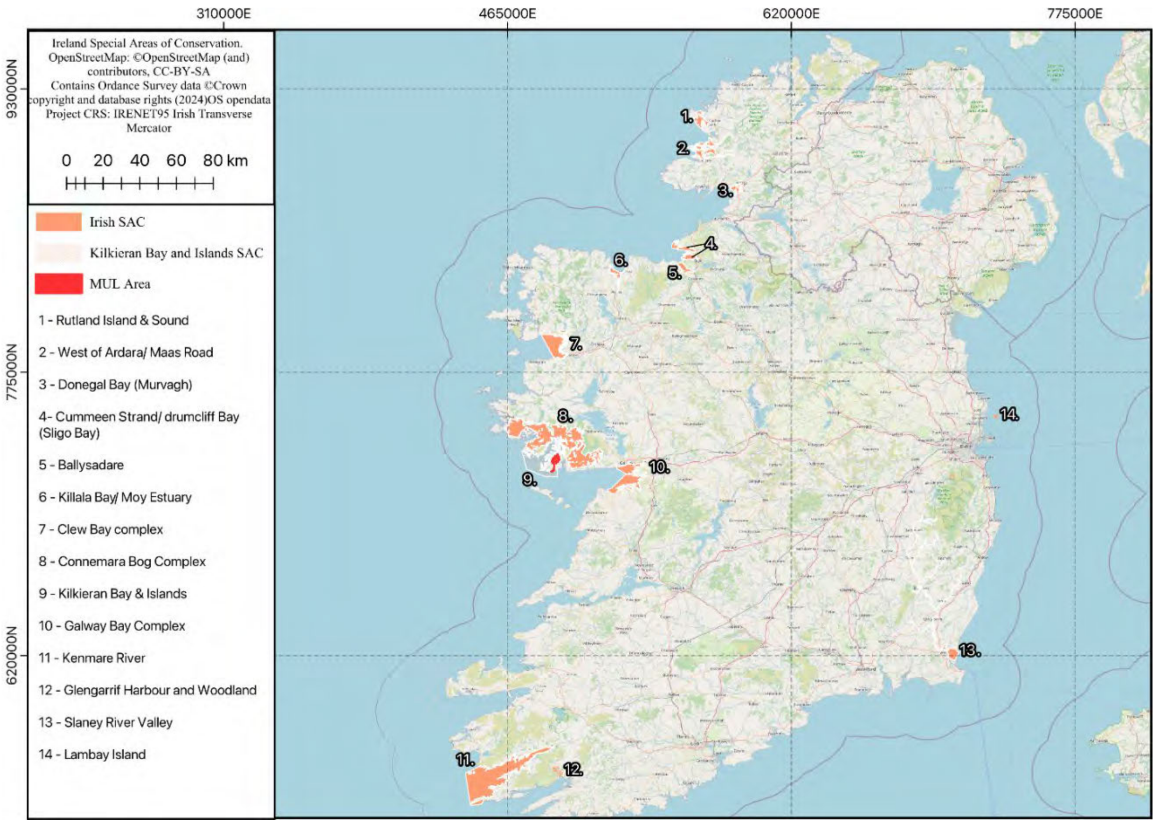

Figure 10 - Irish SACs within ZOI

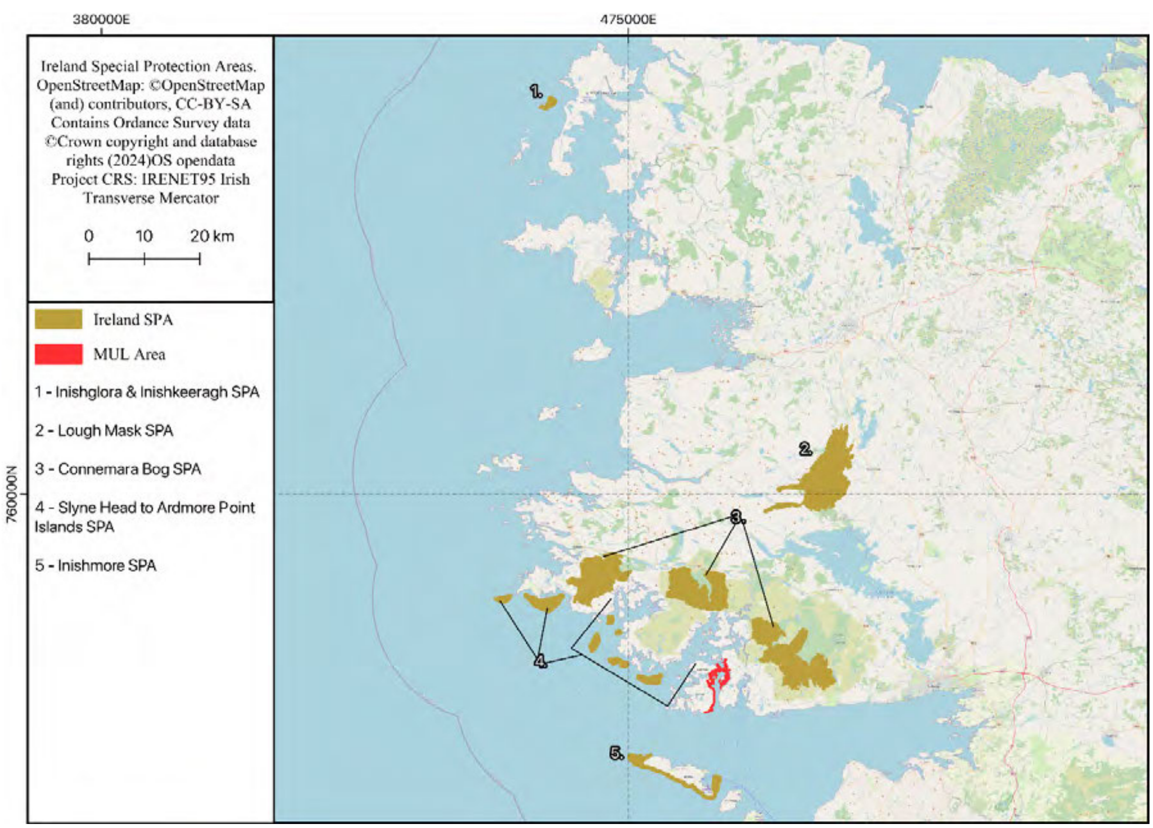

Figure 11 - Irish SPAs within ZOI

4.7 In-Combination Screening for Cumulative Effects

"Cumulative effects, the combined effect of more than one activity, may reinforce the impacts of a single activity due to temporal and/ or spatial overlaps" (OSPAR, 2012)

Cumulative effects arise when multiple activities interact, potentially amplifying the ecological impact of individual undertakings through temporal and spatial overlaps (OSPAR, 2012). This principle underpins the importance of assessing in-combination effects in the context of sustainable seaweed harvesting alongside other planned or ongoing maritime initiatives within the Irish maritime area.

Only those projects planned within the marine environment have been considered in assessing in-combination effects due to other developments that may influence the Natura 2000 sites under discussion. Any land-based developments, such as residential, transport infrastructure, commercial establishments, wind energy installations, and similar projects that cannot influence the marine environment, are therefore excluded from in-combination effects assessments involving the proposed seaweed harvesting activities within the SACs and SPAs.

A thorough review of pertinent resources, including the Galway County Council database, the Maritime Area Regulatory Authority (MARA) website, the Department of Housing (DHLH), Department of Agriculture, Food and Marine (DAFM), Local Government and Heritage's Foreshore Licence Applications and Determinations, and the National Marine Planning Framework (NMPF) Activities Map, was conducted. Table 8 summarises foreshore applications classified as Completed, Determined, Submitted, or Under Consideration within proximity to Arramara Teo's proposed MUL area. These projects include activities such as aquaculture, site investigations, buoy deployment and marine infrastructure developments.

Given the relatively small scale of Arramara Teo's proposed seaweed harvesting operation and its spatial separation from the identified projects, the potential for in-combination effects is minimal. Furthermore, the dynamic nature of marine ecosystems and the spatially explicit nature of maritime activities reduce the likelihood of synergistic impacts, even in the absence of mitigation measures.

Based on the analysis, no significant in-combination effects are anticipated between the proposed seaweed harvesting project and other regional maritime activities. However, ongoing monitoring and adaptive management strategies should be employed to address any unforeseen interactions, aligning with the precautionary principle and obligations under the Habitats Directive (92/43/EEC).

Reference	County	Applicant	Title	Date Received	Location	Type of work	Activity	Status	Distances	Effects
FS007085	Galway	Uisce Éireann Irish Water	Irish Water Site Investigations for Sewerage Scheme, Roundstone Bay, Galway	2020	Roundstone Bay, Galway	Survey	Site investigations	Determination	25.61 km	No effects
FS007495	Galway	Atlantic Offshore Renewable Energy 2	Atlantic Offshore Renewable Energy 2 – Site Investigations for proposed offshore wind farm, off County Galway	2021	Off County Galway	Survey	Site investigation survey	Withdrawn	15.22 km	No effects
FS007246	Galway	Farice ehf	Main lay and construction work for installation of the IRIS sub-sea fibre optic cable system, Co Galway	2021	From a landfall in Galway to a landfall in Iceland	Construction	Main lay and construction work	Determination	34.48 km	No effects
FS007100	Galway	Health Service Executive	Health Service Executive Deployment of 6 Swim Buoys along Salthill Promenade	2021	Salthill Promenade, County Galway	Buoys	Buoy deployment	Consultation	30.54 km	No effects
FS007569	Galway	Galway County Council	Galway Wandering Kite Festival, Omey Strand, Claddaghduff, Co Galway	2022	Claddaghduff, Co Galway	Other	Kite Festival	Determination	46.59 km	No effects
FS007543	Galway	Fuinneamh Sceirde Teoranta	Fuinneamh Sceirde Teoranta - Site Investigations for the proposed Sceirde Rocks Offshore Wind Farm (Export Cable Corridor)	2022	Off County Galway	Survey	Site investigation activities	Determination	19.81 km	No effects
FS007161	Galway	Fuinneamh Sceirde Teoranta	Fuinneamh Sceirde Teoranta - Site Investigations for the proposed Sceirde Rocks Offshore Wind Farm	2022	Off County Galway	Survey	Site investigation activities	Determination	19.00 km	No effects
FS007461	Galway	University College Dublin	UCD Research Experiments, Inishmaan	2022	Inishmaan, Co. Galway	Buoys	short term deployment of buoys	Determination	7.85 km	No effects

Table 8 – Summary of Foreshore Applications

Reference	County	Applicant	Title	Date Received	Location	Type of work	Activity	Status	Distances	Effects
FS007016	Galway	Deep Sea Fibre Networks	Deep Sea Fibre Networks Ltd	2022	Ballyloughane Strand, Renmore, Co Galway	Survey	Cable route survey and site investigations	Determination	28.32 km	No effects
MUL240033	Galway	Uisce Éireann	MUL240033 – Uisce Éireann	2024	Galway Bay and Co Clare Costal Area	Survey	Surveys	Applied	Covers the MUL Area	**May have effects**
MUL230024	Galway	Deep Sea Fibre Networks Ltd.	MUL230024- Deep Sea Fibre Networks Ltd.	2024	Galway / South West of Ireland	Survey	Marine Survey and Site Investigations for a cable route	Applied	16.23 km	No effects
MUL240038	Galway	MARUM	MUL240038 – MARUM – Center for Marine Environmental Sciences (University of Bremen)	2024	The Irish economic exclusive zone, West of Galway	Survey	Multidisciplinary marine investigations	Applied	109.35 km	No effects
T09-078-01	Galway	Údarás na Gaeltachta	Údarás na Gaeltachta Aquaculture	2024	Kilkieran Bay, Co. Galway	Aquaculture	Aquaculture activities	Application Accepted	21.48 km	No effects
T09-494	Galway	Connemara Organic Seaweeds	Connemara Organic Seaweeds Aquaculture	2024	Kilkieran Bay, Co. Galway	Aquaculture	Aquaculture activities	Application Accepted	Overlapping the MUL Area	**May have effects**
T09-495	Galway	Connemara Organic Seaweeds	Connemara Organic Seaweeds Aquaculture	2024	Kilkieran Bay, Co. Galway	Aquaculture	Aquaculture activities	Application Accepted	Overlapping the MUL Area	**May have effects**
T09-493	Galway	Connemara Organic Seaweeds	Connemara Organic Seaweeds Aquaculture	2024	Kilkieran Bay, Co. Galway	Aquaculture	Aquaculture activities	Application Accepted	Overlapping the MUL Area	**May have effects**
T09-280	Galway	Bradán Beo Teoranta	Bradán Beo Teoranta Aquaculture	2024	Kilkieran, Connemara, Co. Galway	Aquaculture	Cultivation activities	Application Accepted	17.57 km	No effects
T09-141	Galway	Bradán Beo Teoranta	Bradán Beo Teoranta Aquaculture	2024	Kilkieran, Connemara, Co. Galway	Aquaculture	Cultivation activities	Application Accepted	17.57 km	No effects

Table 8 (cont'd) – Summary of Foreshore Applications

Reference	County	Applicant	Title	Date Received	Location	Type of work	Activity	Status	Distances	Effects
T09-203	Galway	Bradán Beo Teoranta	Bradán Beo Teoranta Aquaculture	2024	Kilkieran, Connemara, Co. Galway	Aquaculture	Cultivation activities	Application Accepted	17.57 km	No effects
T09-114	Galway	Bradán Beo Teoranta	Bradán Beo Teoranta,Aquaculture	2024	Kilkieran, Connemara, Co. Galway	Aquaculture	Cultivation activities	Application Accepted	17.57	No effects
T09-155-1	Galway	Comhlucht Bradain Chonamara Teo	Comhlucht Bradain Chonamara Teo Aquaculture	2024	Bertraghboy Bay, Co. Galway	Aquaculture	Cultivation activities	Application Accepted	21.48 km	No effects
T09-155	Galway	Comhlucht Bradain Chonamara Teo	Comhlucht Bradain Chonamara Teo Aquaculture	2024	Bertraghboy Bay, Co. Galway	Aquaculture	Cultivation activities	Application Accepted	21.79 km	No effects
T09-140	Galway	Mannin Bay Salmon Company	Mannin Bay Salmon Company Aquaculture	2024	Mannin Bay, Co. Galway	Aquaculture	Cultivation activities	Application Accepted	38.17 km	No effects
T09-127	Galway	Ardbear Seafarms Ltd.	Ardbear Seafarms Ltd. Aquaculture	2024	Clifden Bay, Co. Galway	Aquaculture	Cultivation activities	Application Accepted	39.54 km	No effects
T09-107	Galway	Comhlucht Bradain Chonamara Teo	Comhlucht Bradain Chonamara Teo Aquaculture	2024	Bertraghboy Bay, Co. Galway	Aquaculture	Cultivation activities	Application Accepted	21.79 km	No effects
T09/511	Galway	Messrs Kevin and Michael Lydon	Kevin & Michael Lydon Foreshore Licence Application, Killary Harbour, Co.Galway	2024	Killary Harbour, Co. Galway	Aquaculture	Aquaculture activities	Under Consideration	25.67 km	No effects
T09/511A	Galway	Messrs Kevin and Michael Lydon	Kevin & Michael Lydon, Killary Harbour, Co. Galway	2024	Killary Harbour, Co. Galway	Aquaculture	To cultivate Blue Mussels / Aquaculture activities	Consultation	25.67 km	No effects

Table 8 (cont'd) – Summary of Foreshore Applications

Reference	County	Applicant	Title	Date Received	Location	Type of work	Activity	Status	Distances	Effects
T09/511A	Galway	Messrs Kevin and Michael Lydon	Kevin & Michael Lydon, Killary Harbour, Co. Galway	2024	Killary Harbour, Co. Galway	Aquaculture	To cultivate Blue Mussels / Aquaculture activities	Determination	25.67 km	No effects
T09/510	Galway	Messrs Kevin and Michael Lydon	Kevin & Michael Lydon Foreshore Licence Application, Killary Harbour, Co. Galway	2024	Killary Harbour, Co. Galway	Aquaculture	Aquaculture activities	Under Consideration	25.67 km	No effects
T09/510A	Galway	Messrs Kevin and Michael Lydon	Messrs Kevin & Michael Lydon Foreshore Licence Application, in Killary Harbour, Co. Galway	2024	Killary Harbour, Co. Galway	Aquaculture	To cultivate Blue Mussels / Aquaculture activities	Consultation	25.67 km	No effects
T09/510A	Galway	Messrs Kevin and Michael Lydon	Determination of Foreshore Licensing Application	2024	Killary Harbour, Co. Galway	Aquaculture	To cultivate Blue Mussels / Aquaculture activities	Determination	25.67 km	No effects
T09/508	Galway	Mr Pat Lydon	Pat Lydon Foreshore Licence Application, Killary Harbour, Co. Galway	2024	Killary Harbour, Co. Galway	Aquaculture	Aquaculture activities	Under Consideration	25.83 km	No effects
T09/508A	Galway	Mr Pat Lydon	Pat Lydon Foreshore Licence Application, Killary Harbour, Co. Galway	2024	Killary Harbour, Co. Galway	Aquaculture	Aquaculture activities	Determination	25.83 km	No effects
T10/050	Galway	Marine Institute	Public Consultation on an Aquaculture Licence Application	2024	Furnace, Newport, Co. Mayo	Aquaculture	Application to cultivate Salmon, Trout and Rainbow Trout	Public Consultation	80.89 km	No effects

Table 8 (cont'd) – Summary of Foreshore Applications

Reference	County	Applicant	Title	Date Received	Location	Type of work	Activity	Status	Distances	Effects
T09/522A	Galway	Josie King	Public Consultation on an Aquaculture Licence and Foreshore Licence Application and Invitation for Public Submissions or Observations on Appropriate Assessment	2023	On the southern shore of Mannin Creek in an inlet just north of Ardillaun Island, Co. Galway.	Aquaculture	To cultivate Pacific Oysters / Aquaculture activities	Consultation	36.17 km	No effects
T09/93	Galway	MARINE INSTITUTE	Renewal of Aquaculture Licence	2020	Bertraghboy Bay, Co. Galway	Aquaculture	To cultivate shellfish and seaweed	Renewal	24.67 km	No effects
T09/434	Galway	Cleggan Seaweeds Ltd	Renewal of Aquaculture Licence	2020	Cleggan Bay	Aquaculture	To cultivate seaweed	Renewal	48.83 km	No effects
T09-434A	Galway	Cleggan Seaweeds Ltd	Determination of Aquaculture Licensing Application (Renewal)	2022	Cleggan Bay	Aquaculture	To cultivate seaweed	Determination	48.83 km	No effects
T09/521	Galway	Josie King	Aquaculture activities in Ardbear Bay / Clifden Bay Co. Galway	2020	Clifden Bay, Co. Galway	Aquaculture	To cultivate mussels	-	37.58 km	No effects
T09/521	Galway	Josie King	Determination of Aquaculture Foreshore Licensing application	2020	Clifden Bay, Co. Galway	Aquaculture	To cultivate mussels	Determination	37.58 km	No effects
T09/522A	Galway	Josie King	Aquaculture activities on the southern shore of Mannin Creek in an inlet just north of Ardillaun Island, Co. Galway	2023	Mannin Creek	Aquaculture	To cultivate shellfish / aquaculture activities	Determination	36.17 km	No effects

Table 8 (cont'd) – Summary of Foreshore Applications

Reference	County	Applicant	Title	Date Received	Location	Type of work	Activity	Status	Distances	Effects
T09/375A	Galway	De Burca Oysters Limited	Determination to Revoke Aquaculture Licence	2024	Mweelon Bay, Co. Galway	Aquaculture	-	Revoked	54.76 km	No effects
T09-375C	Galway	De Burca Oysters Limited	Determination to Revoke Aquaculture Licence	2024	Mweelon Bay, Co. Galway	Aquaculture	-	Revoked	56.12 km	No effects
T09-398A	Galway	Mr Martin Lee	Determination to Revoke Aquaculture Licence	2024	Killary Harbour, Co. Galway	Aquaculture	-	Revoked	48.29 km	No effects
T09-093	Galway	The Marine Institute	Determination of Aquaculture Licensing Application (Renewal & Review)	2022	Lehannah Pool, Bertraghboy Bay, Co.Galway	Aquaculture	To cultivate various species of finfish, shellfish and seaweeds	Determination	24.78 km	No effects
T09-524A	Galway	Conor O' Malley	Determination of Aquaculture Licensing Application (New)	2022	Cleggan Bay	Aquaculture	To cultivate blue mussels	Determination	49.75 km	No effects
T09/301	Galway	Boet Mor Seafoods Ireland Ltd	Ministerial Determination in relation to EIS Requirement for an Aquaculture Licence Renewal in Cushatrough, Cladddaghduff, Co. Galway	2021	Cushatrough, Claddaghduff, Co. Galway	Aquaculture	To cultivate shellfish	Renewal	46.33 km	No effects
T09/520	Galway	Galway Gourmet Oysters Ltd	Determination of Aquaculture Foreshore Licensing application	2020	Mweeloon Bay, Co. Galway	Aquaculture	To cultivate Pacific Oysters	Determination	48.35 km	No effects
T09/519	Galway	Galway Gourmet Oysters Ltd	Determination of Aquaculture Foreshore Licensing application	2020	Aughinish Bay, Co. Galway.	Aquaculture	To cultivate Pacific Oysters	Determination	48.35 km	No effects

Table 8 (cont'd) – Summary of Foreshore Applications

Reference	County	Applicant	Title	Date Received	Location	Type of work	Activity	Status	Distances	Effects
T09/512	Galway	Dara Vaughan	Determination of Aquaculture Foreshore Licensing application	2020	South Galway Bay, Co. Galway	Aquaculture	To cultivate King Scallops	Determination	59.35 km	No effects
T09/504	Galway	Michael Irwin	Determination of Aquaculture Foreshore Licensing application	2020	Mweeloon Bay, Co. Galway	Aquaculture	To cultivate Pacific Oysters	Determination	37.35 km	No effects
T09/503	Galway	Galway Gourmet Oysters	Determination of Aquaculture Foreshore Licensing application	2020	Inishcorra Bay, Co. Galway	Aquaculture	To cultivate Pacific Oysters	Determination	35.94 km	No effects
T09/501	Galway	Thomas Connolly	Determination of Aquaculture Foreshore Licensing application	2020	South Galway Bay, Co. Galway	Aquaculture	To cultivate Pacific Oysters	Determination	37.39 km	No effects
T09/500	Galway	Thomas Connolly	Determination of Aquaculture Foreshore Licensing application	2020	Kinvara Bay Co. Galway	Aquaculture	To cultivate Pacific Oysters	Determination	38.47 km	No effects
T09/499	Galway	PJ Martyn	Determination of Aquaculture Foreshore Licensing application	2020	Kinvarra Bay, Co. Galway	Aquaculture	To cultivate Pacific Oysters	Determination (unsuccessful)	36.51 km	No effects

Table 8 (cont'd) – Summary of Foreshore Applications

In-Combination Screening for Cumulative Effects

Maritime developments have been identified and are listed in Table 8. This project's cumulative effects spatial scope (CESS) includes only those maritime developments that overlap with the proposed MUL. These overlapping developments have been highlighted in Figure 12. Of the maritime plans and projects in development, 3 were within the CESS.

- Uisce Éireann
- Connemara Organic Seaweeds

Arramara Teo's Resource Managers also engaged with local stakeholders (fishers, farmers, harvesters) regarding any potential upcoming plans or projects in the maritime area near the proposed MUL. Their investigations found that no further plans or projects were in place. Exact location data for some maritime developments was unavailable, so a central reference point (centroid) was used instead.

In-Combination Effects Determination

After a thorough assessment, it has been concluded that the probability of substantial impacts on the conservation sites, combined with other regional plans and developments, cannot be reliably dismissed. Therefore, they are screened in for Stage 2 Appropriate Assessment and will be considered further in the Natura Impact Statement if required.

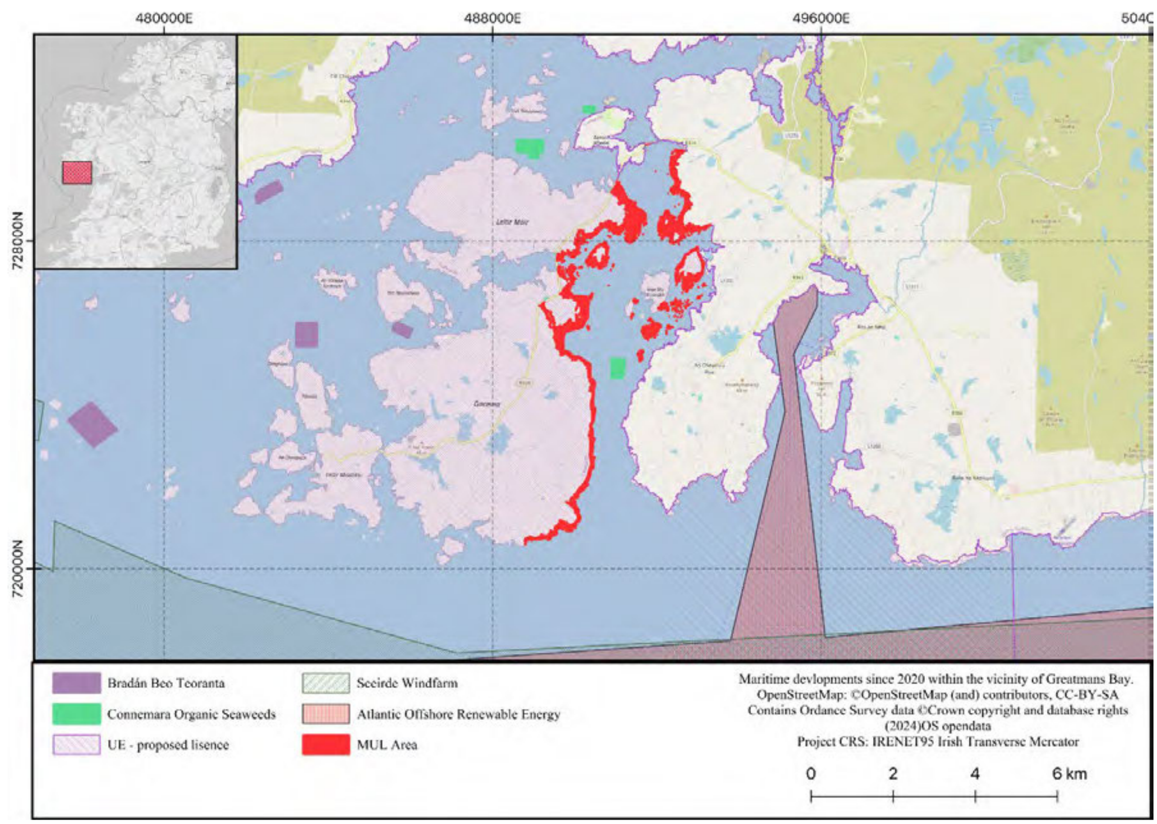

Figure 12 – Maritime Developments within the vicinity of Greatmans Bay.

4.8 Potential Significant Impacts

Removal of Target Species

The sustainable harvesting of *Ascophyllum* (limited to 20% removal, below the species' annual growth rate), maintains habitat functionality and ecological balance. This approach leaves sufficient biomass to support associated flora and fauna while allowing natural regrowth and replenishing the habitat. Notably, there is minimal overlap between the seaweed bed area where harvesting occurs and Annex I habitats (Table 9), ensuring no significant impact on the intertidal rocky shores within the Greatmans Bay SAC.

Consequently, the removal of *Ascophyllum* and *Fucus* will not negatively affect the rocky intertidal habitats or the broader ecological integrity of the Greatmans Bay SAC.

Up to 2,271 tonnes per annum of *Ascophyllum* and *Fucus* will be removed from the intertidal shoreline in the MUL area (see Table 2). The harvest percentage of seaweed per site, along with the method of site management through rotation, have been planned to ensure that a limited amount of biomass is removed from any one area, or indeed from the sites in combination, and to ensure that the seaweed harvesting in the Greatmans Bay SAC remains sustainable.

Seaweed harvesting is unlikely to significantly impact the ecological function of the bay due to the removal of target species; a potential pathway for impacts has not been identified, and mitigation measures are not required.

SAC	Greatmans Bay Total MUL area (Ha)	Greatmans Bay Total seaweed bed area (Ha)	Annex I Habitat	Total area of Annex I Habitat within SAC (ha)	Total Area Overlap (Ha) (MUL)	Total Area Overlap (Ha) (seaweed bed)	Percentage of Total Area Affected (%) (MUL)	Percentage of Total Area Affected (%) (seaweed beds)
Greatmans Bay SAC	272	137	Coastal lagoons [1150] *	-	-	-	-	-
			Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or Isoeto-Nanojuncetea [3130] *	-	-	-	-	-
			Lowland hay meadows (Alopecurus pratensis, Sanguisorba officinalis) [6510] *	-	-	-	-	-
			Najas flexilis (Slender Naiad) [1833] *	-	-	-	-	-
			Machairs *	-	-	-	-	-
			Salt marsh *	-	-	-	-	-
			Tidal Mudflats and Sandflats (1140)	491	0	0	0	0
			Large Shallow Inlets and Bays (1160)	18,760	273	123	1.4	0.7
			Reefs (1170)	9,084	257	116	2.8	1.3

*Habitats to be avoided

Table 9 - Predicted areas of Annex I habitats within the Connemara Bog Complex SAC impacted by sustainable harvesting of seaweed

Removal of Non-Target Species

The removal of target seaweeds may also involve non-target species, such as epiphytic flora like *Vertebrata lanosa* and fauna like *Littorina obtusata* and *L. littorea,* which contribute to the intertidal rocky shore community. Although not Qualifying Interests, these associated species play a role in the habitat's ecological balance.

Some snails, such as *Littorina spp*., typically detach during harvesting, but an unknown proportion may remain attached and be removed. Invertebrates attached to rocks beneath the seaweed may also be affected. Research from North America indicates that while some non-target species are removed during harvesting, many remain in the area. Studies from Philippi et al. 2014; Fegley, 2001; Trott and Larsen, 2012; Mittelstaedt, 2023; Sharp et al 1997; Hamilton 1997; show that harvesting *Ascophyllum* has minimal to no long-term impact on associated fauna. Due to conservative exploitation rates, most biomass within the MUL area remains unharvested, preserving enough non-target species and preventing over-exploitation. Thus, the ecological function of intertidal rocky shores is maintained. The removal of *Ascophyllum* and *Fucus* biomass also impacts habitat availability for associated species like *Vertebrata lanosa* and *Littorina obtusata.* However, the impact of the harvest will most likely be insignificant. Studies done in Maine, USA, showed that the harvest of *Ascophyllum* only removed 0.3% of the snail population in a bay (Ugarte et al. 2010).

Seaweed harvesting is unlikely to significantly impact the ecological function of the bay due to the removal of non-target species; a potential pathway for impacts has not been identified, and mitigation measures are not required.

Uncovering Previously Hidden Fauna

Harvesting of *Ascophyllum* and *Fucus* will reduce the cover and may uncover previously hidden invertebrates such as winkles *Littorina* spp., whelk *Nucella* spp., *Gibbula umbilicalis*, limpet *Patella vulgata* and shore crabs, thus increasing their availability as food items. Mobile fauna such as crabs will quickly move to alternative nearby refugia before predators such as otters approach, i.e. before the harvesters have left the area. Gastropods such as *Littorina* spp. and *Nucella* spp. However, it will remain stationary until the shore is inundated by the incoming tide which birds may predate on them.

Although Greatmans Bay is not in itself an SPA, there are several SPAS in the vicinity of the MUL area, namely Slyne Head to Ardmore Point Islands SPA.

Shorebirds associated with the Slyne Head to Ardmore Point Islands SPA, including Arctic Tern, Sandwich Tern and Little Tern, primarily feed on small fish and invertebrates in shallow nearshore waters (BirdWatch Ireland, 2025a, 2025b, 2025c) and are unlikely to forage directly on exposed rocky intertidal areas. Barnacle Goose is a herbivore that grazes on coastal grasslands and salt marshes rather than intertidal zones (BirdWatch Ireland, 2025d), and its feeding ecology is similarly unaffected by intertidal harvesting activities.

Shorebirds and waders of the Connemara Bog Complex SPA, including Golden Plover and Common Gull, feed on intertidal invertebrates such as mussels, gastropods, polychaetes, and crustaceans (BirdWatch Ireland, 2025e, 2025f). The temporary exposure of intertidal invertebrates during harvesting may increase foraging efficiency for these birds. However, sufficient biomass and cover will remain in unharvested areas, preserving adequate refugia for invertebrate populations and ensuring their resilience to increased predation pressure. Consequently, any increased foraging success among these birds will not lead to significant ecological impacts on invertebrate populations or habitat function.

The Cormorant primarily feeds on fish (BirdWatch Ireland, 2025g) and is not reliant on rocky intertidal invertebrates. Therefore, these species are unlikely to be affected by the uncovering of intertidal invertebrates.

Seaweed harvesting is unlikely to significantly impact the ecological function of the bays due to uncovering previously hidden fauna; a potential pathway for impacts has not been identified, and mitigation measures are not required.

Desiccation of Sediment

Due to the rocky substrata present, seaweed harvesting is unlikely to significantly impact the ecological function of Greatmans Bay SAC due to the desiccation of sediment; a potential pathway for impacts has not been identified, and mitigation measures are not required.

Trampling of Flora and Fauna during the weed-cutting process and collection

Traditional hand harvesters will walk on the shore to cut the seaweed, and some trampling will occur. However, the pressure exerted by one or two people walking on the shoreline will be low. The effect of this pressure, particularly on hard substrates such as rocky shores where the target species grow, will also be low. Also, an area will only be harvested rotationally and then be allowed to regrow depending on the bay. Hence, the intervals at which the trampling will occur will be infrequent. Therefore, trampling by traditional hand harvesters may directly impact the shorelines on which harvesting occurs but is unlikely to affect rocky intertidal shorelines negatively.

Seaweed will be transported by boat to shore access locations, where the "climíní" will be off-loaded for subsequent collection by tractor and trailer. The tractor and trailers will access the area via existing roads and remain off the shore; therefore, they will not significantly impact the area. No trampling will occur from using the boat and rake harvest method.

Seaweed harvesting is unlikely to significantly impact the ecological function of the bays due to trampling of flora and fauna during the weed-cutting process and collection; a potential pathway for impacts has not been identified, and mitigation measures are not required.

Trampling Due to Access

Access to sites is shown in Figure 5 of this document and avoid areas of the following habitats: Coastal lagoons [1150], Machairs (21A0), Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) (1330), Mediterranean salt meadows (*Juncetalia maritimi*) (1410), Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or Isoeto-Nanojuncetea [3130], Lowland hay meadows (Alopecurus pratensis, Sanguisorba officinalis) [6510] and Najas flexilis (Slender Naiad) [1833].

Mudflats and sandflats not covered by seawater at low tide (1140) are found below the intertidal area and are not traversed by harvesters en route to areas where the target seaweed species grow.

Seaweed harvesting is unlikely to significantly impact the ecological function of the bay due to trampling due to access; a potential pathway for impacts has not been identified, and mitigation measures are not required.

Trampling by Arramara Teo Personnel

The sampling and monitoring activities by Arramara Teo personnel involve walking on the shoreline to measure seaweed biomass. While this necessitates some trampling, the associated impact is minimal for several reasons. First, the pressure exerted by one or two individuals walking on rocky intertidal substrates, where *Ascophyllum* grows, is inherently low. These substrates are composed of hard rock and boulders, which are resistant to physical damage from human footfall. Moreover, the rotational nature of sampling ensures that any given area is revisited only after sufficient intervals, allowing the habitat to recover fully between sampling efforts.

Seaweed sampling by Arramara Teo personnel is unlikely to impact the ecological function of the bay significantly; a potential pathway for impacts has not been identified, and mitigation measures are not required.

Potential Pollution from Boats

Due to Arramara Teo's stringent operational protocols and adherence to international and national regulations, the potential for pollution from boats involved in seaweed harvesting activities is minimal. Vessels operated by Arramara Teo are small (20-30 HP outboard motors) and certified by the Maritime Safety Office, ensuring compliance with environmental safety standards. These boats use low-emission, modern engines designed to minimise the release of pollutants into the marine environment.

Refuelling operations are conducted off-site, eliminating the risk of accidental fuel spills near the harvesting areas. In addition, harvesting boats carry minimal fuel reserves during operations, further reducing the likelihood of significant contamination in the event of an incident.

Potential pollution from boats is unlikely to impact the ecological function of the bay significantly; a potential pathway for impacts has not been identified, and mitigation measures are not required.

Increased Turbidity

Due to the low-impact nature of the activities and the specific characteristics of the harvesting methods, the sustainable harvesting of *Ascophyllum* and *Fucus* is not expected to increase turbidity in the marine environment significantly.

Increased turbidity from boats is unlikely to impact the ecological function of the bay significantly; a potential pathway for impacts has not been identified, and mitigation measures are not required.

Disturbance of Fauna by Harvest Activities

Migratory Birds:

Arctic Terns (*Sterna paradisaea*), Common Gulls (*Larus canus*), Lesser Black-backed Gulls (*Larus fuscus*), and Sandwich Terns (*Thalasseus sandvicensis*) are migratory bird species that utilise coastal and intertidal habitats and their foraging ranges may overlap with the proposed MUL. These species exhibit varying degrees of reliance on the intertidal zone for feeding, with some primarily foraging in nearshore waters or deeper marine areas. The potential for disturbance to these birds arises mainly from the presence of harvesters on the shore and the associated activities of Arramara Teo harvesting boats.

Sandwich Terns and Arctic Terns are plunge divers that forage on small fish and invertebrates (Dunn, 1972, Morten et al. 2022), typically in nearshore waters rather than directly on the intertidal. Common Gulls are opportunistic feeders that forage on a variety of prey, including intertidal invertebrates (Pierotti & Annett, 1991). These species may occasionally interact with the rocky intertidal habitat but are highly mobile and capable of relocating to nearby undisturbed areas.

Lesser Black-backed Gulls are more commonly associated with nearshore and offshore foraging habitats, relying on fish rather than intertidal resources (Camphuysen & Garthe, 2000). Their presence in the intertidal zone is infrequent, and any disturbance caused by harvesting activities would likely result in temporary displacement without significant disruption to their feeding ecology.

During the breeding season, Arctic Terns and Sandwich Terns nest colonially on coastal islands, sandbanks, or shingle spits above the high-water mark (BirdWatch Ireland, 2025a, 2025b), well outside the intertidal zone. Similarly, Common Gulls and Lesser Black-backed Gulls nest in a variety of habitats, including coastal cliffs, dunes, and offshore islands (BirdWatch Ireland, 2025f, 2025i), none of which overlap with the intertidal areas targeted for seaweed harvesting.

While migratory birds foraging in the intertidal zone may experience localised and temporary disturbance due to harvester presence, this disturbance is expected to be minimal. Harvesting activities are rotational and infrequent, affecting small, discrete sections of the shoreline at any given time. Birds disturbed by human activity typically move to nearby undisturbed areas, mitigating the likelihood of prolonged disruption.

Although seaweed harvesting is unlikely to impact migratory bird species which overlap the MUL area significantly, a potential pathway for impacts has been identified, and mitigation measures are required.

Marine Mammals:

The Common bottlenose dolphin (*Tursiops truncatus*), Otter (*Lutra lutra*), Harbour porpoise (*Phocoena phocoena*), Common seal (*Phoca vitulina*), and Grey seal (*Halichoerus grypus*) are marine mammals regularly observed in Irish waters. While these species are highly mobile and display diverse habitat usage patterns, their potential interaction with seaweed harvesting activities is a critical consideration of Arramara Teo in ensuring the sustainability of these operations.

Marine mammals frequent the coastal and nearshore waters of the west of Ireland, where they engage in activities such as foraging, socialising, and resting. Common bottlenose dolphins exhibit a broad range of habitat preferences, from shallow bays to offshore waters (Ingram & Rogan, 2002). While they may enter bays within the MUL area, their primary foraging habitats are deeper waters where fish schools aggregate. Harbour porpoises are primarily found in shallow waters but typically forage in areas with strong tidal currents (Embling et al. 2010), where prey species are abundant. They are not dependent on intertidal zones targeted for seaweed harvesting. Common and Grey seals haul out on beaches, sandbanks, and rocky outcrops for resting, moulting, and breeding (Marine Scotland, 2014). While their haul-out sites may occasionally be near harvesting areas, seals predominantly forage in the water column rather than the intertidal habitat. Otters primarily forage in the intertidal and shallow subtidal zones, preying on fish, crabs, and other marine invertebrates (Coletti, 2021). They often use coastal rock crevices, vegetation, or holts near water as resting or denning sites. Unlike many other marine mammals, otters are closely associated with intertidal habitats, meaning their activities could potentially overlap with seaweed harvesting areas. Ensuring that harvesting practices minimise disturbance to these habitats is essential for the continued conservation of otter populations in the area.

The localised and intermittent nature of seaweed harvesting minimises its potential to disturb marine mammals significantly.

Although seaweed harvesting is unlikely to significantly impact marine mammal species that overlap the MUL area, a potential pathway for impacts has been identified, and mitigation measures are required.

Potential impacts from physical disturbance from harvesters, acoustic disturbance from boat motors, and impacts on water quality have been identified, leading to mitigation requirements. Mitigation cannot be provided in a Screening for Appropriate Assessment report.

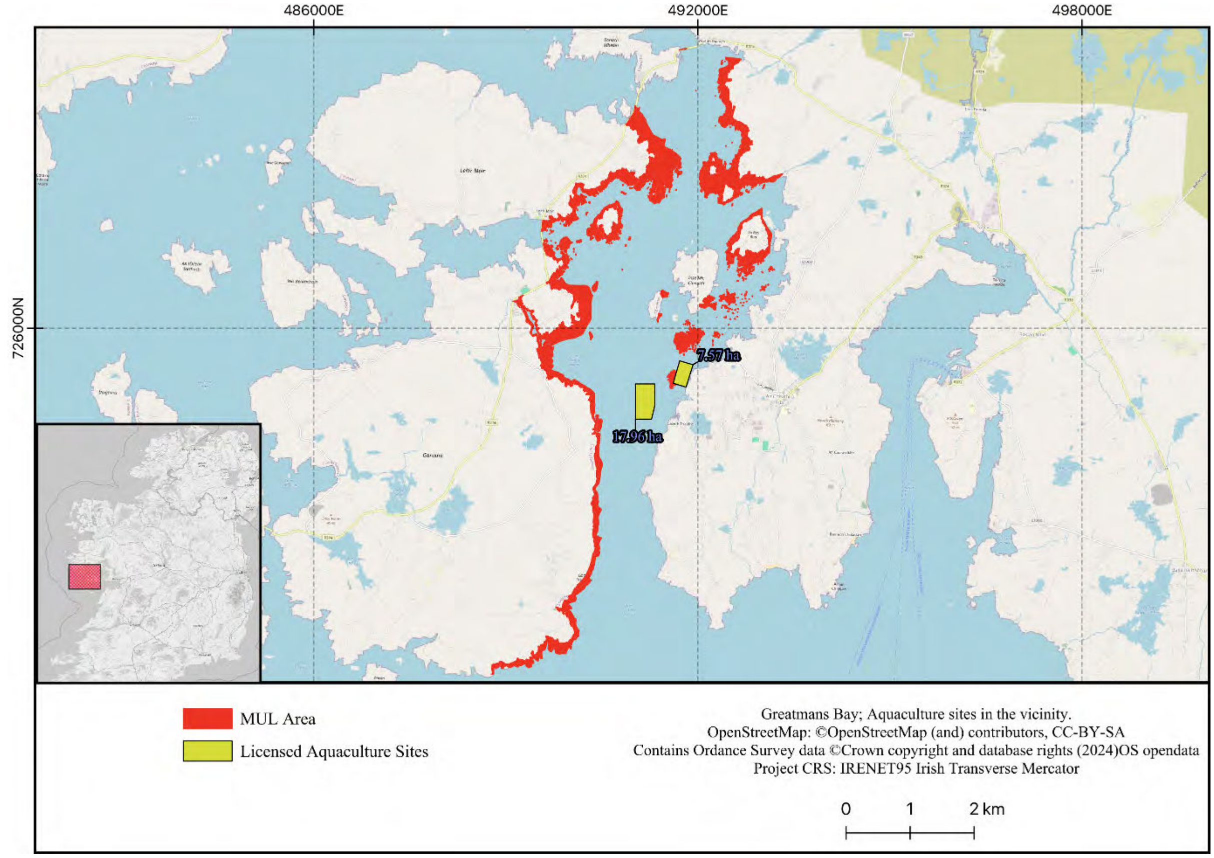

Figure 13 – Aquaculture sites in the vicinity of Greatmans Bay

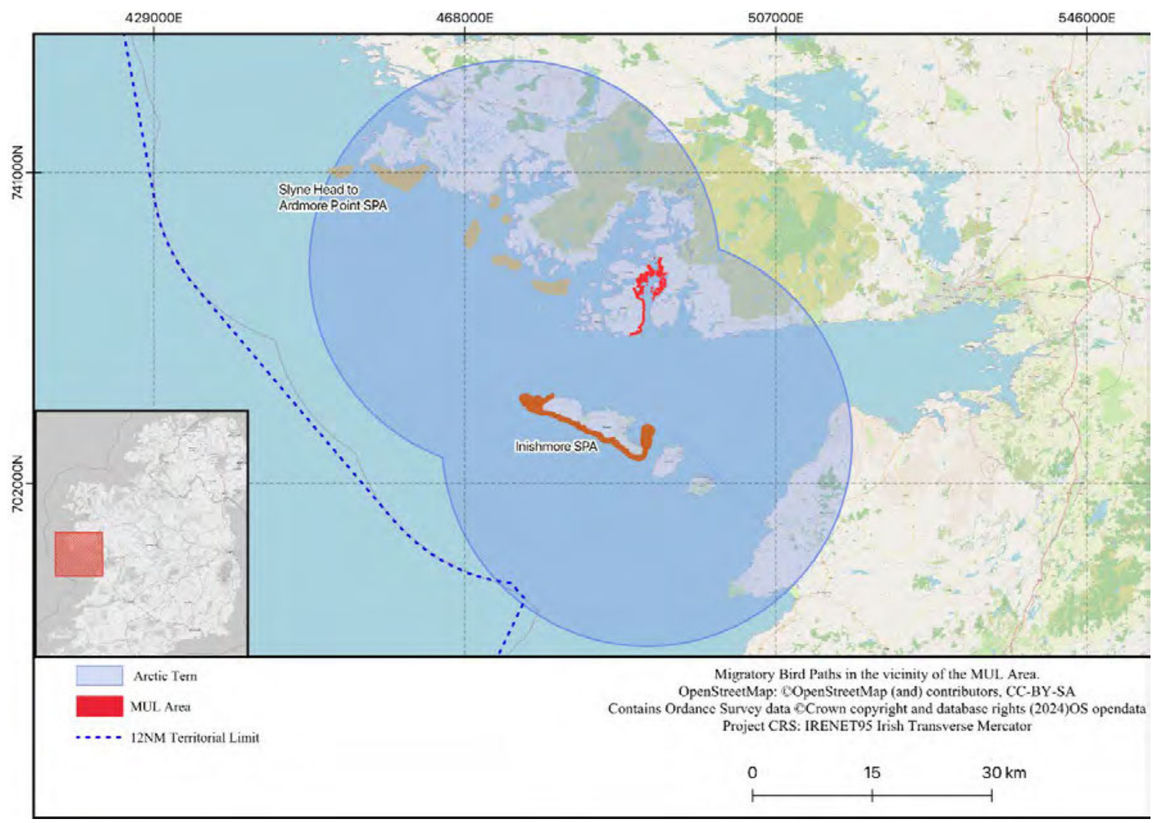

Figure 14 – Path of the Arctic Tern inhabits near Greatmans Bay

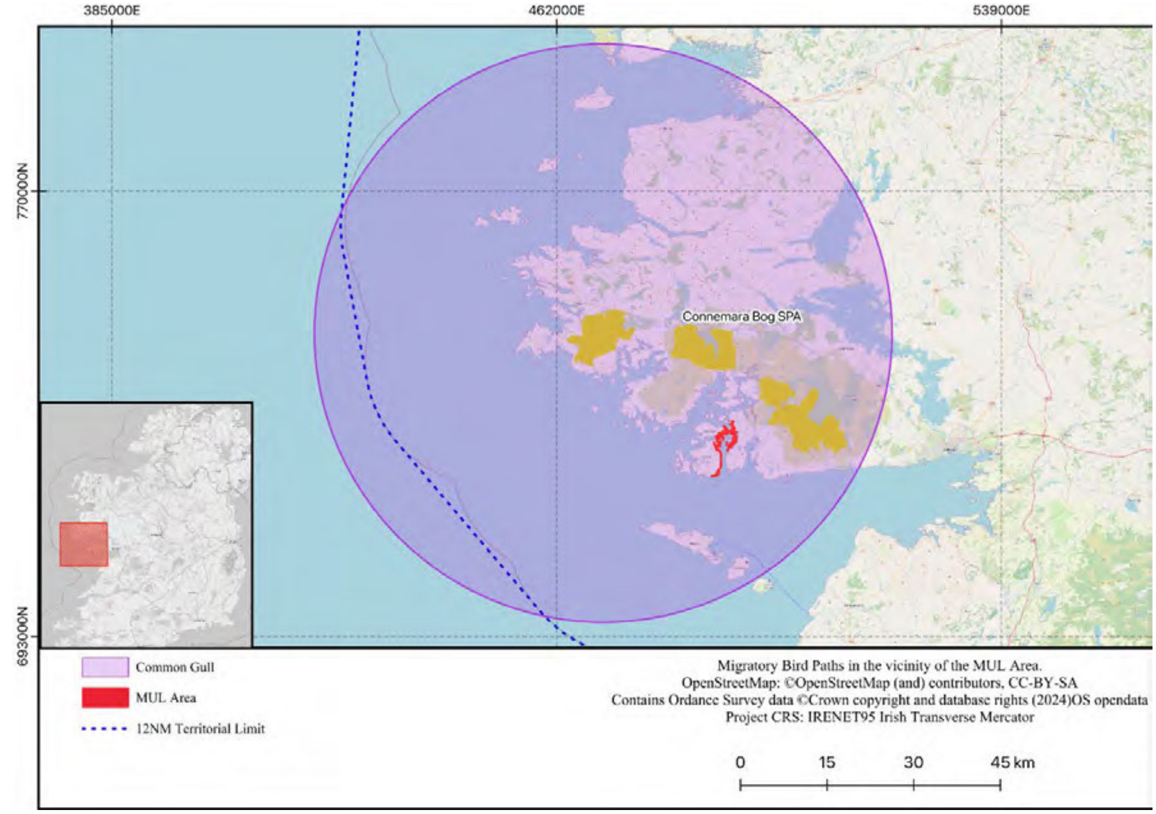

Figure 15 – Path of the Common Gull near Greatmans Bay

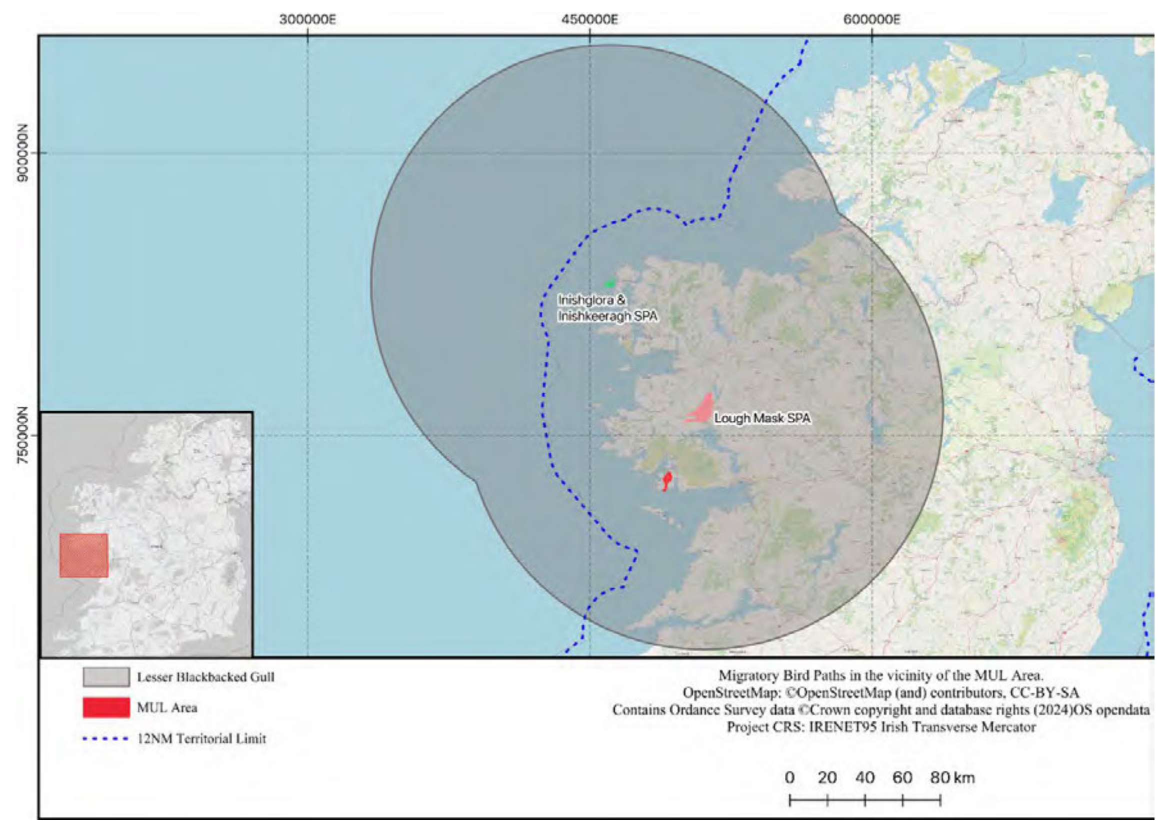

Figure 16 – Path of the Lesser Black-Backed Gull near Greatmans Bay

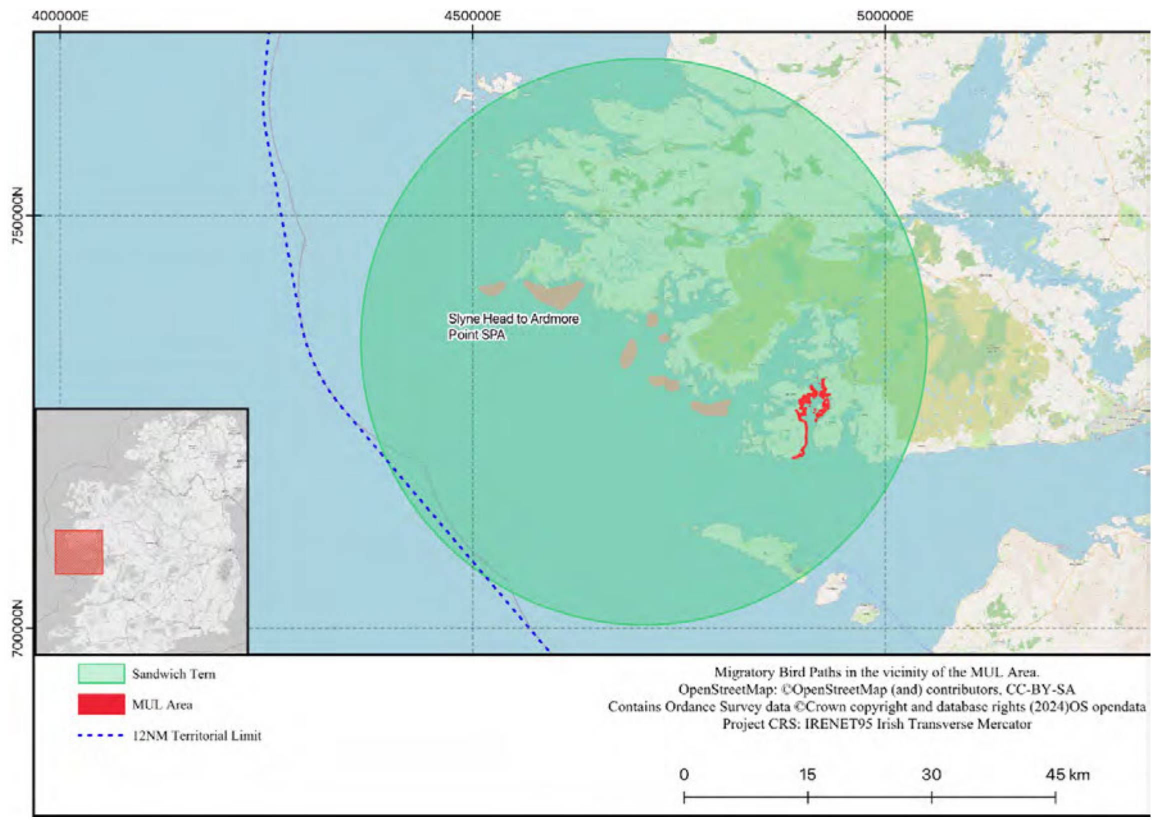

Figure 17 – Path of the Sandwich Tern near Greatmans Bay

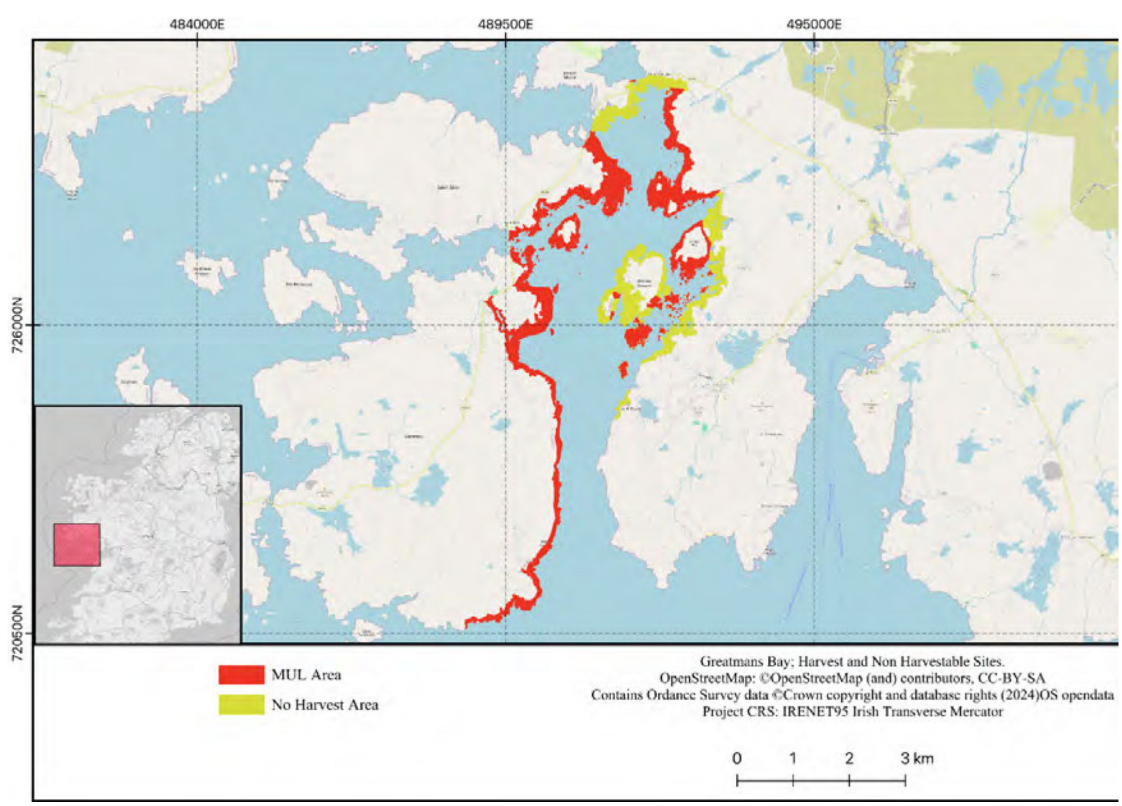

Figure 18 – Non-Harvestable Areas in Greatmans Bay

Table 10 below summarises the requirement of mitigation measures for the MUL area.

	Mitigation measures required	No mitigation measures required
Removal of target species		x
Removal of non-target species		x
Uncovering previously hidden fauna		x
Desiccation of sediment		x
Trampling of flora and fauna during the weed-cutting process and collection		x
Trampling due to access		x
Trampling by Arramara Teo personnel		x
Potential pollution from boats		x
Increased turbidity		x
Disturbance of fauna by harvest activities	x	

Table 10 - Summary Table

4.9 Screening Determination Statement

Following careful and thorough examination of all potentially relevant SACs and SPAs within the ZOI, the following have been screened in for Stage 2 Appropriate Assessment.

Natura 2000 Sites	Habitat/Species	Potential Impact
Kilkieran Bay and Islands SAC IE002111	**Mudflats and sandflats not covered by seawater at low tide [1140]**	Physical disturbance from harvesters
Kilkieran Bay and Islands SAC IE002111	**Large shallow inlets and bays [1160]**	Physical disturbance from harvesters
Kilkieran Bay and Islands SAC IE002111	**Reefs [1170]**	Physical disturbance from harvesters
Kilkieran Bay and Islands SAC IE002111	**Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [1330]**	Physical disturbance from harvesters
Kilkieran Bay and Islands SAC IE002111	**Mediterranean salt meadows (*Juncetalia maritimi*) [1410]**	Physical disturbance from harvesters
Kilkieran Bay and Islands SAC IE002111 Connemara Bog Complex SAC IE002034	**Otter *Lutra lutra* [1355]**	Physical disturbance from harvesters, acoustic disturbance from boat motors and impacts on water quality
Kilkieran Bay and Islands SAC IE002111	**Harbour porpoise *Phocoena phocoena* [1351]**	Physical disturbance from harvesters, acoustic disturbance from boat motors and impacts on water quality
Glengarriff Harbour and Woodland SAC IE000090 Slaney River Valley SAC IE000781 Galway Bay Complex SAC IE000268 Clew Bay Complex SAC IE001482 Kenmare River SAC IE002158 Lambay Island SAC IE000204 Kilkieran Bay and Islands SAC IE002111 Ballysadare Bay SAC IE000622 Cummeen Strand/Drumcliff Bay (Sligo Bay) SAC IE000627 Donegal Bay (Murvagh) SAC IE000133 Killala Bay/Moy Estuary SAC IE000458 Rutland Island and Sound SAC IE002283 West of Ardara/Maas Road SAC IE000197	**Common seal *Phoca vitulina* [1365]**	Physical disturbance from harvesters, acoustic disturbance from boat motors and impacts to water quality
Connemara Bog Complex SPA IE004181	**Common Gull (*Larus canus*) [A182]**	Physical disturbance from harvesters
Inishglora and Inishkeeragh SPA IE004084	**Lesser Black-backed Gull (*Larus fuscus*) [A183]**	

Table 11 – Habitat and species screened in for Stage 2 Appropriate Assessment

Natura 2000 Sites	Habitat/Species	Potential Impact
Slyne Head to Ardmore Point Islands SPA IE004159	**Sandwich Tern (*Sterna sandvicensis*) [A191]; Arctic Tern (*Sterna paradisaea*) [A194]**	Physical disturbance from harvesters
Inishmore SPA IE004152	**Arctic Tern (*Sterna paradisaea*) [A194]**	
Lough Mask SPA IE004062	**Lesser Black-backed Gull (*Larus fuscus*) [A183]**	

Table 11 (cont'd) – Habitat and species screened in for Stage 2 Appropriate Assessment

4.10 Screening Outcome

In total, screening has found likely significant effects on 14 SACs and 5 SPAs because of the proposed seaweed harvesting by Arramara Teo. It is not possible to exclude likely significant effects from underwater disturbances on mobile marine mammals such as harbour porpoises, bottlenose dolphins, grey seals, and common seals.

In summary, the following species and their associated SACs and SPAs have been screened in for Stage 2 Appropriate Assessment:

- Otter
- Harbour porpoise
- Common seal
- Lesser Black-backed Gull
- Sandwich Tern
- Arctic Tern
- Mudflats and sandflats not covered by seawater at low tide
- Large shallow inlets and bays
- Reefs
- Atlantic salt meadows
- Mediterranean salt meadow

5. Conclusion

This report evaluates the need for the Appropriate Assessment Process to determine if the proposed project, alone or in combination with other plans, will likely impact any European site(s). Using the Source-Pathway-Receptor approach, we assessed the conservation interests of European sites that could be affected. After thorough analysis, it was concluded that significant impacts on the conservation goals of these sites, either from this project alone or in combination with other plans, cannot be excluded.

Conclusion	Potential Outcome	Outcome
Greatmans Bay		
The project is directly connected to or necessary for the management of a designated site.	Stage 2 Appropriate Assessment is not required.	
No potential for significant effects	Stage 2 Appropriate Assessment is not required.	
The potential for significant effects identified, or the potential for impacts is uncertain.	Stage 2 Appropriate Assessment is required, and a Natura Impact Statement will be prepared	X

Table 12 - Results of Screening for Appropriate Assessment in Greatmans Bay

The proposed seaweed harvesting operation could have a significant negative impact on the Qualifying Interests/Special Conservation Interests identified or conservation objectives of the relevant SACs and SPAs. Therefore, it is concluded that an Appropriate Assessment is required.

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APPENDIX A

Literature Review of Commercial Harvesting of *Ascophyllum nodosum*

Document in support of a Marine Usage License Application presented to the Maritime Area Regulatory Authority

Assessment prepared by:

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Contents

1. *Ascophyllum nodosum* Biology & Ecology

Ascophyllum nodosum is a member of the order Fucales. It is a perennial brown seaweed found in the intertidal zone from the Arctic Circle to New Jersey and the White Sea to Portugal. It is found in a range of wave-exposures on stable substrate but is replaced or mixed with other related species (i.e. *Fucus spp*.) in the most exposed and ice-scoured areas. It is the predominant species found in the rocky intertidal zone along the Atlantic coastline of Eastern Canada, on sheltered shores in the West of Ireland and on the Scottish intertidal coastline and elsewhere, where it forms extensive beds (Baardseth, 1970; Sharp, 1986; Burrows *et al*., 2010; Guiry & Morrison, 2013).

Ascophyllum nodosum is attached to rocks or bedrock by a holdfast. Shoots arise from the holdfast and develop as a complex assemblage of branching dominant shoots and basal or suppressed shoots. As the tide rises, the plant floats due to gas bladders (vesicles) on the shoots, creating a floating canopy. Most new shoots arise vegetatively from existing basal holdfast tissue. As the plants grow, their holdfasts coalesce with the holdfasts of adjacent plants, forming clumps (Cousens, 1984; Sharp, 1986; Ugarte, 2011). Annual vegetative biomass production in the Canadian Maritimes and Maine, USA could be as high as 55% (Cousen, 1984; Vadas *et al*., 2004).

In the spring, reproductive receptacles, containing either egg or sperm-producing tissues, form along the sides of shoots. Gametes are released in late spring or early summer and the receptacles fall off shortly afterward. Newly settled germlings are extremely vulnerable to grazers and wave action (Vadas et al. 1990). As a result, the recruitment of new plants is episodic. Holdfasts can be long-lived (Aberg, 1992) but individual shoots are rarely over 17 to 20 years old (Lauzon-Guay et al 2022). Growth is not only apical but also occurs in older parts of the frond (Lauzon-Guay et al. 2022). Length increases on each main distal branch from 10 to 20 cm per annum, depending on geography (Kay et al 2016).

Rockweed forms a very stable canopy in the intertidal zone; however, storms, ice and forms of pollution can reduce the abundance or restrict distribution (Sharp, 1986). Any foreshore development that changes the bottom type, such as boulder removal or siltation, will reduce abundance and distribution. The high density of lateral and basal shoots in a clump and the distribution and biomass of clumps in the intertidal zone also create a complex habitat for invertebrates and fish during the tidal cycle (Rangeley & Kramer, 1998).

2. Commercial Harvesting of *Ascophyllum nodosum*

Ascophyllum nodosum is commercially harvested in Canada (Ugarte & Sharp, 2001 & 2012), USA, Western Ireland (Walsh, 2012), Scotland (Burrows *et al*., 2010), France, Norway and Iceland.

2.1. Canada

In Canada, *Ascophyllum nodosum* is harvested in the provinces of Nova Scotia and New Brunswick. The intertidal zone is considered crown land and is managed by the provincial and federal governments. The standing stock of *Ascophyllum nodosum* present in the two provinces combined is estimated at 352,723 tonnes. The harvest is predominately done from boats with harvesters using cutter rakes mounted on three-metre poles. Mechanical harvesters and hand harvest on foot at low tide were used in the past in Nova Scotia, and were largely discontinued (Ugarte & Sharp, 2001) until recently when mechanical harvesters were re-introduced in the province of Nova Scotia following several years of experimental harvest, monitored by the government. *Ascophyllum* *nodosum* has been harvested since the late 1950's, and in recent years, 40,000 tonnes is harvested annually (Ugarte and Sharp 2012). Approximately 120 individuals participate in harvesting *Ascophyllum nodosum* in Canada each year (DFO, 1998).

2.2. Maine, USA

A preliminary, remote-sensing analysis shows an estimated 2.37 million tonnes of *Ascophyllum nodosum* and *Fucus spp*. on the coast of Maine, USA (Stefan Claesson, Nearview Ltd, pers. comm.). Commercial-scale *Ascophyllum nodosum* harvesting operations began in Maine in the 1970s. In the 1980s, Maine laws were enacted that required the Department of Marine Resources (DMR) to issue harvester licenses for a fee, issue violation fees, and establish a dedicated seaweed management fund (a per-landed-ton fee is paid into this fund).

Between 2017-2022, 125 harvesting permits were issued (Webber et al., 2024). As much as 10,500 tonnes of *Ascophyllum nodosum* has been harvested in a year throughout the state (DMR Landings data, 2023). The harvest is conducted either with mechanical harvesters or by boat and rake. A 2019 court ruling established that seaweed growing in the intertidal zone is the property of the upland landowner and that permission is required from the landowner to harvest seaweed.

2.3. Ireland

In Ireland, *Ascophyllum nodosum* accounts for 95% of total Irish seaweed landings (MacMonagail et al., 2021). There is an estimated 75,000 to 159,000 tonnes of *Ascophyllum nodosum* available for harvest in Ireland (Culliane 1984, Hession 1998). Historically, 8,000 to 28,000 tonnes of *Ascophyllum nodosum* have been harvested in Ireland (Guiry & Morrison, 2013). In 2012, 30,000 tonnes of *Ascophyllum nodosum* was harvested by approximately 40 enterprises, employing upwards of 300 people. Over 80% (32) were micro-enterprises employing five or fewer people (Walsh, 2012).

Ascophyllum nodosum is harvested in Ireland using two different methods: traditional hand harvesting, and boat and rake harvesting. Traditional hand harvesters use small knives at low tide to cut the fronds, leaving about 25 cm at the base, which is sufficient material for regeneration after a 3-to-5-year fallow period, depending on the regrowth of the bed (Guiry & Morrison, 2013; MacMonagail *et al.*, 2017). Boat and rake harvesters utilise specially designed boats that they manoeuvre to target seaweed beds on the rising tide. The harvester cuts seaweed using a specially designed cutting rake that allows the harvester to target and trims individual plants before depositing them in the boat. All rakes are equipped with a guard to prevent the cutting from occurring too close to the holdfast, in case a harvester inadvertently hits the bottom or a rock.

2.4. Scotland

The total amount of *Ascophyllum nodosum* in the Outer Hebrides of Scotland was estimated to be 170,500 tonnes (Burrows *et al.*, 2010). It is estimated that the present accessible area would yield 60,700 tonnes of *Ascophyllum nodosum* (36% of the total). With improved infrastructure, the accessible amount could rise to 97,000 tonnes (Burrows *et al.,* 2010).

In Scotland, the harvesting of *Ascophyllum nodosum* was traditionally done manually using a sickle, and more recently using a boat and rake and mechanically using a seaweed harvesting boat. Traditional hand harvesting occurs at low tide. The harvesters encircle the chosen area with a rope or net and then cut the *Ascophyllum nodosum* down to about 25 cm within that area. When the tide returns, the seaweed floats to form a large circular bail and is towed by a small boat to the landing area. Individual cutters handle their cutting areas and rotate the areas to ensure sustainability. Cutting occurs only near the tops of the fronds, allowing the seaweed to grow relatively quickly (Hebridean Seaweed Company website July 2011).

2.5. Iceland

The harvest of *Ascophyllum nodosum* in Iceland is concentrated in Breiðafjörður on the west coast of the country. Over the last four years, an average of 17,000 tonnes has been harvested each year by mechanical harvesters. The estimated standing stock is estimated at 1,100,000 to 1,300,000 tonnes (Gunnarson et al. 2017).

2.6. Norway

An estimated 1,800,000 tonnes of *Ascophyllum nodosum* is found along the coast of Norway (Baardseth 1970) with an annual harvest between 10,000 and 20,000 (Meland and Rebours). The harvest is conducted mainly by one company that uses mechanical harvesters.

3. Regulations for Harvesting *Ascophyllum nodosum*

3.1. Canada

Area-based management of *Ascophyllum nodosum* was introduced in Nova Scotia, Canada in the late 1970s. This approach places harvesting controls on relatively small geographic sectors. Initially, the sectors were not well monitored or controlled, and there were no harvestable biomass targets for each area. Also, there was little to no consideration given to the impacts of harvesting and protection of the *Ascophyllum nodosum* habitat and associated ecosystem (Sharp *et al*., 2006).

In 1995, a joint Federal-Provincial Memorandum of Understanding coordinated the resource management in New Brunswick, Canada. A Rockweed Management Committee reviews the annual management plans, and the industry produces harvest reports on an annual basis. Since 1995, seaweed management in New Brunswick, in particular that of *Ascophyllum nodosum*, has used an evidenced based but highly precautionary approach. Both provinces have established a maximum harvest rate, a minimum cutting height (12.5 to 25 cm), plus a maximum allowable holdfast removal rate (10%). They also impose gear restrictions and employ protected areas to ensure the sustainability of the seaweed resource as part of the wider coastal ecosystem (Ugarte & Sharp, 2001 & 2011). This ongoing and active management approach uses data from all sources (harvesters, researchers, stakeholders and licensed companies) to customise annual harvest plans in response to local and seasonal situations. The approach provides licensed companies with long-term harvesting rights, which in turn gives the companies security of raw material supply, allowing them to invest in research and further refinement of sustainable harvesting methods and to seek to develop value-added products from the harvested biomass (Chopin & Ugarte, 2006).

In both provinces, lease agreements for large sections of the shoreline are awarded exclusively to a single company for a period of up to 15 years. Companies rely on harvesters to harvest the seaweed. Each lease is divided into harvesting sectors. Companies must submit biomass assessments to the government prior to any harvesting activities taking place in a sector. The harvest rate of *Ascophyllum nodosum* is the proportion of the standing stock that is harvested annually. The province of New Brunswick implemented a 17% harvest rate at the onset of the fishery in 1995 as a precautionary measure. At the time, limited information was available, and one study suggested that a bed would recover after three years when 50% of the biomass was removed

(50%/ 3 years = ~17% per year). The neighbouring province of Nova Scotia allows up to 25% of the biomass to be removed annually. Over the last 3 years, a 25% harvest rate has been applied to some sectors in New Brunswick as more recent studies indicated that a harvest at 25% was sustainable (Lauzon-Guay et al 2021).

Harvesters keep daily logs of their harvest tonnage, and companies must provide monthly reports on harvest per sector to the provincial governments. When the harvest within a sector has reached its yearly quota, the sector is closed to the harvest until the following year. To optimise the manual harvesting of seaweed and balance that against the productivity of each harvester and the sustainable management of the seaweed resource, the approach to assign sectors to individual harvesting crews, with set quotas and monitoring of daily landings, has proved to be extremely effective, so much so that each sector does not require a fallow period (Ugarte & Sharp, 2011). Through the careful monitoring of *Ascophyllum nodosum* biomass within each harvest sector, the effects of other influences on the available harvestable Ascophyllum nodosum resource can be determined, such as the effects of changes in climate, pollution, grazers, disease and other factors that affect the biomass and re-growth. This allows for the level of sustainably harvestable seaweed to be calculated and adjusted on a regular (and ideally frequent) basis.

3.2. Maine, USA

In 2000, the Maine Department of Marine Resource (DMR) implemented a 40 cm minimum cutting height for *Ascophyllum nodosum* and mandated landings reporting. In 2019, DMR began requiring landings to be reported by established state seaweed sectors. In 2009, the Cobscook Bay Rockweed Management Area was established by statute. This area has additional regulations that do not apply to the rest of the state. The Cobscook Bay Management area is like the seaweed management regulations in New Brunswick. Cobscook Bay is divided into 36 harvest management sectors. Harvesters apply for sectors allocated annually at the beginning of the year. No more than 17% of the total biomass per sector may be harvested per year, and the total *Ascophyllum nodosum* biomass in each sector must be provided based on a survey conducted within the previous three years. Some areas designated by DMR are closed to harvesting for research and conservation, and harvesters must make reasonable efforts to return any bycatch collected while harvesting to the ocean (Title 12 6803-C, 2009).

In 2014, the State drafted the Fishery Management Plan for Rockweed, proposing additional regulations such as statewide exploitation rate limits, seasonal closures, designated areas closed to harvesting, and bycatch limits. (Maine DMR-RMDT 2014 Fishery Management Plan for Rockweed). However, the long-disputed legality of Ascophyllum nodosum ownership has hindered the State's implementation of this management plan.

3.3. Scotland

Although Crown Estates Scotland owns most of the coastline in Scotland, some are privately owned therefore, agreements are required with the shoreline owners to be able to harvest seaweed. Scotland has no set regulations for the harvest of *Ascophyllum nodosum,* but a management plan must be submitted and approved by NatureScot before harvesting operations can take place. Regulation will depend on the area where the harvesting operations take place and the proximity to Special Areas of Conservations and Special Areas of Protection. A maximum harvest rate of 20% of the standing stock is generally used in the Outer Hebrides. Seasonal closures near seal haul-out sites are also in place. In the Outer Hebrides, Scotland, a 25% maximum harvest rate is recommended (Burrows *et al*., 2010).

4. Harvesting Impacts

Recent studies have shown that most beds where up to 50% of the biomass is removed will recover within one year (Ugarte et al 2006, Johnston et al 2023, Feibel et al 2023), and that after 20 years of commercial harvest, there is no long-term impact of a 25% annual harvest rate on bed biomass (Lauzon-Guay et al 2021). If the harvesting of *Ascophyllum nodosum* is undertaken using a pulse strategy at rates above 50% of the harvestable crop, the stand requires a three to five-year period to recover (Ugarte & Sharp, 2011); however, the optimum regeneration period for *Ascophyllum nodosum* has been found to vary at each location and be directly related to harvesting intensity (Seip, 1980).

A recent study has shown that *Ascophyllum nodosum* in beds that have been harvested for 20 years have the same morphology as individuals at non-harvested sites (Lauzon-Guay et al 2023). However, immediately after harvest, net changes in canopy height and biomass are apparent within harvested patches (Ugarte et al 2006). These changes quickly become diluted to small differences between harvested and un-harvested stands when placed in the context of the entire bed (Johnston et al 2023) and intertidal landscape. These structural changes are short-lived and compensated for by the overall production during the summer and autumn months, thus redeveloping the complexity of the bed within a year. To ensure rapid regrowth, it is recommended that there is a minimum cutting height of 20 to 25 cm from the base of the holdfast (DFO, 1998; Burrows *et al*., 2010).

The *Ascophyllum nodosum* habitat also offers shelter from predation during immersion within the floating clumps. In Ireland, Kelly et al. (2001) found no effect of mechanical or hand harvesting on community diversity. Trott & Larsen (2012) found that two months after harvesting Ascophyllum nodosum, using the New Brunswick harvesting method, the epifaunal populations associated with beds of *Ascophyllum nodosum* in Maine, USA were unaffected; there were no differences in the populations from the harvested and un-harvested areas. The same results were found in a recent study in Jonesport, Maine, USA (Dr. Brian Beal – U. Maine, Machias, pers. comm.) and with adult fish and their larval stages in New Brunswick (Van Guelpen and Pohle 2014). Lauzon-Guay et al. (2023) also compared the biomass of littorinids at control and harvested sites and found no significant difference. Field studies have not detected any significant long-term impact of *Ascophyllum nodosum* harvesting on invertebrate communities associated with *Ascophyllum nodosum* beds (Fegley 2001, Hamilton and Nudds 2003, Phillippi et al 2014, Mittelstaedt 2024). A 2024 study from Maine has found no evidence for an effect of *Ascophyllum nodosum* harvesting on bird visitation at the sites (Johnston et al 2024). In literature review presented to the Maine Rockweed Working Group, Dr. Brian Beal from the University of Maine concluded that "any negative effects on habitat and invertebrate densities due to removal/harvesting of rockweed are short-lived or were not statistically detectable" (Beal 2015).

Holdfast removal can be an issue; however, the level of holdfast material in any harvested *Ascophyllum nodosum* can be due to several reasons such as a friable substratum, a naturally damaged clump, the level of harvest and the type and condition of the harvesting tool. With low harvest levels and the careful design and maintenance of cutting tools, the holdfast removal rate can be managed and minimised (Ugarte, 2011). Ugarte (2011) also found that even when there are very robust management systems in place, including the use of special, well-maintained, handheld cutter rakes designed to cut the *Ascophyllum nodosum* plants and not dislodge the clumps and their holdfasts, close to 6% of the biomass harvested annually contains holdfast material. Analysing the effect of harvest on the holdfast clumps, Ugarte (2011) found that the rakes were removing only about 17% of the holdfast surface of any affected clump. This significantly reduced the mortality of those clumps and, consequently, had a positive effect on the recovery of the seaweed. The study also compared the effects of harvesting to the levels of natural storm-cast *Ascophyllum nodosum* (i.e. dislodged plants cast upon the high-water mark of the shore) over the same period (2004), which showed a similar effect on clump structure; however, the incidence of holdfast detachment, due to storms, was shown to be as high as 30%.

It can take *Ascophyllum nodosum* quite some time to re-establish after total removal from an area; in a study undertaken in Iceland, Ingólfsson & Hawkin (2008) found that it took 7 to 8 years for the seaweed to re-establish; however, even after 20 years the original ecology had not recovered from the clearance; while Jenkins *et al.* (2004) found that the complete removal of *Ascophyllum nodosum* from a site on the Isle of Man, UK resulted in the development of a mix of Fucus serratus, Fucus vesiculosus and Ascophyllum nodosum, as well as other long-term changes to the immediate ecology that did not recover, even after completion of their 12-year study. Interestingly, carefully managed harvesting of *Ascophyllum nodosum* can enhance the growth of the seaweed due to a stimulation of growth and branching of suppressed shoots of the clumps, increased light availability, improved water flow and availability of nutrients (Sharp & Pringle, 1990; Lazo & Chapman, 1996; Ugarte, 2006; Trot & Larsen, 2012).

5. Regulation of Harvest of Other Seaweed Species

5.1. Chile

The absence of regulation resulted in the collapse of the natural beds of Gracilaria chilensis in Southern Chile (Santelices & Ugarte, 1987; Santelices & Doty, 1989). Also, in Chile, the harvest of the brown seaweed Lessonia nigrescens, the world's largest harvest of wild seaweed stock, is under a type of government management (Vásquez, 2008). In this case, recommendations for harvest amounts are not based on a precautionary approach. However, the focus is on the harvest methodology, which itself is based on biological and ecological parameters rather than harvest quantities and concessions of shoreline areas. The principle has been "how you harvest is more important than how much you harvest" (Vásquez et al., 2012). The method used was coproduced involving a wide range of stakeholders. Since implementation in 2006, in 2011, Vásquez & Piaget reported that the agreed management strategy seemed to work.

However, more recently (2013), after a study of the level of harvesting of several seaweed species (Lessonia trabeculata, L. nigrescens and Macrocystis spp.) in the Actacama region of Chile, it was found that more of those seaweed species had been harvested in the first six months of 2013, then the biologically acceptable quota for the entire year. Therefore, due to the urgent need for conservation measures and proper resource administration, the Management Committee of Kelp of the Actacama Region III (formalised in 2012) banned harvesting during the last four months of 2013 (Fish Information Service, 2013). This appears to be a case where, despite the regulation of harvesting of the seaweed resource being co-produced and regulated by various stakeholders, that agreed regulation did not address all aspects of the exploitation of the resource and has led to its over-exploitation. Therefore, "how much you harvest" and "how you harvest" appear important, especially for *Lessonia nigrescens*. On the positive side, monitoring the exploitation of the resource has allowed remedial action to be taken (authors note).

There is a growing demand for Lessonia trabeculata for use in biomedical and pharmaceutical products. This seaweed is harvested by semi-autonomous divers who appear not to respect harvesting recommendations; they exceed plant removal distances, do not consider the minimal size of extraction and return to harvest sites before populations have had the chance to recover (Vásquez *et al*., 2012), all of which contribute to unsustainable harvesting practices as well as damage to the marine ecology.

Borras-Chavez *et al*. (2012) undertook a two-month study to determine a better harvesting technique for Macrocystis pyrifera in Northern Chile (than that used at that time, i.e. cutting all the fronds from all the plants) whilst also investigating the impact of the harvest techniques on the seaweed understory diversity and herbivore abundance. They found that the removal of half of the fronds from all the plants was the best method for maintenance of the resource for future harvest as it allowed for rapid growth of new fronds on the harvested individuals, which in turn promoted recruitment of new individuals and reduced herbivore densities through physical abrasion.

5.2. South Africa

In South Africa, concessions of shoreline are given to individuals or organisations to manage the available resources (i.e. Ecklonia maxima) based on some biological conservation principles (Anderson *et al*., 1989, 2003); however, information on the size of the stock or how the landings or quotas were controlled is not clear, nor available.

5.3. Norway

In Norway, the mechanised harvesting of Laminaria hyperborea, which began 60 years ago, is now under a management regime developed and refined in a partnership between the Norwegian government, the seaweed industry, researchers and other stakeholders (i.e. fishermen). The management program was developed using a clear understanding of the ecology and life cycle of the seaweed and the wider ecosystem and predominantly uses a five-year cycle and rotating zones as the plan's foundation (Vea & Ask, 2011). The harvesting of Laminaria hyperborea typically (but not exclusively) falls under the Norwegian Marine Resources Act (2009), which has a set of principles that ensure the sustainable and economically profitable management of living marine resources and promote employment and settlement in coastal communities.

Since 1972, the Norwegian coastline has been divided into harvesting fields, with a width of about one nautical mile, each initially having four zones. In 1992, these were increased to five zones used for the (initially four, now five-year) harvest cycle (Vea & Ask, 2011).

However, due to the management and monitoring being undertaken within relatively small areas (like the Nova Scotia and New Brunswick approaches); it has enabled a small area in the south of the country (viz. Rogaland) to return to a four-year cycle, as studies have shown that the kelp grew faster in that area (Sjøtun, 2000). The new management regime has been in place for ten years and seems to have maintained the resource in good condition (Vea & Ask, 2011). Sustainable management protocols for exploiting seaweeds will vary due to individual seaweed biology and their specific (local) habitat, the economics of harvesting, the type of harvesting equipment used, and the political, social and other wider economic factors at any given time.

In other words, there is no “one size fits all” solution to developing a sustainable seaweed harvest. However, some key principles are being developed, along with required tools to monitor and research the impact of seaweed harvesting that will continue to feed into (what should be) developing, evolving and adaptable harvest plans for the commercial but sustainable exploitation of natural seaweeds (authors notes).

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APPENDIX B

Ecological Assessment – Greatmans Bay

1. Methodology

Horizontal and vertical shore transects were taken at each of the locations. Vertical shore transects with multiple quadrats allowed a description of the extent of the biotopes present in the survey sites. Data recorded included substrate type, wave exposure, GPS positions of transects and width of the algal band on the shore. Fauna and epiphytic algae were also recorded. As the shores tended to be composed of hard substrates such as bedrock, boulders, cobble and gravel, collecting cores for the fauna was impossible.

A description of Greatmans Bay, including a description of each biotope recorded and the fauna encountered, as well as the extent of the biotope, is outlined below. Descriptions of the biotopes are from the JNCC Marine Habitat Classification for Britain and Ireland (Connor *et al.* 2004).

Greatmans Bay

Greatmans Bay is part of the Kilkieran Bay and Islands SAC (002111). Intertidal surveys revealed substrates which varied from bedrock and boulders to mixed. Algal distribution down the shore was *Pelvetia canaliculata*, *Fucus spiralis*, *Fucus vesiculosus*, *Ascophyllum nodosum* and *Fucus serratus*. *Ulva* sp. and *A. nodosum ecad mackaii* were present. *F. spiralis*, *F. serratus*, *Vertebrata lanosa* and *F. vesiculosus* were recorded as epiphytic on *A. nodosum*.

Fauna of the upper *A. nodosum band* was *Spirorbis* sp., *Littorina obtusata*, *Melarhaphe neritoides*, *L.saxatilis*, *Gibbula umbilicalis, L. littorea*, *Actinia equina*, *Nucella lapillus*, barnacles, *Patella vulgata*, *Anurida maritima*, amphipods, *Mytilus edulis*, *Carcinus maenus* and bryozoans. Mid band fauna were *Spirobis* sp., *L. obtusata*, *L. saxatilis*, *N. lapillus*, *P. vulgata*, *L. littorea*, hydroids, *Necora puber*, amphipods, *Osilinus lineatus*, *C. maenus*, *Gibbula* sp. and bryozoans. In the lower band were L. *obtusata*, *N. lapillus*, barnacles, *M. nerotoides*, *L. littorea*, *Spirobis* sp., *Pagurus* spp., *O. lineatus*, *Gibbula* sp., tunicates and bryozoans. Table 2 outlines the extent of the biotopes found at this location in the upper, middle and lower shore. These biotopes are briefly outlined in Table 1.

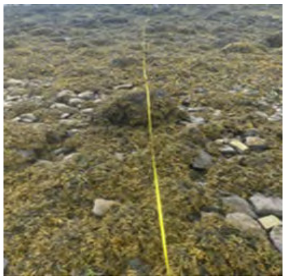
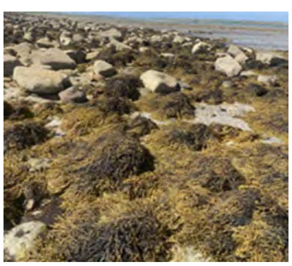
	**LR.LLR.F.Pel. *Pelvetia canaliculata* on sheltered littoral fringe rock JNCC Biotope Description**
	JNCC Biotope Classification
	Lower littoral fringe bedrock or stable boulders and mixed substrata in sheltered to extremely sheltered conditions characterised by a dense cover of the *Pelvetia canaliculata* . The biotope may be present in localised sheltered patches on moderately exposed shores. Individuals of the *Fucus spiralis* can usually be found among the *P. canaliculata* and/or in lower part of the biotope.
	**LR.LLR.F.Fspi.X. *Fucus spiralis* on full salinity upper eulittoral mixed substrata**
	JNCC Biotope Description
	Moderately exposed to sheltered full salinity upper eulittoral mixed substrata characterised by a band of *Fucus spiralis* with occasional clumps of the *Pelvetia canaliculata* . This zone usually lies below a zone dominated by P. Canaliculata (PelB; Pel).
	**LR.LLR.F.Fspi.FS. *Fucus spiralis* on full salinity sheltered upper eulittoral rock**
	JNCC Biotope Description
	Sheltered upper eulittoral bedrock characterised by a band of *Fucus spiralis* . This zone usually lies below a zone dominated by *Pelvetia canaliculata* (PelB; Pel), but occasional clumps of *P. canaliculata* may be present (usually less than common) amongst the *F. spiralis* . Fspi occurs above the *Ascophyllum nodosum* (Asc) and/or *Fucus vesiculosus* (Fves) zones
	***LR.LLR.F.Fves.X Fucus vesiculosus* on mid eulittoral mixed substrata**
	JNCC Biotope Classification
	Sheltered and very sheltered mid eulittoral pebbles and cobbles lying on sediment in fully marine conditions typically characterised by *Fucus vesiculosus* . *Ascophyllum nodosum* can occasionally be found on larger boulders.

Table 1 - Description of Biotopes found throughout the MUL area

	***LR.LLR.F.Asc.X. Ascophyllum nodosum* on full salinity mid eulittoral mixed substrata**
	JNCC Biotope Classification
	Sheltered to extremely sheltered full salinity mixed substrata characterised by a canopy formed by a mosaic of *Ascophyllum nodosum* and *Fucus vesiculosus* . Winkles are common and *Littorina littorea* and *L. obtusata* may occur in high densities, while species such as the limpet *Patella vulgata* , the shore crab *Carcinus maenas* and the whelk *Nucella lapillus* may also occur.
	**LR.LLR.F.Asc.Fs. *Ascophyllum nodosum* on full salinity mid eulittoral rock**
	JNCC Biotope Classification:
	Bedrock, stable boulders and cobbles in the mid-eulittoral zone of moderately exposed to extremely sheltered shores, in fully marine conditions, characterised by a dense canopy of *Ascophyllum nodosum* . This biotope is usually found between *Fucus spiralis* (Fspi) and *F. serratus* dominated biotopes (Fserr).
	**LR.LLR.F.Fserr.X. *Fucus serratus* on full salinity lower eulittoral mixed substrata**
	JNCC Biotope Description
	Sheltered to extremely sheltered full salinity lower eulittoral mixed substrata with dense stands of *Fucus serratus* . Fserr.X occurs in the lower eulittoral below the biotopes dominated by *A. nodosum* (Asc.X) on mixed substrata shores, or on sediment shores where mixed substrata occurs in discrete patches on the lower shore.

Table 1 (cont'd) - Description of Biotopes found throughout the MUL area

Bay	Biotope	LR.LLR.F.Pel	LR.LLR.F.Fspi.X	LR.LLR.F.Fspi.FS	LR.LLR.F.Asc.X	LR.LLR.F.Asc.Fs	LR.LLR.F.Fves.X	LR.LLR.F.Fves.FS	LR.LLR.F.Fserr.Fs	LR.LLR.F.Fserr.X	LS.LSa.MuSa.MacAre
Greatmans Bay	**Transect Number**	***Pelvetia canaliculata* on sheltered littoral fringe rock**	***Fucus spiralis* on full salinity upper eulittoral mixed substrata**	***Fucus spiralis* on full salinity sheltered upper eulittoral rock**	***Ascophyllum nodosum* on full salinity mid eulittoral mixed substrata**	***Ascophyllum nodosum* on full salinity mid eulittoral rock**	***Fucus vesiculosus* on full salinity mid eulittoral mixed substrata**	***Fucus vesiculosus* on full salinity moderately exposed to sheltered mid eulittoral rock**	***Fucus serratus* on full salinity sheltered lower eulittoral rock**	***Fucus serratus* on full salinity lower eulittoral mixed substrata**	***Macoma balthica* and *Arenicola marina* in littoral muddy sand**
	51	0-2.4m		0.7-4.3m	5-38m					38m+	
	52	0-0.5m		0.5-1m	0.7-10.4m					10.4m+	
	53	0-1m		0-1m	2-55m		0-55m			55m+	
	54	0-28m		0-35m			25-100m	29-100m		80-100m+	
	55	0-26m		2-45m	4-30m					30m+	
	56	0-1.9m		0-1m; 3-5.2m	5.2-19.1m					19.3-19.5m+	
	57	0-3.5m		3.5-10m; 15-16m	11.4-15m; 19-62.8m					62.8m+	
	58	0-1m		1-10m				10-29m		29m+	
	59	0-10m		10-16.2m				16.2-50m; 60-97m (57-60m mud)		60m+	

Table 2 – Greatmans Bay - Biotopes present in upper shore, middle shore and lower shore

APPENDIX C

Biomass assessments of *Ascophyllum nodosum* and *Fucus spp*.

1. Introduction

The quantity of *Ascophyllum* and *Fucus* resources in Greatmans Bay, County Galway, was estimated using a combination of satellite imagery analysis and field surveys. This method has been employed previously in other jurisdiction and has led to the sustainable management of the *Ascophyllum nodosum* harvest over the last 25 years in Canada. The total bed area for each sector of the *Ascophyllum* and *Fucus* was calculated satellite imagery.

2. Bed Mapping

The area included as part of the MUL was defined by mapping the *Ascophyllum nodosum* and *Fucus spp.* beds in the regions of interest.

All the following work was completed in the open source QGIS project, version 3.28.2 Firenze (https://www.qgis.org/en/site/) or in ArcGIS Pro and Online https://www.arcgis.com/index.html).

2.1 Satellite Imagery

The European Space Agency's Sentinel-2 (https://sentinel.esa.int/web/sentinel/missions/sentinel-2) mission consists of two optical Earth observation satellites, Sentinel-2A and Sentinel-2B**.** Depending on the spectral band, these satellites deliver free, high-resolution imagery with spatial resolutions of 10 m, 20 m, and 60 m. Sentinel-2 provides imagery across 13 multispectral bands**,** including visible (Red, Green, Blue), near-infrared (NIR), and shortwave infrared (SWIR). While the resolution is lower compared to commercial satellites, Sentinel-2 imagery is freely available and offers consistent global coverage. Additionally, Sentinel-2's revisit frequency of 5 days allows users to select imagery from specific timeframes, including those captured near low tide, depending on availability. Only bands with a 10 m spatial resolution were used in these analyses.

When choosing specific images for this project, two major factors had to be overcome. Firstly, the images had to be as close to low tide as possible. Secondly, images with as little cloud cover as possible were chosen, as the Sentinel satellites cannot produce accurate images through clouds. The most appropriate, cloud-free, and low-tide satellite images were chosen for further processing. Details of Sentinel-2 image acquisition are listed below (Table 1).

Bay	Image Acquisition Date and Time	Time of low tide
Greatmans Bay	28/04/2022. 12 pm	11.22 am

Table 1 – Acquisition Details of Sentinel-2 Image

As the *Ascophyllum nodosum* beds do not change significantly in size based on the time of year and do not change significantly in size from year to year, we were satisfied with the Sentinel imagery that was available and are confident that they will accurately describe the bed areas in the MUL area.

2.2 NDVI

The main purpose of using Sentinel 2 imagery was to utilize multispectral bands, more specifically, the near-infrared (NIR) and red band, to create an NDVI layer. NDVI stands for Normalized Difference Vegetation Index and is calculated for each pixel of the satellite images as:

(NIR Reflectance – Red Reflectance) / (NIR Reflectance + Red Reflectance)

Because vegetation (*e.g.*, trees, grasses, seagrass, and macroalgae) absorbs a much greater proportion of red light compared to near-infrared light, vegetation has high NDVI values compared to non-vegetation (*e.g.*, rocks, sand, mud, water, etc.). By creating an NDVI layer and then calibrating it by including factors such as land masking (to eliminate land which contains trees, which are picked up with the NDVI) and the width of *Ascophyllum nodosum* beds measured in the field, we can use NDVI to measure bed area semi-automatically.

2.3 Using NDVI – Land Mask

Before reclassifying the NDVI image into areas of vegetation and non-vegetation, this project needs to isolate the areas where *Ascophyllum* and *Fucus* beds occur. If this step was not completed, the *Ascophyllum* and *Fucus* bed areas would run into low-lying marsh areas, seagrass beds, forested areas, etc., and a true bed area could not be calculated.

OSI high watermark coastal shapefile was used to act as a land mask for our NDVI. Anything covered by the land mask would be removed, and any vegetation remaining would be in the intertidal zone or shallow subtidal (*i.e.*, intertidal macroalgae and shallow water seagrass). In some areas, the coastline was drawn too far out into the intertidal, and therefore, *Ascophyllum* and *Fucus* bed areas were being covered. Any inaccuracies in the land mask were manually corrected.

2.4 Using NDVI – Calibrating with Real-World Data

As mentioned above, we used the multispectral bands from the Sentinel 2 imagery to calculate an NDVI number across the entire image. Utilising the land mask, any vegetation highlighted will be macroalgae and seagrass. The next step in the bed mapping process was to ensure we only measured *Ascophyllum* and *Fucus* with the NDVI data. Appropriate NDVI cut-off points were applied based on previous experimental work on comparing the width of the beds in the field to the widths of the beds measured with the different NDVI cut-offs; the NDVI cut-off value with the closest fit to the measured bed's widths was chosen for this project.

2.5 Bed Polygons

After the raster image with the most appropriate NDVI cut-off value was chosen for each Sentinel-2 image, it was converted into a polygon shapefile. Any beds that overlapped two sectors were split along the sector boundary line. All beds were labelled with the correct sector information, and the area of each bed was calculated. The shapefiles were then reviewed to ensure any areas that were not Ascophyllum nodosum beds (based on field surveys) were removed. Following this initial delineation of seaweed beds using NDVI, additional manual editing of the polygons was performed to refine boundaries and enhance accuracy due to the moderate resolution limitations of Sentinel-2 imagery.

While conducting fieldwork across the MUL area in Greatmans Bay, Arramara Teo field technicians also collected measurements to calibrate the NDVI data. At various locations where biomass transects were being completed, we measured the width of the *Ascophyllum nodosum* bed perpendicular to the shore. This bed width was recorded along with an accurate GPS position.

Visual observations were conducted on other aerial imagery to ensure that the threshold value selected accurately selected the *Ascophyllum nodosum* bed. Several other image classification methods were tested but did not provide better results than the method employed above.

3. Biomass Surveys

The field biomass surveys aimed to estimate the average biomass density of *Ascophyllum nodosum* and *Fucus spp*. in each sector, which will be used when calculating harvestable biomass. Sampling locations were selected haphazardly within the main beds, attempting to obtain a representative sampling within each sector. Sampling was done during a six-hour window around low tide.

A 30 m transect line was deployed at each sampling location in the middle of the *Ascophyllum nodosum* zone, parallel to the shore, with ten 50 × 50 cm (0.25 m^2) quadrats randomly positioned along the transect length. All *Ascophyllum nodosum* and *Fucus spp.* shoots originating from the quadrat were then cut 25 cm away from the holdfast and weighed in a mesh dive bag using a digital hook scale. The mass of *Ascophyllum nodosum* and *Fucus spp*. above 25 cm from the holdfast per unit area is defined as biomass density in the present study. Importantly, we have detected no sampling bias between individuals making the measurements.

Seasonal reproduction of *Ascophyllum nodosum* occurs in late spring when reproductive receptacles rapidly increase in weight and can account for over 50% of the weight of a clump (*Vadas et al. 2004*). Because of this, all biomass data was collected between the end of the reproductive season after the shedding of receptacles in early May and early Autumn so that only vegetative biomass is included.

4. Biomass Estimation and Harvest Quantities

The average biomass density of *Ascophyllum nodosum* and *Fucus spp.* in each sector was multiplied by the bed area within the corresponding sector. This value represented the total seaweed biomass within the sector. The maximum yearly harvest per sector was calculated as 20% of the total biomass within a sector. A 25% harvest rate has been found to be sustainable over time (see Appendix A – Literature Review of Commercial Harvesting); however, we used a lower harvest rate as a precautionary measure.