moray offshore renewables ltd

Environmental Statement

Technical Appendix 4.6 A - Intertidal Benthic Ecological Characterisation Survey

Telford, Stevenson, MacColl Wind Farms and associated Transmission Infrastructure Environmental Statement

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moray offshore renewables limited

4th Floor
40 Princes Street
Edinburgh
EH2 2BY

Tel: +44 (0)131 556 7602

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1.1. Study Background

1.1.1. Following successful award of exclusive development rights from Crown Estate, Moray Offshore Renewables Ltd. (MORL) (a consortium developer comprising EDP Renovaveis and Repsol Nuevas Energias UK (formerly SeaEnergy Renewables)) commissioned a detailed technical study to support a consent application for the proposed Moray Firth R3 offshore wind farm (eastern development area) export cable landfall site.

1.1.2. Information derived from this study will be used to inform the Environmental Impact Assessment (EIA), with respect to predicted effects of the installation of the export cable at its landfall site to assist in the development of mitigation measures where agreed and appropriate. This will aid in the development of the Environmental Statement (ES) in support of the consent application.

1.1.3. To address these aspects, EMU Limited (EMU) was commissioned to undertake a benthic ecology sampling survey of two proposed options for the Moray Firth R3 offshore wind farm export cable landfall for statutory review and approval. Accordingly, this document presents the survey methods used, the data collected and gives a characterisation of the intertidal benthic environment within and around the selected export cable landfall option in terms of the seabed habitats available and their associated biological communities. Similar sublittoral benthic studies relevant to the export cable route have been undertaken and reported separately but will also be used to underpin EIA.

1.2. Aims of the study

1.2.1. Study aims include:

- Characterisation of the intertidal environment and associated in- and epifauna and the subsequent allocation of biotopes within the vicinity of the proposed export cable landfall option, and
- Assessment of the predicted impacts of the proposed export cable landfall option with the aim of informing the EIA.

1.3. Study Overview

1.3.1. 'The proposed export cable makes landfall on the East Grampian coastline at Fraserburgh Bay. Figure 1.1 shows the location of the proposed offshore wind farm site and export cable route.

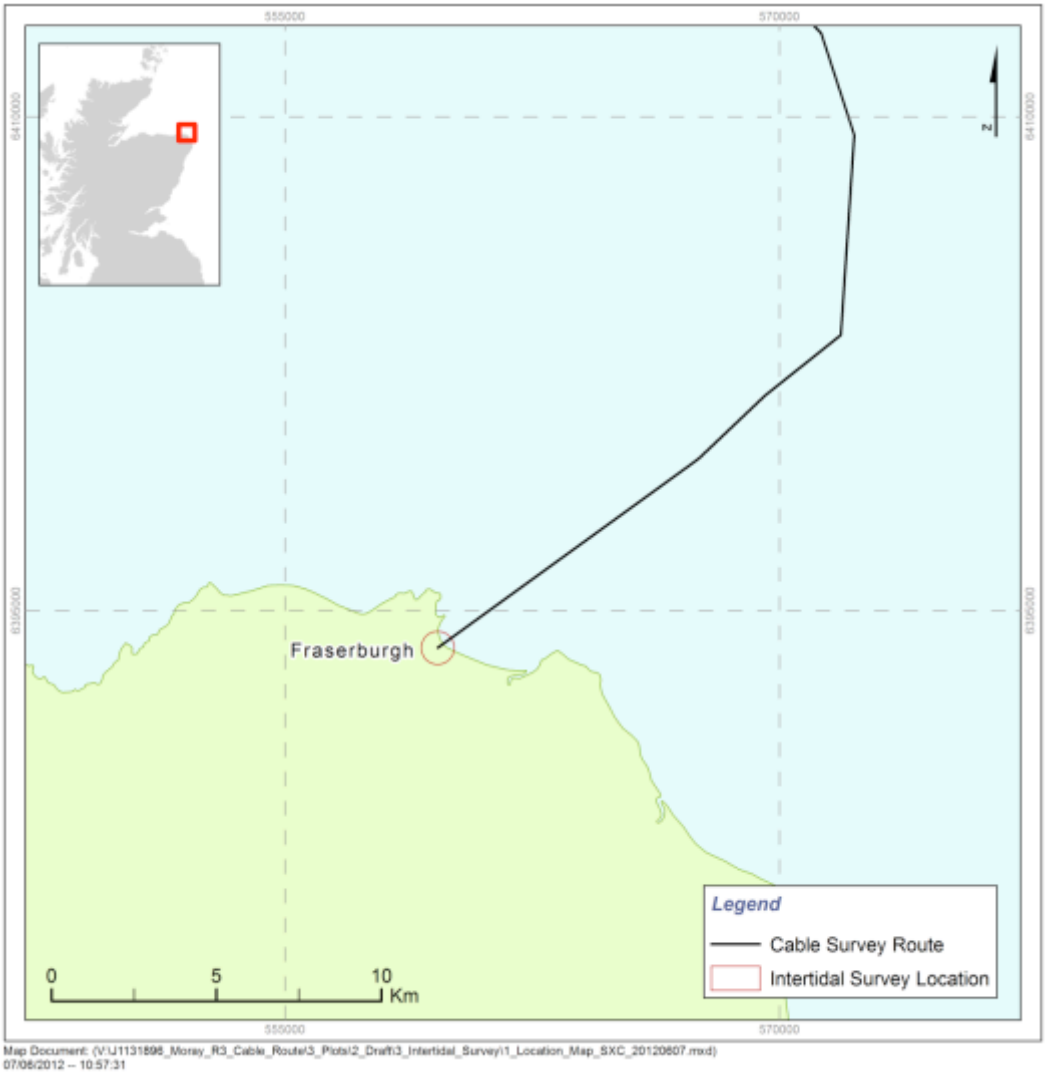

Figure 1.1 Location of the proposed cable route landfall sites of the Moray Firth R3 Offshore Wind Farm Development.

1.4. Regional Physical Environment

1.4.1. The geology of the coastline in the region is varied and consists of metamorphic, sedimentary and igneous rocks, most of which are older than the Carboniferous (~ 360 million years old) although some date back to the Precambrain period. On the Grampian coast between Fraserburg and St Fergus the bedrock is composed of greywacke, pelite, schist and quartzite rocks dating from the Middle Dalradian (Late Precambrian to Cambrian) (Barne *et al*., 1996).

1.4.2. Due to the hard nature of the underlying bedrock, the coastline consists of extensive rocky outcrops, many of which extend sublittorally from land in variable extent and size (Eleftheriou *et al*., 2004), as found to the north of the Fraserburgh Bay study site. Several of the rocky shores within the region are backed by dunes or seacliffs between which sedimentary beaches are interspersed (Eleftheriou *et al*., 2004). Beach substrates range from cobblestones to boulders to mixed sandy sediments, fine sands and muds.

1.4.3. The landfall site is situated on the eastern most part of the Grampian coastline which stretches from Kinnairds Head in Fraserburgh to the mouth of the River North Esk by St. Cyrus. Here, cliffs, rocky shores, long sandy beaches, estuaries, salt marsh and some of the largest sand dunes in the UK are found (East Grampian Coastal Partnership, 2011).

1.4.4. The beach at Fraserburgh is approximately 3.6 km long and fronted by a shallow bay exposed to North Sea winds and swell predominantly from a north east direction (Eleftheriou and Robertson, 1988). This beach has a relatively steep profile, a maximal intertidal width of ~120 m, and is characterised by moderate to well sorted mobile sands of fine to medium grain size (Eleftheriou and Robertson, 1988).

1.5. Regional Biological Context

1.5.1. The East Coast of mainland Scotland encompasses a wide range of aquatic habitats which support many species of birds, fish, marine mammals and invertebrates (see Barne *et al*., 1996).

1.5.2. Benthic communities within the region have been previously described in the Strategic Environmental Assessment (SEA) region 5 by Eleftheriou *et al*. (2004). For the most part, communities, assemblages and associations of the east of Scotland share much in common with those in the North Sea, the west coast of Scotland, Ireland and the North East Atlantic (Eleftheriou *et al*., 2004).

1.5.3. A series of intertidal ecological surveys of the sandy beach fauna by Eleftheriou and Robertson (1988) broadly characterised the habitats and associated species at several sites along the Scottish east coast. Fauna typically consisted of three main groups, including polychaetes, crustaceans and molluscs. Crustaceans such as *Bathyporeia pilosa* and *Talitrus saltator* were found to occupy the upper shore. On the middle and lower shores, crustaceans such as *Haustorius arenarius*, *Eurydice pulchra*, *Bathyporeia pelagica* and *B. sarsi*, and the polychaetes *Paraonis fulgens*,

Eteone longa, *Ophelia rathkei* and *Scolelepis squamata* were found. The majority of the fauna were found on the lower foreshores, including the polychaetes *Spio filicornis*, *Nephtys cirrosa*, *Spiophanes bombyx* and *Lanice conchilega*, the crustaceans *Pontocrates altamarinus*, *P. arenarius*, *Bathyporeia elegans*, *B. guilliamsoniana*, *Pseudocuma gilsoni* and *Atylus swammerdami*, and the bivalves *Tellina tenuis* and *Donax vittatus*. These authors note that where beaches are subject to high exposure, species richness is limited.

1.5.4. Rocky littoral communities are typically colonised by barnacles and limpets on vertical surfaces, with fucoid algae existing sublittorally. There is a distinct zonation of species on many rocky shores, particularly those with a steep inclination, although on the more gently sloping boulder and bedrock shorelines, such as in the rocky area at Fraserburgh Bay, this pattern is less pronounced.

1.5.5. Reviews of existing biological and environmental data relative to the foreshore at Fraserburgh Bay reveal that this site does not hold any statutory designations for nature conservation.

2. Methods

2.1. Survey Design

2.1.1. At the proposed export cable landfall site at Fraserburgh Bay (Figure 1.1), a broad scale biotope mapping survey of the intertidal area within 500 m either side of the cable landfall route was conducted.

2.1.2. The survey encompassed sampling points situated at varying levels within the vertical width of the shore, extending from the supra-littoral (splash/lichen) zone to the sub-littoral fringe, within an area extending 500 m either side of the proposed cable landfall route. Surveys followed JNCC Procedural Guidelines 3-1 (Wyn & Brazier, 2001) and comprised modified Phase I habitat mapping surveys along the route of the proposed cable on the foreshore.

2.1.3. A total of 12 sampling sites were surveyed. Samples were collected by an 11.3 cm diameter corer and processed on site to identify associated infauna.

2.2. Sampling Survey

2.2.1. Surveys were conducted on 15/08/11 during low spring tides to allow access to the lowest reaches of the shore and to maximise working time.

2.2.2. In the field, base maps derived from aerial photography and ordnance survey were annotated with inventories of conspicuous species where possible.

2.2.3. Biotopes were classified on the basis of the Marine Habitat Classification System (Connor *et al*., 2004).

2.2.4. The boundaries of each intertidal polygon/biotope were located and recorded using a Garmin 48 hand held Global Positioning System unit (GPS), accurate to 10 m but often achieving <5 m accuracy. Polygon boundaries were identified by a change in the dominance or occurrence of conspicuous species or communities in combination with changes in physical characteristics of the habitat.

2.2.5. For each polygon the following information was noted:

- Physical characteristics, such as substrate type and topographic features (sand ripples, areas of standing water etc)
- Species present and their SACFOR abundances
- Details of specimen samples taken from sites within the polygon.

2.2.6. Each waypoint marked with the GPS was noted on the waypoint log form along with the following information:

- Waypoint number
- A description of what the waypoint represented
- Any photo numbers associated with each waypoint

2.2.7. Digital photographs were taken to illustrate each habitat.

2.2.8. Biotope maps were augmented with target notes to record un-mappable information. These included features too small (<25 m²) to be accurately portrayed

on a map, features on vertical faces and those found under boulders or overhangs. Target notes were also used to describe human activities, such as outfalls, coastal protection measures and other man made features that are potential habitat modifiers.

2.2.9. Key species and substrate conditions that characterised the biotopes were identified and enumerated on site using the SACFOR abundance scale.

2.2.10. The biotope classifications were subsequently assigned and mapped over aerial photographs to allow area wide interpolation of the survey data. The boundaries of each biotope were digitised and incorporated within an ArcGIS and overlaid onto the base-mapping layer as a series of polygons. Target notes were also overlaid onto the base map.

2.3. Biotope Classification

2.3.1. Biotope code allocations were made using the current UK Marine Classification System V 4.05 (Connor *et al*., 2004).

2.3.2. Choice of biotope was made using the biotope decision making tool Bioscribe (Hooper *et al*., 2011). The BioScribe tool matches the species list from a sample to the biological communities usually recorded with potential biotope matches. Confidence indicators and direct links to habitat descriptions from the Marine Habitat Classification for Britain and Ireland are provided to facilitate the process. The tool was used by an experienced ecologist practiced in matching UK biotopes to field survey data with codes applied through expert judgment based on the BioScribe outputs and knowledge of the current biotope classification system. All survey data was used to inform the biotope allocation process, including site descriptions, photographic data, and target notes.

3. Results

3.1. General Information

3.1.1. Appendix I presents summary site descriptions and species recorded at each waypoint location at Fraserburgh Bay.

3.2. Biotope Mapping

3.2.1. A total of 3 biotopes were identified across the Fraserburgh Bay survey area. Table 3.1 presents a summary of observed biotopes and features of interest.

3.2.2. Descriptions from Connor *et al.* (2004) of the observed biotopes recorded at Fraserburgh Bay are provided in Table 3.2. The distribution of the intertidal biotopes is presented in Figure 3.1.

3.2.3. Table 3.13 to Table 3.55 present the details of the observed biotopes across the Fraserburgh Bay survey area together with illustrative photographs and data supporting biotope classification. In the paragraphs following these tables the associated habitats and communities observed at Fraserburgh Bay are summarised.

Table 3.1 Summary of observed intertidal biotopes and features of interest within the survey area at Fraserburgh Bay.

Waypoint / Target Note	Biotope Code / Place Mark	Biotope Name / Species Present
Waypoints 1, 8, 9 and 10	LS.LSa.MoSa	Barren or amphipod-dominated mobile sand shores
Waypoints 3 to 7	LR.HLR.MusB.Sem.Litx	*Semibalanus balanoides* and *Littorina* spp. on exposed to moderately exposed eulittoral boulders and cobbles
Waypoint 12	LR.FLR.Lic.YG	Yellow and grey lichens on supralittoral rock
Waypoint 2 and 11	No biotope amenable to classification	n/a
Target Note 1	Seaward side of rock armour	No species detected
Target Note 2	Next to outfall / stream	No species detected

Table 3.2 Classification of observed biotopes at Fraserburgh Bay from Connor *et al*. (2004).

Biotope	Biotope Description
LS.LSa.MoSa Barren or amphipod-dominated mobile sand shores	Shores consisting of clean mobile sands (coarse, medium and some fine-grained), with little very fine sand, and no mud present. Shells and stones may occasionally be present on the surface. The sand may be duned or rippled as a result of wave action or tidal currents. The sands are non-cohesive, with low water retention, and thus subject to drying out between tides, especially on the upper shore and where the shore profile is steep. Most of these shores support a limited range of species, ranging from barren, highly mobile sands to more stable clean sands supporting communities of isopods, amphipods and a limited range of polychaetes. Species which can characterise mobile sand communities include *Scolelepis squamata*, *Pontocrates arenarius*, *Bathyporeia pelagica*, *B. pilosa*, *Haustorius arenarius* and *Eurydice pulchra*.
LR.FLR.Lic.YG Yellow and grey lichens on supralittoral rock	Vertical to gently sloping bedrock and stable boulders in the supralittoral (or splash zone) of the majority of rocky shores are typically characterised by a diverse maritime community of yellow and grey lichens, such as *Xanthoria parietina*, *Caloplaca marina*, *Lecanora atra* and *Ramalina* spp. The black lichen *Verrucaria maura* is also present, but usually in lower abundance than in the littoral fringe zone. In wave exposed conditions, where the effects of sea-spray extend further up the shore, the lichens generally form a wide and distinct band. This band then becomes less distinct as wave exposure decreases, and in sheltered locations, cobbles and pebbles may also support the biotope. Pools, damp pits and crevices in the rock are occasionally occupied by winkles such as *Littorina saxatilis* and halacarid mites may also be present.
LR.HLR.MusB.Sem.Litx *Semibalanus balanoides* and *Littorina* spp. on exposed to moderately exposed eulittoral boulders and cobbles	Large patches of boulders, cobbles and pebbles in the eulittoral zone on exposed to moderately exposed shores colonised by the barnacle *Semibalanus balanoides* and, on larger rocks, the limpet *Patella vulgata*. The winkles *Littorina littorea* and *Littorina saxatilis* and the whelk *Nucella lapillus* are typically found in high numbers on and around cobbles and smaller boulders, while the anemone *Actinia equina* occurs in damp areas between and underneath larger boulders. Between the cobbles and pebbles, the mussel *Mytilus edulis* occasionally occurs, but always at low abundance, as do the crab *Carcinus maenas* and gammarid amphipods. Ephemeral green seaweeds such as *Ulva (Enteromorpha) intestinalis* may cover cobbles and boulders. The foliose red seaweeds *Chondrus crispus, Mastocarpus stellatus* and *Osmundea pinnatifida* as well as the wrack *Fucus vesiculosus* may also occur in low abundance on cobbles and boulders. The top shells *Gibbula cineraria* and *Gibbula umbilicalis* can, on more sheltered shores, be found among the seaweeds or underneath the boulders. The barnacle *Elminius modestus* is present on some shores.

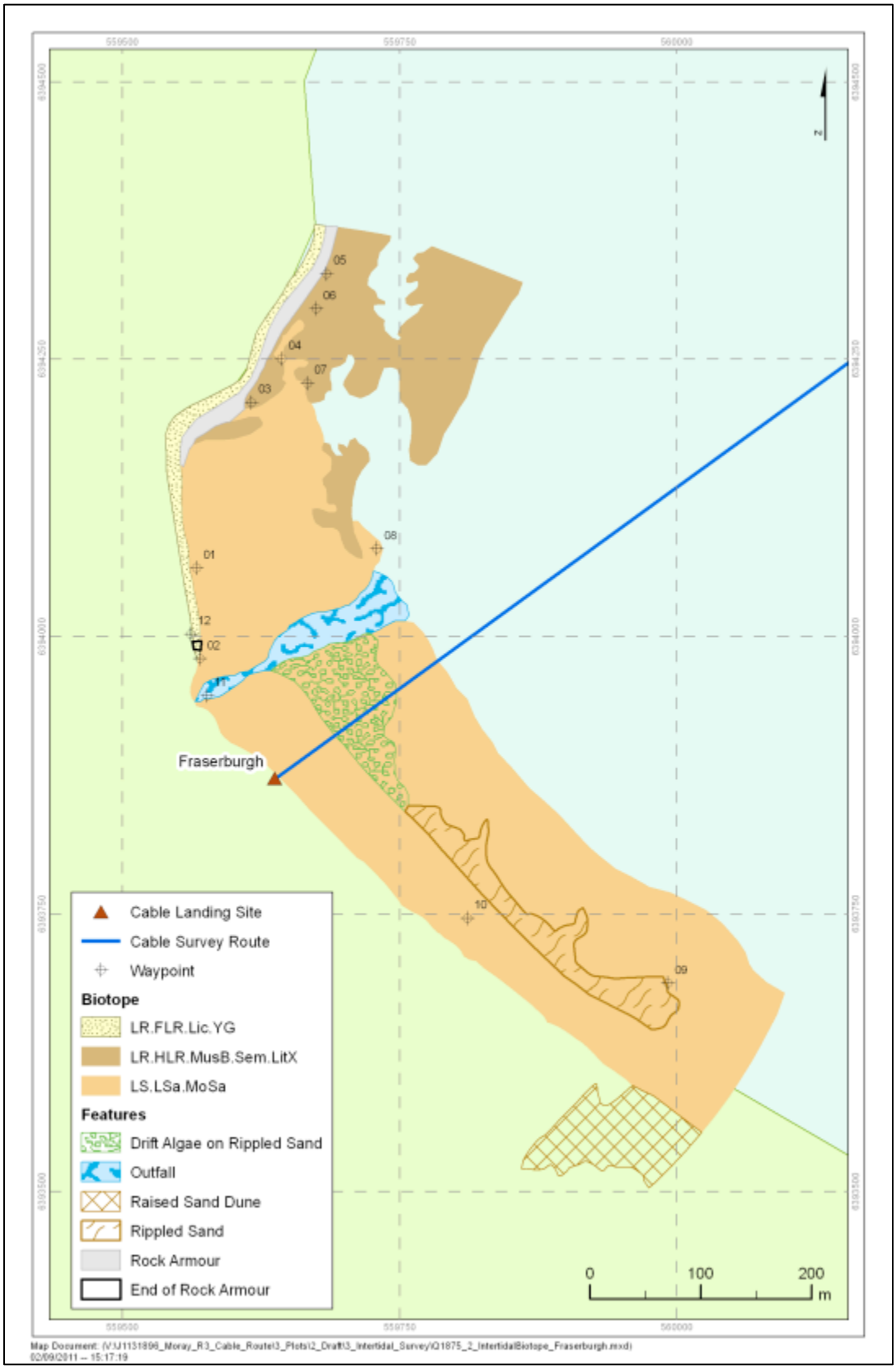

Figure 3.1 Fraserburgh Bay intertidal biotope and features map.

Table 3.3 LS.LSa.MoSa observed biotope at Fraserburgh Bay.

Broad Habitat	LS	Littoral sediment
Habitat Complex	LSa	Littoral sand
Biotope Complex	MoSa	Barren or amphipod-dominated mobile sand shores

Waypoint 1: At the bottom of steps on the upper shore along the strandline

Photo taken looking north.

Waypoint 8: Lower shore in middle of survey area

Photo taken looking north.

Waypoint 9: Clean sandy area in the middle of intertidal zone bordering rippled recessed sand.

Photo taken looking west.

Waypoint 10: Along the strandline on the upper shore

Photo taken looking north.

Description of Observed Biotope

This biotope covered the majority of the survey area from the upper to the lower shore. The sediment at all waypoints consisted of sands. Drift algae was found along the strandline at waypoints 1 and 10 but no fauna were detected. Holes in the sand were noted at waypoint 10 although core samples did not reveal the presence of any macrofauna. At waypoints 8 and 9 only two individuals of the spionid polychaete *Scolelepis (Scolelepis) squamata* was recorded, one from each site.

The substrate type and lack of fauna all concur with the MoSa biotope complex description. Sands associated with this biotope complex are typically described as clean, mobile and non-cohesive with low water retention, and subject to drying out between tides, especially on the upper shore. This results in a limited range and abundance of species.

Table 3.4 LR.FLR.Lic.YG observed biotope at Fraserburgh Bay.

Broad Habitat	LR	Littoral rock (and other hard substrata)
Habitat Complex	FLR	Features of littoral rock
Biotope Complex	Lic	Lichens or small green algae on supralittoral and littoral fringe rock
Biotope	YG	Yellow and grey lichens on supralittoral rock
Waypoint 12: Situated on walkway although biotope corresponds to clean sea defence rock armour in front of walkway.		
 Rock armour in front of walkway with band of yellow lichens. Photo taken looking north north east.		 Looking down to the shore, illustrating lichens on lower section of rock armour and unidentified angiosperm.
Description of Observed Biotope This biotope consisted of a narrow horizontal band of yellow lichens located on the lower rock armour in the supralittoral zone above the beach. Grey lichens were also present but in lower abundance. The level on the shore, substrate type and community present all correspond to the 'yellow lichens on littoral rock', YG, biotope.		

Table 3.5 LR.HLR.MusB.Sem.LitX observed biotope at Fraserburgh Bay.

Broad Habitat	LR	Littoral rock
Habitat Complex	HLR	High energy littoral rock
Biotope Complex	MusB	Mussel and/or barnacle communities
Biotope	Sem	*Semibalanus balanoides* and *Littorina* spp. on exposed to moderately exposed eulittoral boulders and cobbles
Sub-Biotope	LitX	*Semibalanus balanoides* on exposed to moderately exposed or vertical sheltered eulittoral rock
Waypoints 3, 4, 5, 6 and 7	3 - 5: Rock armour sea defence 6 - 7: Lower shore boulders and bedrock outcrop	
Waypoint 3: Upper shore to the north of the survey area.  Bolders and bedrock in front of rock armour. Photo taken looking south west.	Waypoint 3: Sediments interspersed between bedrock  Beadlet anemones *A. equina* in damp area between and on the undersides of boulders. Note drift kelp frond.	

Table 3.5 LR.HLR.MusB.Sem.LitX observed biotope at Fraserburgh Bay (cont.).

Waypoint 4: Rock armour to north of survey area.  Close-up of epifaunal community consisting of *S. balanoides*, *N. lapillus* and *M. edulis*.	Waypoint 5: Rock armour boulders and bedrock interspersed by sediment  Boulders with *Ulva intestinalis* on upper surface. Photo taken looking south south west.
Waypoint 6: Lower shore bedrock outcrop  Bedrock colonised by *U. intestinalis*, foliose red seaweeds and limpets Patellidae	Waypoint 7: Bedrock outcrop  *The brown alage Fucus serratus* colonising the leeward side of a bedrock outcrop in the lower eulittoral zone. Photo taken looking south.

Description of Observed Biotope

Bedrock and boulders in the mid to upper eulittoral zone to the north of the survey area were colonised by a community consisting of barnacles *Semibalanus balanoides*, limpets Patellidae, periwinkles *Littorina* spp., mussels *Mytilus edulis* and whelks *Nucella lapillus*. The beadlet anemone *Actinia equina* also occurred in between rocks in damp areas. The green alga *Ulva intestinalis* was regularly present as were red algae in the lower eulittoral, such as *Mastocarpus stellatus* and *Osmundea pinnatifida*.

The communities found at waypoints 3 to 7, colonising moderately exposed to exposed bedrock or boulders in the eulittoral are all characteristic of the LitX biotope. However, on the lowest part of the survey area at waypoint 7 the toothed wrack *Fucus serratus* was present in between rocks, and possibly represents the *Fucus serratus* biotope on boulders (Fser.Bo) which is found underneath the LitX biotope on less exposed shores.

3.3. Summary of habitats and communities at Fraserburgh Bay.

3.3.1. Fraserburgh Bay consisted of an exposed, high energy, clean sandy beach. This beach was flanked by landward sea defence rock armour to the north east of the survey area and boulders and outcrops of bedrock to the north. Interspersed between lower shore boulders were patches of sandy sediment.

3.3.2. A freshwater outflow approximately midway along the beach created a shallow channel that bisected the intertidal survey area and flowed directly towards the sea. Several smaller side channels extended off the main channel along the beach towards the south of the survey area before entering the sea. These channels created ripples in the topography of the beach sediment.

3.3.3. An extensive drift algae bed was located on top of the rippled sand close to the outfall at the time of sampling. The rippled sand, without overlying drift algae, continued to extend in a southerly direction. These features are likely to be transient in space and time depending in part on interactions between tides, local currents, and outfall flow rate.

3.3.4. Although not surveyed during the current study, sand dunes were noted at the back of the beach to the south. Beach sediments directly in front of the dunes were well drained and dry.

3.3.5. Many of the sand areas observed were either duned or rippled which is consistent with the exposed nature of the site, where by such forms are created by wave action or tidal currents.

3.3.6. All of the core samples collected from the sand highly depauperate and accordingly were classified as the barren or amphipod-dominated mobile sand shores, **LS.Lsa.MoSa**, biotope. This biotope is typical of more exposed shores with a steep profile, where the mobility and degree of drainage of the sediments enables very few, if any, individuals to survive (Connor *et al*., 2004).

3.3.7. The sea defence rock armour running along the north eastern region of the survey area in the supralittoral zone was colonised by yellow and grey lichens. These rocks were ascribed to the Yellow and grey lichens on supralittoral rock, **LR.FLR.Lic.YG.**, biotope.

3.3.8. Habitat to the north of the survey area was relatively complex and consisted of boulders and outcrops of bedrock rising to various heights off the beach / seafloor and at differing distances from the sublittoral fringe. In between the boulders casts made by the polychaete *Arenicola marina* were observed. The biotope best matching the rocky boulder area was the *Semibalanus balanoides* and *Littorina* spp. on exposed to moderately exposed eulittoral boulders and cobbles, **LR.HLR.MusB.Sem.Lit,** biotope. Of note is that the toothed wrack *Fucus serratus* was found between boulders and bedrock on the lower shore, where it may have been buffered from exposure to wave stress and afforded an increase in tidal inundation relative to species on more landward substrata. Hence the possibility of assigning the

Fucus serratus and under-boulder fauna on exposed to moderately exposed lower eulittoral boulders, **LR.MLR.BF.Fser.Bo**, biotope to the lowest and most seaward rocks and boulders at waypoint 7 should be noted.

3.3.9. At waypoints 1 and 10 patches of drift algae were also noted at the top of the shore, which corresponds to the strandline, **LS.LSa.St**, biotope. This biotope is likely to be transient in time and space due to the influence of weather patterns and tides which are responsible for the erosion of macroalgae out at sea and subsequent deposition and movement of holdfasts and fronds on the beach.

4. Discussion

4.1.1. This study has characterised the intertidal habitats and associated macrofaunal and macroalgal communities within 500 m of the proposed cable landfall site of the Moray Firth R3 wind farm development. These data will inform the Environmental Impact Assessment and Environmental Statement to accompany the development application.

4.1.2. The beach at Fraserburgh Bay was moderately to highly exposed and consisted of clean sands subject to mobility. Hard substrata was restricted to sea defence rock armour and outcrops of bedrock to the north of the survey area.

4.1.3. The **LS.Lsa.MoSa** biotope was recorded extensively within the Fraserburgh sandy beach, on both the upper and lower shore. The habitats where this biotope is found are inhospitable to many beach fauna, since sands on the upper shore dry out quickly between tides and sediments on the lower shore are subject to intense wave and current action. Therefore, these habitats often support only a limited number of species and individuals.

4.1.4. More diverse biological communities were associated with hard substrata to the north of Fraserburgh Bay, which hosted the potentially important biotope **LR.HLR.MusB.Sem.LitX**. This biotope was found within bedrock and boulders, which are subject to the following considerations:

- ***Rocky Boulder and Bedrock communities***

  - Rocky reefs are an Annex I habitat under the EC Habitats Directive as a Habitat of International Conservation Importance (Council Directive EEC/92/43 on the Conservation of Natural Habitats and Wild Fauna and Flora). As with intertidal biogenic reefs, Annex I rocky reefs are generally subtidal and for an intertidal area to qualify the rocky aggregation needs to be connected to a sublittoral reef.

- ***Under-boulder communities***

  - Intertidal boulders with diverse under-boulder communities are listed as priority habitats for conservation under the UK Biodiversity Action Plan.

4.1.5. These habitats were not recorded along the immediate route of the proposed cable and so will not be directly affected by cable installation at Fraserburgh Bay.

5. Conclusions

5.1.1. This study has provided a characterisation of the intertidal beach and shoreline habitats and biological communities within the vicinity of the proposed cable landfall option for the Moray Firth R3 wind farm eastern development area. The data will inform the Environmental Impact Assessment to accompany the development application.

5.1.2. Extremely depauperate sand communities of invertebrates dominated the potential cable landfall site. The impoverished nature of the fauna is a natural consequence of the exposed conditions and associated mobility of the dominant sand habitat. Attaching fauna, such as barnacles, winkles, whelks and algae were limited to hard substrata represented by coastal defences. No rare or protected species or biotopes were found and habitats were typical of sandy beaches and rocky shores within the wider region.

5.1.3. The rocky outcroppings observed to the north of the Fraserburgh study area potentially match intertidal rocky reef and under-boulder faunal communities, but were beyond the predicted direct effects of cable installation activities.

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Appendix I Site description and species list

Waypoint no.	Position WGS84 DD° mm.mmm'		Description of site	Species name	SACFOR
	Longitude	Latitude			
01	57° 41.090'N	002° 00.060'W	Bottom of steps down to beach. Sandy sediments with no obvious fauna.		
02	57° 41.046'N	002° 00.058'W	End of rock armour. Rock armour 3m high.		
03	57° 41.170'N	002° 00.008'W	Upper shore rock armour to the north of the survey area. Filamentous green algae on both the upper and mid shore rock armour, other species found on the mid shore. Drift algae, rubbish and rope also present.	*Fucoids* (juv) *Actiniaria equina* *Semibalanus balanoides* *Patella* sp. *Mytilus edulis* (juv) *Porphyra purpurea* *Heterosiphonia plumosa* *Ulva intestinalis*	R R C O C C R R
04	57° 41.191'N	001° 59.980'W	Rock armour to the north of the survey area. Rock armour down to sandy lower shore (cores on sandy sediments). Green algae on upper shore rock armour, *Porphyra*, *Ulva* and Cirripedia on lower shore rock armour and *Arenicola* casts in sandy sediment	Actiniaria equina *Semibalanus balanoides* *Patella* sp. *Littorina* sp. *Nucella lapillus* *Porphyra purpurea* *Mastocarpus stellatus* *Ulva intestinalis* *Haustorias arenarius* *Bathyporeia pelagica* *Malacoceros fulginosus*	R C R O R R R R R R R
05	57° 41.232'N	001° 59.938'W	Rock armour boulders. Dense drift algae within crevices. Offshore rock visible but minor. Waypoint	*Actiniaria equina* *Semibalanus balanoides* *Patella* sp. *Nucella lapillus*	R C F R

			at the extent of the lower shore, water lapping at the rocks.	*Porphyra purpurea* *Ulva intestinalis*	R R
06	57° 41.215'N	001° 59.948'W	Lower shore, bedrock outcropping.	*Semibalanus balanoides* *Patella* sp. *Audouinella flouridula* *Chondrus* sp. *Heterosiphonia plumosa* *Osmundea pinnatifida* *Ulva intestinalis*	A F R R R R O
07	57° 41.179'N	001° 59.957'W	Lower shire, rock outcropping.	*Semibalanus balanoides* *Littorina* sp. *Fucus serratus* *Ulva intestinalis*	A F O O
08	57° 41.098'N	001° 59.896'W	Lower shore in the middle of the survey area. Sand substrate, coarser sand.	*Scololepis squamata*	R
09	57° 40.885'N	001° 59.572'W	Rippled recessed sand. Mapped as cross-hatching on map, half of area had drift algae on top of the rippled recessed sand. Channels of water from outfall.	*Scololepis squamata*	R
10	57° 40.918'N	001° 59.819'W	Along the strandline, upper shore. Sand had holes in surface so cores taken to see if fauna within sediment.		
11	57° 41.028'N	001° 00.052'W	Next to outfall/stream. No algae or notable species present.		
12	57° 41.058'N	002° 00.066'W	On raised walkway behind the rock armour. No fauna visible, rock armour is above splash zone.		

Appendix II Intertidal Photo Log

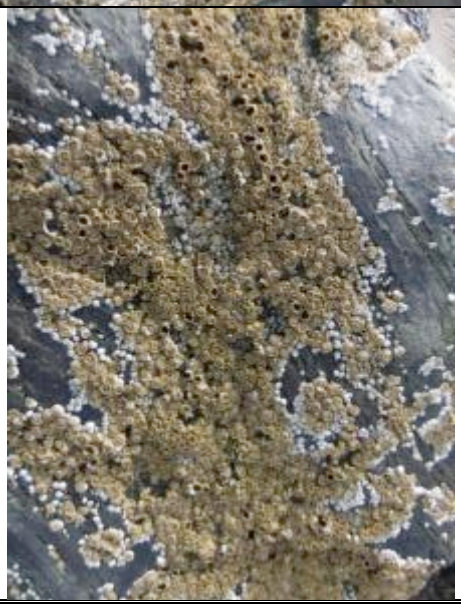
Waypoint no.	Date	Position WGS84 DD° mm.mmm'		Photo no.	Direction
		Longitude	Latitude		
01	15/08/2011	57° 41.090'N	002° 00.060'W	DSCF 0329 DSCF 0330 DSCF 0331 DSCF 0332	N 40° S 130°
02	15/08/2011	57° 41.046'N	002° 00.058'W	DSCF 0334	310°
03	15/08/2011	57° 41.170'N	57° 41.170'N	DSCF 0335 DSCF 0336 DSCF 0337 DSCF 0338 DSCF 0339 DSCF 0340 DSCF 0341 DSCF 0342 DSCF 0343 DSCF 0344	230° - - - S 20° - - - -
04	15/08/2011	57° 41.191'N	001° 59.980'W	DSCF 0345 DSCF 0346 DSCF 0347 DSCF 0348 DSCF 0349 DSCF 0350 DSCF 0351 DSCF 0352	- - - 240° 200° 20° 140° -
05	15/08/2011	57° 41.232'N	001° 59.938'W	DSCF 0353 DSCF 0354 DSCF 0355 DSCF 0356 DSCF 0357 DSCF 0358 DSCF 0359 DSCF 0360	300° - - 200° - N 120° 120°
06	15/08/2011	57° 41.215'N	001° 59.948'W	DSCF 0361 DSCF 0362 DSCF 0363	E - -
07	15/08/2011	57° 41.179'N	001° 59.957'W	DSCF 0364 DSCF 0365 DSCF 0366	S - -

				DSCF 0367 DSCF 0368 DSCF 0369	- - -
08	15/08/2011	57° 41.098'N	001° 59.896'W	DSCF 0371 DSCF 0372 DSCF 0373	160° 260° N
09	15/08/2011	57° 40.885'N	001° 59.572'W	DSCF 0374 DSCF 0375 DSCF 0376 DSCF 0377	290° 210° 130° N
10	15/08/2011	57° 40.918'N	001° 59.819'W	DSCF 0378 DSCF 0379 DSCF 0380 DSCF 0381 DSCF 0382 DSCF 0383 DSCF 0384 DSCF 0385 DSCF 0386	N 325° 130° 130° 220° 10° 10° 105° 105°
11	15/08/2011	57° 41.028'N	001° 00.052'W	DSCF 0387 DSCF 0388 DSCF 0389 DSCF 0390 DSCF 0391 DSCF 0392	265° 265° 70° 60° 265° 140°
12	15/08/2011	57° 41.058'N	002° 00.066'W	DSCF 0393 DSCF 0394 DSCF 0395 DSCF 0396 DSCF 0397	140° 75° - - 10°

Appendix III Intertidal Photographs

Fraserburgh Bay 15/08/2011				
Waypoint	**Direction**	**Photo no.**	**Photograph**	**Comments / Description**
01	N	DSCF 0329		Along rock armour backing the shore.
01	40°	DSCF 0330		
01	S	DSCF 0331		

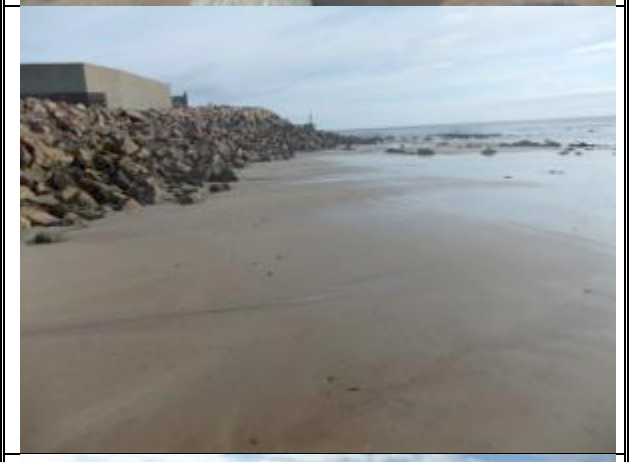
01	130°	DSCF 0332		
02	310°	DSCF 0334		End of rock armour, 3m high
03	230°	DSCF 0335		Dense drift algae, rock armour, mid-upper shore. *Porphyra* sp. (common) (sampled), limpets (occasional) and barnacles on rocks

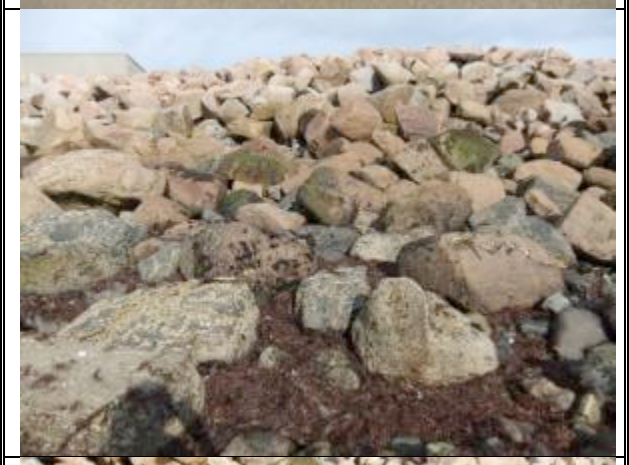
03	-	DSCF 0336		Filamentous green algae on mid shelf rock armour
03	-	DSCF 0337		Barnacles (sampled) on rock
03	-	DSCF 0338		As above zoomed in

03	S	DSCF 0339		
03	20°	DSCF 0340		Rock armour
03	-	DSCF 0341		*Beadlet anemones (Actinia aquina*

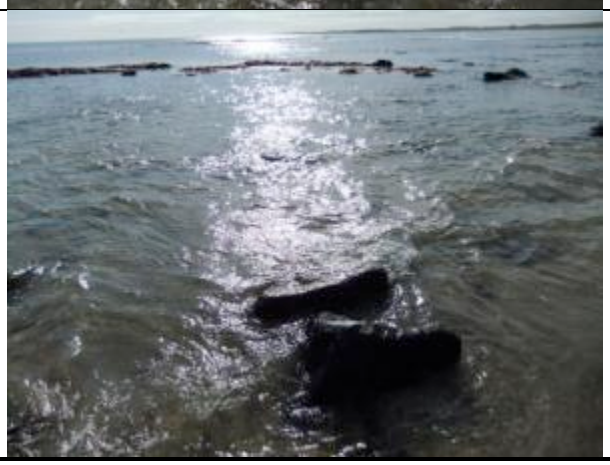
03	-	DSCF 0342		As above zoomed in
03	-	DSCF 0343		Short tufts of algae (sampled)
03	-	DSCF 0344		*Porphyra sp.*

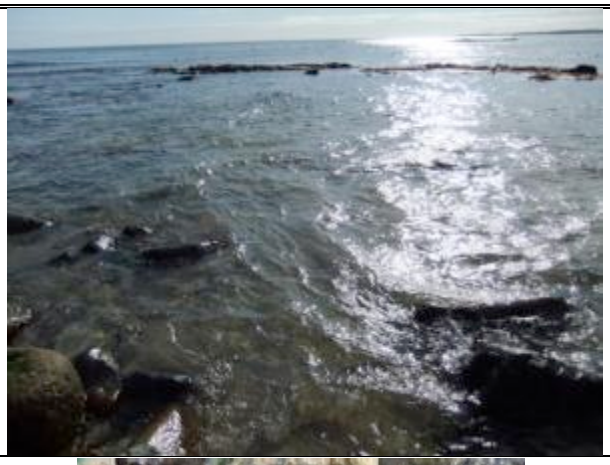
04	-	DSCF 0345		Winkles (*Littorina* sp.)
04	-	DSCF 0346		*Ulva intestinalis* and *Porphyra*
04	240°	DSCF 0348		Transition of lower to upper shore rock armour

04	200°	DSCF 0349		Transition of lower to upper shore rock armour
04	20°	DSCF 0350		
04	140°	DSCF 0351		

04	-	DSCF 0352		*Lugworm (Arenicola marina)* casts
05	300°	DSCF 0353		Lower-mid shore rock armour boulders
05	-	DSCF 0354		Lower shore rock armour

05	-	DSCF 0355		Lower shore rock edging
05	200°	DSCF 0356		
05	-	DSCF 0357		Lower shore boulder

05	N	DSCF 0358		Lower shore rock armour, towards the lighthouse
05	120°	DSCF 0359		Offshore rock outcrops
05	120°	DSCF 0360		Duplicate of DSCF 0360

06	E	DSCF 0361		Offshore rock outcrop
06	-	DSCF 0362		Lower shore boulders
06	-	DSCF 0363		Barnacles and limpets

07	S	DSCF 0364		
07	-	DSCF 0365		Rock outcrop with attached brown algae (*Fucus* spp.)
07	-	DSCF 0366		Fucoids

07	-	DSCF 0367		*Littorina* sp.
07	-	DSCF 0368		
07	-	DSCF 0369		Banacles and winkles

08	160°	DSCF 0371		Lower shore, shallow covering of water near waters edge
08	260°	DSCF 0372		
08	N	DSCF 0373		

09	290°	DSCF 0374		Rippled recessed sand with trapped water
09	210°	DSCF 0375		Sand water feature towards the land based dune feature
09	130°	DSCF 0376		

09	N	DSCF 0377		Channel of water
10	N	DSCF 0378		Along strandline on upper shore
10	325°	DSCF 0379		

10	130°	DSCF 0380		Strandline towards the dune feature
10	130°	DSCF 0381		Duplicate of DSCF 0380
10	220°	DSCF 0382		Upper shore, path seen on aerial photograph obscured by raised edge of dune

10	10°	DSCF 0383		
10	10°	DSCF 0384		As above zoomed version
10	105°	DSCF 0385		

10	105°	DSCF 0386		As above zoomed version
11	265°	DSCF 0387		Outfall
11	265°	DSCF 0388		As above zoomed version

11	70°	DSCF 0389		Outflow from outfall
11	60°	DSCF 0390		As above
11	265°	DSCF 0391		

11	140°	DSCF 0392		Across shore from the outfall area
12	140°	DSCF 0393		From the walkway behind the rock armour
12	75°	DSCF 0394		

12	-	DSCF 0395		View straight down from the rock armour
12	-	DSCF 0396		As above zoomed out
12	10°	DSCF 0397		View across the rock armour

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