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Appendices*

APPENDIX 12-A INTERTIDAL BENTHIC
ECOLOGICAL CHARACTERISATION
SURVEY





Centre for Marine and Coastal Studies Ltd



Nigg Bay

Intertidal Survey Report

Technical Report

CMACS Ref: J3262 (Nigg Bay Intertidal Survey Report) v2

Prepared for: Fugro-Emu Ltd



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Cover Image: View towards the south shore of Nigg Bay from the north shore

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Appendix 1...Images of Biotopes within Nigg Bay

Appendix 2...Overview Images of Nigg Bay

Appendices provided as a separate document

1. INTRODUCTION

Aberdeen Harbour Board propose the design and construction of a new harbour facility at Nigg Bay immediately south of the existing harbour. The purpose of the new facilities is to complement and expand the capabilities of the existing harbour, accommodate larger vessels, retain existing custom and attract increased usage of Aberdeen Harbour.

The new harbour development shall include but is not be limited to:

- Dredging the existing bay to accommodate vessels up to 9.5m draft with additional dredge depth of 10.5m to east quay;
- Provision of new North and South breakwaters to protect the harbour;
- Provision of approximately 1500m of new quays and associated support infrastructure. The quay will be mostly built of solid quay wall construction with suspended decks over open revetment;
- Provision of areas for development by others to provide fuel farm;
- Land reclamation principally through using materials recovered from dredging operations;
- Provision of ancillary accommodation for the facility;
- Off-site highways works to the extent necessary to access the facility and to satisfy statutory obligations;
- Diversions and enabling works necessary to permit the development.

Fugro EMU Limited (Fugro EMU), with support from the Waterman Group has been appointed by Aberdeen Harbour Board to undertake a full Environmental Impact Assessment and prepare an Environmental Statement in relation to the proposed construction of a new harbour facility in Nigg Bay, to the south of the existing harbour.

As part of this process, CMACS Ltd was commissioned by Fugro EMU to carry out a baseline survey of the intertidal area of Nigg Bay (Figure 1) between the headlands of Girdle Ness in the north and Greg Ness in the south. The survey consisted of a Phase I walkover survey, to identify, map and describe the intertidal biotopes (including information on the main substrates) within the area.

The survey was carried out during the spring tides of 26th to 28th October 2014 inclusive.

Any potentially important or protected species or habitats, including potential Annex 1 habitat or Annex II species as defined by the Habitats Directive, or Priority Marine Features as recently listed by Marine Scotland (JNCC 2014) were noted.

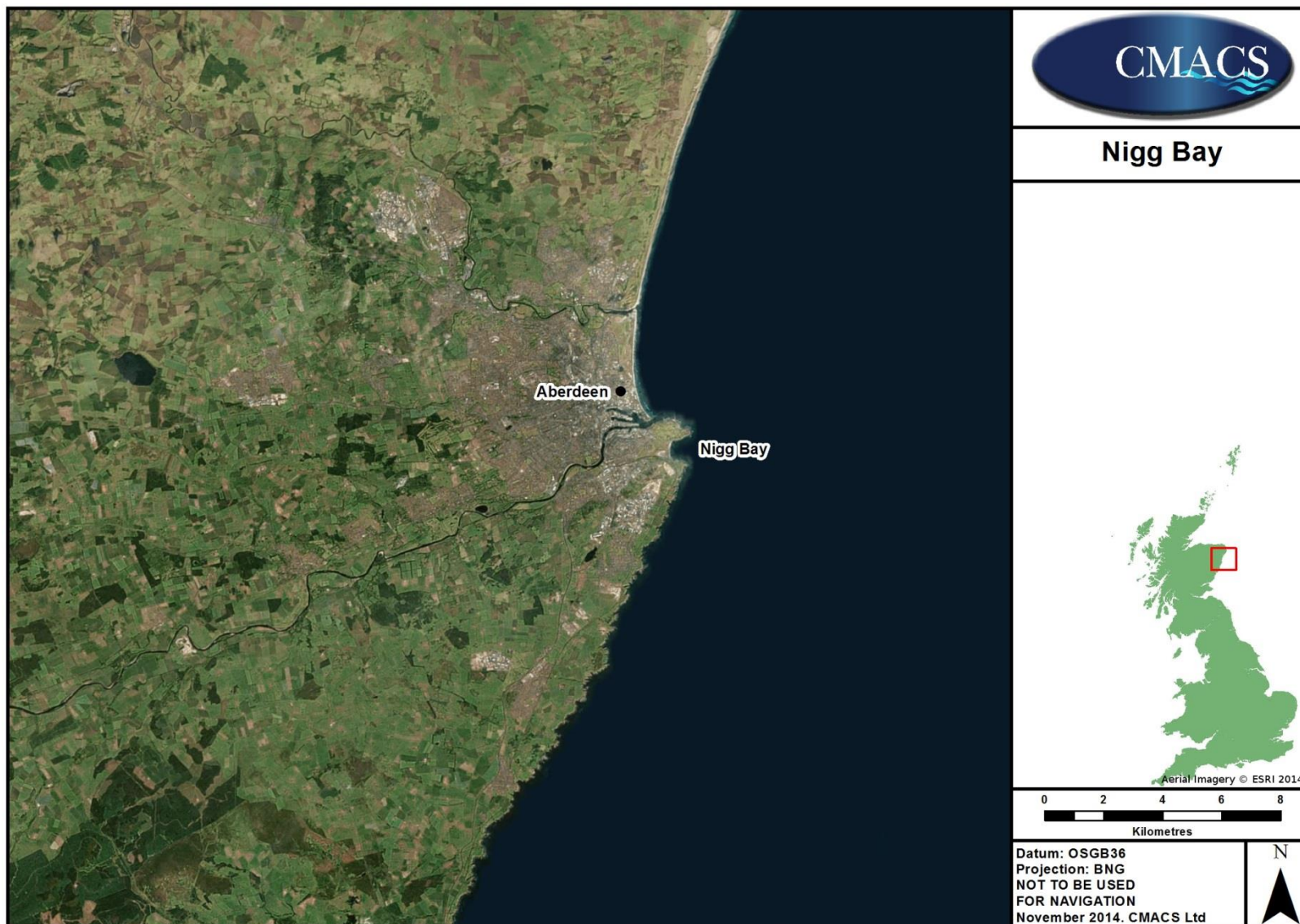


Figure 1. Location of Nigg Bay.

2. METHODOLOGY

The survey was carried out following as far as possible JNCC Phase I methods (JNCC 2006). Two surveyors worked together on the shore at all times. As much of the shore was visited as possible within the time available, and the biotopes present were identified and mapped. The main biotope boundaries were mapped primarily using GPS, although aerial imagery from ESRI and on-line at <http://www.bing.com/maps/> was sometimes used to refine the boundaries, particularly for smaller areas, or for more inaccessible areas. Much of the southern rocky shore out towards Greg Ness, and small parts of the northern shore at Girdle Ness, were very steep and somewhat inaccessible; nevertheless it was possible to get sufficiently close to identify the biotopes present, although in some cases their extent could not be determined using the GPS but had to be estimated visually.

Areas of sand were limited in extent, but where larger areas of these were present (more or less in the centre of the bay) a trowel and portable 1mm mesh sieve were used to investigate the main infauna present, by digging pits of circa 0.1m² to a depth of approximately 15cm, washing the sand through the sieve using a nearby pool, and observing any retained fauna.

Garmin handheld GPS units with stated accuracy of better than 1m were used to provide waypoints, or recorded tracks, in order map the major community boundaries in the field, and also to provide locations for specific points of interest. However, in practice during the survey accuracy was typically limited to around 2-4m when staying still for long periods (thus utilising the GPS averaging function to improve accuracy), or more usually of the order of 3-6m when moving around. Along with the GPS records, hand-drawn maps and annotations were made during the survey.

The biological communities and their associated physical habitats were matched to the biotopes described in Connor et al (2004). The biotope classification system is hierarchical; biotopes with similar characteristics are grouped into "biotope complexes"; whilst some biotopes can be further split into "sub-biotopes". In the main the communities here were identified to biotope or sub-biotope level, but on occasion could only be identified to biotope complex.

A large number of photographs were also taken and these, along with aerial images ESRI, were also used for reference in order to help translate the field notes into a final biotope map. At least one example photograph of each of the main biotopes or biotope complexes was taken.

In each of the main biotopes, the abundance of the main species found was assessed against the SACFOR abundance scale as described in Connor et al (2004) (reproduced in Table 1) (see back of report for all data Tables) based on a minimum of five minutes search for the main species. These abundances are presented either as area target notes (if the species list was considered representative of the biotope as a whole, or is accompanied by additional notes on the relevant biotope), or as point target notes (if the species list was representative of a precise location, or presents additional information for a particular biotope).

3. RESULTS

Biotores have been mapped in Figure 2 to Figure 4. On occasion an area did not match a single biotope but could best be described as a complex patchwork of two distinct biotores. These have been mapped and described as mosaic communities of the two relevant biotores.

Target notes are indicated on the maps and the notes themselves are given in Table 2 (broader area target notes; one for each of the main biotores encountered, including those in mosaic areas,) and Table 3 (point target notes). At least one example image of each of the main biotores is given in Appendix 1, whilst representative broader views of the bay are given in Appendix 2.

As full biotope names are often very long, an abbreviated version is used on the maps and within the text – both the abbreviated and full version of all biotope names can be found in the table of area target notes (Table 2).

The upper shore in the centre of the bay was dominated by more or less barren gravels shingle, cobble and boulder, often with much rubble, broken concrete and patches of broken tarmac. Patches of cobble and boulder also occurred at high shore levels on the northern and southern shorelines, although lichen dominated biotores became increasingly common towards the two headlands, with a more or less continuous bands of rock of boulders dominated by the black lichen *Verrucaria maura* representing the biotope Ver.Ver often containing noticeable amounts of the rough periwinkle *Littorina saxatilis*; (and sometimes mixed with barnacles and hence representing the biotope Ver.B) above which was a band of yellow-green lichens (Lic.YG). The lichens within the yellow-green lichen band were noticeably more luxuriant at the headlands of Greg Ness and Girdle Ness but even here were not rich in comparison to similar habitats on very exposed cliffs. These lichen dominated biotores, which have a low species richness, were quite broad in places.

Much of the centre of the bay was dominated by sands with little or no fauna that best matched the biotope LS.LSa.MoSa “Barren or amphipod dominated mobile sands”, although there were numerous scattered rocks with small amounts of barnacles or seaweed such as *Ulva intestinalis* and *Desmarestia aculeata* (the latter was sometimes found protruding from the sand, though likely in each case to be anchored on a buried stone) The only infauna found were in small patches adjacent to some of the larger rocks where small numbers of the sand mason (a polychaete worm) *Lanice conchilega* were found, along with very occasional worm casts (probably of the lugworm *Arenicola marina*); it was noticeable that even during sieving of sand no empty or broken shells or other evidence of infauna was found, save for a single fragment of an unidentified polychaete worm. Assuming the sand extends to seaward beyond the areas seen on the survey, there is potential for a change in biotope on the lower edge of the intertidal zone in location of target note. However this could not be properly investigated on these tides as it did not dry out; this would best be investigated by ensuring there is at least one grab sampling / camera station near the low water mark during subtidal grab / camera survey planned for spring 2015.

Elsewhere sand was virtually absent, except for very occasional small patches of coarse gravelly sands covering a few square metres some of the gulleys on the south side of the bay.

Much of the remaining intertidal area at mid shore levels was dominated by biotopes characterised by barnacles (e.g. LR.HLR.MusB.Sem.Sem “*Semibalanus balanoides*, *Patella vulgata* and *Littorina* spp. on exposed to moderately exposed or vertical sheltered eulittoral rock”), or by a mixture of barnacles and fucoid seaweeds (LR.MLR.BF.FvesB “*Fucus vesiculosus* and barnacle mosaics on moderately exposed lower eulittoral rock”) barnacles and periwinkles LR.HLR.MusB.Sem.LitX “*Semibalanus balanoides* and *Littorina* spp. on exposed to moderately exposed eulittoral boulders and cobbles”) or sparse barnacles on lichen dominated rock (LR.FLR.Lic.Ver.B “*Verrucaria maura* and sparse barnacles on very exposed to very sheltered upper littoral fringe littoral rock”). In some places where large boulders predominated the Sem.sem biotope formed mosaics, either with the SemLitx biotope, or with the algal turf biotope LR.HLR.FR.Mas “*Mastocarpus stellatus* and *Chondrus crispus* on very exposed to moderately exposed lower eulittoral rock” (see target notes /19 and /13 respectively in Table 2 and Figure 3) whereby the barnacles predominated on the larger boulders. In the more central parts of the bay these biotopes were found on boulders of various sizes, whilst towards the headlands they were increasingly found on bedrock. On more stable rock, or where there was sufficient protection from wave action, then the bladderwrack *Fucus vesiculosus* sometimes became more apparent (the FvesB biotope) or even dominant (LR.LLR.F.Fves.FS “*Fucus vesiculosus* on full salinity moderately exposed to sheltered mid eulittoral rock”; very limited in extent). Although the horizontal extent of these biotopes was often somewhat limited along the southern shoreline, it should be noted that in many places here the vertical extent was in fact considerable due to the vertical or steep nature of the rocks. It was noticeable throughout the bay that the majority of the barnacles were small, and many were thought likely to be this years (2014) settlement.

Ephemeral algae (notably the green gutweed *Ulva intestinalis* and the red seaweed *Porphyra purpurea*) dominated in a number of locations, either on unstable cobble and boulders (LR.FLR.Eph.EphX “Ephemeral green and red sea weeds on variable salinity and/or disturbed eulittoral mixed substrata”) or on larger boulders adjacent to sand (LR.FLR.Eph.Eph.EntPor “*Porphyra purpurea* and *Enteromorpha* spp. on sand-scoured mid or lower eulittoral rock”), usually in narrow bands and mostly in the more central parts of the bay.

Along parts of the northern and southern shorelines of the bay, the lower shore is dominated by biotopes characterised by dense growths of serrated wrack *Fucus serratus* with *Palmaria palmata* and other red seaweeds, which in turn was usually fringed on its lower edge by the much more continuous biotope complex IR.MIR.KR.Ldig “*Laminaria digitata* on moderately exposed sublittoral fringe rock”. In Nigg Bay this biotope complex appears to consist of a mixture of the biotopes IR.MIR.KR.Ldig.Ldig “*Laminaria digitata* on moderately exposed sublittoral fringe rock”, and IR.MIR.KR.Ldig.Bo “*Laminaria digitata* and under-boulder fauna on sublittoral fringe boulders”; somewhat similar biotopes that are distinguished by the increased proportion of bedrock and the presence of some additional kelp species (notably *Alaria esculenta* which was more apparent in the more wave exposed areas of Nigg Bay) in the former. The tide was not sufficiently low at the time of the survey to allow accurate mapping of the lower extent of these biotopes, which is somewhat indicative, but the boulder version of the biotope seemed to be more prevalent within the bay and on parts of the northern shore, whilst the bedrock version became more prevalent towards the two headlands, especially on the southern shoreline.

A number of other biotopes were found over much more restricted areas as listed in Table 2 and shown in Figures 2-4.

The coastline outside of the survey area to the north of Girdle Ness and to the South of Greg Ness was in both cases a rocky coastline indented by gulleys, especially to the south of Greg Ness, which appeared likely to be dominated largely by a similar mixture of barnacles and furoid seaweeds, with occasional patches of mussels, as found at the two Nesses. The gulleys were not observed closely but at least some of these can be expected to contain boulder or shingle in places.

All of the intertidal biotopes found in this survey are likely to be widespread on Scottish coastlines. Similarly, all of the species encountered are common on Scottish shores. No rare, unusual or protected intertidal species or biotopes, including any Priority Marine Features were found. Small numbers of sandeels, which are a predominantly subtidal PMF species, were seen swimming at the water's edge within the sandy area.

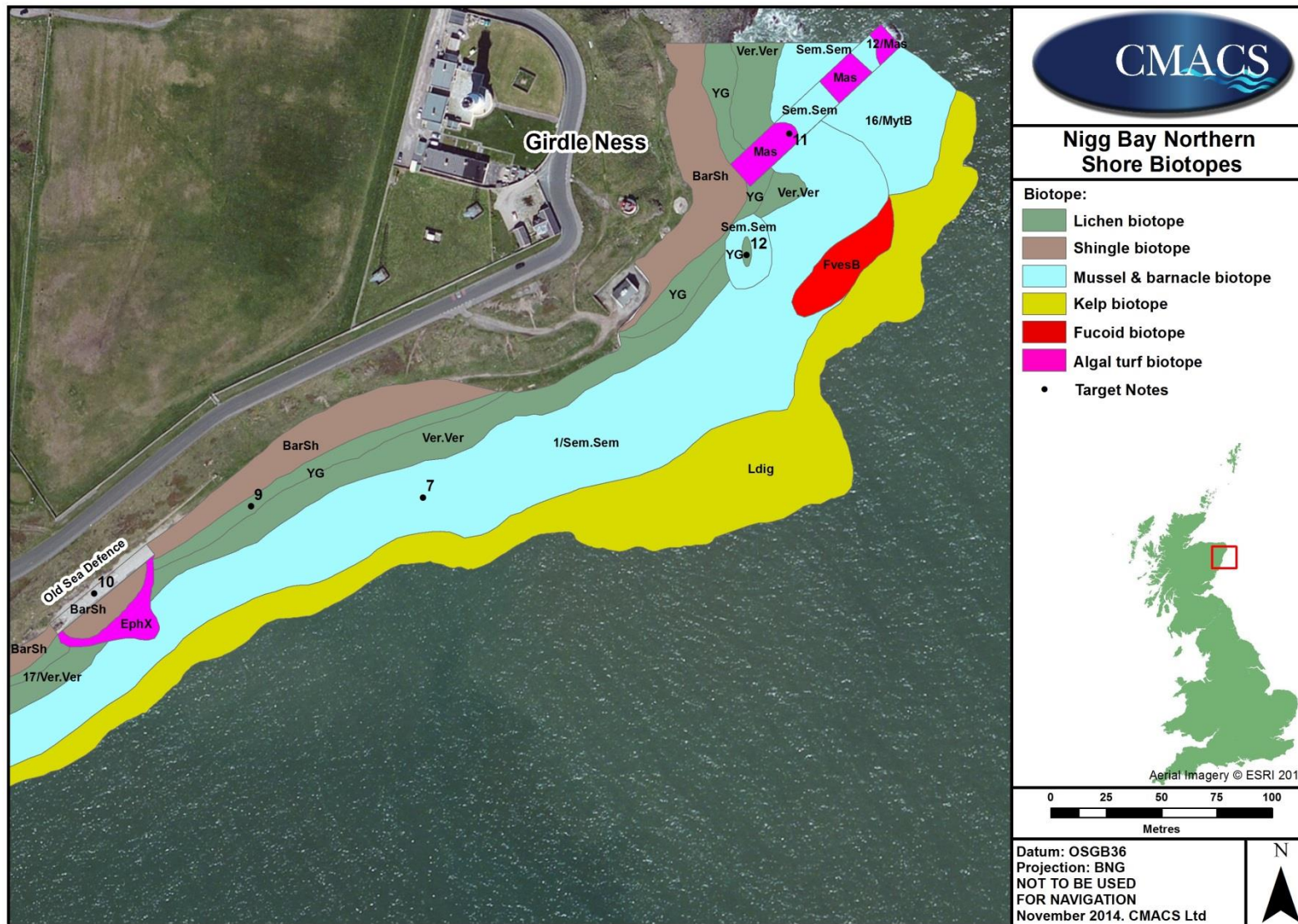


Figure 2. Biotope map of the northern section of Nigg Bay.

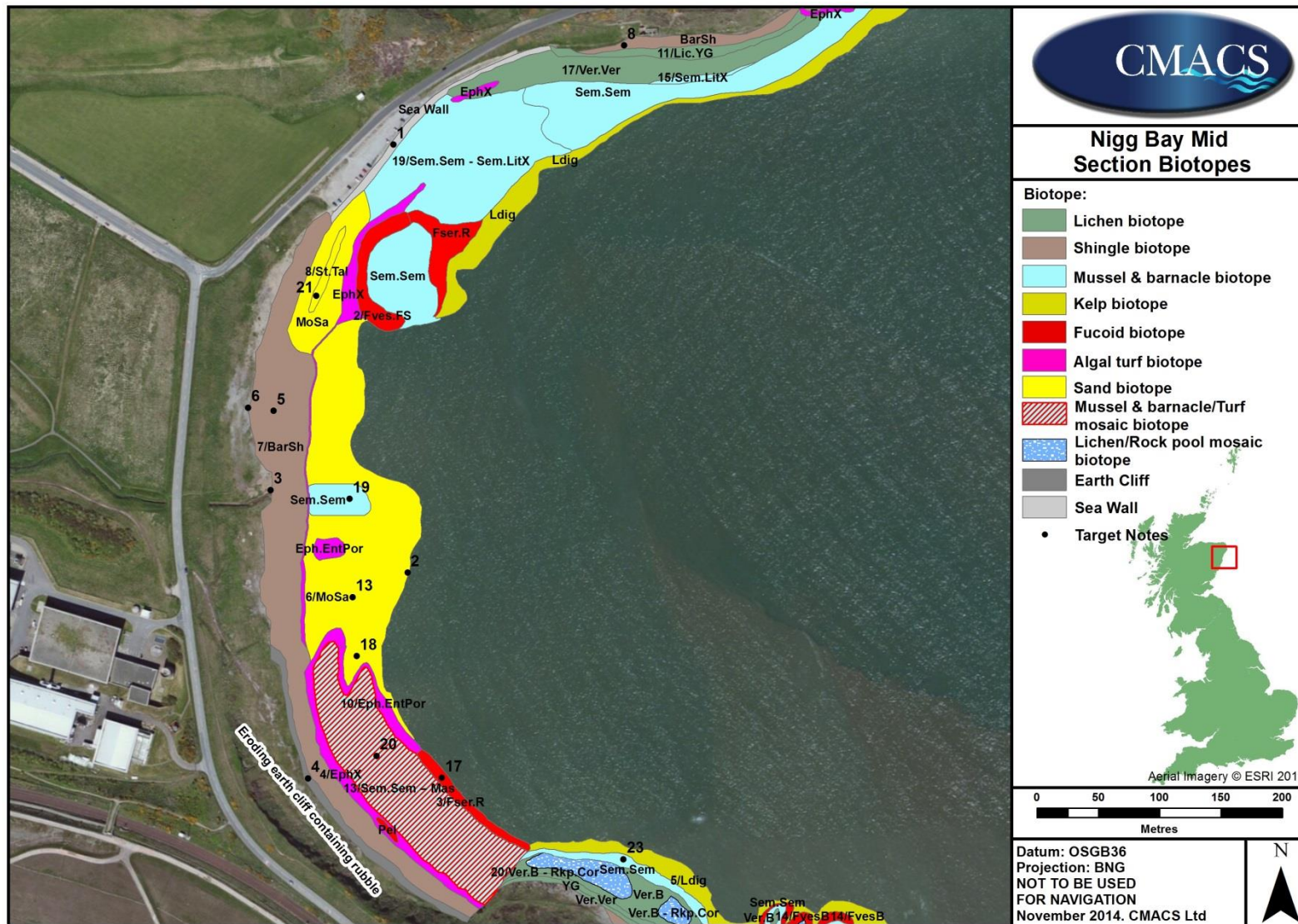


Figure 3. Biotope map of the central section of Nigg Bay

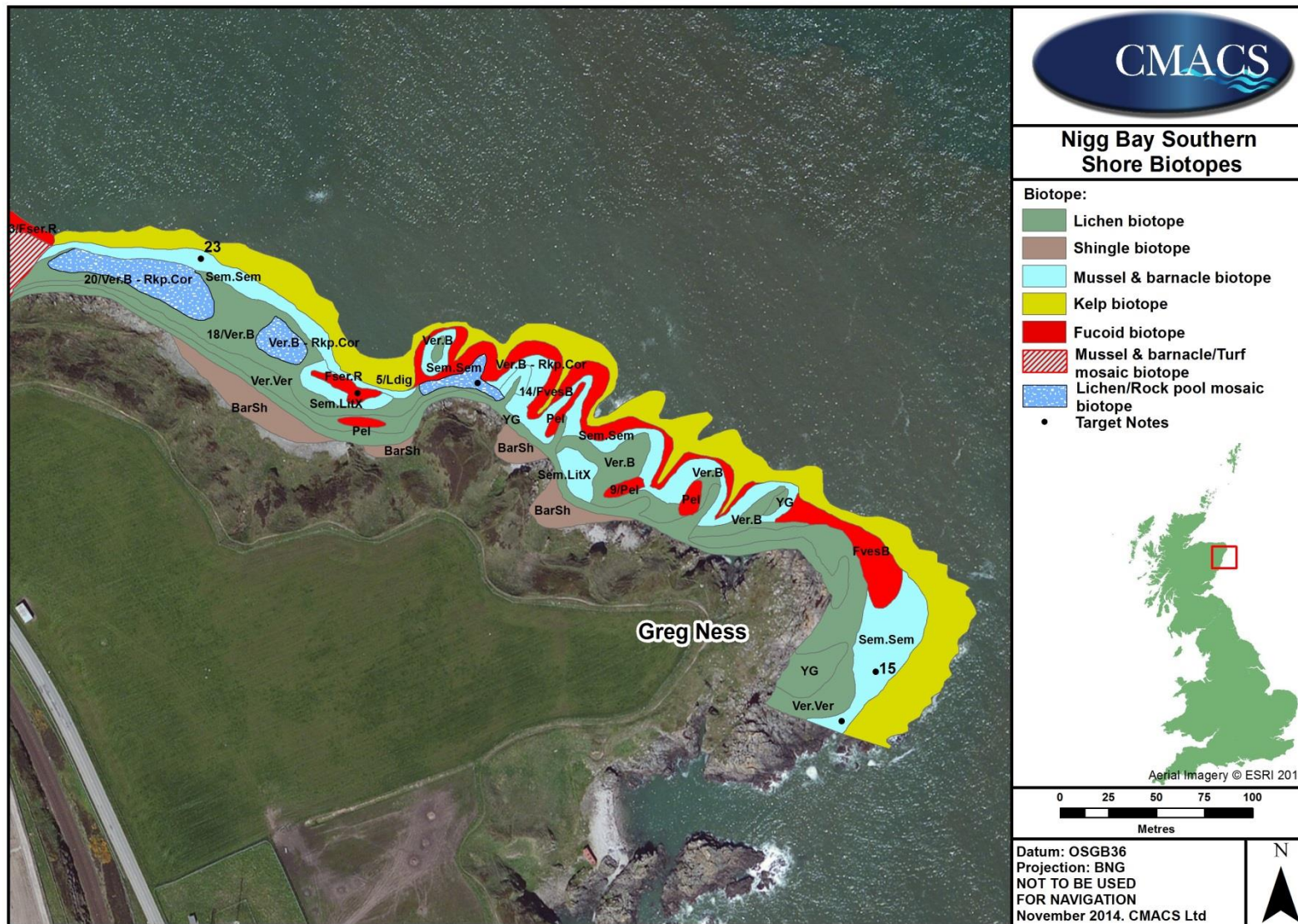


Figure 4. Biotope map of the southern section of Nigg Bay

4. SUMMARY

The upper shore in the centre of Nigg Bay was dominated by more or less barren gravels shingle, cobble and boulder, often with much rubble, broken concrete and patches of broken tarmac. Patches of cobble and boulder also occurred at high shore levels on the northern and southern shorelines, although lichen dominated biotopes became increasingly common towards the two headlands. The yellow-green lichen band was noticeably more luxuriant at the headlands of Greg Ness and Girdle Ness but even here were not rich in comparison to similar habitats on very exposed cliffs. These lichen dominated biotopes, which have a low species richness, were quite broad in places.

Much of the centre of the bay was dominated by mobile sands with little or no fauna that best matched the biotope IMoSA mobile sands, although there were scattered rocks with small amounts of barnacles or seaweeds. The only infauna found were in small patches adjacent to some of the larger rocks where small numbers of the sand mason (a polychaete worm) *Lanice conchilega* were found, along with very occasional worm casts (probably of the lugworm *Arenicola marina*). Elsewhere sand was virtually absent.

Much of the remaining intertidal area at mid shore levels was dominated by biotopes, or mosaics of biotopes, characterised by barnacles *Semibalanus balanoides*, or by a mixture of barnacles and fucoid seaweeds, a mixture of barnacles and periwinkles, or sparse barnacles on lichen dominated rock. It was noticeable throughout the bay that the majority of the barnacles were small, and many were thought likely to be this years (2014) settlement. On more stable rock, or where there was sufficient protection from wave action, then the bladderwrack *Fucus vesiculosus* became apparent, or occasionally even dominant). In the centre of the bay these biotopes were found on boulders of various sizes, whilst towards the headlands they were increasingly found on bedrock. Although the horizontal extent of these biotopes was often somewhat limited along the southern shoreline, in many places the vertical extent was in fact considerable due to the vertical or steep nature of the rocks.

Ephemeral algae (notably the green gutweed *Ulva intestinalis* and the red seaweed *Porphyra purpurea*) dominated in a number of locations, either on unstable cobble and boulders or on larger boulders adjacent to sand, usually in narrow bands and mostly in the more central parts of the bay.

Along parts of the northern and southern shorelines of the bay, the lower shore is dominated by biotopes characterised by dense growths of serrated wrack *Fucus serratus* with *Palmaria palmata* and other red seaweeds, which in turn was usually fringed on its lower edge by biotopes characterised by the kelp *Laminaria digitata* on moderately exposed sublittoral fringe rock.

A number of other biotopes were found over much more restricted areas.

The coastline outside of the survey area to the north of Girdle Ness and to the South of Greg Ness was in both cases a rocky coastline indented by gulleys, especially to the south of Greg Ness, which appeared likely to be dominated largely by a similar mixture of barnacles and fucoid seaweeds, with occasional patches of mussels, as found at the two

Nesses. The gulleys were not observed closely but at least some of these can be expected to contain boulder or shingle in places.

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5. REFERENCES

Connor, D.W., Allen, J.H., Golding, N., Howell, K.L., Lieberknecht, L.M., Northen, K.O., and Reker, J.B. (2004). The Marine Habitat Classification for Britain and Ireland Version 04.05 JNCC, Peterborough.

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Table 1. SACFOR abundance scale, from Connor et al (2004).

S = Superabundant, A = Abundant, C = Common, F = Frequent, O = Occasional, R = Rare

GROWTH FORM			SIZE OF INDIVIDUALS / COLONIES				DENSITY	
% COVER	CRUST / MEADOW	MASSIVE / TURF	< 1 cm	1-3 cm	3-15 cm	> 15 cm		
> 80%	S		S				> 1 / 0.001 m ² (1x1 cm) > 10,000 / m ²	
40-79%	A	S	A	S			1-9 / 0.001 m ² 1000-9999 / m ²	
20-39%	C	A	C	A	S			1-9 / 0.01 m ² (10 x 10 cm) 100-999 / m ²
10-19%	F	C	F	C	A	S	1-9 / 0.1 m ² 10-99 / m ²	
5-9%	O	F	O	F	C	A	1-9 / m ²	
1-5% or density	R	O	R	O	F	C	1-9 / 10 m ² (3.16 x 3.16 m)	
< 1% or density	R		R		O	F	1-9 / 100 m ² (10 x 10 m)	
			R			O	1-9 / 1000 m ² (31.6 x 31.6 m)	
			R				>1 / 10,000 m ² (100x100 m) <1 / 1000 m ²	
PORIFERA	Crusts <i>Halichondria</i>	Massive spp. <i>Pachymatisma</i>	Sml solitary <i>Grantia</i>		Lge solitary <i>Stelligera</i>			
HYDROZOA	Turf species <i>Tubularia</i> <i>Abietinaria</i>		Small clumps <i>Sarsia</i> <i>Aglaophenia</i>		Solitary <i>Corymorpha</i> <i>Nemertesia</i>			
ANTHOZOA	<i>Corynactis</i>	<i>Alcyonium</i>	Sml solitary <i>Epizoanthus</i> <i>Caryophyllia</i>	Med. solitary <i>Virgularia</i> <i>Cerianthus</i> <i>Urticina</i>	Large solitary <i>Eunicella</i> <i>Funiculina</i> <i>Pachycerianthus</i>			
ANNELIDA	<i>Sabellaria spinulosa</i>	<i>Sabellaria alveolata</i>	<i>Spirorbis</i>	Scale worms <i>Nephtys</i> <i>Pomatoceros</i>	<i>Chaetopterus</i> <i>Arenicola</i> <i>Sabella</i>			
CRUSTACEA	Barnacles Tube-dwelling amphipods		<i>Semibalanus</i> Amphipods	<i>B. balanus</i> <i>Anapagurus</i> <i>Pisidia</i>	<i>Pagurus</i> <i>Galathea</i> Small crabs	<i>Homarus</i> <i>Nephrops</i> <i>Hyas araneus</i>		
MOLLUSCA			Sml gastropod <i>L. neritoides</i>	Chitons Med. gastropods <i>L. littorea</i> <i>Turritella</i>	Lge gastropod <i>Patella</i> <i>Buccinum</i> Lge bivalves <i>Mya</i> <i>Pecten</i> <i>Arctica</i>			
	<i>Mytilus</i> <i>Modiolus</i>		Sml bivalves <i>Nucula</i>	Med. bivalves <i>Mytilus</i> <i>Pododesmus</i>				
BRACHIOPODA			<i>Neocrania</i>					
BRYOZOA	Crusts	<i>Pentapora</i> <i>Bugula</i> <i>Flustra</i>			<i>Alcyonidium</i> <i>Porella</i>			
ECHINODERMATA					<i>Antedon</i> Sml starfish Brittlestars <i>Echinocyamus</i> <i>Aslia</i> <i>Thyone</i> <i>Ocnus</i>	Large starfish <i>Echinus</i> <i>Holothuria</i>		
ASCIDIACEA	Colonial <i>Dendrodoa</i>		Sml solitary <i>Dendrodoa</i>	Lge solitary <i>Ascidia</i> <i>Ciona</i>	<i>Diazona</i>			
PISCES					Gobies Blennies <i>Zostera</i>	Dogfish Wrasse Kelp <i>Halidrys</i> <i>Chorda</i> <i>Himanthalia</i>		
PLANTS	Crusts Maerl <i>Audouinella</i> Furoids/Kelp <i>Desmarestia</i>	Foliose Filamentous						

Examples of groups or species for each category

Table 2. Area target notes associated with biotope maps. Short codes associated with the biotope name as used in the text and maps are given in bold.

Area target note no.	Biotope Name	SACFOR	Notes
/1	LR.HLR.MusB. Sem. Sem <i>Semibalanus balanoides</i> , <i>Patella vulgata</i> and <i>Littorina</i> spp. on exposed to moderately exposed or vertical sheltered eulittoral rock.	<i>Actinia equina</i> - C <i>Amphipoda</i> sp. - C <i>Carcinus maenas</i> - F <i>Fucus vesiculosus</i> - R <i>Littorina littorea</i> - C <i>Littorina saxatilis</i> - F <i>Mastocarpus stellatus</i> - R <i>Nucella lapillus</i> - F <i>Patella vulgata</i> - C <i>Pholis gunnelis</i> - R <i>Rhodothamniella floridula</i> -R <i>Semibalanus balanoides</i> - C <i>Verrucaria maura</i> - O <i>Verrucaria mucosa</i> - R	
/2	LR.LLR.F. Fves.FS <i>Fucus vesiculosus</i> on full salinity moderately exposed to sheltered mid eulittoral rock	<i>Ceramium rubrum</i> - R <i>Diadumene cincta</i> - R <i>Fucus vesiculosus</i> - SA <i>Hildenbrandia rubra</i> - O <i>Laminaria digitata</i> - R <i>Littorina littorea</i> - C <i>Littorina saxatilis</i> - F <i>Mastocarpus stellatus</i> - O <i>Patella vulgata</i> - C <i>Semibalanus balanoides</i> - R <i>Ulva intestinalis</i> - R <i>Ulva lactuca</i> - R <i>Verrucaria maura</i> - R	
/3	LR.MLR.BF. Fser.R <i>Fucus serratus</i> and red seaweeds on moderately exposed lower eulittoral rock	<i>Actinia equina</i> - F <i>Chondrus crispus</i> - O <i>Fucus serratus</i> - F <i>Gelidium pusillum</i> - R <i>Hildenbrandia rubra</i> - R <i>Laminaria digitata</i> - R <i>Lithothamnia</i> - O <i>Mastocarpus stellatus</i> - C <i>Nucella lapillus</i> - F <i>Osmundea pinnatifida</i> - R <i>Palmaria palmata</i> - A <i>Patella vulgata</i> - C <i>Polysiphonia</i> sp - R <i>Porphyra umbilicalis</i> - R <i>Semibalanus balanoides</i> - C <i>Ulva intestinalis</i> - R <i>Ulva lactuca</i> - R	
/4	LR.FLR.Eph. EphX Ephemeral green and red sea weeds on variable salinity and/or disturbed eulittoral mixed substrata.	<i>Littorina saxatilis</i> - C <i>Porphyra purpurea</i> - C <i>Porphyra umbilicalis</i> - C <i>Ulva intestinalis</i> - A <i>Fucus spiralis</i> - R <i>Pelvetia canaliculata</i> - R	

Area target note no.	Biotope Name	SACFOR	Notes
/5	IR.MIR.KR. Ldig <i>Laminaria digitata</i> on moderately exposed sublittoral fringe rock	<i>Ahnfeltia plicata</i> - R <i>Chondrus crispus</i> - R <i>Cladophora rupestris</i> - R <i>Flustrellidra hispida</i> - R <i>Fucus serratus</i> - C <i>Laminaria digitata</i> - S <i>Lithothamnium</i> - A <i>Mastocarpus stellatus</i> - C <i>Membranipora membranacea</i> - O <i>Membranoptera alata</i> - R <i>Palmaria palmata</i> - F <i>Patella pellucida</i> - R <i>Patella vulgata</i> - C <i>Semibalanus balanoides</i> - R <i>Ulva lactuca</i> - R	.
/6	LS.LSa. MoSa Barren or amphipod dominated mobile sands.	<i>Arenicola marina</i> - R <i>Lanice conchilega</i> - R	Further information given in several point target notes.
/7	LS.LCS.Sh. BarSh Barren littoral shingle	NA	Widespread on upper shore, although often contains larger boulders; or grades into areas of larger boulders especially higher up the shore.
/8	Ls.LSa. St.Tal Talitrids on the upper shore and strandline	<i>Talitridae sp.</i> - C	
/9	LR.LLR.F. Pel <i>Pelvetia canaliculata</i> on sheltered littoral fringe rock.	<i>Fucus spiralis</i> - O <i>Littorina saxatilis</i> - F <i>Patella vulgata</i> - O <i>Pelvetia canaliculata</i> - C <i>Semibalanus balanoides</i> - R <i>Verrucaria maura</i> - C	
/10	LR.FLR.Eph. Eph.En tPor <i>Porphyra purpurea</i> and <i>Enteromorpha</i> spp. on sand-scoured mid or lower eulittoral rock.	<i>Littorina littorea</i> - F <i>Porphyra purpurea</i> - O <i>Ulva intestinalis</i> - S <i>Ulva lactuca</i> - C	
/11	LR.FLR.Lic. YG Yellow and grey lichens on supralittoral rock.	Present within Lic.YG in varying abundances and locations: <i>Caloplaca maritima</i> <i>Lecanora atra</i> <i>Lichina pygmaea</i> <i>Ramalina siliquosa</i> <i>Xanthoria parietina</i>	
/12	LR.HLR.FR. Mas <i>Mastocarpus stellatus</i> and <i>Chondrus crispus</i> on very exposed to moderately exposed lower eulittoral rock	<i>Littorina littorea</i> - A <i>Mastocarpus stellatus</i> - S <i>Semibalanus balanoides</i> - O <i>Ulva intestinalis</i> - O	Note that <i>Chondrus crispus</i> , whilst occasionally observed in small amounts elsewhere in the bay, was not observed in this biotope in Nigg bay during this survey.

Area target note no.	Biotope Name	SACFOR	Notes
/13	Mosaic of: LR.HLR.MusB. Sem.Sem and LR.HLR.FR. Mas (= Sem.Sem – Mas)	<u>Sem.Sem:</u> <i>Fucus vesiculosus</i> – R <i>Littorina littorea</i> - A <i>Nucella lapillus</i> – F <i>Patella vulgata</i> – C <i>Semibalanus balanoides</i> - S <i>Ulva intestinalis</i> – R <u>Mas:</u> <i>Actinia equina</i> - R <i>Corallina officinalis</i> - O <i>Fucus vesiculosus</i> – R <i>Hildenbrandia rubra</i> – R <i>Littorina littorea</i> - A <i>Mastocarpus stellatus</i> – A <i>Nucella lapillus</i> – F <i>Semibalanus balanoides</i> - O <i>Ulva intestinalis</i> – O	Area of large boulders dominated by LR.HLR.MusB. Sem.Sem interspersed with areas of smaller boulders, cobble and shingle dominated by dense stands of <i>Mastocarpus</i> turf LR.HLR.FR. Mas . Both of these biotopes are also found individually elsewhere in Nigg Bay
/14	LR.MLR.BF. FvesB <i>Fucus vesiculosus</i> and barnacle mosaics on moderately exposed lower eulittoral rock.		Inaccessible; Dominated by barnacles <i>Semibalanus balanoides</i> but <i>Fucus vesiculosus</i> was also present though highly variable in abundance.
/15	LR.HLR.MusB. Sem.LitX <i>Semibalanus balanoides</i> and <i>Littorina</i> spp. on exposed to moderately exposed eulittoral boulders and cobbles.	<i>Semibalanus balanoides</i> - S <i>Patella vulgata</i> – O <i>Littorina littorea</i> - C <i>Mastocarpus stellatus</i> – R <i>Palmaria palmata</i> – R <i>Carcinus maenas</i> – O <i>Lanice conchilega</i> – R <i>Porphyra purpurea</i> - R	
/16	LR.HLR.MusB. MytB <i>Mytilus edulis</i> and barnacles on very exposed eulittoral rock.	<i>Fucus vesiculosus</i> – R <i>Mytilus edulis</i> – S <i>Semibalanus balanoides</i> – S <i>Ulva intestinalis</i> – O	
/17	LR.FLR.Lic. Ver.Ver <i>Verrucaria maura</i> on exposed littoral fringe littoral rock.	<i>Fucus spiralis</i> – R <i>Littorina littorea</i> – F <i>Littorina saxatilis</i> – F <i>Patella vulgata</i> – O <i>Pelvetia canaliculata</i> – R <i>Porphyra umbilicalis</i> - R <i>Semibalanus balanoides</i> - R <i>Ulva intestinalis</i> – R <i>Verrucaria maura</i> – C	
/18	LR.FLR.Lic. Ver.B <i>Verrucaria maura</i> and sparse barnacles on very exposed to very sheltered upper littoral fringe littoral rock.	<i>Littorina littorea</i> – C <i>Littorina saxatilis</i> - O <i>Patella vulgata</i> – C <i>Semibalanus balanoides</i> - F <i>Verrucaria maura</i> – F	

Area target note no.	Biotope Name	SACFOR	Notes
/19	Mosaic of LR.HLR.MusB. Sem.Sem and LR.HLR.MusB. Sem.LitX : (= Sem.Sem - Sem.LitX)	Specific SACFOR information not collected but the fauna was broadly typical of that found in these two biotopes in adjacent areas of the bay. Barnacles, limpets and the periwinkle <i>Littorina littorea</i> were found more or less throughout but barnacles and limpets were more abundant in the Sem.Sem areas (mostly larger boulders) and <i>Littorina littorea</i> was relatively more abundant in the Sem.LitX areas.	This area was difficult to categorise but is probably best described as a mosaic of LR.HLR.MusB. Sem.Sem on larger more stable boulders and LR.HLR.MusB. Sem.LitX on smaller or less stable boulders and stones, often in between the larger boulders. There were frequent small patches of standing water in places and on the occasion visited much plastic waste in the form of very degraded small thin sheets of unknown origin, accompanied by an unpleasant organic smell.
/20	Mosaic of: LR.FLR.Lic. Ver.B and LR.FLR. Rkp.Cor Coralline crust-dominated shallow eulittoral rockpools (= Ver.B - Rkp.Cor)	Species list refers to the coralline algae ("lithothamnia") dominated pools: <i>Actinia equina</i> - C <i>Anomiidae</i> - R <i>Ceramium rubrum</i> - R <i>Chondrus crispus</i> - R <i>Cladophora rupestris</i> - R <i>Corallina officinalis</i> - O <i>Diadumene cincta</i> - R <i>Halidrys siliquosa</i> - O <i>Hildenbrandia rubra</i> - R <i>Lipophrys pholis</i> - C Lithothamnia - A <i>Littorina littorea</i> - A <i>Mastocarpus stellatus</i> - R <i>Pagurus bernhardus</i> - C <i>Patella vulgata</i> - C <i>Semibalanus balanoides</i> - R <i>Ulva intestinalis</i> - R	Broad mosaic area of Ver.B and Coralline pools. Deeper pools have dense patches of <i>Halidrys siliquosa</i> , some <i>Laminaria digitata</i> and <i>Fucus serratus</i> . Mostly bedrock with some boulders. Similar small mosaic areas exist elsewhere along the southern shore of Nigg Bay.

Table 3. Point target notes associated with biotope maps

Target Number	Notes
1	Concrete Seawall, mostly vertical until 4-5m of steeply sloping area at base. Virtually barren with very small amount of orange lichen and <i>Caloplaca maritima</i> in places. Occasional patches of <i>Ulva intestinalis</i> and <i>Porphyra umbilicalis</i> . Also very rare patches of <i>Pelvetia canaliculata</i> and <i>Fucus spiralis</i> sporelings on the lower edge. Seawall has 3-4m maximum horizontal extension. <i>Fucus spiralis</i> – R <i>Pelvetia canaliculata</i> - R <i>Porphyra umbilicalis</i> - R <i>Ulva intestinalis</i> - O
2	Mobile sand could only be assessed to low water on date of survey. There is obviously potential for a change in biotope on the lower edge of the intertidal zone in location of target note, however this could not be properly investigated on these tides as it did not dry out; this would best be investigated by ensuring there is at least one sampling station near the low water mark during the subtidal grab / camera survey planned for spring 2015. At low shore small amounts of <i>Alaria esculenta</i> and <i>Laminaria digitata</i> were occasionally seen growing on rocks. Some small sandeels seen at water's edge.
3	Small freshwater stream runs into bay.
4	Eroding earth cliff varying 2-3m in height containing soil boulders, rubble, concrete and tarmac.
5	Barren area consisting of pebbles, boulders, rubble, concrete and broken pieces of tarmac (rubble concrete etc becomes more common to the south. Largely items of boulder size especially higher up..
6	Above the barren pebbles, boulders, rubble etc, these are gradually replaced by partially vegetated coarse sand with cobbles.
7	As Sem.Sem band continues East substrate becomes mainly broken bedrock with boulders up to 2m diameter in many places. Frequent small shallow pools found throughout Sem.Sem biotope containing <i>Lithothamnium</i> sp., <i>Mastocarpus stellatus</i> , <i>Spongomorpha arcta</i> , <i>Patella vulgata</i> , <i>Littorina littorea</i> , <i>Pagurus bernhardus</i> , <i>Carcinus maenas</i> and <i>Actinia equina</i> .
8	Headland beyond seawall, substrate initially boulders for 100m then becoming broken bedrock out to point. Barren rock 3-5m above in places. Upper band Lic.YG 3-5m wide, Lichen <i>Caloplaca maritima</i> 10-50% cover on boulders (including area of boulders set in concrete at end of seawall). Below this, boulders around 1m diameter interspersed with cobble and pebble with Ver.ver biotope <i>Littorina littorea</i> – R (common in places, more than usual for this Ver.ver biotope) <i>Littorina saxatilis</i> – F <i>Mastocarpus stellatus</i> – R <i>Mytilus edulis</i> - O <i>Patella vulgata</i> – A (more than usual for this biotope) <i>Pelvetia canaliculata</i> – R <i>Semibalanus balanoides</i> - R <i>Ulva intestinalis</i> – R <i>Verrucaria maura</i> – A As continues East towards old sea defence Lic.YG becomes wider to 10m, rare <i>Xanthoria parietina</i> amongst <i>Caloplaca maritima</i> here.
9	Beyond sea defence towards point Lic.YG narrows, towards the point widens again to up to 15m. There is an increase in the amount of green lichen along with the <i>Caloplaca maritima</i> and also patches of <i>Xanthoria parietina</i> .
10	Old concrete sea defence, barren of life. Patch of barren shingle in front to EphX, leading to Sem.Sem below then L.dig at edge of shore.
11	Concrete sewer outlet, fully submerged at high water, fully exposed at low water. Patches of dense <i>Mastocarpus stellatus</i> , with some juvenile <i>Mytilus edulis</i> . Also areas of Sem.Sem overgrown with either <i>Mastocarpus</i> or <i>Porphyra</i> spp and <i>Ulva</i> spp in places at the upper end).

Target Number	Notes
12	Large rock 10m x 5m, height of approximately 5m. Large area of Lic.YG on top leading into Sem.Sem. To seaward side some deeper pools to a few meters across with <i>Halidrys siliquosa</i> , <i>Laminaria digitata</i> and small amounts of <i>Saccharina latissima</i> in the deeper parts, though coralline seaweeds dominated shallower edges. Also scattered smaller pools dominated by <i>Corallina officinalis</i> , some containing large numbers of <i>Lipophrys pholis</i> .
13	Mobile sand, very little infauna. Small numbers of <i>Lanice conchilega</i> observed, near to adjacent rocks. These sandy areas appeared to be more or less barren – several 30x30cm pits were dug and sieved over a 1mm sieve in region of point target notes 2 and 13 (including where worm casts were seen) and only a single small fragment of an unidentified polychaete was found. Almost no worm casts appeared on the open areas of sand during several hours of low tide, the very few that did appear seeming likely to be of the lugworm <i>Arenicola marina</i> , and there were no mollusc shells, living or empty, on the shore or in the sand. In several locations, where the sand was adjacent to rocks there were very small patches containing a small number of tubes belonging to the sand mason <i>Lanice conchilega</i> (a polychaete worm), but these areas were never extensive or dense enough to map as a separate biotope. Occasional rocks with <i>Semibalanus balanoides</i> , <i>Ulva intestinalis</i> , <i>Palmaria palmata</i> and <i>Polysiphonia</i> sp. especially in region of target note. In areas which did not fully dry out at low tide (at least on this visit) a few <i>Desmarestia aculeata</i> on sand (presumably anchored to stones within the sand), no other obvious species.
14	Mosaic area of Ver.B and Coralline pools. Mostly bedrock with some boulders. Species list refers to the pools: <i>Ceramium</i> sp – R <i>Cladophora rupestris</i> - R <i>Corallina officinalis</i> – R <i>Gelidium pusillum</i> – R <i>Halidrys siliquosa</i> – F <i>Lithothamnium</i> – A <i>Littorina littorea</i> – C <i>Patella vulgata</i> – C <i>Semibalanus balanoides</i> – R <i>Ulva intestinalis</i> – R
15	Several small pools in Sem.Sem area of Greg Ness containing similar species as listed for other coralline pools.
16	Around point of Greg Ness are patches of FvesB and MytB within the Sem.Sem biotope, however no areas of either large enough to map as a biotope.
17	Mostly narrow area of Fser.R. - <i>Fucus serratus</i> and <i>Palmaria palmata</i> on boulders - but lower seaweed abundance than is typical of this biotope. May extend slightly more to seaward in places on a bigger tide. <i>Actinia equina</i> – C <i>Fucus serratus</i> - C <i>Mastocarpus stellatus</i> – C <i>Palmaria palmata</i> – F <i>Patella vulgata</i> - O <i>Semibalanus balanoides</i> – R <i>Ulva intestinalis</i> – F <i>Ulva lactuca</i> – O
18	Rocks on sand with much <i>Desmarestia aculeata</i> , some <i>Palmaria palmata</i> , <i>Polysiphonia</i> sp, <i>Ulva lactuca</i> and <i>Littorina littorea</i> . Some standing water.
19	Large patch of small boulders and cobble. Good match to this Sem.Sem biotope though more exposed than is usual and boulders are larger than biotope description. Small patches of <i>Mastocarpus stellatus</i> turf in places, and patches of <i>Palmaria palmata</i> in others between boulders.

Target Number	Notes
20	Large boulders to 1m with smaller boulders, cobble and shingle in between. Mosaic of Sem.Sem on large boulders and Mas. Turf on low lying areas between and on smaller boulders c. (60% Sem.Sem, 40 % Mas. Ratio).
21	This area was a relatively light strandline composed mainly of cast fucoids, with many kelp flies and a few talitrids. Clearly highly variable (and indeed had moved up the shore and a few tens of metres to the north on the second day of survey).
22	<p>Isolated patch of FSer.R on a mixture of boulders and bedrock</p> <p><i>Actinia equina</i> – F <i>Chondrus crispus</i> - O <i>Fucus serratus</i> - A <i>Gelidium pusillum</i> - R <i>Hildenbrandia rubra</i> – R <i>Laminaria digitata</i> – R Lithothamnia - O <i>Lomentaria articulata</i> – R <i>Mastocarpus stellatus</i> - C <i>Membranoptera alata</i> – R <i>Nucella lapillus</i> – F <i>Osmundea pinnatifida</i> – O <i>Palmaria palmata</i> – A <i>Patella vulgata</i>– C <i>Polysiphonia</i> sp - R <i>Porphyra umbilicalis</i> - R <i>Saccharina latissima</i> - R <i>Semibalanus balanoides</i> - C <i>Ulva intestinalis</i> – R <i>Ulva lactuca</i> – R</p>
23	<p>Large area of Sem.Sem, vast majority of <i>barnacles Semibalanus balanoides</i> are juvenile</p> <p><i>Actinia equina</i> – O <i>Corallina officinalis</i> - R <i>Eulalia viridis</i> – F Lithothamnia – R <i>Littorina littorea</i> - F <i>Nucella lapillus</i> – F <i>Osmundea pinnatifida</i> – R <i>Palmaria palmata</i> – R <i>Patella vulgata</i> – A <i>Semibalanus balanoides</i> - S <i>Ulva intestinalis</i> – R <i>Verrucaria maura</i> - R</p>

APPENDIX 1 IMAGES OF BIOTOPES WITHIN NIGG BAY

1. LR.HLR.MusB.Sem.Sem



2. LR.LLR.F.Fves.FS



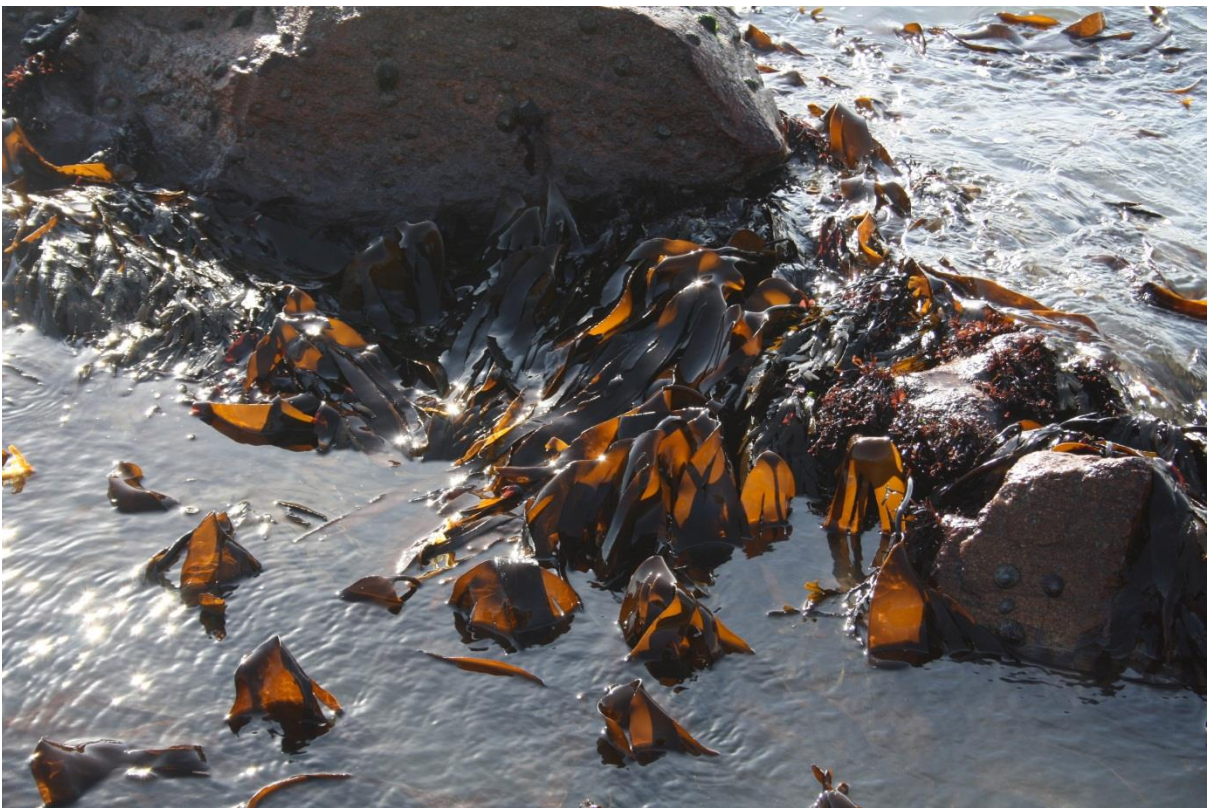
3. LR.MLR.BF.Fser.R



4. LR.FLR.Eph.EphX



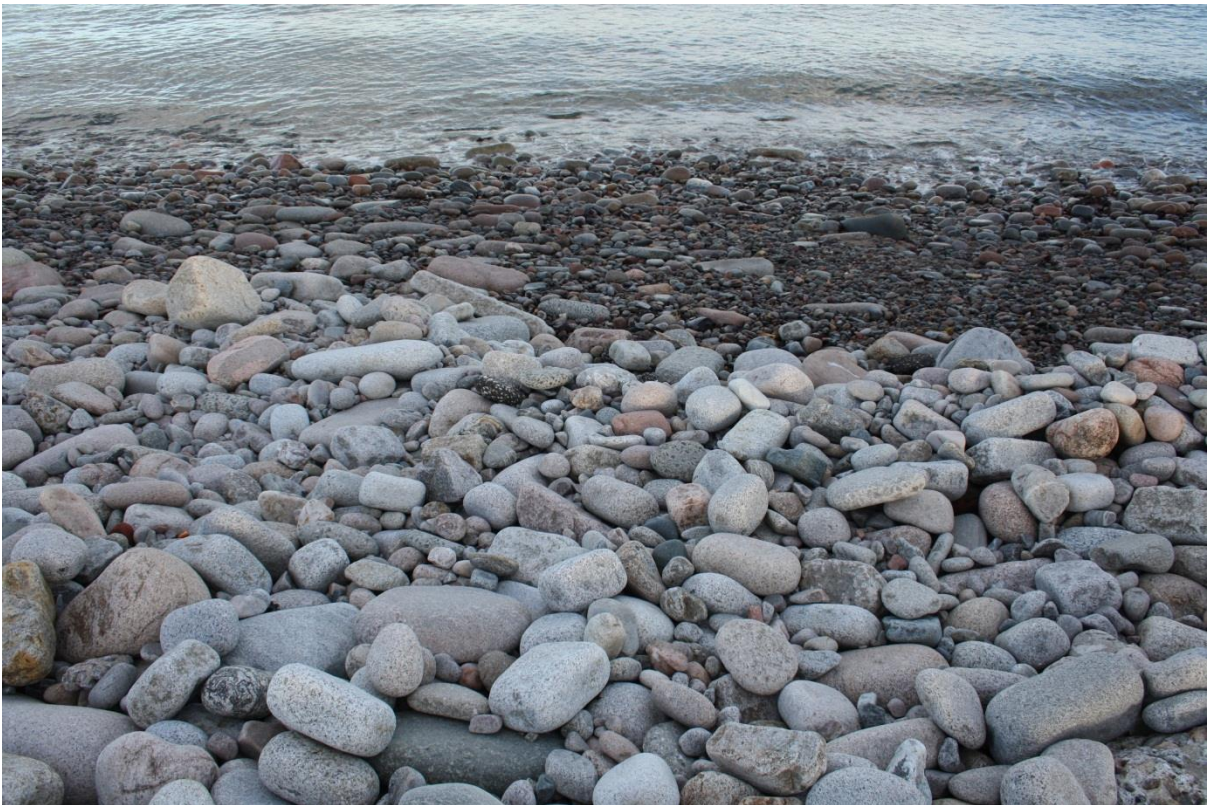
5. IR.MIR.KR.Ldig



6. LS.LSa.**MoSa**



7. LS.LCS.Sh.**BarSh**



8. Ls.LSa.St.Tal



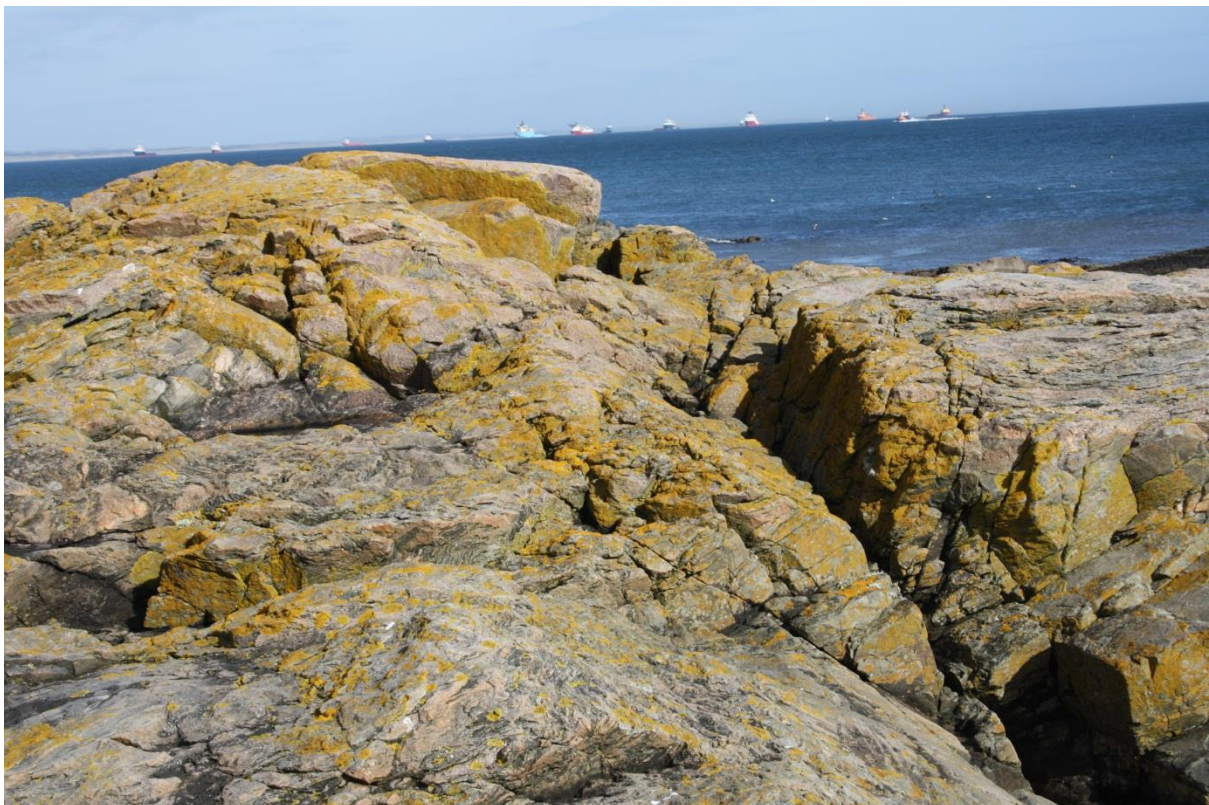
9. LR.LLR.F.Pel



10. LR.FLR.Eph.Eph.EntPor



11. LR.FLR.Lic.YG





12. LR.HLR.FR.Mas



13. **Sem.Sem – Mas** Mosaic



14. **LR.MLR.BF.FvesB**



15. LR.HLR.MusB.Sem.LitX



16. LR.HLR.MusB.MytB



17. LR.FLR.Lic.Ver.Ver



18. LR.FLR.Lic.Ver.B



19. Mosaic of LR.HLR.MusB.**Sem.Sem** and LR.HLR.MusB.**Sem.LitX**



20. Mosaic of LR.FLR.Lic.**Ver.B** and LR.FLR.Rkp.**Cor**



APPENDIX 2 OVERVIEW IMAGES OF NIGG BAY

1. Girdle Ness (looking North-west at low water)



2. Gregg Ness (looking South at low water)



3. Looking towards the centre of Nigg Bay from part way along the south shore (circa 2 hours after low water)

