Natural England

VERIFICATION SURVEY OF INTERTIDAL ROCKY SHORE FEATURES IN THE ALLONBY BAY RMCZ

Final Report

November 2013

APEM Reference: 412902

Natural England Reference: 25014

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APEM PROJECT NO:	**412902**
DATE OF ISSUE:	**03 December 2013**

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1 EXECUTIVE SUMMARY

APEM conducted an intertidal verification survey of the rocky shore biotopes within the Allonby Bay recommended Marine Conservation Zone (rMCZ) from Saturday 7th to Monday 9th September 2013. Natural England accompanied APEM on Saturday 7th September 2013 to carry out extent mapping of the honeycomb worm *(Sabellaria alveolata*) reef. The aim of the surveys was to determine the presence and extent of broad scale habitats (BSH) and habitats of conservation interest (HOCI), the presence of species of conservation interest (SOCI), and to provide a baseline to inform future condition assessment.

The Phase I survey effort was directed across the whole of the intertidal region of Allonby Bay within the rMCZ. The intertidal region was split into 7 sites (based on the wireframe maps produced to conduct mapping) for convenience of reporting. The majority of the honeycomb worm reef was mapped although the reef around Allonby itself was not mapped due to time constraints. In addition, the low tide extent of the honeycomb worm reef cannot be guaranteed due to time constraints and the low tide limiting the amount of shore that could be surveyed. The Phase II survey effort was directed to representative areas of rocky shore biotopes at sites geographically spread throughout the bay.

The primary objective of the Phase I survey was to gain as much information on the general biotopes present in the region as possible The Phase II survey provided quantitative detail in specific areas for the main biotopes identified.MNCR habitat forms were filled in for the main biotopes of focus for the surveys. This resulted in both good coverage of the area and detailed quantitative data for all main biotopes encounted.

All of the rocky shore biotopes contained within the intertidal region of the Allonby Bay rMCZ were mapped in detail (EUNIS level 5 and 6). Littoral sediments were not of focus for the surveys thus were not mapped, however, all areas where rocky shore biotopes were not recorded can be assumed to be littoral sediments (LS, EUNIS code A2). The main biotopes present were littoral biogenic reefs (LS.LBR), features of littoral rock (LR.FLR) and barren shingle (LS.LCS.Sh.BarSh) with low energy, moderate energy and high energy biotopes represented by only one biotope each.

A total of 12 different biotopes/biotope complexes were recorded in Allonby Bay during the survey with an additional 13th biotope potentially present (kelp rockpools, LR.FLR.Rkp.FK). Biotopes were assigned to EUNIS level 5 (9 biotopes) and EUNIS level 6 (2 biotopes) and peat and clay exposures were recorded as a HOCI rather than a specific biotope complex for mapping purposes. The most frequently recorded biotopes were A2.111 (LS.LCS.Sh.BarSh), A2.711 (LS.LBR.Sab.Salv), A2.721 (LS.LBR.LMus.Myt) and A2.821 (LR.FLR.Eph.EphX), all occurring within every site. There were 3 biotopes (FVS.FspiVS, Eph.Ent and Lic.Ver.Ver) that were recorded only at single sites, 1 biotope (Rkp.H) recorded at a single site but with other potential occurrences in other sites and 1 biotope (BF.FvesB) recorded at a single site but potentially interchangeable with Eph.EphX or Eph.EntPor due to the faunal composition of these three biotopes.

Half of the recorded biotopes are typical to the area and have been recorded previously and form part of the core records of the JNCC's marine habitat classification with a further 3 biotopes (Lic.Ver.Ver, FVS.FspiVS and BF.FvesB)

being been found previously on nearby shores further west. A further 3 biotopes (Sh.BarSh, Rkp.H and peat and clay exposures i.e.piddock habitats) have not been recorded in or near the region as part of the core or tentative records of the JNCC's marine habitat classification thus the current records of these habitats are important for future condition monitoring within the site, particularly the HOCI peat and clay exposures.

As part of the Phase II surveys, 90 quadrats were assessed (10 transects with 3 stations – low, mid, upper – each with 3 replicates). The Phase II quantitative data was collected using standarised methods to ensure comparability with similar future monitoring to detect temporal trends and changes.These contained 17 encrusting species and macrophytes. Blue mussels (*Mytilus edulis*) had, by far, the largest coverage of encrusting organisms recorded in the quadrats across the Allonby Bay rMCZ (40% of the total area of encrusting species) and the most common macrophyte species recorded was *Enteromorpha* spp., found in 58 quadrats (17% of the total area of encrusting species). *Semibalanus balanoides* and *Porphyra* spp. were also common, found in over 50 quadrats each (16 and 14% of the total area of encrusting species, respectively).

A total of 8 'mobile' or 'free-living' species were recorded in the quadrats, 2 of which (*Patella vulgata* and *Macoma balthica*) only had 1 individual recorded. The most common and abundant species was *Littorina littorea*, recorded in 32 of the quadrats with an overall abundance of 155 individuals. Their highest abundances were in Transects 1 and 4 in mussel beds.

Within the Allonby Bay rMCZ, we identified two specialised biotopes (A1.414 LR.FLR.Rkp.H and A1.412 LR.FLR.Rkp.FK (potentially present)), one nationally or more than nationally important community (A2.71 LS.LBR.Sab.Salv), three non-native intertidal species *(Polysiphonia harveyi* (potentially present), *Austrominius (Elminius) modestus, and Crassostrea gigas), and* three,potentially four, intertidal Biodiversity Action Plan (BAP) habitats (*Sabellaria alveolata* reefs, Peat and clay exposures with piddocks, Blue mussel beds and potentially Estuarine rocky habitats)

No intertidal BAP species were recorded and no nationally rare or scarce species were encountered.

The main anthropogenic pressures observed were the Pacific oyster *Crassostrea gigas* fishery in the northernmost Site 1 at Dubmill Scar and the water outlets at various points around the bay. The Dubmill Scar area also has groynes installed to retain littoral sediments and dog walkers frequent the bay.

In conclusion, various habitats and species of conservation interest (HOCI and SOCI) are present within the Allonby Bay rMCZ including a high proportion of *Sabellaria alveolata* reef and blue mussel (*Mytilus edulis*) beds which are the primary habitats in the area. Site 4 contained the least amount of rocky shore biotopes and was primarily littoral sediments. As the rocky shore biotopes were composed of mostly biogenic reefs and features rather than actual bedrock, there is the potential that any major shifts in environmental parameters, such as currents affecting sedimentary processes, freshwater influence altering the salinity or pollution, may affect the distribution of the rocky shore biotopes in the Allonby Bay rMCZ. The low level and restricted nature of the anthropogenic impacts observed are unlikely to cause

significant change in the short-term but potential risks should be considered in future monitoring of this area.

2 INTRODUCTION

2.1 Background

APEM were commissioned by Natural England to conduct an intertidal survey of the rocky shore biotopes within the Allonby Bay recommended Marine Conservation Zone (rMCZ) (Figure 1). The survey aimed to determine the presence and extent of broad scale habitats (BSH) and habitats of conservation interest (HOCI), the presence of species of conservation interest (SOCI), and to provide baseline data to inform future condition assessment. The Allonby Bay rMCZ site was identified as part of the Irish Seas Conservation Zone (ISCZ) Project and is the furthest north of all of the rMCZs identified in the Irish Sea.

This document outlines the methodology and results of the rocky shore intertidal surveys, describes the presence and extent of HOCI and SOCI, and provides a general account of anthropogenic pressures identified at the time of survey that may impact the integrity of the rMCZ.

2.2 Allonby Bay rMCZ

The Allonby Bay rMCZ extends over 39 km^2 of Cumbria's coastline up to 5.5 km offshore, encompassing the entirety of Allonby Bay (intertidally around the bay from NY0745145892 to NY0413538060 (Figure 1).

The rMCZ is recommended in order to provide protection to a number of features of conservation interest including blue mussel beds, honeycomb worm (*Sabellaria alveolata*) reefs and peat and clay exposures as well as a number of broad scale habitats including high energy intertidal rock (ISCZ, 2011) (Table 1).

The rMCZ does not contain any existing designations although the landward part of Allonby Bay is part of the Solway Coast Area of Outstanding Natural Beauty (AONB) and, subtidally, the north western area of the site contains a recommended Reference Area (rRA H –Allonby Bay). There are a number of existing designations close to, but not overlapping with, the northern section of the rMCZ: Solway Firth Special Area of Conservation (SAC), Upper Solway Flats and Marshes Special Protection Area (SPA) and Upper Solway Flats and Marshes Ramsar.

The Dubmill Scar area of the rMCZ is considered to be highly diverse and contains an intertidal aquaculture site for Pacific oyster *Crassostrea gigas*, extensive blue mussel (*Mytilus edulis*) beds and one of the best examples of honeycomb worm (*Sabellaria alveolata*) reef in the UK (ISCZ, 2011).

Table 1. Features proposed for designation in the Allonby Bay rMCZ including their recorded area of coverage at the time of writing the ISCZ MCZ recommendations report (table extracted from the Selection Assessment Document rMCZ 10 Allonby Bay in Part 3.1 of ISCZ, 2011).

Feature type	Feature name	Area covered within site (for broad scale habitats and habitats of conservation importance)
Broad scale habitat (BSH)	A1.1 High energy intertidal Rock*	0.005 km^2 (0.45 Ha)
	A2.7 Intertidal biogenic reefs	4.47 km^2 (446.89 Ha)
	A5.1 Subtidal coarse sediment	22.05 km^2 (2204.48 Ha)
	A5.2 Subtidal sand	11.26 km^2 (1126.03 Ha)
Habitat of conservation Importance (HOCI)	Blue mussel (*Mytilus edulis)* beds*	
	Peat and clay exposures*	
	Honeycomb worm (*Sabellaria alveolata)* reefs*	1.01 km^2 (101.46 Ha)
	Subtidal sands and gravels	35.04 km^2 (3503.6 Ha)
Species of conservation Importance (SOCI)	n/a	
Geological feature	n/a	
Other feature	n/a	

*BSH and HOCI of specific focus for these surveys

2.3 Objectives

The main objectives of this project were to:

- Carry out Phase I biotope surveys of the intertidal zone of the main broadscale habitats (BSH) and habitats of conservation importance (HOCI) proposed for designation (Table 1), identifying and mapping the extent and distribution of the biotopes of focus to a minimum of EUNIS level 3.
- Carry out Phase II surveys of the intertidal zone of the main BSH and HOCI at 10 transects to provide robust quantitative information on species and biotopes within the main areas identified in the Phase I habitat survey (Figure 1).
- Identify, record, and report presence and extent of any habitat and species FOCI as proposed for the rMCZ where possible, as well as any additional FOCI encountered.
- Assess anthropogenic influences potentially impacting on identified features where possible.

Data were gathered following standard methodologies and best professional practices ensuring sufficient quality to act as a baseline of the presence and extent of the pre-identified BSHs and HOCI to allow future condition assessment, should this area be designated as an MCZ.

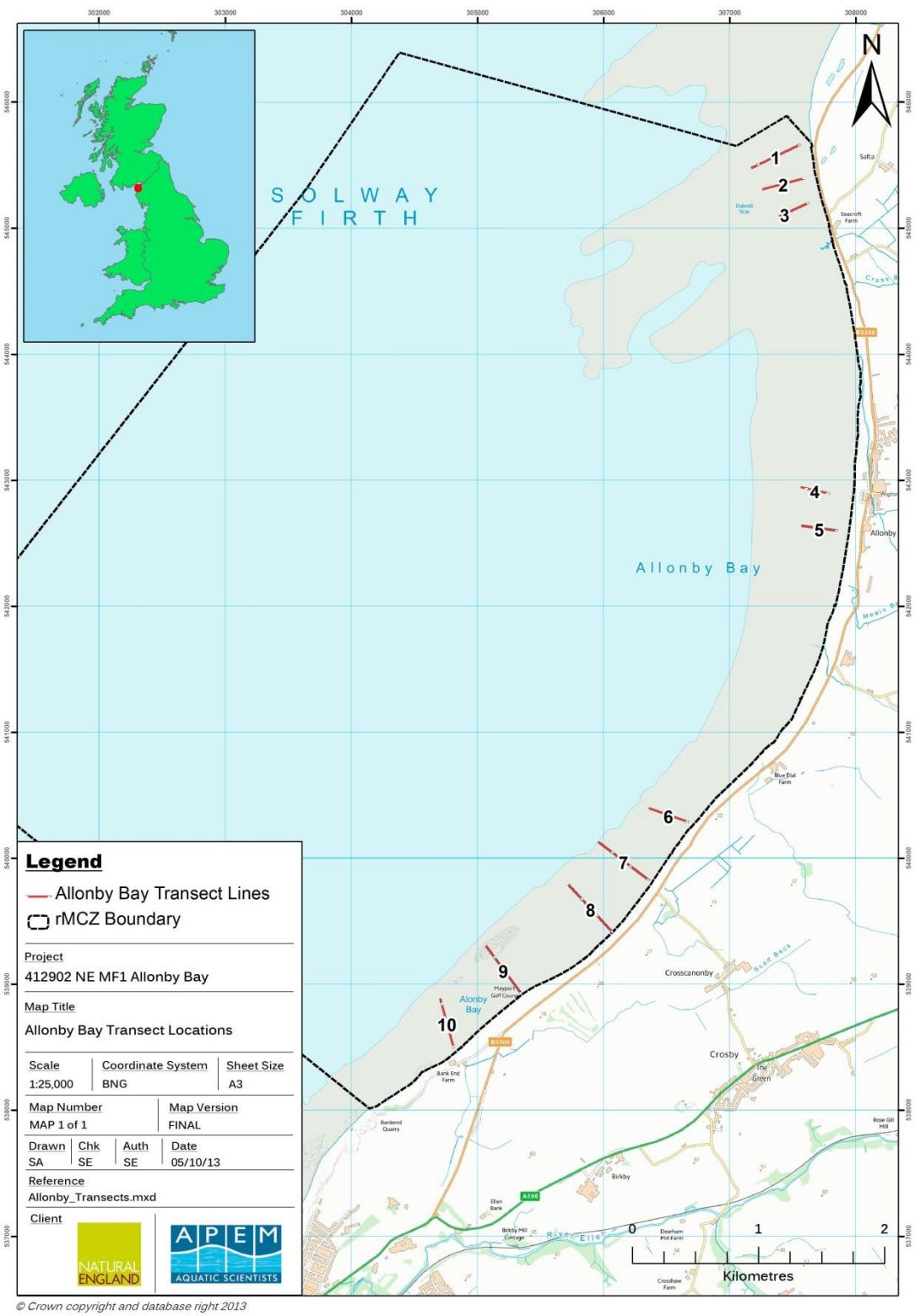

Figure 1. Allonby Bay rMCZ boundary (black dashed polygon) with actual transect locations (red) (Transects did not include *Sabellaria alveolata* reef). Contains Ordnance Survey data.

3 METHODS

Field survey methods incorporated a combination of qualitative Phase I and quantitative Phase II approaches (Wyn, et al., 2000; Davies, et al., 2001; JNCC, 2004). The Phase I biotope allocation approach enabled a broad characterisation of the communities present within the rMCZ. The Phase II methods provided species composition and abundance data for specific transects suitable for the application of statistical analyses.

3.1 Features of interest surveyed

The specific features of interest for these surveys, included in the list of proposed habitats for designation in this rMCZ following identification by the Irish Sea Conservation Zone project, were:

Broad-scale habitat:

- A1.1 High energy intertidal rock

Habitat of conservation importance:

- Blue mussel (*Mytilus edulis*) beds
- Peat and clay exposures
- *Honeycomb worm (Sabellaria alveolata) reef – extent surveyed by Natural England staff.*

Whilst the honeycomb worm reef had a confidence score of high for presence and moderate for extent, the last comprehensive mapping of this feature took place in 2002 thus it was considered necessary to assess the current extent of this feature. This survey was conducted by Natural England and the resultant data reported on the biotope maps in this report.

3.2 Survey locations

The location of Phase I and II survey sites were initially determined by previous records of rocky shore biotopes and features of conservation interest and were then micro-located on site. It was considered that the whole of Allonby Bay was easily accessible by foot thus 100% coverage of the site was possible at Phase I and access was not an issue for micro-location of the Phase II survey. Health and safety was considered in the project planning phases (APEM Ltd, 2013).

For the Phase II surveys, conducted concurrently with Phase I, a total of 10 transects were surveyed (Figures 2 to 5) containing 9 quadrats per transect spread over different shore heights to encompass the different rocky shore biotopes present.

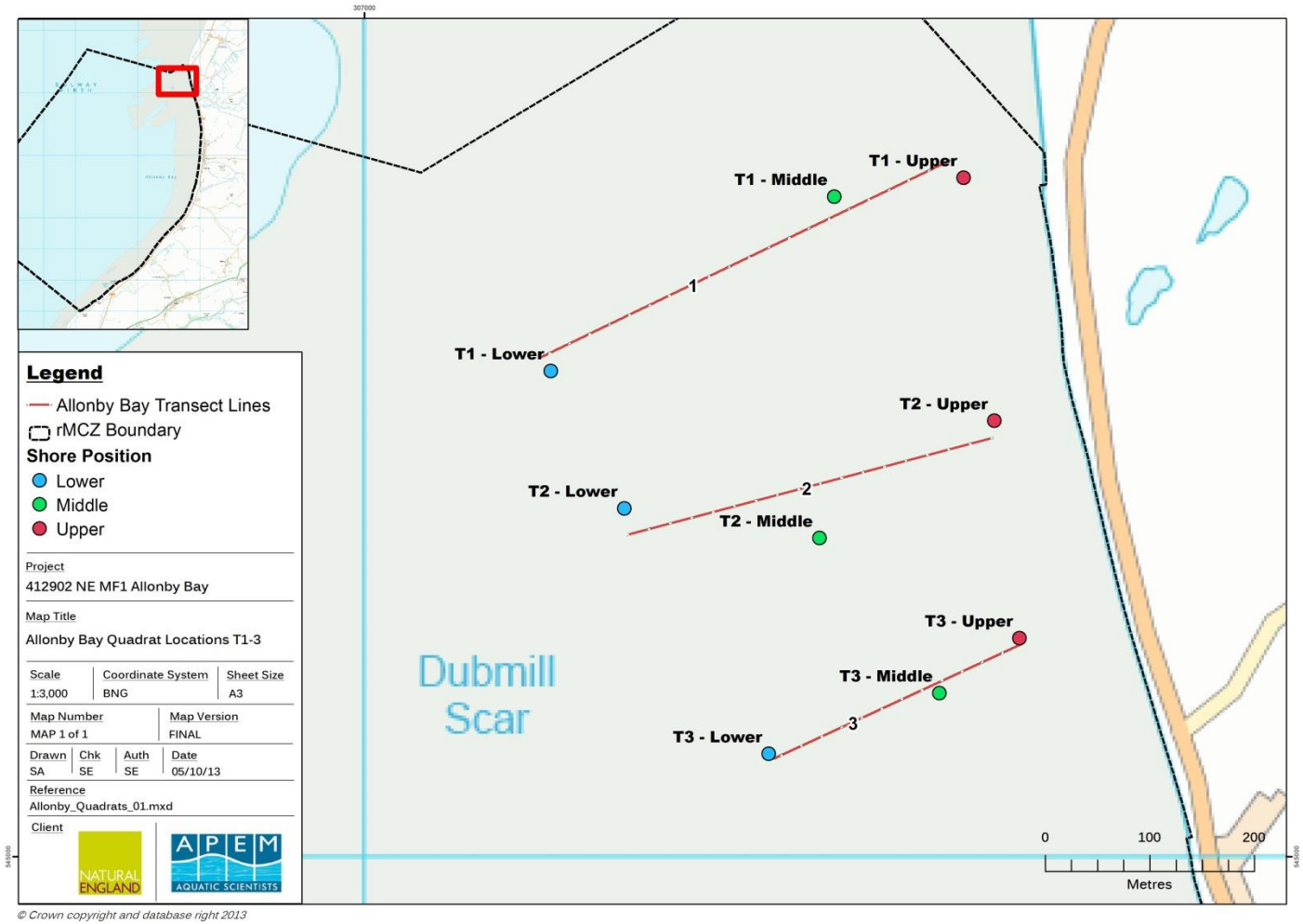

Figure 2. Upper, mid and lower shore station locations for Transects 1, 2 and 3. A total of 3 replicates were taken at each station within representative biotopes. Approximate transect locations shown (red) (Transects did not include *Sabellaria alveolata* reef). Contains Ordnance Survey data.

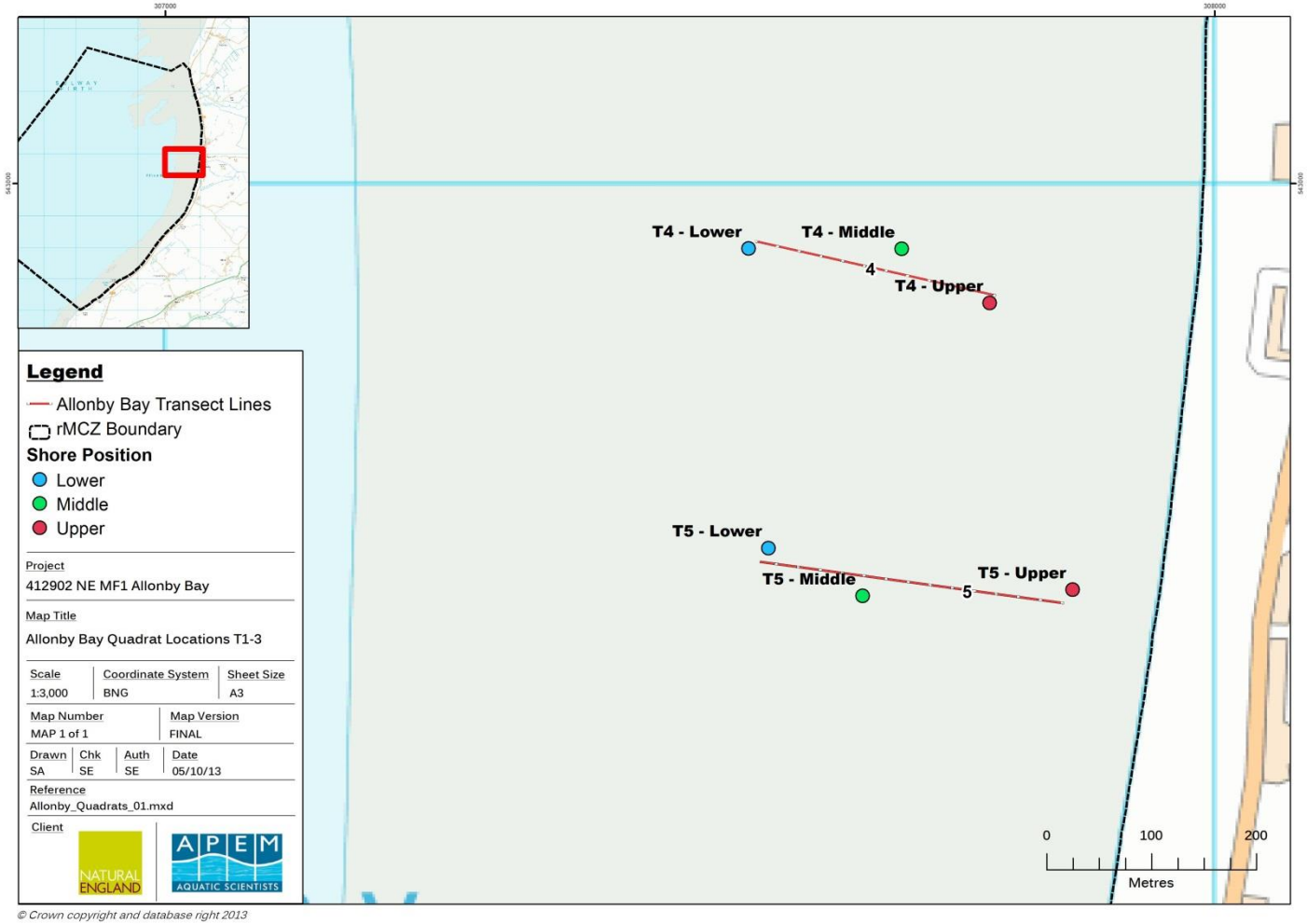

Figure 3. Upper, mid and lower shore station locations for Transects 4 and 5. A total of 3 replicates were taken at each station within representative biotopes. Approximate transect locations shown (red) (Transects did not include *Sabellaria alveolata* reef). Contains Ordnance Survey data.

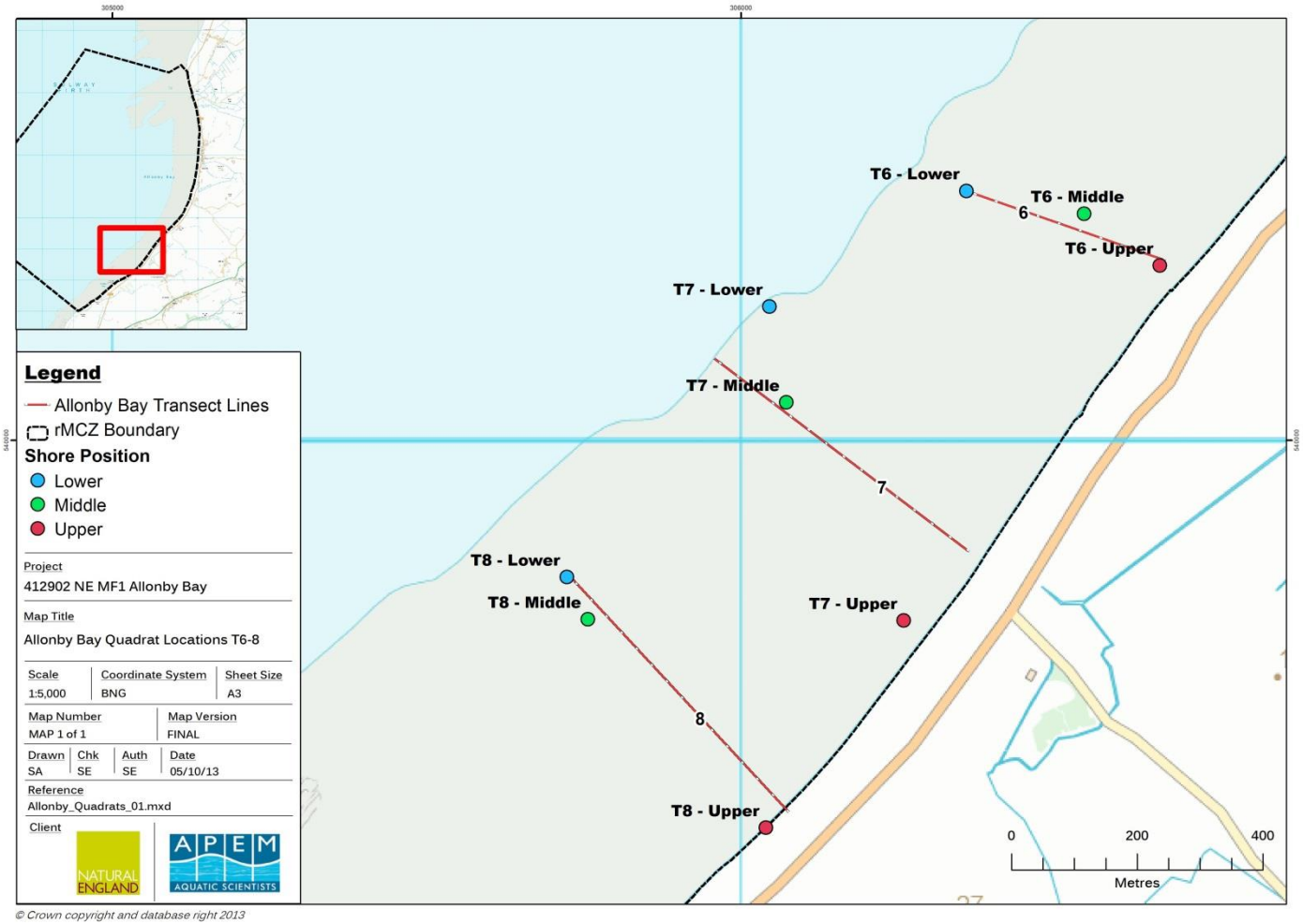

Figure 4. Upper, mid and lower shore station locations for Transects 6, 7 and 8. A total of 3 replicates were taken at each station within representative biotopes. Approximate transect locations shown (red) (Transects did not include *Sabellaria alveolata* reef). Contains Ordnance Survey data.

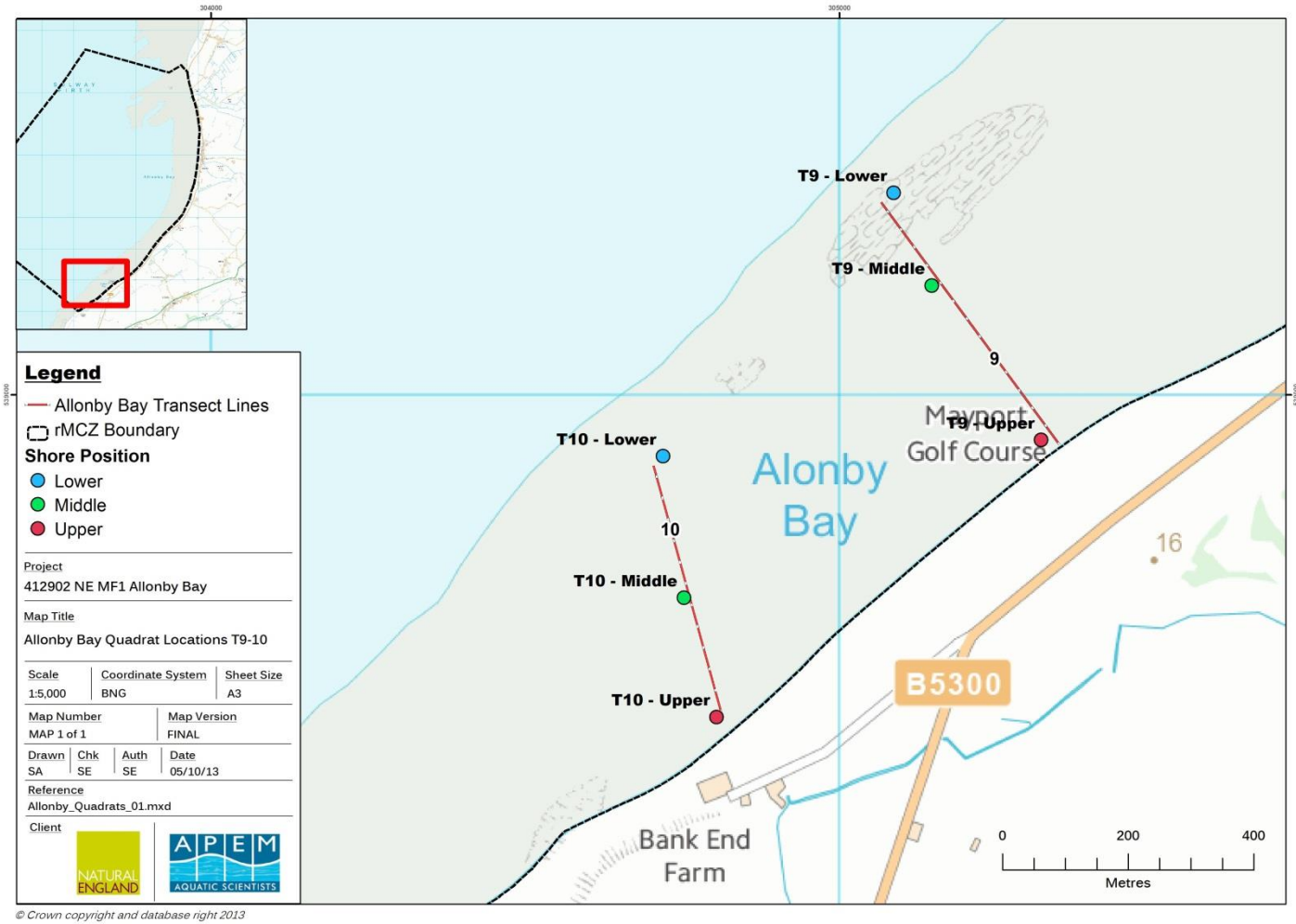

Figure 5. Upper, mid and lower shore station locations for Transects 9 and 10. A total of 3 replicates were taken at each station within representative biotopes. Approximate transect locations shown (red) (Transects did not include *Sabellaria alveolata* reef). Contains Ordnance Survey data.

3.3 Survey design

Phase I biotope surveys

Surveys were conducted following best practice guidance including the Countryside Council for Wales (CCW) Handbook for Marine Intertidal Phase I mapping surveys (Wyn, et al., 2000), Marine Monitoring Handbook (Davies, et al., 2001) and Common Standards Monitoring guidance (JNCC, 2004).

Wireframe maps were produced from aerial imagery obtained from the Channel Coastal Observatory (CCO, 2013) and were used to sketch *in-situ* the locations and shapes of each biotope in the rMCZ and provide a reference document to aid accurate mapping in GIS. A handheld dGPS device (accuracy better than 5m) was used to record waypoints of important features and tracks of each large scale biotope. The intertidal region was split into 7 sites (based on the wireframe maps produced to conduct mapping) for convenience of reporting.

Two teams of two conducted the survey. The teams jointly revised the recording methodology prior to the commencement of the surveys to ensure they both followed the same protocol and harmonisation of the task. Surveyors worked down the shore on the ebbing tide and back up the shore on the flowing tide. The surveyors aimed to survey the low shore area ±1 hour either side of the predicted low tide to maximise the time available to survey this region of the shore.

At each site, the faunal assemblage was noted by experienced field taxonomists in order to enable biotope allocation. Biotope allocation was conducted in the field where possible and confirmed on return to the office. A range of information was additionally recorded including:

- Substrate type (bedrock, cobbles, boulders, etc.)
- Presence of macroalgae (% coverage recorded if present)
- Anthropogenic pressures
- Target notes on features of interest

Biotopes were assigned according to JNCC's National Marine Habitat Classification for Britain and Ireland: Version 04.05 (Connor, et al., 2004). The classification used species information, relative abundances, exposure of the shore and substrate type. A proportion of assignments were verified by a second taxonomist to provide quality control and consistency in the assignments. The JNCC's correlation table (JNCC, 2010) was used to assign EUNIS codes to each biotope.

The honeycomb worm (*Sabellaria alveolata*) reef extent was surveyed by Natural England. Extent was depicted by at least 10% coverage of reef-like structures of at least 10cm in height and covering at least 10m^2. Full coverage was not possible due to time constraints of the project. There was an area of reef at Allonby that was not mapped for this reason and the low tide extent of the mapped reef cannot be guaranteed in all areas as the tide was ebbing or flowing when conducting the walkover in some of the sites.

Phase II quantitative quadrat survey

The Phase II survey was conducted concurrently to Phase I. The target transects for placement of quadrats were validated or modified in the field primarily according to presence of rocky shore biotopes and features of interest.

To gather robust quantitative data, representative sites were selected to characterise the biotopes present along the length and width of each transect. Sample sites were selected at three shore locations along the transect with a focus on collecting data from the upper shore, mid shore and lower shore where possible and in accordance with how far the hard substrate biotopes extended.

A total of nine quadrats were sampled on each transect with three replicates each at low, mid and upper shore. Percentage coverage of macroalgae, encrusting and colonial species within each 0.25m^2 quadrat was recorded along with actual abundances of solitary organisms.

It should be noted that whilst *Enteromorpha* spp. has recently changed genus and is now classed as *Ulva* spp., for the purposes of using the JNCC biotope classification and for reporting, this species will be referred to as *Enteromorpha* throughout the report and data with the exception of the quadrat data whereby it is referred to as *Enteromorpha/Ulva*. This will aid interpretation according to existing biotope descriptions and also ensure the most up to date nomenclature is used in the dataset.

3.4 Photographic Evidence

Photographs were taken of sites and representative biotopes where possible. These included records of key species present and views from each site towards the land and sea. In addition, individual specimen photographs were taken. Some features were georeferenced, others were not depending on the feature and intended use of the information e.g. a photograph of an individual anemone, *Actinia equina*, and photographs of macrophytes to be used as reference for identification were generally not georeferenced.

A full photograph log can be found in Appendix 4.

3.5 Timings of surveys

Ideally, the survey would have been carried out on midday spring tides to maximise the tidal extent possible to survey and during summer months (June-August) to avoid any winter algal dieback and maximise the daylight hours available. However, due to the timescales of the project, this was not possible thus the field work was conducted during spring tides in September. Spring tides optimise the length of time available for each survey and ensure the lower reaches of the shores can be surveyed. Work was possible during two low tides per day in the morning and early evening which limited the time available to reach the lower shore and also the daylight hours available. However, this schedule was considered the most practical and time efficient way to collect the maximum amount of information in the time allowed by the available tide windows during daylight hours. Surveys were conducted during spring low tides from Saturday 7th to Monday 9th September 2013 (Table 2).

Table 2. Survey times in relation to tide times, heights, and time of sunrise. All times are in BST.

Date	Day	Time of sunrise (BST)	Time of sunset (BST)	Time of low tide (BST)	Height of low tide (m)	Time of high tide (BST)	Height of high tide (m)	Start time (BST)	Finish time (BST)
07/09/13	Saturday	06.33	19.50	07.41/19.55	0.93/1.10	13.27	8.26	06.40 16.20	11.00 20.15
08/09/13	Sunday	06.35	19.47	08.16/20.31	0.92/1.11	14.02	8.26	06.35 16.40	11.30 20.10
09/09/13	Monday	06.37	19.45	08.53/21.10	1.05/1.25	14.40	8.13	07.30	10.40

3.6 Mapping and statistical analysis

On completion of the surveys, raw data were transferred to electronic spreadsheets. This included a GPS waypoints log, GPS tracks log, photograph log and general site descriptions. The GPS waypoints and tracks logs were subsequently used to create the biotope maps showing extent and distribution of rocky shore biotopes in Allonby Bay rMCZ and the resulting polygons and points were modified according to field notes and photographs where necessary.

All GIS outputs were generated in ArcGIS v9.2 and metadata were produced in accordance with MEDIN standards in the MESH data exchange format (DEF).

The quantitative data collected during the Phase II survey were analysed using univariate and multivariate statistics. A method statement describing the approach taken for statistical analysis of quantitative quadrat data can be found in Appendix 6.

4 RESULTS

4.1 Phase I survey biotopes

A total of 12 different rocky shore biotopes/biotope complexes were recorded in the intertidal region of the Allonby Bay rMCZ during the 2013 survey (Table 3). These consisted of 9 biotopes taken to EUNIS level 5, 2 taken to EUNIS level 6 and the remaining biotope classified as peat and clay exposures, a habitat of conservation interest (HOCI) of focus for this survey which does not have a specific EUNIS code.

The most frequently recorded biotopes across Allonby Bay were A2.111 (LS.LCS.Sh.BarSh), A2.711 (LS.LBR.Sab.Salv), A2.721 (LS.LBR.LMus.Myt) and A2.821 (LR.FLR.Eph.EphX), all occurring across the whole of the bay within the 7 sites surveyed. However, A2.721 covered the largest area (0.760 km^2), making up 36.9% of the coverage of rocky shore biotopes. The other 3 most frequently recorded biotopes also had relatively high coverage (0.362 – 0.408 km^2) with all other biotopes covering less than 0.080 km^2. Whilst peat and clay exposures, a habitat of conservation interest (HOCI) of focus for this survey, was recorded relatively frequently, it only covered an area of 0.004 km^2. There were 5 biotopes that were recorded at single sites with 3 of them located in Site 7, the southernmost site.

Table 3. Biotopes recorded in the Allonby Bay rMCZ rocky shore survey detailing EUNIS code, JNCC biotope code, JNCC biotope description and the sites the biotopes were recorded in (in order of highest area coverage). ***Greyed out biotope (kelp rockpools) indicates the biotope was recorded but was only likely to be present as the shore had not completely drained due to the time of survey.***

EUNIS Code	Biotope	Description	Area of biotope in Allonby Bay rMCZ and *sites present [potentially present]*
A2.721	LS.LBR.LMus.Myt	*Mytilus edulis* beds on littoral sediments	0.760 km^2 *1, 2, 3, 4, 5, 6, 7*
A2.821	LR.FLR.Eph.EphX	Ephemeral green and red seaweeds on variable salinity and/or disturbed eulittoral mixed substrata	0.409 km^2 *1, 2, 3, 4, 5, 6, 7*
A2.711	LS.LBR.Sab.Salv[†]	*Sabellaria alveolata* reefs on sand abraded eulittoral rock	0.396 km^{2+} *1, 2, 3, 4, 5, 6, 7*
A2.111	LS.LCS.Sh.BarSh	Barren littoral shingle	0.362 km^2 *1, 2, 3, 4, 5, 6, 7*
A1.1133	LR.HLR.MusB.Sem.LitX[#]	*Semibalanus balanoides* and *Littorina* spp. on exposed to moderately exposed eulittoral boulders and cobbles	0.077 km^2 *2, 3*
A1.451	LR.FLR.Eph.Ent	*Enteromorpha* spp. on freshwater influenced and/or unstable upper eulittoral rock	0.020 km^2 *7*

A1.213	LR.MLR.BF.FvesB	*Fucus vesiculosus* and barnacle mosaics on moderately exposed mid eulittoral rock	0.015 km^2 *7 [1, 2, 3, 4]*
A1.452	LR.FLR.Eph.EntPor	*Porphyra purpurea* and *Enteromorpha* spp. on sand-scoured mid or lower eulittoral rock	0.010 km^2 *3, 6, 7*
B3.1132	LR.FLR.Lic.Ver.Ver	*Verrucaria maura* on very exposed to very sheltered upper littoral fringe rock	0.007 km^2 *7*
No EUNIS code (HOCI)	Peat and clay exposures^	Peat and clay exposures	0.004 km^2 *2, 3, 4, 5*
A1.414	LR.FLR.Rkp.H*	Hydroids, ephemeral seaweeds and *Littorina littorea* in shallow eulittoral mixed substrata pools	0.001 km^2 5, [1, 2, 3, 4]
A1.322	LR.LLR.FVS.FspiVS	*Fucus spiralis* on sheltered variable salinity upper eulittoral rock	54.91 m^2 4
A1.412 (intermediate with A5.521)	LR.FLR.Rkp.FK* (intermediate with SS.SMp.KSwSS.LsacR)	Fucoids and kelp in deep eulittoral rockpools (intermediate with *Laminaria saccharina* and red seaweeds on infralittoral sediments)	[3]

* Specialised biotopes

† Nationally and more than nationally important communities

^ Habitat of Conservation Interest (HOCI) of focus for these surveys

Broad Scale Habitat (BSH) of focus for these surveys

+ Note that this extent figure is approximate and is an underestimation – the reef extended considerably into the subtidal region beyond the boundary mapped here

4.1.1 Site descriptions and biotope maps

In the Allonby Bay rMCZ the whole of the intertidal region was accessible by foot and 100% coverage of the area was achieved for the Phase I survey (Figure 6). By having two teams of two surveyors, the surveys were conducted quickly and covered a wide area, enabling all rocky shore areas to be mapped within the allocated survey days. Natural England conducted extent mapping of the HOCI honeycomb worm (*Sabellaria alveolata*) reef and this data has been incorporated into the final biotope maps.

For the purposes of data recording and reporting, the Allonby Bay intertidal region was split into 7 different areas according to the wireframe maps used (scale 1:5,000, maps show approximately 1km x 2km) numbered from 1 to 7 from north to south (Figure 6). Only rocky shore biotopes and other habitats of focus for these surveys

are included in the biotope maps presented in this report. All other areas not depicted on the maps as specific polygons are to be considered as littoral sediment biotopes.

It should be noted that in most cases, the biotopes did not fully match any of the JNCC's biotope descriptions and thus the best fit approach was taken, primarily based on the species composition identified. In cases where the distinction between biotopes was particularly unclear, these have been noted in the report.

It was considered that due to the timing of the surveys, some winter algal dieback was likely to have already begun and thus some areas of the shore would potentially have more *Enteromorpha* spp. coverage during June/July/August that would indicate different characteristic biotopes than those provided in this current report. This is potentially one of the reasons many of the biotopes did not fully match the JNCC's descriptions. However, another possibility is that the biotopes in Allonby Bay are variants of existing biotopes or biotopes that have not yet been described.

The majority of the foreshore at Allonby was characterised by littoral sediments with large patches of cobbles, blue mussel (*Mytilus edulis*) beds, honeycomb worm (*Sabellaria alveolata*) reef and other rocky shore biotopes. Overall though, Allonby Bay was a fairly barren shore during the time of the survey.

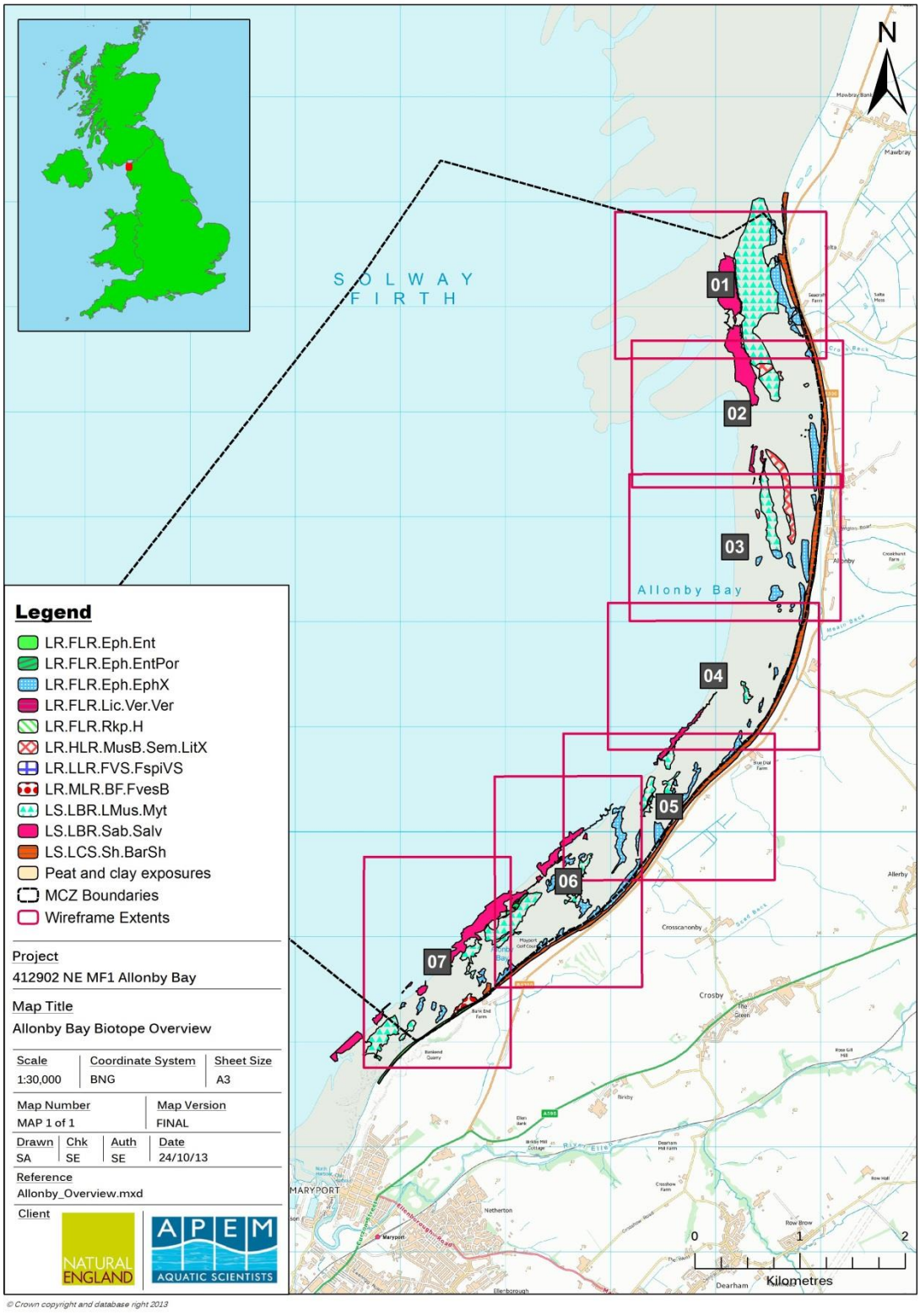

Figure 6. Overview of the rocky shore biotopes present in Allonby Bay with wireframe map extents shown (pink rectangles).

4.1.1.1 Site 1 (Map 01)

Site 1 was located in the north eastern section of the rMCZ close to Mawbray and encompassed Dubmill Scar down to the Cross Beck outfall/Oldkiln (Figure 7). This site contained an active *Crassostrea gigas* aquaculture facility and a disused farm that was previously used for the same activity. In addition, there was freshwater influence in the southern part of this site in the form of two outfalls carrying water from two different streams (Cross Beck and Black Dub) underneath the B5300 road onto the shore. The location of both aquaculture facilities and water runoff were recorded by the survey team (see Appendix 1)

A band of barren littoral shingle (LS.LCS.Sh.BarSh) was present along the entire upper shore section of this site. The lower part of the upper shore was primarily littoral sediments (sandy mud) with large patches of ephemeral seaweeds, primarily *Enteromorpha* spp. and *Porphyra* spp., on rock (LR.FLR.Eph.EphX). There was generally sparse cover of these seaweeds with moderate numbers of *Littorina* spp. and barnacles (*Semibalanus balanoides* and *Austrominius (Elminius) modestus*). This biotope was considered similar to LR.MLR.BF.FvesB due to the presence of some *Fucus vesiculosus* but was more similar to Eph.EphX.

The majority of the mid and lower shore was characterised by a large blue mussel (*Mytilus edulis*) bed (LS.LBR.LMus.Myt) (a HOCI of focus for this survey) which overlapped with and formed a mosaic with the lower part of the shore composed of honeycomb worm (*Sabellaria alveolata*) reef (a HOCI within the rMCZ). In addition, small pools containing gobies (*Pomatoschistus* spp.), *Littorina* spp., some hydroids and cobbles (potentially the specialised biotope LR.FLR.Rkp.H) were noted across the site at all shore heights in isolated patches. However, as the biotope was recorded at intermediate stages of the tide and were generally just dips in the sand, it is possible the shore had not yet drained fully and thus they would likely disappear at low tide. The biotope was therefore not mapped as it was considered only to be present at certain stages of the tide and was not a permanent feature. Overall, *Enteromorpha* spp., *Porphyra* spp., barnacles, blue mussels (*Mytilus edulis*) and the honeycomb worm (*Sabellaria alveolata*) were dominant species at this site.

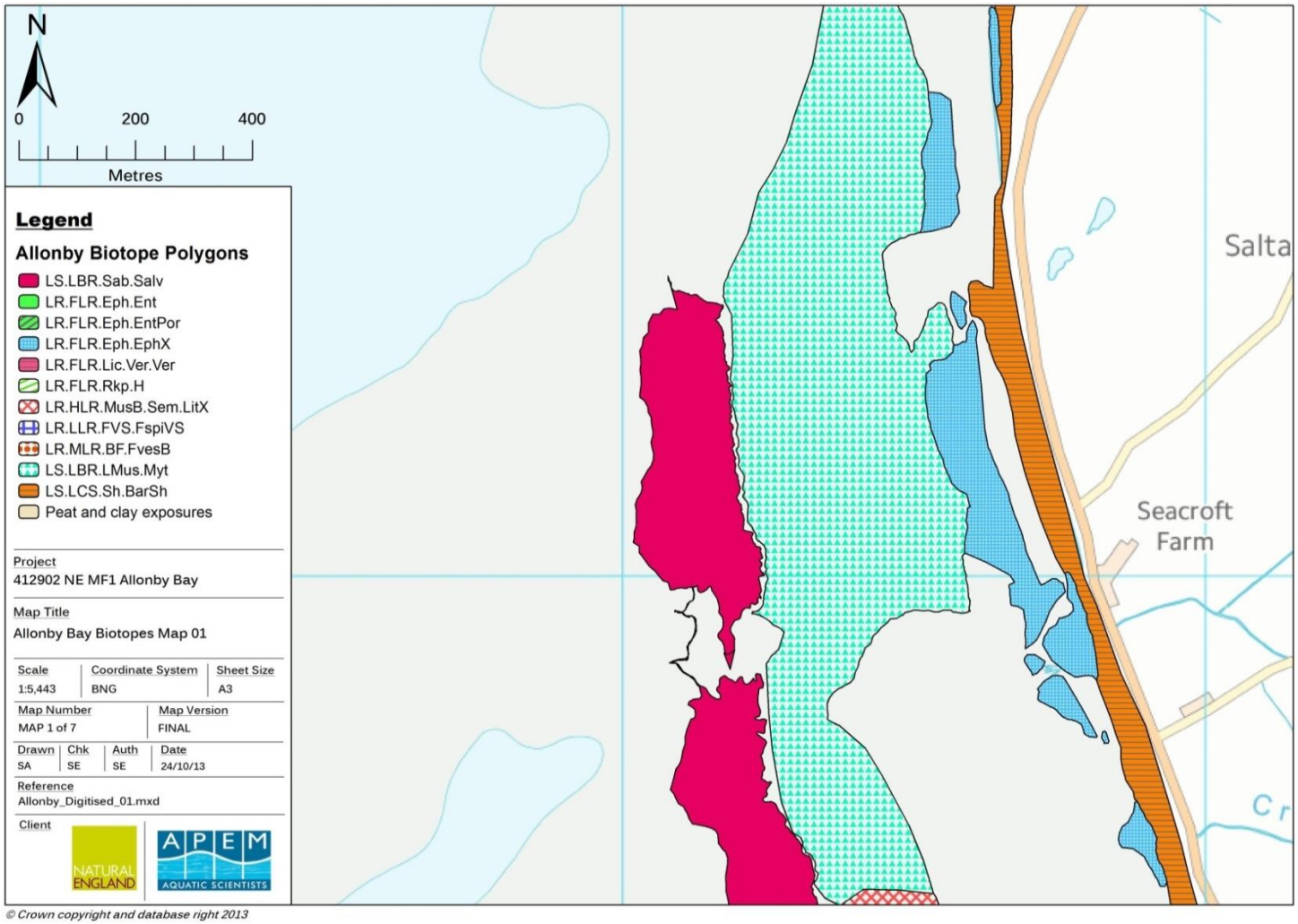

Figure 7. Biotope map of Site 1 from Phase I survey carried out on foot. Contains Ordnance Survey data. Note that the *Sabellaria alveolata* reef extends considerably into the subtidal region which is not shown here. The full seaward extent was not accessible at this stage of the tide.

4.1.1.2 Site 2 (Map 02)

Site 2 was located in the north eastern section of the rMCZ between the Cross Beck outfall and Moss Lane in Allonby (Figure 8). This site contained Allonby Beck, providing a freshwater influence, running along the top of the shore into the middle of the upper shore.

The upper shore section of this site contained a band of barren littoral shingle (LS.LCS.Sh.BarSh) with some patches of ephemeral seaweeds, primarily *Porphyra* spp. and *Enteromorpha* spp., on mixed substrata (LR.FLR.Eph.EphX) with moderate numbers of *Littorina* spp. and barnacles (this biotope was considered similar to LR.MLR.BF.FvesB due to the presence of some *Fucus vesiculosus*), and a small patch of peat and clay exposures (a HOCI of focus for this survey) with *Hediste* spp. and *Carcinus* spp. burrows and some *Enteromorpha* spp..

The mid shore was dominated by littoral sediments (primarily sandy mud separating the upper and mid shore rocky biotopes) with patches of blue mussels (*Mytilus edulis*) (LS.LBR.LMus.Myt) (a HOCI of focus for these surveys) making up approximately half of the lower shore, and barnacle and *Littorina* communities (LR.HLR.MusB.Sem.LitX), the only instance of a high energy intertidal rock biotope (a BSH of focus for these surveys). The rocky shore substrate in this region was primarily cobbles on boulders and mud with high coverage of barnacles, *Fucus vesiculosus*, *Porphyra* spp., *Enteromorpha* spp., whelks, *Littorina* spp., *Ascophyllum* spp.*, Lithothamnion* spp. and *Arenicola* spp. casts in the mud. Some kelp (*Laminaria* spp.) was also noted in pools at the lower edge of the mussel beds in this region. In the lower shore there was one large patch of honeycomb worm (*Sabellaria alveolata*) reef (a HOCI within the rMCZ), a continuation of the reef present in Site 1, and a couple of smaller patches of the same reef in the southern part of the site. In addition, small pools containing gobies (*Pomatoschistus* spp.), *Littorina* spp., some hydroids and ephemeral seaweeds (potentially the specialised biotope LR.FLR.Rkp.H) were noted across the site at all shore heights in isolated patches. However, as the biotope was recorded at intermediate stages of the tide and were generally just dips in the sand, it is possible the shore had not yet drained fully and thus they would likely disappear at low tide. The biotope was therefore not mapped as it was considered only to be present at certain stages of the tide and was not a permanent feature.

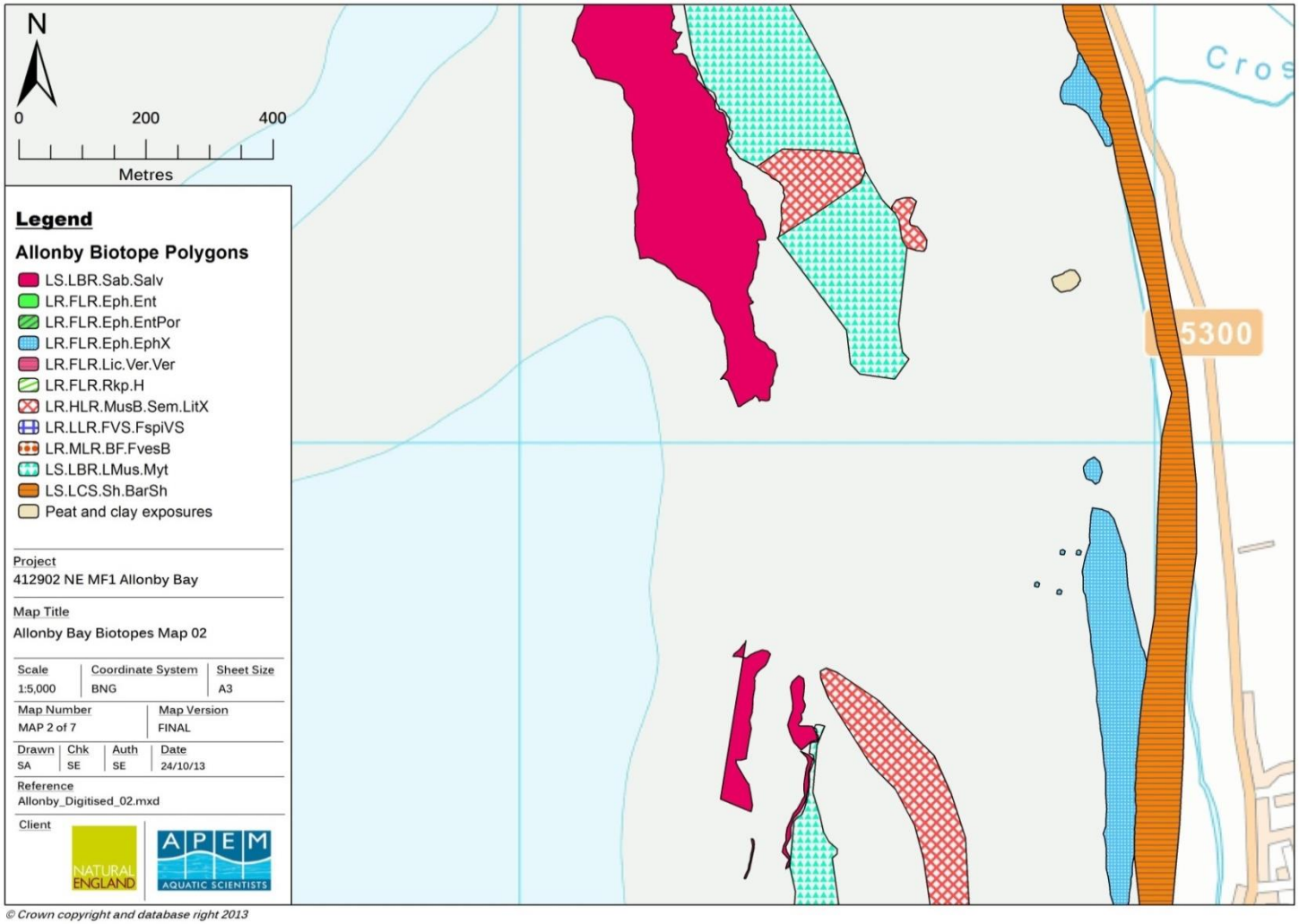

Figure 8. Biotope map of Site 2 from Phase I survey carried out on foot. Contains Ordnance Survey data. Note that the *Sabellaria alveolata* reef extends considerably into the subtidal region which is not shown here. The full seaward extent was not accessible at this stage of the tide.

4.1.1.3 Site 3 (Map 03)

Site 3 was located in the mid section of the rMCZ between Moss Lane in Allonby and where Mealo Beck meets the B5300, around the region of Allonby Bay's caravan parks (Figure 9). There was freshwater influence in the southern part of this site in the form of an outfall carrying water from Mealo Beck onto the shore at the high tide mark, in line with the northern part of the car park in this area.

The band of barren littoral shingle and cobbles (LS.LCS.Sh.BarSh) continued along the upper shore at Site 3 with a number of patches of ephemeral green and red seaweeds, primarily *Enteromorpha* spp. and *Porphyra* spp. (LR.FLR.Eph.EphX similar to LR.FLR.Eph.BLitX due to moderate numbers of *Littorina* spp. and barnacles) in the lower parts of the upper shore and also into the mid section where it was the primary biotope in the southern part of the site other than littoral sediments. There was a very small area of *Porphyra* spp. and *Enteromorpha* spp. within the shingle band, classified as LR.FLR.Eph.EntPor, around the water outlet from Mealo Beck. This biotope was an atypical form with *Semibalanus balanoides*, *Austrominius (Elminius) modestus* and *Patella vulgata*, and is normally a mid to lower shore biotope. This biotope was considered similar to LR.MLR.BF.FvesB due to the presence of some *Fucus vesiculosus* but was more similar to Eph.EntPor. The main species in this region of the shore were *Littorina* spp., *Enteromorpha* spp., *Fucus* spp., *Palmaria* spp., chitons, *Porphyra* spp. and dogwhelks. Polychaete casts, mostly *Arenicola* spp. and potentially *Notomastus* spp., and barnacles were also present.

Cobbles were prevalent in the mid shore of this site with patches of blue mussel (*Mytilus edulis*) beds (a HOCI of focus for these surveys) with high numbers of young, recently recruited, mussels, and *Semibalanus balanoides* and *Littorina* spp. communities on exposed substrata (LR.HLR.MusB.Sem.LitX), a continuation of the biotopes from Site 2, present in the northern part of the site. It should be noted that some parts of this biotope could be considered as intermediate with LR.FLR.Eph.BLitX due to the coverage of *Porphyra* spp.. The main species present in this area were whelks, *Enteromorpha* spp., *Fucus vesiculosus*, barnacles and *Macoma balthica*. *Arenicola* spp. casts and *Carcinus maenas* were also recorded. There was also a small patch of the HOCI peat and clay exposures in the southern part of the site with *Hediste* spp. and *Carcinus* spp. burrows.

The lower shore was dominated by honeycomb worm (*Sabellaria alveolata*) reef (LS.LBR.Sab.Salv) (a HOCI within the rMCZ). However, this biotope is not shown on the map as it was not possible to map the extent in this area within the timeframe available. Other species recorded in the lower shore included *Enteromorpha* spp., *Porphyra* spp., whelks, barnacles and blue mussels (*Mytilus edulis*) as well as kelp (*Laminaria* spp.) in pools along the bottom of the mussel bed in the site. These were potentially the biotope LR.FLR.Rkp.FK in isolated patches. Other pools containing hydroids, ephemeral seaweeds and *Littorina littorea* were also present across the site (potentially LR.FLR.Rkp.H). However, as the two rockpool biotopes were recorded at intermediate stages of the tide and were generally just dips in the sand, it is possible the shore had not yet drained fully and thus they would likely disappear at low tide. These biotopes were therefore not mapped as they were considered only to be present at certain stages of the tide and not permanent features of the shore.

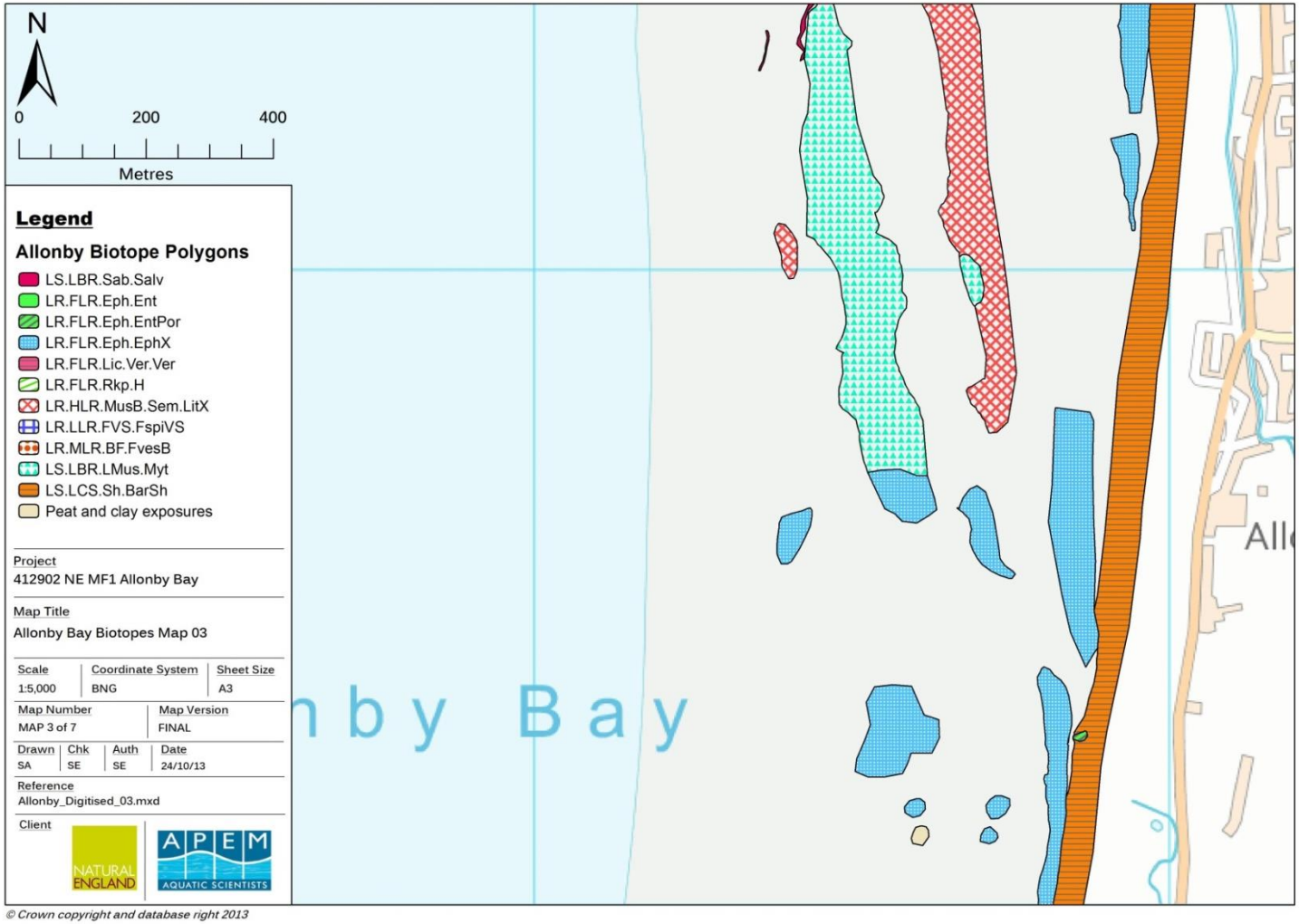

Figure 9. Biotope map of Site 3 from Phase I survey carried out on foot. Contains Ordnance Survey data. It was not possible to map the *Sabellaria alveolata* reef in the timeframe thus the extent of this biotope is not shown.

4.1.1.4 Site 4 (Map 04)

Site 4 was located in the central part of the rMCZ between the area where Mealo Beck meets the B5300 south-westwards to the point just north of Blue Dial Farm (Figure 10).

The upper shore section of this site contained a band of barren littoral mixed substrata including shingle (LS.LCS.Sh.BarSh), a continuation of the biotope from Site 3; an extremely small patch of *Fucus spiralis* (LR.LLR.FVS.FspiVS); and some small patches of ephemeral red and green seaweeds, primarily *Enteromorpha* spp. with some *Porphyra* spp., (LR.FLR.Eph.EphX) in the lower part of the upper shore and also mid shore. This biotope was considered similar to LR.MLR.BF.FvesB due to the presence of some *Fucus vesiculosus* but was more similar to Eph.EphX.

The peat and clay exposures patch (a HOCI of focus for these surveys) in the mid shore in the northern part of this site was the same patch that was highlighted in Site 3 and signifies the point of cross-over between the two site maps. There was a single small blue mussel (*Mytilus edulis*) bed (a HOCI of focus for these surveys) on mixed substrata in the mid shore of this site and the remainder of the mid-shore was littoral sediments.

Honeycomb worm (*Sabellaria alveolata*) reef (a HOCI within the rMCZ) was present along the whole of the extreme lower shore, although the extent was not fully mapped within the timeframe available.

In addition, small pools containing gobies (*Pomatoschistus* spp.), *Littorina* spp., some hydroids and ephemeral seaweeds (potentially the specialised biotope LR.FLR.Rkp.H) were noted across the site at all shore heights in isolated patches. However, as the biotope was recorded at intermediate stages of the tide and was generally just dips in the sand, it is possible the shore had not yet drained fully and thus they would likely disappear at low tide. The biotope was therefore not mapped as it was considered only to be present at certain stages of the tide and was not a permanent feature.

This site contained the smallest area coverage of rocky shore biotopes of all other areas of the Allonby Bay rMCZ..

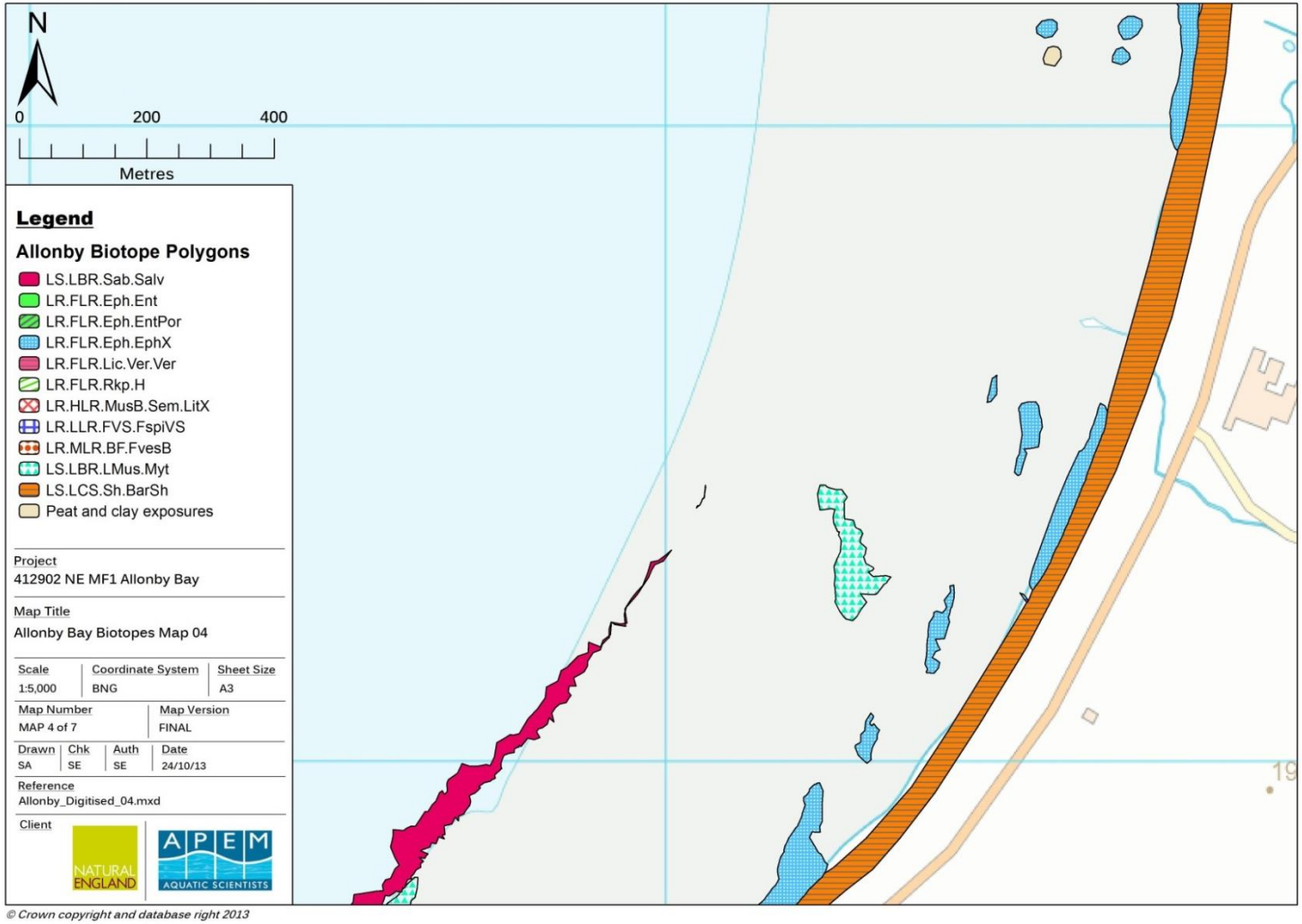

Figure 10. Biotope map of Site 4 from Phase I survey carried out on foot. Contains Ordnance Survey data. Note that the *Sabellaria alveolata* reef extends considerably into the subtidal region which is not shown here. The full seaward extent was not accessible at this stage of the tide.

4.1.1.5 Site 5 (Map 05)

Site 5 was located in the mid section of the rMCZ between Blue Dial Farm and just south of the road from Crosscanonby that meets the B5300 (Figure 10). There was a freshwater outfall at this site although the source of the freshwater was unclear.

The upper shore of Site 5 contained a band of barren littoral shingle (LS.LCS.Sh.BarSh), a continuation of this section across all sites. The majority of this area was littoral sediments but there were also patches of ephemeral green and red seaweeds (LR.FLR.Eph.EphX) immediately below the band of shingle and, in one location, there were peat and clay exposures (a HOCI of focus for these surveys) and a large rockpool (LR.FLR.Rkp.H) next to each other between the shingle and ephemeral seaweeds. The ephemeral green and red seaweeds were also interspersed in the mid to lower shore of the site with one patch starting from the lower part of the upper shore and leading down to the mean low water mark.

There were several blue mussel (*Mytilus edulis*) beds (a HOCI of focus for these surveys) in this site in the mid and lower shore regions with one bed containing a strip of peat and clay exposures (a HOCI of focus for these surveys). At the extreme lower shore, there was a continuation of the honeycomb worm (*Sabellaria alveolata*) reef (a HOCI within the rMCZ) from Site 4 although this only continued for approximately 400 m into Site 5. The remainder of the area contained very patchy reef of <10% coverage thus the reef was not mapped fully although the waypoint notes do explain where there was some reef present.

4.1.1.6 Site 6 (Map 06)

Site 6 was located in the southern section of the rMCZ between just south of the road from Crosscanonby that meets the B5300 and the southern boundary of Mayport Golf Course (Figure 12). There is an outfall from the Golf Course carrying water from Scad Beck.

The upper part of the shore contained a continuation of the barren littoral shingle (LS.LCS.Sh.BarSh) present in all sites. Immediately below this, there was a band of ephemeral green and red seaweeds (LR.FLR.Eph.EphX). The mid shore of the site was primarily littoral sediments with patches of ephemeral seaweeds and also blue mussel (*Mytilus edulis*) beds (a HOCI of focus for these surveys). Between the largest mussel bed at this site and the honeycomb worm (*Sabellaria alveolata*) reef (a HOCI within the rMCZ) that was present across the lower shore of this site, there was a large area of *Porphyra* and *Enteromorpha* on rock (LR.FLR.Eph.EntPor).

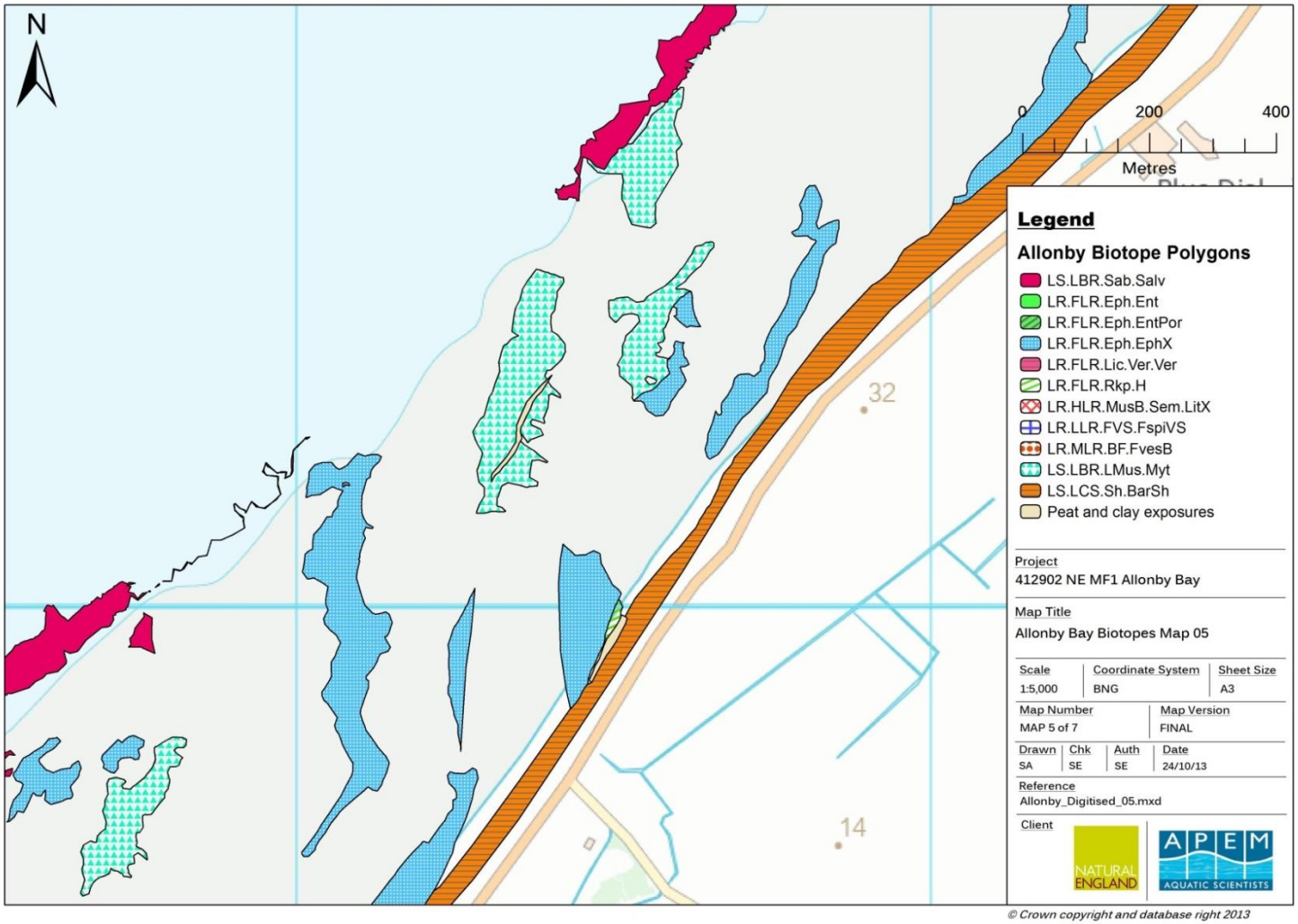

Figure 11. Biotope map of Site 5 from Phase I survey carried out on foot. Contains Ordnance Survey data. Note that the *Sabellaria alveolata* reef extends considerably into the subtidal region which is not shown here. The full seaward extent was not accessible at this stage of the tide.

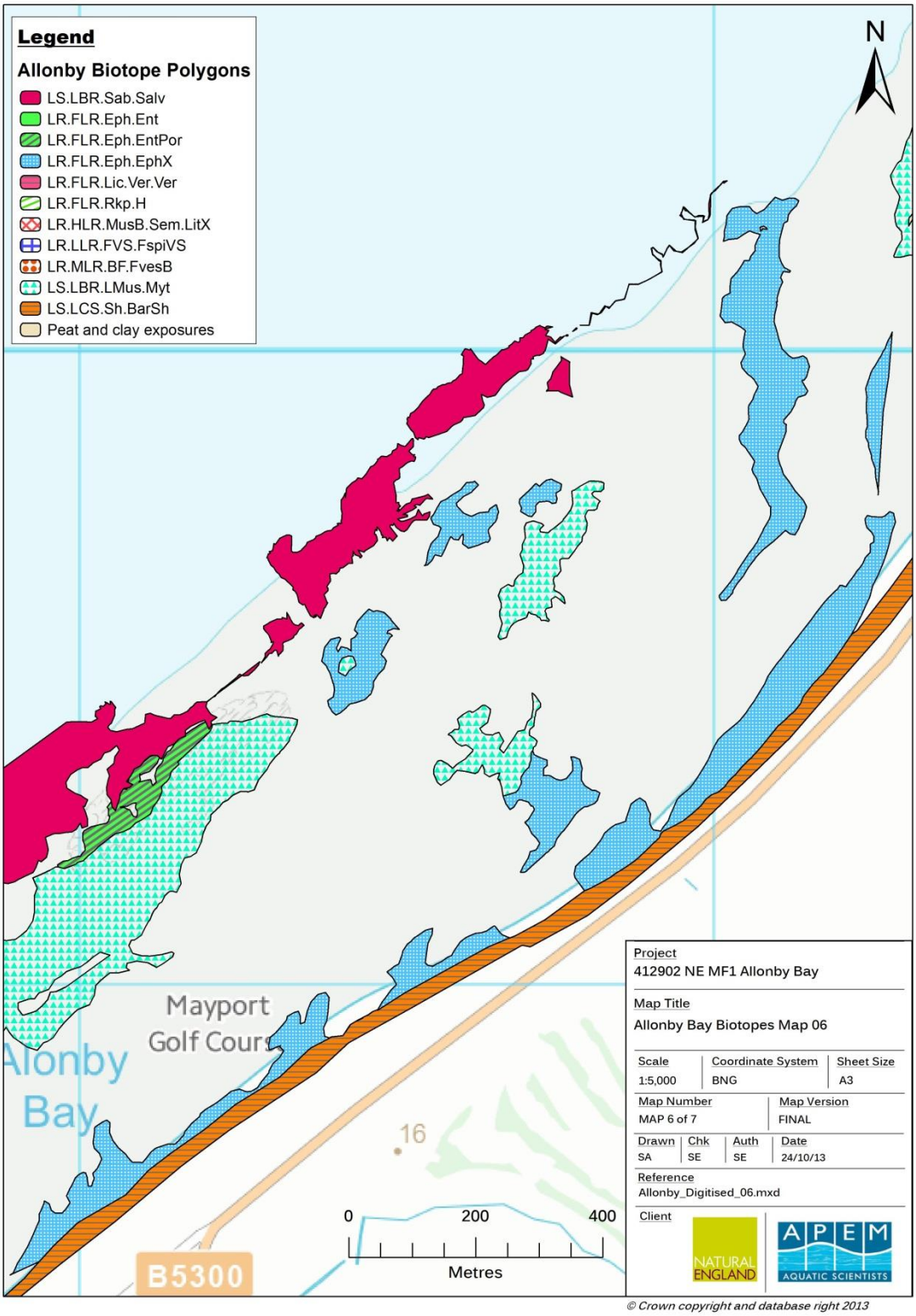

Figure 12. Biotope map of Site 6 from Phase I survey carried out on foot. Contains Ordnance Survey data. Note that the *Sabellaria alveolata* reef extends considerably into the subtidal region which is not shown here. The full seaward extent was not accessible at this stage of the tide.

4.1.1.1 Site 7 (Map 07)

Site 7 was located in the southern part of the rMCZ between Mayport Golf Course and the southern edge of Bankend Quarry to incorporate the rMCZ boundary out to mean low water (Figure 13).

The upper shore section of this site contained a band of barren littoral shingle (LS.LCS.Sh.BarSh) for approximately 300 m as a continuation of the band from Site 6. This band then turned into a strip of *Verrucaria maura* (LR.FLR.Lic.Ver.Ver) in the extreme upper shore and a strip of *Enteromorpha* (LR.FLR.Eph.Ent) immediately below this. At the point where the shingle band changed to rock with *Verrucaria maura* and *Enteromorpha*, there was a patch of shingle that extended approximately 75 m downshore. South west of this patch joining onto the band of *Enteromorpha* there was an area of *Fucus vesiculosus* (LR.MLR.BF.FvesB) approximately 300 m wide and extending 50 m downshore. The mid shore of this site was littoral sediments interspersed with patches of ephemeral green and red seaweeds (LR.FLR.Eph.EphX) and blue mussel (*Mytilus edulis*) beds (a HOCI of focus for these surveys). The lower shore was dominated by honeycomb worm (*Sabellaria alveolata*) reef extending into the subtidal.

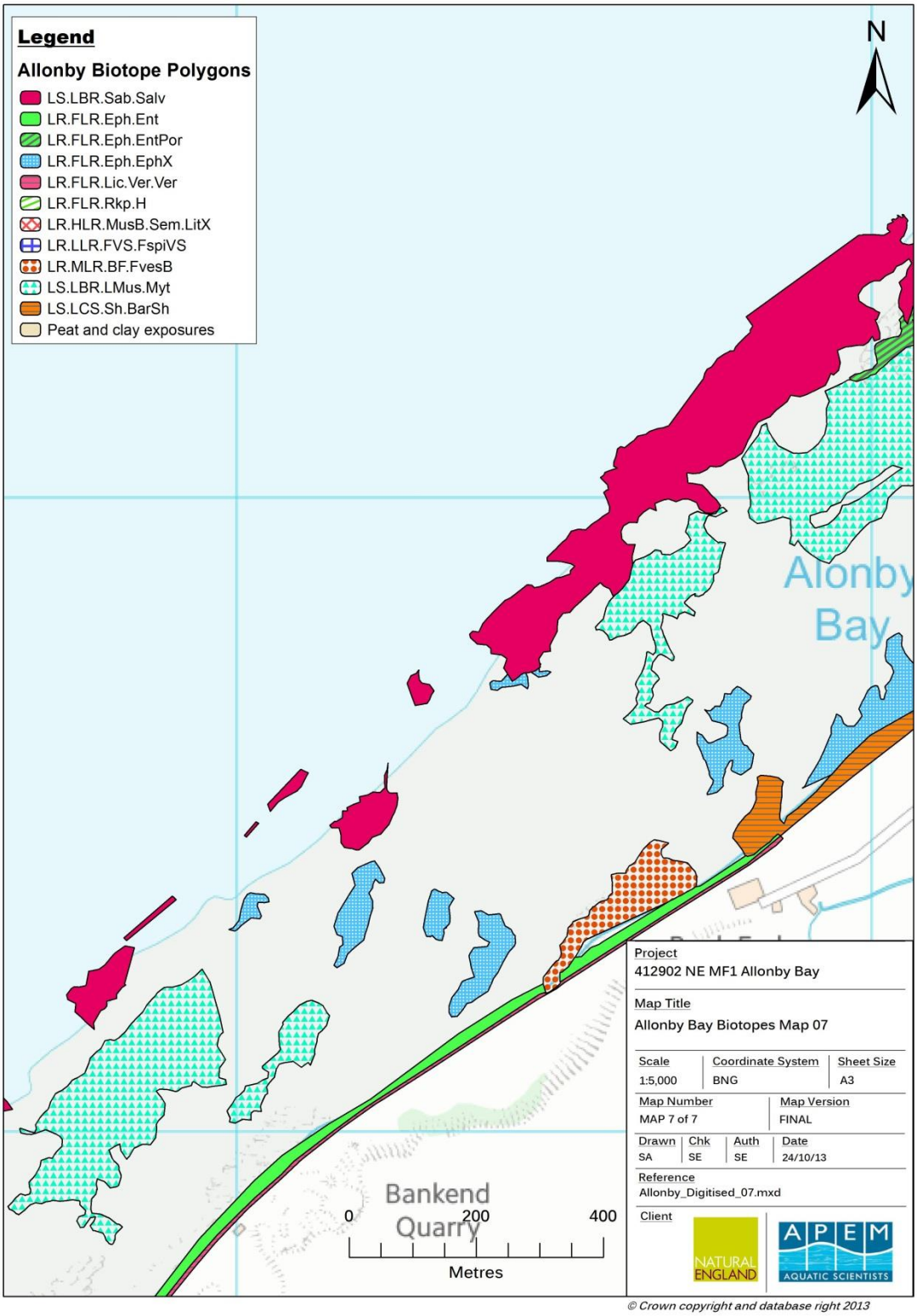

Figure 13. Biotope map of Site 7 from Phase I survey carried out on foot. Contains Ordnance Survey data. Note that the *Sabellaria alveolata* reef extends considerably into the subtidal region which is not shown here. The full seaward extent was not accessible at this stage of the tide.

4.2 Phase II survey quadrats

The Phase II survey was conducted immediately following the Phase I survey but in the case of Transects 9 and 10, Phase II was conducted concurrently with the Phase I survey as this was the most efficient approach in this instance.

A total of 90 quadrats were assessed as part of the Phase II surveys with a total of 17 encrusting organisms and macrophytes and 8 free-living taxa recorded (total 25 taxa recorded in the quadrats) (Appendix 5) . Some of these were not possible to take to species level in the field, primarily due to their juvenile status, e.g. Cirripedia and Balanidae, or the complexity of the genus, e.g. *Porphyra* spp. and *Ceramium* spp.. There was one occasion where a single *Austrominius modestus* (Australasian barnacle) was observed in a quadrat – as this was the only record where an actual abundance was recorded, this was classified as <1% coverage for data analysis purposes as it is an encrusting species.

Species recorded included biogenic reef-forming species *Mytilus edulis* (blue mussel) and *Sabellaria alveolata* (honeycomb worm), macroalgae, barnacles, periwinkles and other species typical of rocky shores. Algal species, particularly *Enteromorpha* spp. and *Porphyra* spp., were recorded at many of the sites (58 and 55 quadrats respectively), due to the hard substrate providing good anchorage for the organisms.

The sedimentary shore species, *Macoma balthica* and *Lanice conchilega*, were also present, likely due to the rocky shore biotopes overlapping with littoral sediments (the dominant substrate in Allonby Bay), although both are infaunal and not normally observed at the surface.

The data were split into percentage coverage data and simple counts for the purposes of description but were combined as presence/absence data for the purposes of performing community ordination analysis in PRIMER v6 (see method statement in Appendix 6).

The blue mussel, *Mytilus edulis*, was by far the most common encrusting/colonial/canopy-forming organism recorded in the quadrats across the Allonby Bay rMCZ contributing to 40% of the observed percentage coverage of encrusting species (Figure 14). The second highest contributor was *Enteromorpha* spp. (17%). Barnacles, *Semibalanus balanoides*, and *Porphyra* spp. also contributed nearly as much as *Enteromorpha* spp. (16% and 14% respectively). These 4 species were also the most frequently occurring encrusting/colonial/canopy-forming species in the quadrats present in between 48 and 58 quadrats each although the graph indicates a relatively even distribution of species overall. The lower shore had the highest species richness (14 taxa) with an average % coverage of these organisms of 28%. Conversely, the mid shore had the highest average % coverage (30.5%) but lower species richness (12 taxa). The upper shore had the lowest average % coverage (16.6%) and also the lowest species richness (9 taxa). This is to be expected as the upper shore is more susceptible to dessication due to the lower reaches of the shore being covered with seawater for longer.

A total of 8 free-living species were recorded, 2 of which only had 1 individual recorded (*Macoma balthica* and *Patella vulgata*). The most common, and also the most abundant species, was *Littorina littorea* recorded in 32 of the quadrats with an overall abundance of 155 individuals (Figure 15). The highest abundances for this species were recorded at Transects 1 and 4 (Dubmill Scar and mid-Allonby Bay) in mussel bed biotopes. The second most common and abundant species was *Nucella lapillus* with a total of 41 individuals present in 21 quadrats found only in the mid and lower shore regions. Very few free-living species were observed in the upper shore (3 taxa, 10 individuals) compared to the mid shore where species richness was highest (7 taxa, 93 individuals) and the lower shore where

abundances were highest (4 taxa, 122 individuals) (ANOVA, F=16.65, P<0.001). Again, these results support the fact that the upper shore is more prone to desiccation than the mid and lower reaches of the shore thus will have less species overall.

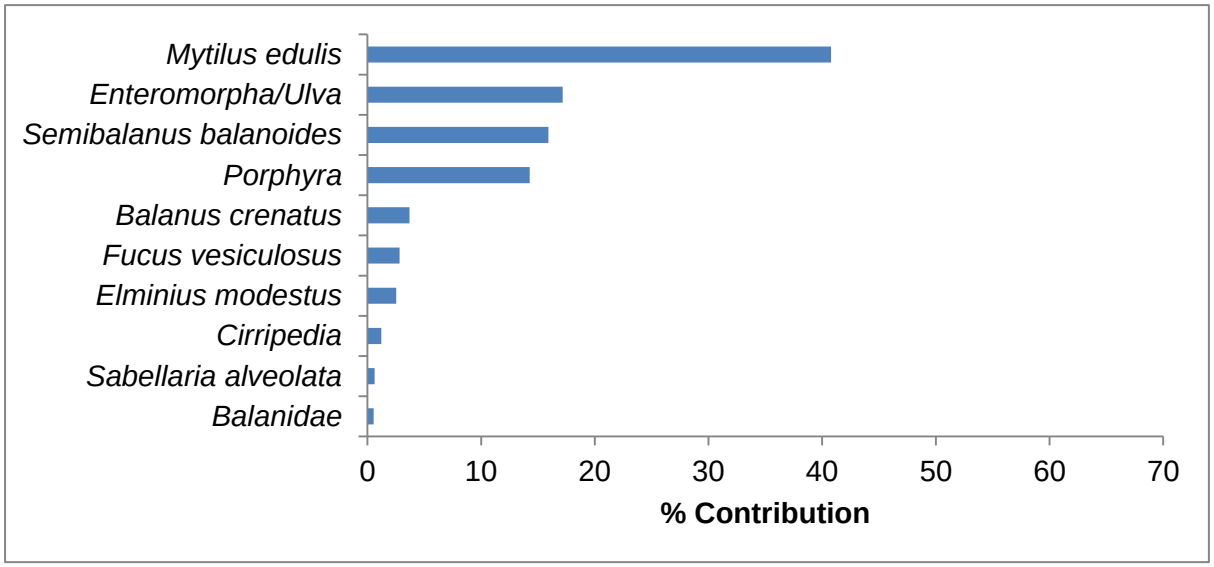

Figure 14. Ranked percentage contribution of the ten most prominent encrusting/colonial/canopy-forming species recorded in the Allonby Bay rMCZ rocky shore Phase II survey (based on percentage coverage data).

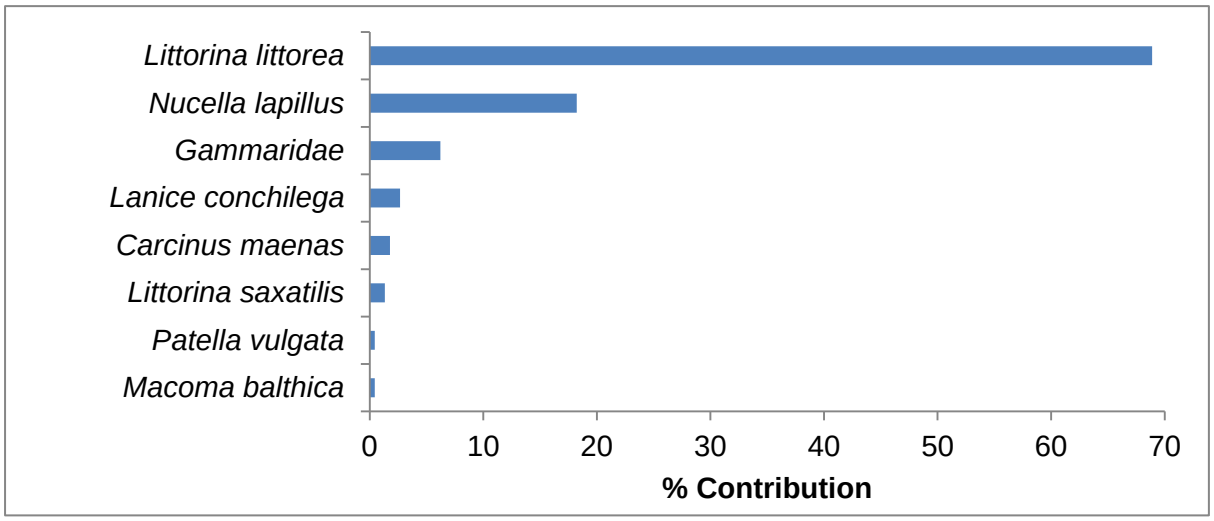

Figure 15. Ranked percentage contribution of each free-living species recorded in the Allonby Bay rMCZ rocky shore Phase II survey (based on actual abundance data).

Table 4. Mean number of taxa identified in each station (% coverage and actual abundance data combined) with standard deviation and coefficient of variation (CV) indicated.

Transect	Shore height	Mean no. of taxa	Standard deviation	CV (%)	Biotope
1	Low	5	1.00	20.00	LS.LBR.LMus.Myt
2	Low	4	0.00	0.00	LS.LBR.LMus.Myt
3	Low	4	1.73	43.30	LS.LBR.LMus.Myt
4	Low	4	0.58	15.75	LS.LBR.LMus.Myt
5	Low	4	1.00	25.00	LR.FLR.Eph.EphX
6	Low	6	1.53	26.96	LS.LBR.LMus.Myt
7	Low	5	1.00	20.00	LR.FLR.Eph.EphX
8	Low	5	0.58	12.37	LR.FLR.Eph.EphX
9	Low	4	1.00	25.00	LR.FLR.Eph.EntPor
10	Low	5	0.58	10.83	LS.LBR.LMus.Myt
1	Mid	4	0.00	0.00	LS.LBR.LMus.Myt
2	Mid	4	0.58	15.75	LS.LBR.LMus.Myt
3	Mid	4	0.58	15.75	LS.LBR.LMus.Myt
4	Mid	6	1.00	16.67	LR.HLR.MusB.Sem.LitX
5	Mid	5	0.58	10.83	LR.FLR.Eph.EphX
6	Mid	5	0.58	10.83	LS.LBR.LMus.Myt
7	Mid	5	1.00	20.00	LR.FLR.Eph.EphX
8	Mid	5	0.58	12.37	LS.LBR.LMus.Myt
9	Mid	3	1.53	45.83	LS.LBR.LMus.Myt
10	Mid	4	0.58	13.32	LR.FLR.Eph.EphX
1	Upper	3	0.58	17.32	LR.FLR.Eph.EphX
2	Upper	2	0.58	24.74	LR.FLR.Eph.EphX
3	Upper	2	1.00	50.00	LR.FLR.Eph.EphX
4	Upper	4	0.58	13.32	LR.HLR.MusB.Sem.LitX
5	Upper	5	1.15	24.74	LR.FLR.Eph.EphX
6	Upper	3	1.00	33.33	LR.FLR.Eph.EphX
7	Upper	3	0.58	17.32	LR.FLR.Eph.EphX
8	Upper	3	1.53	57.28	LR.FLR.Eph.EphX
9	Upper	3	0.58	21.65	LR.FLR.Eph.EphX
10	Upper	3	1.00	33.33	LS.LCS.Sh.BarSh

Table 5. The overall coefficient of variation (CV) based on species richness for each the 5 biotopes assessed as part of the Phase II surveys and the CV for each biotope by shore height.

Biotope	Overall CV (%)	Lower CV (%)	Mid CV (%)	Upper CV (%)
LR.FLR.Eph.EntPor	25.00	25.00	-	-
LR.FLR.Eph.EphX	29.72	11.18	10.41	27.22
LR.HLR.MusB.Sem.LitX	22.81	-	16.67	13.32
LS.LBR.LMus.Myt	18.28	17.95	18.25	-
LS.LCS.Sh.BarSh	33.33	-	-	33.33

The maximum number of taxa observed in a quadrat was 7 in Transect 4 quadrat 5 (Allonby Bay_4.5 in the mid shore) and in Transect 6 quadrat 9 (Allonby Bay_6.9 in the lower shore). The lowest number of taxa observed in a quadrat was 1 in Transect 3 quadrat 1 (Allonby Bay_3.1 in the upper shore) and in Transect 8 quadrat 2 (Allonby Bay_8.2 in the upper shore). A large coefficient of variation (CV) (CV=100*(Standard Deviation/Mean)) indicates a more variable group that is less stable or less uniform, thus the results show that LS.LCS.Sh.BarSh had the highest variability in species richness (Table 5) and, overall, LS.LBR.LMus.Myt had the lowest level of variability. However, the lower and mid shore examples of LR.FLR.Eph.EphX appeared to be the most stable groups when breaking down the results by shore height.

There was a significant difference in the number of taxa seen between Transects (ANOVA, F=2.13, P=0.036) specifically between the northernmost transects (primarily 2 and 3) and the mid-Allonby Bay transects (4, 5 and 6) and between the mid-Allonby Bay transects (4, 5 and 6) and one of the southernmost transects (9), the mid transects having higher species richness than the others.

As the quadrat data obtained was recorded as percentage coverage for encrusting/colonial and canopy-forming organisms and as actual abundances for free-living species, as per standard guidance, statistical analysis is not normally performed. Abundances and/or % coverage are generally compared between years to assess for change within specific biotopes (Davies, et al., 2001). However, as some statistical analysis was required to give an assessment of the general species composition of the area, the data were transformed to presence/absence to make actual abundances and % coverage comparable. A Jaccard distance matrix was used for the ordination analysis as this was deemed most suitable in the case of presence/absence data.

Hierarchical clustering with SIMPROF analysis identified 5 distinctive faunal groups (Figure 16), 4 of which contained mostly samples taken within the LMus.Myt biotope. Multi-dimensional scaling (MDS) showed that there was a general pattern of upper shore quadrats being grouped separately to mid shore quadrats with lower shore quadrats overlapping both upper and mid shore quadrats (Figure 17). When biotopes were overlaid on the MDS ordination (Figure 17), there was a good pattern of grouping of the biotopes which indicates the biotopes were assigned consistently and corresponded well to the species data.

There was a significant difference in faunal composition both between Transects (ANOSIM test[1], R = 0.2, significance level = 0.1%) and also between shore height (ANOSIM test, R = 0.207, significance level = 0.1%). However, whilst there was a significant difference in faunal composition between Transects and also shore height, there was some degree of overlap observed as visually inferred in the MDS ordination (Figure 17).

[1] The R statistic gives an indication of the structure of the results. R = 0 indicates a lack of structure and completely random grouping. See Appendix 6 for further guidance on the interpretation of the ANOSIM test.

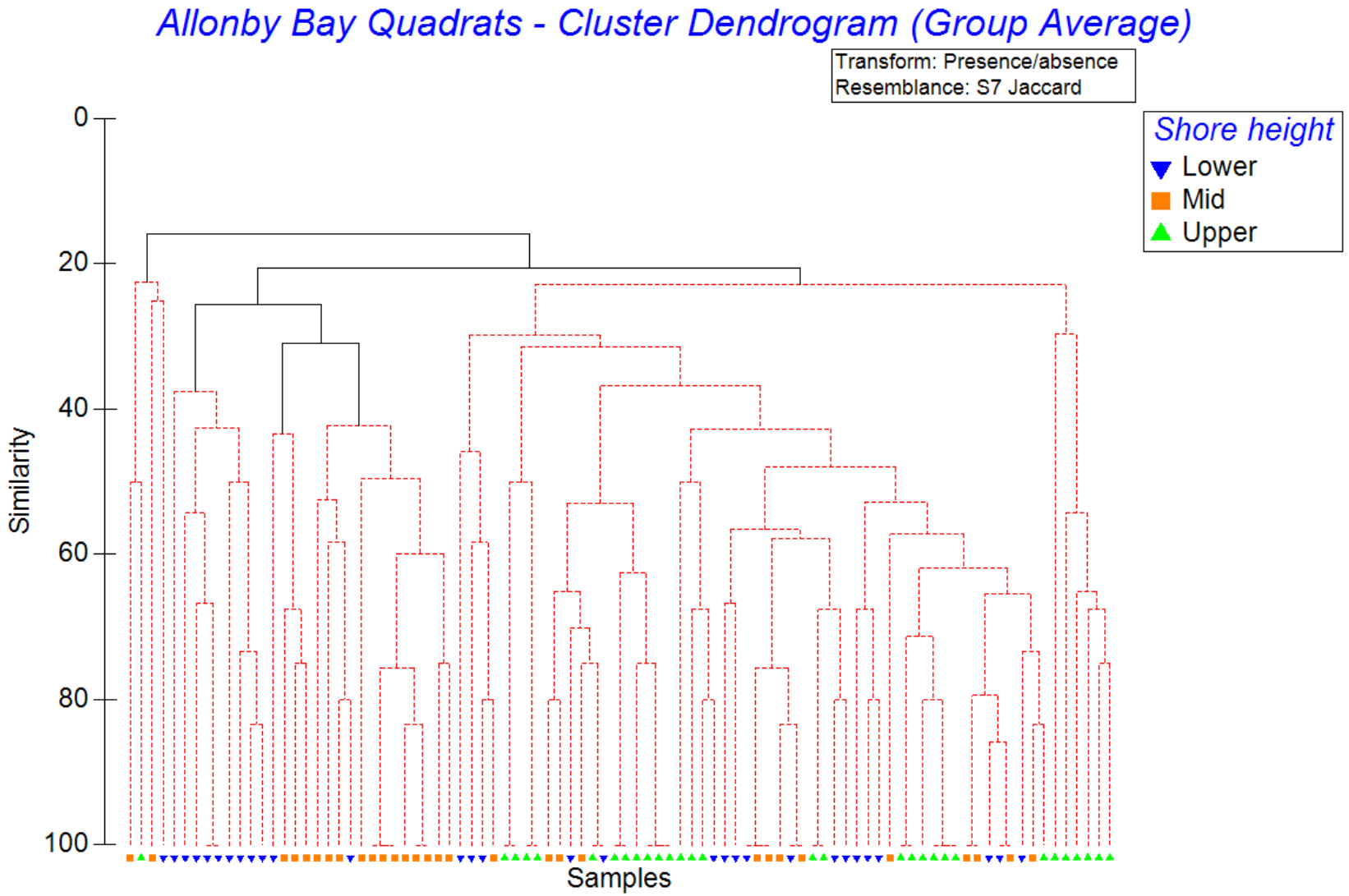

Figure 16. A group average sorting dendrogram based on presence/absence transformed macrofaunal abundance and percentage coverage data combined (Jaccard similarity was used). A total of 5 groups were identified using the SIMPROF test.

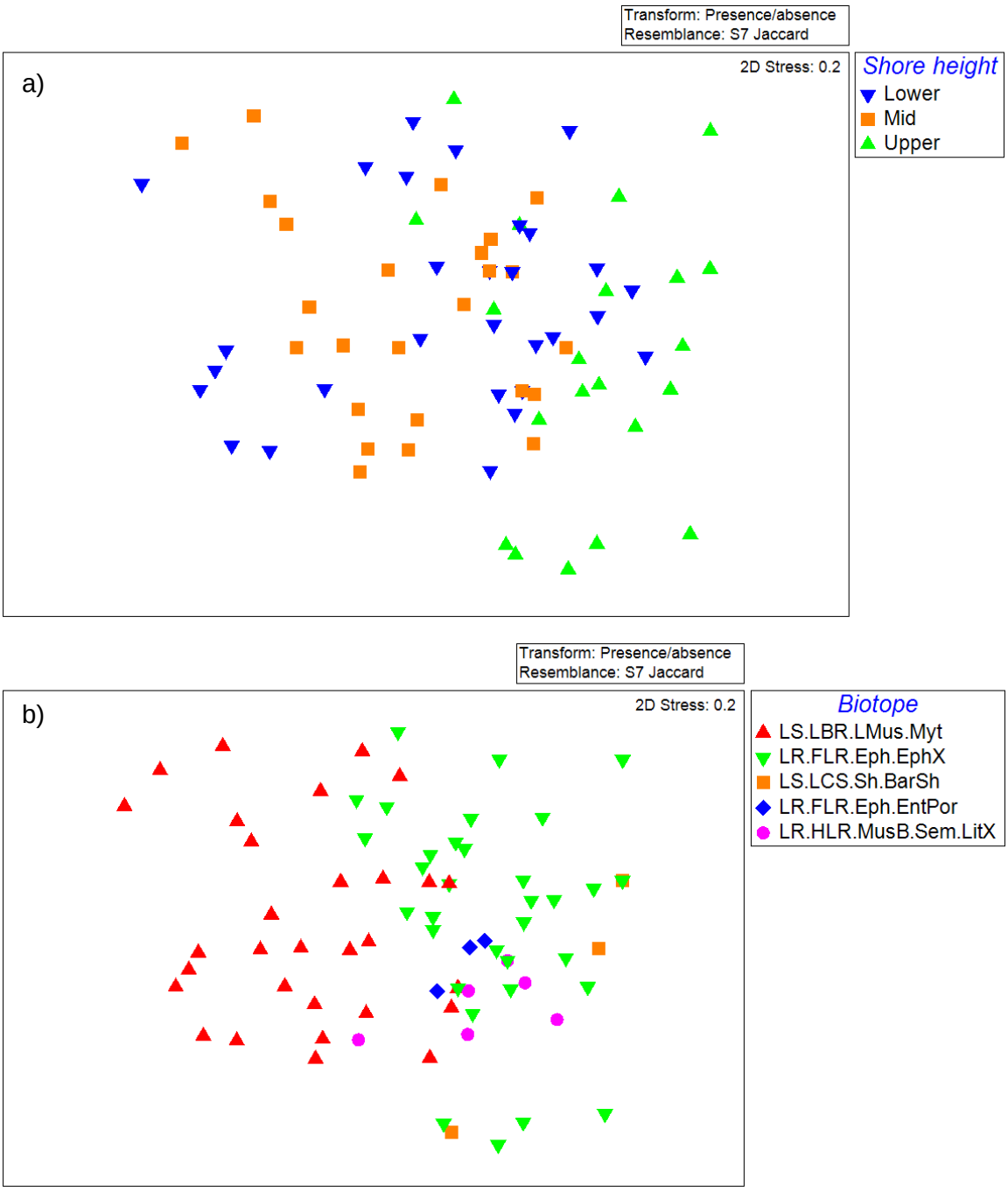

Figure 17. Allonby Bay rMCZ rocky shore MDS configuration plots of species presence/absence data using Jaccard similarity. Sample symbols are provided according to shore elevation (a) and assigned biotopes (b). Symbol labels are given in the figure.

4.3 Habitats and Species of Conservation Interest (HOCI and SOCI)

Data from these surveys were compared against the species and habitats of conservation interest (HOCI and SOCI) indicated in Appendices 1-5 in Wyn, *et al.* (2000). Within the Allonby Bay rMCZ, 2 specialised biotopes, 1 nationally or more than nationally important community, 2 (potentially 3) non-native intertidal species and several Biodiversity Action Plan (BAP) habitats as stated in Wyn, *et al.* (2000) and from current JNCC information (JNCC, 2013) were recorded. No nationally rare or scarce species were knowingly encountered although the brief nature of the survey limited the amount of time available to search for inconspicuous specimens and also limited the level of identification of some species as this was not necessary for much of the biotope allocation within the Phase I survey.

Where these species and habitats constituted main biotopes, these were mapped as part of the Phase I biotope mapping (see Section 4.1.1). Where the extent of biotopes was not sufficient to be mapped, some inference was made to their general location. The Phase I survey notes should be consulted for more information on their approximate locations (Appendix 1 and 2).

4.3.1 Specialised biotopes

A1.414 Hydroids, ephemeral seaweeds and Littorina littorea in shallow eulittoral mixed substrata pools (LR.FLR.Rkp.H)

This biotope was observed as a permanent feature in the upper shore at Site 5 and was potentially also present in Sites 1-4, however, it is highly likely the cobble dominated pools observed at Sites 1-4 were only temporarily present. The amount of rainfall prior to and during the survey was very heavy and therefore overall freshwater influence across the bay was more likely to be the cause of their presence as they did not appear to contain any fauna and were thus thought to be large temporal 'puddles' rather than actual rockpools. This biotope contained a large number of *Pomastoschistus* spp. (small gobid fishes) in some instances although this was more evident in the regions around low shore.

A1.412 Fucoids and kelp in deep eulittoral rockpools (LR.FLR.Rkp.FK)

This rockpool biotope was potentially present in Site 3. However, it should be noted that the shore had not fully drained for low tide at the time of data recording in this area thus it may not be a permanent feature of Allonby Bay. The pools recorded were relatively shallow dips in the sand with cobbles. Fucoids and small amounts of kelp were generally present together in the lower shore below the blue mussel beds. This biotope was also similar to A5.521 (SS.SMp.KSwSS.LsacR).

4.3.2 Nationally and more than nationally important communities

A2.71 Sabellaria alveolata reefs on sand-abraded eulittoral rock (LS.LBR.Sab.Salv)

One of the main features of conservation interest encountered in the Allonby Bay rMCZ was *Sabellaria alveolata* reef. Aggregations of this nationally and internationally important Annex I habitat were common in the lower shore and extending into the subtidal across all sites (Section 4.1). These areas were subject to public use of the beaches but seem to be thriving despite this. Whilst condition data was not collected due to the time constraints of the survey, notes taken included

whether crisp apertures were present or not which could potentially be used as an indicator of the general health of the reef.

4.3.3 Non-native intertidal species

Austrominius (Elminius) modestus

The barnacle *Austrominius* (*Elminius) modestus* was recorded in at least one quadrat from all transects apart from Transects 9 and 10. This demonstrates the wide distribution of this non-native species across Allonby Bay.

Crassostrea gigas

The non-native Pacific oyster (*Crassostrea gigas*) is part of an established aquaculture fishery in the northern part of Allonby Bay and thus has been introduced into the area deliberately. However, this species appeared to be restricted to the designated fishery area and does not seem to have spread throughout the bay.

Plate 1. (L-R) Non-native barnacle *Austrominius modestus* recorded in the lower shore of Transect 7; Non-native Pacific oyster, *Crassostrea gigas*, aquaculture facility in the Dubmill Scar area of Allonby Bay.

4.3.4 Intertidal Biodiversity Action Plan (BAP) habitats and species in the UK

Priority habitat – Littoral rock – Sabellaria alveolata reefs

See Section 4.3.2.

Priority habitat – Littoral rock – Peat and clay exposures with piddocks

Peat and clay exposures, a Habitat of Conservation Interest (HOCI) of focus for this survey, were recorded in 3 areas (Sites 2 and 5 plus the area where Sites 3 and 4 overlapped). A number of burrows were observed in the peat and clay exposures although these were confirmed to be *Hediste* spp. and *Carcinus maenas* burrows as opposed to the typical piddock burrows found in these types of habitats (no piddock shells were recorded) and a high coverage of *Enteromorpha* spp. was also observed. *Porphyra* spp. and barnacles were also observed on several surfaces within these patches.

Priority habitat – Littoral rock – Blue mussel beds

Blue mussel (*Mytilus edulis*) beds on littoral sediments, such as those found in Allonby Bay, are now classed as a priority BAP habitat due to their role in coastal

sediment dynamics, being an important food source for overwintering birds and providing areas of enhanced biodiversity (BRIG, 2008). The mussel beds were found across the mid-lower shore in all sites surveyed.

Priority habitat – Littoral rock – Estuarine rocky habitats

The priority habitat estuarine rocky habitats includes a number of variable salinity biotopes, some of which were found in Allonby Bay. There are a number of outfalls providing freshwater influence in the bay which have an effect on the communities present by providing variable salinity conditions. Whilst Allonby Bay is not an estuarine environment and thus does not conform to this specific priority habitat, it is important to note the estuarine biotopes covered under the priority habitat description that were observed in Allonby Bay: LR.LLR.FVS.FspiVS, LR.FLR.Lic.Ver.Ver LR.FLR.Eph.EntPor and LR.FLR.Eph.Ent.

Plate 2. (Top, L-R) The HOCI and BAP habitat peat and clay exposures within Site 2 in the upper shore; The HOCI, nationally and more than nationally important communities habitat and BAP habitat honeycomb worm (*Sabellaria alveolata*) reef (LS.LBR.Sab.Salv, EUNIS A2.711) in the lower shore of Site 6. (Bottom, L-R): The HOCI and BAP habitat blue mussel (*Mytilus edulis*) beds (LS.LBR.LMus.Myt, EUNIS A2.721) along Transect 3 in Site 1; Example of LR.LLR.FVS.FspiVS in Site 3.

4.4 Anthropogenic pressures

Various anthropogenic pressures were noted during the survey.

The main anthropogenic pressures observed were the Pacific oyster *Crassostrea gigas* aquaculture facility at Dubmill Scar and the water outlets at various points around the bay. The water outlets primarily carried water from natural freshwater courses under roads and on to the shore but created a different habitat type in these areas. It is also possible that these water courses contain leachates from nearby farmland and run-off from populated areas thus potentially are a route of nutrient enrichment or pollution into the shore. Some monofilament net was observed in the bay with some fish species tangled within them including a ray and a dogfish. The Dubmill Scar area also has groynes installed to retain littoral sediments which is important for maintaining the existing habitats in that region and for public use as the bay is a popular tourist area and dog walkers are frequent users of the bay.

Plate 3. (Top, L-R): The groynes at Dubmill Scar in Site 1; The Cross Beck water outlet at Site 1. (Bottom, L-R): Monofilament net with Site 2; The old water outlet pipe in Site 4.

Table 6. Anthropogenic pressures observed in the Allonby Bay rMCZ. General grid references are noted as some impacts were observed from a distance.

Site	Easting	Northing	Category	Anthropogenic disturbance observed	Notes
1	307390	545185	Collection	Bait digging	General site co-ordinates given
1	307390	545185	Boulder turning	Boulder turning for peelers	General site co-ordinates given
1	307294 307363	545132 545176	Aquaculture	Oyster fishery - start point Oyster fishery - end point	
1	307402 307438	545217 545273	Aquaculture	Oyster fishery - historic start point Oyster fishery - historic end point	
1	307765 307630	544945 545715	Coastal defence	Groynes - southern point Groynes - northern point	
1	307804	544899	Other	Water outlet (Black Dub)	
1	307915	544554	Other	Water outlet (Cross Beck - crossover with Site 2)	
2	307997	544010	Collection	Bait digging	General site co-ordinates given
2	307997	544010	Boulder turning	Boulder turning for peelers	General site co-ordinates given
2	307915	544554	Other	Water outlet (Cross Beck - crossover with Site 1)	
2	307987	543583	Other	Water outlet (Allonby Beck)	
2	307399	543803	Fishing gear	Monofilament net	
2	307394	543794	Fishing gear	Monofilament net	
3	307957	542342	Collection	Bait digging	General site co-ordinates given
3	307957	542342	Boulder turning	Boulder turning for peelers	General site co-ordinates given
3	307858	542270	Other	Water outlet (Mealo Beck)	
4	307567	541324	Collection	Bait digging	General site co-ordinates given
4	307567	541324	Boulder turning	Boulder turning for peelers	General site co-ordinates given
4	307777	541571	Other	Water outlet (from farmland)	
4	307565	541253	Other	Old water outlet pipe (from farmland)	
5	306436	539839	Other	Water outlet (Brunsow Beck)	
5	306434	539795	Other	Water outlet (from farmland)	
5	304991	538620	Other	Water outlet (Scad Beck)	

5 SUMMARY AND CONCLUSIONS

1. APEM conducted the intertidal verification Phase I and Phase II surveys of the rocky shore biotopes within the Allonby Bay recommended Marine Conservation Zone (rMCZ) from 7th to 9th September 2013. Natural England accompanied APEM on Saturday 7th September 2013 to carry out extent mapping of the honeycomb worm *(Sabellaria alveolata*) reef. The objective of the surveys was to identify and map the extent, distribution and quality of littoral rock biotopes with special emphasis on features of conservation importance as proposed for the rMCZ. Additional information on anthropogenic pressures with potential effects on the site's features were recorded.
2. The Phase I survey effort was directed across the whole of the intertidal region of Allonby Bay within the rMCZ. The primary objective of the Phase I survey was to assess as much of the area as possible rather than focus on detailed assessments of each biotope creating a trade-off between the two. However, MNCR habitat forms were filled in for the main representative biotopes and those of particular focus for the surveys which provides some level of detail of the faunal assemblages present. In addition, the Phase II survey provided quantitative data for the main biotopes identified which can be used in future monitoring to detect temporal trends and changes. This resulted in both good coverage of the area and quantitative data for the main biotopes encounted in order to monitor the condition of the area in future.
3. All of the rocky shore biotopes contained within the intertidal region of the Allonby Bay rMCZ were mapped in detail. Littoral sediments were not of focus for the surveys thus were not mapped, however, all areas where rocky shore biotopes were not recorded can be assumed to be general littoral sediments (LS, EUNIS code A2). The main biotopes present were littoral biogenic reefs (LS.LBR), features of littoral rock (LR.FLR) and barren shingle (LS.LCS.Sh.BarSh) with low energy, moderate energy and high energy biotopes represented by only one biotope each.
4. A total of 12 biotopes were recorded within Allonby Bay during the Phase I survey, with an additional 13th biotope potentially present (kelp rockpools, LR.FLR.Rkp.FK). The most frequently recorded biotopes were A2.111 (LS.LCS.Sh.BarSh), A2.711 (LS.LBR.Sab.Salv), A2.721 (LS.LBR.LMus.Myt) and A2.821 (LR.FLR.Eph.EphX), all occurring within every site. There were 3 biotopes (FVS.FspiVS, Eph.Ent and Lic.Ver.Ver) that were recorded only at single sites, 1 biotope (Rkp.H) recorded at a single site but with other potential occurrences in other sites (although not likely to be a permanent feature as timings meant the shore had not fully drained) and 1 biotope (BF.FvesB) recorded at a single site but potentially interchangeable with Eph.EphX or Eph.EntPor due to the faunal composition of these three biotopes.
5. Half of the recorded biotopes are typical to the area and have been recorded previously and form part of the core records of the JNCC's marine habitat classification. A further 3 biotopes (Lic.Ver.Ver, FVS.FspiVS and BF.FvesB) have been found on nearby shores further west as part of the JNCC's marine habitat classification core records. A further 3 biotopes (Sh.BarSh, Rkp.H and peat and clay exposures i.e.piddock habitats) have not been recorded in or near the region as part of the core or tentative records of the JNCC's marine habitat classification.

6. The Phase II survey effort was directed to representative areas of rocky shore biotopes geographically spread throughout the bay. As part of the Phase II surveys, 90 quadrats were assessed (10 transects with 3 stations – low, mid, upper – each with 3 replicates). These contained 17 encrusting species and macrophytes. Blue mussels (*Mytilus edulis*) had, by far, the largest coverage of encrusting organisms recorded in the quadrats across the Allonby Bay rMCZ (40% of the total coverage of encrusting species) and the most common macrophyte species recorded was *Enteromorpha* spp., found in 58 quadrats (17% contribution). *Semibalanus balanoides* and *Porphyra* spp. were also common, found in over 50 quadrats each, and also contributing highly to the coverage of encrusting organisms (16 and 14% contribution, respectively).

7. A total of 8 'mobile' or 'free-living' species were recorded in the 90 quadrats, 2 of which only had 1 individual recorded, *Patella vulgata* and *Macoma balthica*. The most common and abundant species was *Littorina littorea*, recorded in 32 of the quadrats with an overall abundance of 155 individuals. Their highest abundances were in Transects 1 and 4 in mussel bed biotopes.

8. Within the Allonby Bay rMCZ, several habitats and species of conservation interest (HOCI and SOCI) were recorded. These comprised 2 specialised biotopes, 1 nationally or more than nationally important community, 2 (potentially 3) non-native intertidal species and several Biodiversity Action Plan (BAP) habitats as stated in Wyn, *et al.* (2000) and from current JNCC information (JNCC, 2013) were recorded. No nationally rare or scarce species were encountered although the nature of the Phase I survey limited the level of identification of some species as this was not necessary for much of the biotope allocation.

9. The main anthropogenic pressures observed were the Pacific oyster *Crassostrea gigas* fishery in the northernmost Site 1 at Dubmill Scar and the water outlets at various points around the bay. The Dubmill Scar area also has groynes installed to retain littoral sediments, and dog walkers were observed around the bay.

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7 APPENDICES

Appendix 1. Allonby Bay master GPS waypoints log.

Appendix 2. Allonby Bay master tracks log.

Appendix 3. Allonby Bay quadrat locations (lifted from Appendix 1)

Appendix 4. Allonby Bay master photo log

Appendix 5. Allonby Bay quadrat data (species and physical data)

Appendix 6. Method statement – statistical analyses

Further information

Natural England evidence can be downloaded from our **Access to Evidence Catalogue**. For more information about Natural England and our work see **Gov.UK**. For any queries contact the Natural England Enquiry Service on 0300 060 3900 or e-mail **enquiries@naturalengland.org.uk** .

Report number RP01603
ISBN 978-1-78354-351-9