

# Connemara Organic Seaweeds



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**CONNEMARA ORGANIC SEaweeds  
134A SEACREST  
KNOCKNACARRA  
CO. GALWAY**

**Please find enclosed:**

- 1. Application Form**
- 2. Estimation of Biomass**
- 3. Proposal to Monitor Harvesting**
- 4. Maps**
- 5. Business Plan**

**I will email you on the proposal also and if you need any more information, please do not  
hesitate to contact me.**

**Yours sincerely,**

**Bartley Noel Lee**

**Dept. of Environment, Heritage  
& Local Government**

**1 8 DEC 2013**

**Wexford**



**Comhshaol, Pobal agus Rialtas Áitiúil**  
Environment, Community and Local Government

For Office Use

Ref. No. \_\_\_\_\_

Application date: \_\_\_\_\_

Date of receipt. \_\_\_\_\_

Date Validated: \_\_\_\_\_

**APPLICATION FOR A LEASE/LICENCE/CONSENT UNDER THE FORESHORE ACT  
1933 (AS AMENDED)**

- Applications for Offshore renewable energy (ORE) projects should use an ORE specific form.
- Please complete the form electronically. Type details in the boxes provided, space will expand as you type.
- The enclosures checklist should also be completed

**Applicant Details:**

**Contact Name:** Bartley Noel Lee

**Company/Organisation:** Connemara Organic Seaweeds Ltd

**Address:** 134, A, Seacrest, Knocknacarra, Galway, Co Galway

**Phone No:**

**E-mail address:**

**Nominated Contact/Agent (Where different from above):**

**Name:** John Costelloe

**Company:** Aquafact Internationala Services Ltd

**Address:** N/A  
12 Kilkierran Pk., Liosbaun, Co. Galway

**Phone No:** N/A  
091-756812

**E-mail address:** N/A  
Johncostelloe1@gmail.com

**Applicant's Legal Advisor:**

**Name:** Lewis C. Doyle Solicitors

**Address:** ST. Augustine Street, Galway, Co. Galway

**Phone No:** (091) 549300

**E-mail address:** info@lewiscdoyle.com

**Part 1: Proposal Details (Attach additional documents as required)**

1.1	<b>Description of proposed works/activity.</b> See Attached detailed submission prepared by Aquafact International Services Ltd. Laying out a work plan and planned monitoring of Activity to ensure it is carried out in a sustainable and environmentally responsible fashion.																
1.2	<b>Describe the nature and scale of any structure to be erected on the foreshore. Is the structure proposed to be temporary or permanent</b> N.A.																
1.3	<b>Indicative timing of the works/activity: (i) Start date (ii) Duration (iii) Any other information relevant to timing.</b> See attached detailed submission prepared by Aquafact International Services Ltd with a proposed start date of 2014 and an ongoing period for 5 years																
1.4	<b>Primary usage for proposed development (please tick)</b> <table border="1" data-bbox="379 952 1225 1245"> <tr> <td><b>Use</b></td><td></td></tr> <tr> <td><b>Industrial</b></td><td></td></tr> <tr> <td><b>Commercial</b></td><td>✓</td></tr> <tr> <td><b>Within Fishery Harbour Centre</b></td><td></td></tr> <tr> <td><b>Sea Fisheries</b></td><td></td></tr> <tr> <td><b>Local Authority</b></td><td></td></tr> <tr> <td><b>Community/Co Op scheme</b></td><td></td></tr> <tr> <td><b>Other(specify)</b></td><td></td></tr> </table>	<b>Use</b>		<b>Industrial</b>		<b>Commercial</b>	✓	<b>Within Fishery Harbour Centre</b>		<b>Sea Fisheries</b>		<b>Local Authority</b>		<b>Community/Co Op scheme</b>		<b>Other(specify)</b>	
<b>Use</b>																	
<b>Industrial</b>																	
<b>Commercial</b>	✓																
<b>Within Fishery Harbour Centre</b>																	
<b>Sea Fisheries</b>																	
<b>Local Authority</b>																	
<b>Community/Co Op scheme</b>																	
<b>Other(specify)</b>																	
1.5	<b>Do the proposed works provide for public use, commercial use, restricted use or strictly private use? Provide Details</b> see attached work plan prepared by Aquafact international services ltd																
1.6	<b>Might the proposed works restrict public use/enjoyment of the foreshore? Provide details.</b> No all works to be undertaken from the sea so access is not an issue.																
1.7	<b>Has the applicant held or does the applicant hold any previous Foreshore Licences, Leases or applications over the area sought or over any other area including pending applications? (Give details including Department's file reference number(s)).</b> Yes a foreshore licence has been applied for in 2013 for the sustainable harvesting of Laminarian spp in North Galway Bay between Cashla Point and Corrahona point.																

<b>1.8</b>	<b>Status of planning permission application: Pending/granted/not required.</b> Pending <b>Consent Authority:</b> DECLG <b>Reference Number:</b>  <b>(Please provide copies of consents granted)</b>
<b>1.9</b>	<b>Are any other consents required for this proposal? Please detail.</b>  <b>Consent type</b> <b>Consent Authority:</b> <b>Reference Number:</b> <b>Status of application:</b>  <b>(Please provide copies of consents granted)</b>
<b>1.10</b>	<b>Employment Implications (if any).</b> See business Plan attached
<b>1.11</b>	<b>Capital cost of proposed works (€ - Euro)</b> See Business Plan attached
<b>1.12</b>	<b>Do the proposed works involve the draw down of European Union or State funding? Yes</b> <b>If "Yes" give details, including any time restrictions, etc. applying</b>

**Part 2: Proposed Site. (Attach additional documents as required)**

<b>2.1</b>	<b>County:</b> Galway Bay
<b>2.2</b>	<b>Location name and nearest townland name:</b> Outer southern Burtraghboy Bay north of Carna and west of Glinsk See attached figure 1.1 of the Aquafact report for locations
<b>2.3</b>	<b>Geographic co-ordinates of the area under application in degrees minutes and seconds WGS84 for offshore developments and where the area can also be identified on the Ordnance Survey map and /or is connected to the seashore/mainland , specify Ordnance Survey map no and Irish National Grid co-ordinates</b> see attached the Ordnance Survey map is provided in the attached Aquafact report. The location extends from 53°22'13 N -09°52'10 W to 53°19'44 N -09°54'24 W.
<b>2.4</b>	<b>Please indicate the size of the Foreshore area (Ha<sup>2</sup>) or (M2) or (KM2)</b> see attached Table 1.2 of the Aquafact Report. Approximately 4.5 km <sup>2</sup>

<b>2.5</b>	<b>If offshore please indicate distance from shore (Km):</b> Approximately >100m and at depths of greater of > 3m below low tide mark. See attached Admiralty Chart.
<b>2.6</b>	<b>Is any of the foreshore in the proposed site in private ownership? If yes please provide documentary evidence of same (e.g. folio)</b> No
<b>2.7</b>	<b>Any other site details considered relevant:</b> No

**Part 3. Maps and Drawings, Please refer to Guidance on map and drawing requirements.**

<b>3.1</b>	<b>Site location map attached? Please include reference no(s).</b> Bertraghbui/Moyros Bay. Drawing No. 1229-1000
<b>3.2</b>	<b>Foreshore Lease/Licence map attached? Please include reference no(s).</b> OS Map. Bertraghbui/Moyros Bay. Drawing No. 1229-1000 Admiralty Chart. Bertraghbui/Moyros Bay. Drawing No. 1229-1001
<b>3.3</b>	<b>Drawings of structures to be used and or layout (if required) attached? Please detail and include reference no(s).</b> N.A.
<b>3.4</b>	<b>Admiralty Chart attached?</b> Yes. Admiralty Chart. Bertraghbui/Moyros Bay. Drawing No. 1229-1001
<b>3.5</b>	<b>Other maps/drawings attached ?– please detail and include reference numbers.</b> Yes. OS Map. Bertraghbui/Moyros Bay. Drawing No. 1229-1000

**Part 4: Pre- application consultations**

<b>4.1</b>	<p><b>Describe briefly any consultations undertaken with the following bodies.</b></p> <ul style="list-style-type: none"><li>• <b>National Parks &amp; Wildlife Service (NPWS)</b></li><li>• <b>National Monuments Service (NMS) of Department of Arts, Heritage and the Gaeltacht</b></li><li>• <b>Inland Fisheries Ireland</b></li><li>• <b>Sea Fisheries Protection Authority</b></li><li>• <b>Marine Institute</b></li><li>• <b>Marine Survey Office</b></li></ul> <p><b>Please also provide copies of correspondence. See proposal Document 1</b></p>
<b>4.2</b>	<p><b>Describe briefly any consultations undertaken with other relevant authorities (e.g. Local Authority, port/harbour authority etc) or State Agencies. See proposal Document 1.</b></p>
<b>4.3</b>	<p><b>Describe any consultations undertaken to date with other foreshore users.</b></p>
<b>4.4</b>	<p><b>Describe any likely interactions with activities of the public or other foreshore users during the construction and operational phases of the works/activities (e.g. fishing, aquaculture, sailing, and surfing swimming, walking). Describe any measures proposed to minimise inconvenience to other users. NA</b></p>
<b>4.5</b>	<p><b>Have adjacent land owners, whose properties may be affected by these works been consulted? Please provide details/permissions as appropriate. NA</b></p>

**Part 5: Environmental Considerations**  
**(your consultations with National Parks and Wildlife Service and National Monuments Service may inform your answers. Attach additional reports as required and mark under the R column)**

[www.epa.ie/downloads/advice/ea/guidelines/](http://www.epa.ie/downloads/advice/ea/guidelines/)

[www.environ.ie/en/DevelopmentHousing/PlanningDevelopment/EnvironmentalAssessment/](http://www.environ.ie/en/DevelopmentHousing/PlanningDevelopment/EnvironmentalAssessment/)

<http://www.npws.ie/protectedsites/appropriateassessment/>

	<b>Environmental legislative requirements</b>	<b>Yes</b>	<b>No</b>	<b>R</b>
<b>5.1</b>	<b>Is an Environmental Impact Statement required for this proposal?</b>		✓	
<b>5.2</b>	<b>Is a Natura Impact Statement required for this proposal?</b>		✓	
<b>5.3</b>	<b>Is the area within or adjacent to a NHA, pNHA, SAC, SPA, or National Park? Specify site names and code(s).</b>	✓		
<b>5.4</b>	<b>Describe any other projects or plans for the area, anticipated or developed, that in combination with this proposal, may have a significant effect on a Natura 2000 site: Please list with planning reference numbers (where available).</b>			N.A.

	<b>Environmental Considerations</b>	<b>Yes</b>	<b>No</b>	<b>R</b>
<b>5.5</b>	<b>Will the proposal have any potential environmental impacts? If yes, please describe</b>	Yes. See attached Doc. 5		
<b>5.6</b>	<b>Are you proposing any measures to mitigate the potential environmental impacts? If yes, please describe</b>	Yes. Harvest site rotation. See attached Doc. 5		
<b>5.7</b>	<b>Are there public health/safety implications arising from the proposed works? (e.g. effluent disposal, removal of derelict or dangerous structures etc.) If yes, please describe</b>		No	
<b>5.8</b>	<b>Will the works involve the storage and/or disposal of waste? If "Yes" please give details of the type of waste and the proposed method of storage and/or disposal (including location)</b>		No	

<b>5.9</b>	<b>Other Environmental Considerations? If yes, please specify.</b>			
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	<b>Built Heritage Considerations</b>	<b>Yes</b>	<b>No</b>	<b>R</b>
<b>5.10</b>	<b>Does the area contain an archaeological site or feature? If yes, please specify.</b>			N.A.
<b>5.11</b>	<b>Does the area contain or adjoin a listed archaeological site or monument? If yes, please specify.</b>			N.A.
<b>5.12</b>	<b>Will the proposal have any potential impacts on the archaeological integrity of the site? If yes please describe</b>			No
<b>5.13</b>	<b>Are you proposing any measures to mitigate potential archaeological impacts? If yes, please describe?</b>			N.A.

**Part 6: Navigational Safety Considerations. (Your consultations with relevant stakeholders may inform your answers. Attach additional documents as required and mark under the R column)**

	<b>Navigational Safety Considerations.</b>	<b>Yes</b>	<b>No</b>	<b>R</b>
<b>6.1</b>	<b>Are there public navigational safety implications arising from the proposed works?</b>			N.A.
<b>6.2</b>	<b>What marine activity is there in the area?</b>			N.A.
<b>6.3</b>	<b>How will the marine activity be affected by the proposed works?</b>			N.A.
<b>6.4</b>	<b>What mitigating measures will be put in place?</b>			N.A.
<b>6.5</b>	<b>How will the proposed works affect Marine Navigation in the future?</b>			N.A.

**Part 7: Fishing/Aquaculture considerations (your consultations with IFI, SFP, DAFM may inform your answers. Attach additional documents as required and mark under the R column)**

	<b>Fishing/Aquaculture considerations</b>	<b>Yes</b>	<b>No</b>	<b>R</b>
<b>7.1</b>	<p><b>Is the proposal located in proximity to any of the following:</b></p> <ul style="list-style-type: none"> <li>• aquaculture operation</li> <li>• designated Shellfish Growing Waters</li> <li>• fish spawning ground</li> <li>• other sensitive fisheries location</li> </ul> <p><b>Please illustrate on appropriate chart including distance in Km.</b></p>	<b>Yes. See Doc. 7</b>		
<b>7.2</b>	<b>Are there other potential impacts of the proposal on fishing/aquaculture in the area? If yes, please describe.</b>		<b>No Insignificant due to low level of activity</b>	
<b>7.3</b>	<b>Are there any measures proposed to mitigate potential impacts on fisheries or aquaculture? If yes, please describe.</b>			

**Part 8 – Additional information**

<b>8.1</b>	<b>Please detail any additional relevant information.</b>
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**Declaration and Consent:**

**The details provided here are correct to the best of my knowledge.**

**I understand that no works will be commenced, by me or my agents on the proposed site, without the prior written consent of the Minister.**

**I agree that on completion of the works, all environmental data that is not commercially-sensitive shall be provided within a reasonable timeframe to the Marine Institute; the format and timeframe to be agreed with the Marine Institute. I understand that the Marine Institute may make this information available to individuals and organisations in line with its data access policy.**

**I give consent to the Minister and his servants to copy this application and to make it available for inspection and copying by the public. This consent relates to this application, to any further information, or submission provided by me or on my behalf and to the publication of the licence document.**

**Signed for and on behalf of the applicant:**

Bartley, Noel Lee

**Name of above Signatory (block letters):**

BARTLEY NOEL LEE

**Position Held:**

MANAGING DIRECTOR

**Date** 16/12/2013

**Return completed applications to:**

Foreshore Unit  
Marine Planning and Foreshore  
Department of the Environment, Community and Local Government  
Newtown Road  
Wexford

Enquiries to: [Foreshore@environ.ie](mailto:Foreshore@environ.ie) (Other contact details to be included in Guidance materials)

Email a copy of application documents: [Foreshore@environ.ie](mailto:Foreshore@environ.ie)



# AQUAFACT

**Estimation of *Laminaria* spp. biomass.**

**Outer southern Bertraghbui Bay.**

**Produced by**

**AQUAFACT International Services Ltd**

**on behalf of**

**Connemara Organic Seaweed Ltd**

**Dec 2013**

**AQUAFACT INTERNATIONAL SERVICES Ltd**

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**Min. of Environment, Heritage  
& Local Government**

**18 DEC 2013**

**Wexford**

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## 1. Introduction

Connemara Organic Seaweed Ltd is applying to the Department of Agriculture, Food and the Marine for a Foreshore Licence to mechanically harvest naturally occurring *Laminaria* spp. kelp stands along a section of rocky subtidal coast located on outer southern Bertraghboy Bay. The site location is approximately 80 km west of Galway city, positioned 53°22'13 N -09°52'10 W and between 53°19'44 N -09°54'24 W. As part of the Foreshore Licence application, the total harvest area outlined for the outer southern Bertraghboy Bay was divided into five annual harvest zones, one to be harvested each year for five years (See Figure 1.1).

Kelps are large brown seaweeds belonging to the phylum Phaeophyta. Kelps represent the largest and structurally most complex of these weeds and comprise different genera referred to as the order *Laminariales*. There are five species of kelp common in Irish waters, namely *Laminaria digitata*, *L. hyperborea*, *Saccharina latissima*, *Saccorhiza polyschides* and *Alaria esculenta*. *L. digitata* and *L. hyperborea* form large, monospecific stands which are of commercial interest (Werner & Kraan, 2004). France and Norway harvest 60,000 tonnes and 160,000t respectively of *L. hyperborea* annually (Blight *et al.*, 2011). Ireland pales in comparison processing 36,000t of all naturally occurring seaweed annually (DAFM, 2012). Laminarians can be long lived and are large in size. *L. digitata* can live for three or possibly five years and grow to ca. 2m in height. While *L. hyperborea* can live for approximately 7-12 years and can grow to ca. 2-3m in height (Kelly, 2005).

Laminarians are found on the lower intertidal zone down into the subtidal zone on rocky shores. The lower limit of *Laminaria* is generally determined by light levels. Growth of *Laminaria* spp. is seasonal with most growth occurring from late spring to late summer; in autumn growth rates decrease in order to build up reserves in the form of storage carbohydrates (Werner & Kraan, 2004). Growth rates depend on local environmental factors such as temperature, light and nutrient levels. *L. digitata* and *L. hyperborea* have been shown to have a growth rate of 40-65cm and 35-70cm per year, respectively (Werner & Kraan, 2004). *Laminaria* spp. kelp forests in Europe can be highly productive with primary production values of 1kg of carbon per m<sup>2</sup> per annum (Kelly, 2005). The total naturally occurring resource of *L. digitata* and *L. hyperborea* is estimated to be 81,641t for Galway Bay, ranging from 36,738t and 118,379t when using 95% confidence limits. This equates to approximately 3,000,000t for the entire Irish coastline (Werner & Kraan, 2004).

Data on the density/biomass of kelp in Bertraghboy Bay is limited (Aquafact Ltd., 1995, Hession *et al.*, 1998), however a desk survey carried out by Aquafact Ltd (1995) highlighted that Bertraghboy Bay had potential to

be favourable for Laminarian growth on the more exposed areas. Hession et al., 1998 describes outer southern Burtraghbui Bay as containing a dense bed of mixed kelp with maximum bed depths reaching to 50 metres. Furthermore, Blight *et al.*, 2011 found a kelp biomass of approximately 4.9-5.5 kg/m<sup>2</sup> in Crump and Inishdegil in north Connemara, Co. Galway. Werner & Kraan (2004) reported a standing crop wet weight biomass of 3.4-15 kg/m<sup>2</sup> for *L. digitata* and of 5.8-19.05 kg/m<sup>2</sup> for *L. hyperborea* in Galway Bay. The latter report also stated a biomass of 2-10.5 kg/m<sup>2</sup> for *L. digitata* in Brittany and 6-16 kg/m<sup>2</sup> with maximum values of 27-41 kg/m<sup>2</sup> for *L. hyperborea* in Norway.

Aquafact (2013) estimated *Laminaria* spp biomass along a section of rocky shoreline in North Galway Bay between Cashla Point and Corrahona point to have average mixed kelp wet weight biomass of 14.85 kg/m<sup>2</sup> supporting the findings of Werner & Kraan (2004) for *L. digitata* and *L. hyperborea*. With Bertraghbui Bay being exposed to relatively similar conditions and having similar habitats in subtidal areas to the outer Galway bay areas results from previous studies provide a guideline on the biomass of *Laminaria* spp located in the proposed Bertraghbui harvest sites. Densities were estimated to range from 8.7-38.3 holdfasts per m<sup>2</sup> with depth and substrate type being the main notable varying factors. The average kelp density was recorded at 21.1 holdfasts per m<sup>2</sup> in Galway Bay (Aquafact 2013)

The aim of this report is to provide an estimate of the biomass/densities of *Laminaria* spp. in a proposed harvest area in outer southern Bertraghbui Bay and to provide a working programme for the sustainable harvesting of *Laminaria* spp. from this area.

## 2. Methodology

### 2.1 Sampling

A sampling programme was devised for the estimation and quantification of the *Laminaria* spp. resource in outer southern Bertraghbui Bay in November 2013. However results from the survey work revealed that due to intense storm damage that much of the Laminarian fronds and holdfasts were either damaged or removed and biomass quantification was difficult to ascertain. In addition, the growth of *Laminaria* spp. is seasonal with most growth occurring from late spring to late summer (Werner & Kraan, 2004). For this reason end of season biomass measurement in November would not be representative of the true biomass for the proposed harvest area.

It was decided that field studies in November 2013 would be limited to quadrat analysis of the number of holdfasts per m<sup>2</sup> at different depths and thus would be extrapolated into biomass estimates based on historic data from the region.

### 2.2 Location

The admiralty chart in Figure 1.1 outlines the 5 proposed harvest locations in southern Bertraghbui Bay. It is proposed that each of these sites will be harvested on a rotational basis over a five-year period. The crosshatched area has been determined as representing the optimal habitat for Laminarians (3m-15m) at this location and provides the backdrop for the evaluation of the total biomass for each area. The density of holdfasts was measured at each of the locations marked by the red dots on the map. The latitude, longitude, holdfasts/m<sup>2</sup>, harvest zone and depth of each station can be seen in Table 1.4. A GPS system was used to record the position of each station at each depth.

### 3. Results

#### 3.1. Biomass Estimates

##### A) Biomass derived from measured weights determination

To gain an accurate representation of *Laminaria* spp. biomass located at the harvest site in southern Bertraghbui Bay historical data from Werner & Kraan (2004) and Aquafact (2013) was used. As previously described Werner & Kraan (2004) reported a standing crop wet weight biomass of 3.4-15 kg/m<sup>2</sup> for *L. digitata* and of 5.8-19.05 kg/m<sup>2</sup> for *L. hyperborea* in Galway Bay and Aquafact Ltd (2013) estimated *Laminaria* spp along a section of rocky shoreline in North Galway Bay between Cashla Point and Corrahona point to have average kelp wet weight biomass of 14.85 kg/m<sup>2</sup>. The average biomass (kg/m<sup>2</sup>) from the studies was calculated at 12.83 kg/m<sup>2</sup> and was used to provide individual stipe weights for the total biomass determination for the Bertraghbui sites (Table 1.1.)

Table 1.1 *Laminaria* spp. biomass estimates from previous studies and literature reviews

Resource	Species	Average kg/m <sup>2</sup>
Werner & Kraan (2004)	<i>L. digitata</i>	9.20
	<i>L. Hyperborea</i>	12.43
Aquafact Ltd (2013)	<i>Laminaria</i> spp.	<b>10.81</b>
	<i>Laminaria</i> spp.	<b>14.85</b>
Average biomass of <i>Laminaria</i> spp.		<b>12.83</b>

##### B) Biomass derived from Stipe density determination

To assess the density of *Laminarian* spp. quantitative sampling at three depths of 5, 10 and 13 meters below low tide within each of the 5 harvest areas in Bertraghbui bay was undertaken (See Figure 1.1). The fieldwork was carried out on the 22<sup>nd</sup> of November 2013, commencing two hours before low tide at approximately 11.30 A.M using a 6.5m rigid inflatable boat (RIB). Weather conditions on the day were mixed with

occasional squalls. Wind speed and direction were recorded from Mace Head Co Galway that on the day recorded a mean wind speed of 3.3 knots from the southeast.

Table 1.2. The depth, the number of holdfasts/m<sup>2</sup> and the location for each sampling station in Bertraghbui Bay

Station	Holdfasts/m <sup>2</sup>	Annual Zone (depth)	Lat	Long
1	25	1(5m)	53.32922	-9.90695
2	15	1 (10m)	53.32953	-9.90919
3	15	1 (13m)	53.33250	-9.91287
4	29	5 (5m)	53.34160	-9.89770
5	9	5 (10m)	53.34245	-9.90058
6	2	5 (13m)	53.34376	-9.90308
7	35	3 (5m)	53.35439	-9.90623
8	11	3 (10m)	53.35489	-9.90711
9	7	3 (13m)	53.35534	-9.90740
10	32	4 (5m)	53.36329	-9.89538
11	8	4 (10m)	53.36329	-9.89724
12	8	4 (13m)	53.36430	-9.90301
13	18	2 (5m)	53.37120	-9.87872
14	1	2 (10 m)	53.37261	-9.87871
15	4	2 (13 m)	53.37348	-9.87919

The field survey made no attempt to distinguish between *L. digitata* and *L. hyperborea*. All recordings of kelp holdfasts were recorded as *Laminaria* spp's. Within each of the annual zones a diver sampled a 1m<sup>2</sup> quadrat at each depth (5, 10 and 13 meters) counting each plant within the quadrat. Each holdfast was recorded using a pencil, a waterproof board and a recording of the substrate type was noted. The number of holdfasts across the 5 proposed harvest zones in Bertraghbui ranged in number from 7.67 to 18.33 m<sup>2</sup>

Table 1.3 *Laminaria* spp. densities for each depth of the five harvest zones in Bertraghbui Bay

Depth (meters)	Annual Zone 1	Annual Zone 2	Annual Zone 3	Annual zone 4	Annual Zone 5
5	25	18	35	32	29
10	15	1	11	8	9
13	15	4	7	8	2
Total Holdfasts for each zone	55	23	53	48	40
Average holdfasts for each zone per m <sup>2</sup>	18.33	7.67	17.67	16.00	13.33
Average Holdfast numbers for all 5 zones per m <sup>2</sup>	14.60				

### 3.2. Biomass Overview

The average biomass/m<sup>2</sup> based on historic data and Aquafact Ltd previous work in similar locations is 12.83 kg/m<sup>2</sup> (see section 3.1.A). The average density/m<sup>2</sup> based on the fieldwork carried out in the five harvest zones in outer southern Burtraghbui Bay is 14.60 holdfasts/m<sup>2</sup>. Based on the mean biomass of 12.83 kg/m<sup>2</sup> and relating this to the average number of Stipes per m<sup>2</sup> a figure of 0.88 kg/stipe can be deduced.

The Average biomass of *Laminaria* spp. in the proposed harvest zones based on the number of stipes with an average weight of 0.88 kg is 12.30, 13.47, 16.99, 6.74 and 14.65 kg/m<sup>2</sup> for zones 1 to 5, respectfully.

Table 1.4 A biomass overview from each harvest zone

Biomass Overview					
Depth (meters)	Annual Zone 1	Annual Zone 2	Annual Zone 3	Annual zone 4	Annual Zone 5
5m Biomass Kg/m <sup>2</sup>	21.97	25.48	30.76	15.82	28.12
10m Biomass Kg/m <sup>2</sup>	13.18	7.91	7.03	0.88	9.67
13m Biomass Kg/m <sup>2</sup>	1.76	7.03	13.18	3.52	6.15
Biomass totals kg/m <sup>2</sup>	36.91	40.42	50.97	20.21	43.94
Average Biomass Kg/m <sup>2</sup>	12.30	13.47	16.99	6.74	14.65
Area of Rocky Ground km <sup>2</sup>	1.157	0.431	1.114	0.648	1.114
Biomass Estimates (tonnes)	14,234	5,807	18,926	4,366	16,316

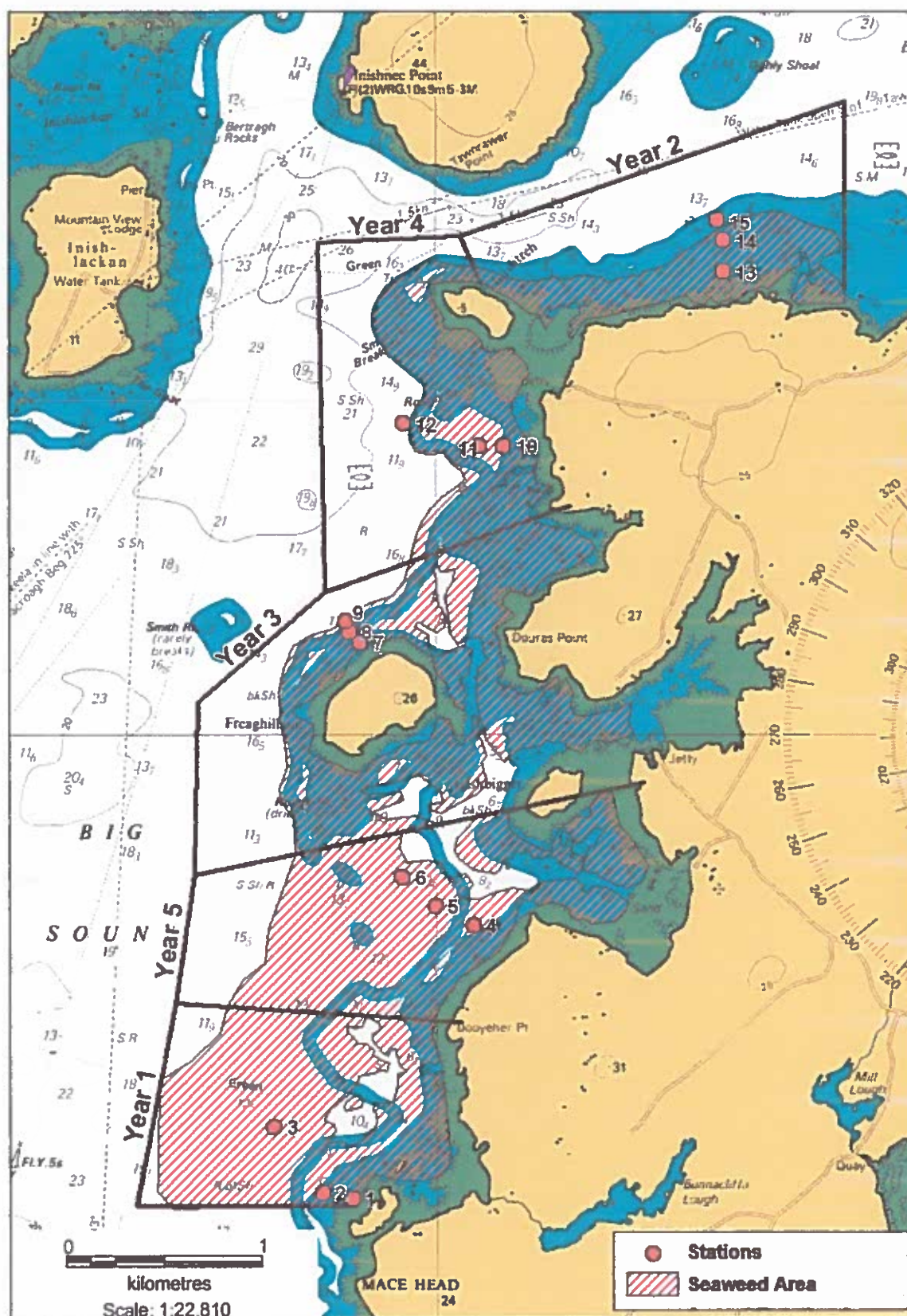


Figure 1.1: Total harvest area between  $53^{\circ}22'13''$  N  $-09^{\circ}52'10''$  W and  $53^{\circ}19'44''$  N  $-09^{\circ}54'24''$  W in outer southern Bertraghboy Bay, showing the five annual harvest zones, seaweed area and sampling stations

The area of rocky ground i.e. suitable substrate for Laminarian growth within the 5 annual harvest zones (Figure1) ranges from 0.431 Km<sup>2</sup> to 1.157 Km<sup>2</sup> and can be seen in Table 1.5.

Table 1.5 Area of rocky ground within the harvest zones in Bertraghboy Bay

Annual Zone	Area (km <sup>2</sup> )	Area (HA)
1	1.157	115.7
2	0.4312	43.1
3	1.114	111.4
4	0.6481	64.8
5	1.114	111.4
Total=	4.4643	446.4

### 3.3 Estimation of Biomass

The biomass (kg/m<sup>2</sup>) of *Laminaria* spp. was obtained by multiplying the holdfast density by the mean stipe weight in each of the harvest zones. The average weight per stipe was estimated to be 0.88 kg. Subsequently the area of rocky ground suitable for seaweed growth was multiplied by this biomass (kg/m<sup>2</sup>) to derive the total biomass in each harvestable zone. It is proposed that the total harvest tonnage from each location will not exceed 10% of the total biomass. The total biomass ranged from 2,904 to 18,640 tonnes across the 5 proposed zones (Table 1.6.).

Table 1.6 Biomass and 10% harvestable tonnage in each harvest zone in Bertraghboy Bay

Annual Zone	Biomass (kg)	Biomass (Tonnes)	10% tonnage
1	18,640,115	18,640	1864.01
2	2,903,739	2,904	290.37
3	17,294,723	17,295	1729.47
4	9,111,058	9,111	911.11
5	13,052,621	13,053	1305.26
Total=	61,002,256	61,002	6,100.23

## 3. Discussion and Summary

Kelp biomass within the harvest zones was estimated by collaborating historic data of Laminarian biomasses

from Aquafact (2013) and Werner & Kraan (2004), which were  $14.85 \text{ kg/m}^2$  and  $10.81 \text{ kg/m}^2$ , thus resulting in an average kelp biomass of  $12.83 \text{ kg/m}^2$ . Blight *et al.*, 2011 found a narrower biomass range of kelp in Crump and Inishdegil, Co. Galway, ranging from approximately  $4.9\text{-}5.5 \text{ kg/m}^2$ . However, these sites have very different subtidal exposure profiles to that of Bertraghbui Bay and Galway Bay as they are isolated exposed islands more susceptible to adverse sea conditions of the Atlantic Ocean. Werner & Kraan (2004) stated a standing crop wet weight biomass of  $3.4\text{-}19.5 \text{ kg/m}^2$  in Galway Bay,  $2\text{-}10.5 \text{ kg/m}^2$  for *L. digitata* In Brittany and  $6\text{-}16 \text{ kg/m}^2$  with maximum values of  $27 - 41 \text{ kg/m}^2$  for *L. hyperborea* in Norway (Werner & Kraan, 2004). Thus, the results produced in this study compare well with results from previous studies.

Using the average kelp biomass of  $12.83 \text{ kg/m}^2$  the overall biomass (tonnes) of *Laminaria* spp. was estimated at 18,640 tonnes 2,904t, 17,295t, 9,111t and 13,053t in the proposed harvest Zones in Bertraghbui Bay in Year 1, 2, 3, 4 and 5 respectively (See table 1.3). On the bases of a 10% harvest the total harvest tonnage will be 6,100t over a five year period

It is proposed to rotate harvesting in the annual zones over a period of five years with harvesting only occurring in one annual zone per year. It is initially planned that up to 10% of the biomass cover in each annual zone will be harvested. The initial 10% proposed is a precautionary approach and further development of a sustainable resource will be subject to a detailed monitoring and management programs (See attached proposed monitoring programme).

#### 4. Monitoring

As part of this application it is proposed to carry out a detailed monitoring plan (See attached proposal to monitor biological parameters at mechanical Kelp harvesting sites on the outer southern Bertraghbui Bay).

#### 5. Maps

Both Admiralty and Ordinate survey maps indicating the proposed harvest sites in Bertraghbui Bay are attached ( See figure 1.1 and attached Ordinate survey map for the Outer southern Bertraghbui Bay area).



## 6. References

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## Proposal to monitor biological parameters at mechanical kelp harvesting sites in the southern approaches to Bertraghbui Bay on the west coast of Ireland

### Introduction.

5 locations on the outer south coast of outer Bertraghbui Bay, have been identified as areas where kelp will be harvested on an annual rota basis. It is proposed that from each region only one of the proposed harvest sites will be utilised in any one season and under this arrangement, a rotation system spanning 5 years will be implemented. The areas of each proposed annual harvest area ranges from 43 to 116ha in the southern Bertraghbui area (see attached Maps. Admiralty Chart Drawing No 1229-1001 and OS Map Drawing No. 1229-1000). In addition to an assessment of kelp biomass, a baseline study will be performed in the first zone to be harvested and a post-harvesting assessment for subsequent years will be compared with this baseline study. The initial review will be carried out in Spring and Autumn; however, after the first year, it is envisaged that an annual assessment will be sufficient.

### Monitoring Programme

#### 1. Fauna

**Invertebrates** – A subtidal survey of a harvest site and a control location will be carried out by experienced marine scientific divers using SCUBA. The BACI (Before-After-Control-Impact) protocol will be employed, wherein a baseline survey will be conducted at selected areas prior to commencement of harvesting. Post-harvest surveys will be carried out in a subset of these areas. The transect area will be approx. 75m x 5m and a standard swimming speed ( $\text{ca } 0.5\text{m } 1\text{ sec}^{-1}$ ) will be used. Diver entry and exit points for each dive will be logged with GPS. It is planned to replicate transects by selecting locations with similar depth profiles. Depending on the size of each harvest block, the total number of transects will vary from 4 – 6 plus an additional control site. Invertebrate species lists will be compiled *in situ* by the divers and digital still photographs will be taken for detailed post-survey examination. The SACFOR (Superabundant, Abundant, Common, Frequent, Rare) scale will be used to semi-quantify the assemblages.

#### Primary parameters:

- Inventory and bundance of macro/epifauna (sufficient seasonal and spatial extent) pre- and post-harvest.
- Harvest and non-harvest areas will have replicate transects stratified by depth.
- Epifauna including fauna attached to kelp and holdfasts as well as to rock in under-story will be inventoried and quantified.

Relative abundance of some species e.g. urchins post-harvest may not become obvious for at least one year. It should be considered to examine harvested sites on an annual basis solely for this reason.

**Fish** – Three survey methods are proposed to record fish species. The first will be carried out while doing the invertebrate transects; the larger, "over canopy" fish species will be counted and logged. For the smaller "under canopy" cryptic species, a stationary technique will be used. A 5 m line will be laid out at selected sites forming a visual cylinder which will be visually surveyed for *ca* 10 mins and species and species numbers will be logged. The third sampling method will be with fyke nets. These will be deployed on one day and recovered 24 hours later. The catch will be counted, identified, measured and where possible scales will be collected for later analysis.

**Birds** – Bird species will be identified and enumerated from the survey vessel while the SCUBA transects are being carried out. Due to seasonality of some species (Lesser Blackbacked Gull, tern species), it is proposed that the Spring survey will not be carried out until these species are present.

2. **Flora** - These surveys will be carried out at the same time as the invertebrate surveys and in post-harvest surveys will include recovery rates. In pre and post-harvest surveys, SACFOR estimates of species will be determined.

## Experimental design

The experimental design will focus on four main elements – biomass assessment, replication, appropriate control sites and selection of species that are suitable for monitoring purposes.

1. With regard to biomass assessment and replication, permanent, marked lead lines will be put in place during the first survey and both video and still photography will be used to document flora and fauna along the length of each transect. Each transect will be marked with GPS for relocation during future surveys. Kelp densities will be assessed from these transect lines and assessments made of abundance and biomass.
2. In relation to controls, it is imperative that selected sites are as similar as possible to the area being harvested. Both biological and physical characteristics will be considered when such controls are being considered. Stratification according to broad physical characteristics (e.g. depth and substrate/habitat type) may be necessary when selecting suitable sampling locations and it may be necessary to focus on one particular type in order to fulfil replication requirements (for test and control locations).
3. Kelp forests are species-rich and include many small and cryptogenic and epiphytic/epifaunal taxa that live within hold fasts and under/on rocks and stones. When selecting species suitable for monitoring, many of these types of species will not be considered. Large taxa such as the laminarians and sponges e.g. *Pachymatisma*, *Cliona*, decapods such as *Cancer* and echinoderms such as *Echinus*, *Asterias* and *Holothuria* are likely candidates for long term monitoring. Attention will also be given to the selection of taxa representing different functional groups e.g. epiphytic, epifaunal, mobile, grazers, filter feeders, predatory. The focus upon indicator species covering a range of functional

groups as opposed to whole community analysis is considered a more practical approach considering the difficulties of quantitatively sampling in this habitat type, i.e., the fact that full analysis is very time consuming, non-destructive sampling is possible and that the response to the kelp removal (pressure) of non-motile faunal can be measured against those of motile fauna which might be expected to vacate barren areas.

4. Selection of these indicators allied with suitable replication will provide a sufficiently robust data set such that large scale changes can be identified and recovery tracked over the period of the sampling program. It is considered that a system-wide approach is more suitable for this type of study than a site/species-specific one and for this reason, adequate replication is required to understand how the system reacts to harvesting (see Section 1 above).

In terms of likely responses to removal of the canopy, it is well understood that seasonal changes in kelp canopy are limited to minor frond removal during stormy periods. Where individual *Laminaria* stipes are lost, colonisation by such opportunistic species as *Saccorhiza* occurs. This is an annual species and sporelings of this taxon and both *Laminaria* and *Saccorhiza* will compete to dominate the macrophyte forest. Harvesting of all laminarians will therefore give rise to recolonisation and it is presumed that the opportunistic *Saccorhiza* will be the primary Stage I colonising species. Some sporelings of the other laminarians will settle also and it is hypothesised that in subsequent years, these will successfully out-compete *Saccorhiza*. Exposure of large areas of reef will alter the microscale physical oceanographic conditions that occur on the seabed.

The statistical analyses will be carried out primarily using PRIMER and will include univariate (number of species, comparison of different depths of transects) and multivariate (species presence/ absence, comparison of different depths of transects, comparison of inter-year variability) analyses. Visual presentation of the data (Multi-Dimensional Scaling) will allow a trajectory of community recovery to a steady state to be documented.

A survey period of 3-years is planned consisting of a pre harvest (assessment (baseline/background) and (Initially) 2/3 years post-harvest to monitor short and long-term impacts and recovery at the first site to be harvested. It is intended to review and refine programme after the year 1 post-harvest survey.