North West Wildlife Trusts

Monitoring honeycomb worm reef (*Sabellaria alveolata*) in the Cumbria Coast Marine Conservation Zone

Georgina Blow
Trainee Marine and Coastal Conservation Officer

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1. Introduction

1.1 Background

The purpose of this survey was to record the distribution and reef type formation of the honeycomb worm *Sabellaria alveolata* (*S. alveolata*) within the Cumbria Coast Marine Conservation Zone (MCZ). This document outlines the methodology and results of the survey undertaken, describes the presence and extent of *S. alveolata* within the MCZ and compares this to previous data from the area.

1.2 *Sabellaria alveolata*

S. alveolata is a small polychaete worm that constructs tubes on low- to mid-shore hard substrata (rock, boulders or scar ground) and is commonly found in sandy areas interspersed with rocks and pebbles (Holt et al. 1998). *S.alveolata* are suspension feeders and construct their tubes from particles in the water column. For this reason *S. alveolata* favours exposed and semi-exposed shores where high water current velocities provide a high suspended sediment load and large quantities of suspended food (Holt et al. 1998). Beginning life with a planktonic larva stage, *S. alveolata* requires a hard substratum for pioneering settlement. After this initial settlement larvae are strongly stimulated to settle by the presence of existing colonies or the remains of dead ones. Once settled *S. alveolata* will begin the construction of tubes from particles of sand and shell. Tubes are built independently of each other, however are attached together at one end, forming a tightly packed honeycomb-like structure. High densities of worm can form biogenic structures, ranging from tens of cm^2 to tens of m^2 in area (Bush, 2016).

The reefs created by *S.alveolata* are considered to be of particular ecological significance and are recognised as being important components of intertidal communities (Holt et al. 1998). Through stabilising substrate and trapping sediment, increasing available spaces for new species to colonize and creating new microhabitats such as crevice, the reefs provide a unique habitat in an otherwise largely homogenous environment. The reef structures may also accumulate faeces, pseudo-faeces and other organic deposits, potentially providing an important food source for other organisms (Holt et al. 1998). Because of this, the biodiversity associated with *S. alveolata* reefs is often found to be much higher than that in the surrounding areas (Dubois et al. 2002; Cole and Chapman, 2007).

Essentially a warmer water species, *S. alveolata* has a lusitanean (southern) distribution, found from Morocco to southwest Scotland (Gruet 1986). It's presence in Britain has mainly been recorded on the west coast stretching from Devon in the south to the Solway Firth in the north. Small isolated recordings have also been reported in the south and north of eastern England (Gubbay, 1998) (Figure 1). Along the eastern Irish Sea coast *S. alveolata* can be found at a wide variety of selected sites, notably with numerous and extensive reefs reported on the Cumbrian coastline, particularly between Morecambe Bay and the Solway Firth (Allen et al. 2002).

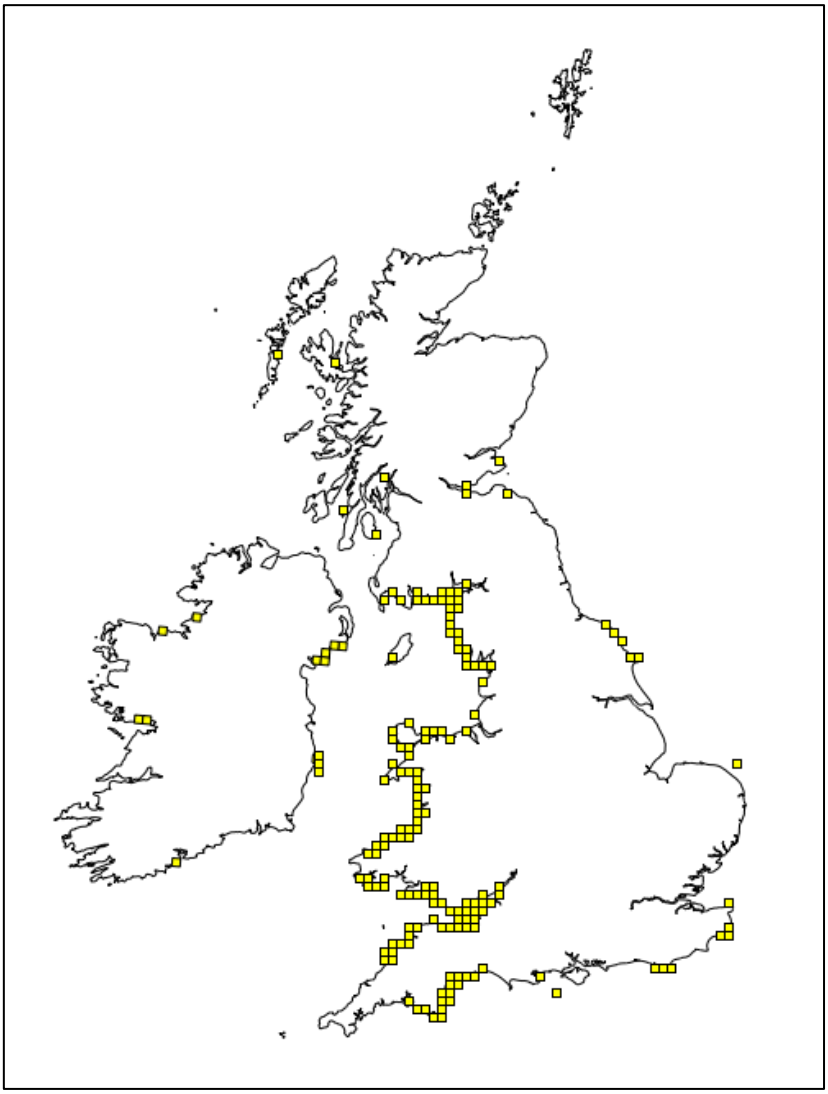

Figure 1 Distribution of *Sabellaria alveolata* in UK Waters
Source: NBN Gateway, JNCC 2017

S. alveolata reefs are highly vulnerable structures and are subject to varying pressures from environmental and anthropogenic sources. Reefs are affected by storm damage and extreme cold weather events which can cause the destruction of the reef structures (Crisp

1964). Other factors reportedly affecting *S. alveolata* include competition for space with the common mussel *Mytilus edulis,* accumulations, losses of reef structure, or the long term burial by sand and the problem of natural variable recruitment (Cunningham et al. 1984). Anthropogenic pressures faced are mainly from trampling by beach users and from those engaged in activities such as angling and bait digging. Other recognised anthropogenic pressures include pollution and aquaculture (UK Marine SACs Project, 2001). *S. alveolata's* restricted distribution in the UK along with its vulnerability to disturbance has led to it being included as a priority habitat within the UK Biodiversity Action Plan and as a biogenic reef forming species it is covered by Annex 1 of the EC habitats directive. *S. alveolata* reefs have therefore been noted as a feature for protection in Marine Protected Areas (MPAs) in the UK.

Historically, there have been a number of studies looking at *S. alveolata* in the UK, with the majority of these focusing on the west coast where *S. alveolata* is prevalent (Cunningham et al. 1984, Allen et al. 2002, Frost et al. 2004, Firth et al. 2015). In 2002, Allen et al. completed a comprehensive distribution and condition assessment of *S.alveolata* in North-West of England, including mapping areas of extensive *S. alveolata* reef in the area now designated Cumbria Coast MCZ. In 2013 a verification survey of intertidal habitat within the recommended Cumbria Coast MCZ was conducted (MESL & APEM, 2013), reporting extensive *S. alveolata* reef across the area. Following the designation of the site at the end of 2013, a similar survey was conducted in the area in 2015, focussing on the mid-shore *S. alveolata* reef at Drigg (Antill et al. 2016).

1.3 The Cumbria Coast MCZ

The Cumbria Coast MCZ (Figure 2) is an inshore site covering a total area of 18km^2. The site extends 27km along the coast of Cumbria, around the cliffs at St Bees Head at the North down along the coast to the Esk River in the Ravenglass estuary at its South. Throughout the zone there is important intertidal rocky shore habitat, consisting of extensive intertidal boulder and cobble reefs, or 'scars', contrasting with the predominantly sedimentary coast of the North-West (DEFRA, 2013) . Notably, at the coast near Drigg is Barn scar, a large area of boulders and cobbles and at St Bees Head there are cliffs where extensive outcrops of bedrock are exposed. The boulder and cobble reefs within the MCZ support good examples of the nationally important *S. alveolata* reef and where they are below the low tide mark, some of the best examples of under-boulder communities on the coast of North-west England can be found (DEFRA, 2013).

The Cumbria Coast MCZ overlaps with the Drigg Coast Special Area of Conservation (SAC) and Site of Special Scientific Interest (SSSI) in the south and with St Bees Head SSSI in the north. The Cumbria Coast MCZ is designated for a number of features of conservation importance, one of which is the presence of *S. alveolata* reefs. The site is also designated for a number of broad scale habitats (Table 1).

Within close proximity to the Cumbria Coast MCZ, NuGeneration Limited (NuGen) is planning to develop a new nuclear power station known as the Moorside project. This station will be located close to the current Sellafield nuclear fuel reprocessing and decommissioning site situated between Braystones and Seascale (Figure 2). The project is likely to involve the construction of a Marine Offloading Facility (MOLF), Beach Landing Facility (BLF), and associated breakwater, as well as Cooling Water Systems (CWS), all of which may impact the intertidal and marine area.

Table 1 Features designated in the Cumbria Coast MCZ

Feature Type	**Feature Name**
Broad Scale Habitats (BSH)	High energy intertidal rock
	Intertidal biogenic reefs
	Intertidal sand and muddy sand
	Moderate energy infralittoral rock
Habitat Features of Conservation Importance (HOCI)	*S. alveolata* reefs
	Intertidal underboulder communities
	Peat and clay exposures

Figure 2 Extent of the Cumbria Coast MCZ

1.4 Objectives

The main aim of this current study was to map the distribution of *S. alveolata* reefs in the Cumbria Coast MCZ and to provide comparison against previous data for the area.
The objectives of the project were:

- To identify and map the present distribution of *S. alveolata* within the Cumbria Coast MCZ (excluding the Moorside project area)
- Record the formation type of *S. alveolata* reefs mapped
- Compare this with previous records of reef type and distribution within the area.

2. Methods

2.1 Survey location

The survey area was restricted to the Cumbria Coast MCZ. Locations for surveys were targeted based on previous survey data of the presence of *S. alveolata*. The majority of the reef in the Cumbria Coast MCZ was mapped, however the area to the North of St Bees head at Fleswick Bay where *S.alveolata* has been reported was not surveyed due to tide and time restraints. Additionally the area around the Moorside project, between Seascale and Braystones was not surveyed as the majority of this area is to be included in surveys carried out as part of the project development.

2.2 Data collection

2.2.1 Survey Period

Field work was conducted between 19 September 2016 and 27 October 2016 (Table 2). The surveys were organised, whenever possible to be carried on the lowest possible tides in order to optimise the length of time available on the shore and allow the furthest extent of reef to be sampled.

Table 2 Survey dates and corresponding daylight hours and tide times

Date	Time of sunrise (BST)	Time of sunset (BST)	Time of low tide (BST)	Height of low tide (BST)	Time of high tide (BST)	Time of high tide (BST)	Number of Surveyors
19/09/2016	06:56	19:19	08:15	-0.2	13:45	8.6	6
21/09/2016	07:00	19:14	09:40	0.5	15:15	8.0	6
12/10/2016	07:39	18:21	15:25	2.3	21:15	6.9	2
26/10/2016	08:07	17:49	15:50	2.0	21:40	7.0	2

2.2.2 Surveyors

Surveys were undertaken by four North West Wildlife Trust and two Cumbria Wildlife Trust staff along with one volunteer from Natural England. Surveyors were split into survey teams, the leader of each team having had prior experience of intertidal shore surveying. All surveyors were briefed on the survey methodology prior to the field surveys, and some time was spent at the beginning of the survey in reef type identification.

2.2.3 Methodology

The perimeter of *S.alveolata* settlements were tracked on foot and points logged using a handheld GPS device (Garmin eTrex 10) and the reef type classified following seven reef types, describing their size, extent, coverage and health, following methods outlined in Allen et al. 2002 (for descriptions see Table 3). Following the identification of an area of *S. alveolata* reef, either a single point was logged for reefs less than a certain size (approx. $10m^2$) as near as possible to the centre of the reef without causing damage. For larger reefs over a certain size (approx. $10m^2$) points were logged continually along the boundary of the reef. Points were taken every 5m, approximately 1-2 seconds at walking pace.

Whilst the descriptions of reef type provided by Allen et al. 2002 accounted for most situations, varying patchiness and fragmentation etc. between reefs meant that best judgement was used to determine the differences between various forms. To support observations, a digital camera was used in each reef type to capture visual data of the state of the reef. For reefs bordered by areas of other reef types, secondary boundaries of reef type were logged. These were either logged continuously, if time constraints allowed, or the approximate points of extent logged. Any uncertain boundaries were noted on the survey form at the time of recording.

Table 3 Descriptions of different reef types used to categorise areas of *S. alveolata* From Allen et al. (2002)

Reef Type	Description
1	Individual reefs of well-developed *S. alveolata* forming continuous colonies (>90% coverage) < $10m^2$ in area, generally >30cm height (but at least >10cm) and sufficiently separated from other reefs in order to justify individual status (see points 3-5).
2	Individual reefs of well-developed *S. alveolata* forming continuous colonies or platforms (>90% coverage) >$10m^2$ in area and >30cm in height.

3	Recognisable areas of *S. alveolata* over 10m^2 with patchy distribution (>50% coverage). Individual patches of *S. alveolata* are of varying size but forming recognisable reef structures (e.g. >10cm diameter/height) and forming a recognisable area as opposed to discrete individual reefs (type 1). The critical distance between individual *S. alveolata* patches used to differentiate between an area and an individual reef will vary depending on the size of the area as a whole and best judgement will be required to determine this, although <2m was found to be applicable during the survey.
4	Areas of *S. alveolata* over 10m^2 in area with very patchy distribution (20-50% coverage) but still forming a recognisable area of reef structures (>10cm diameter/height) as opposed to discrete type 1 reefs. The critical distance between individual *S.alveolata* patches used to differentiate between an area and an individual reef will vary depending on the size of the area as a whole and best judgement will be required to determine this although <5-10m was found to be applicable during the current survey.
5	Dispersed areas of *S.alveolata* over 10m^2 in area with extremely patchy distribution and very low coverage (<20% coverage) but forming a recognisable area of proper reef structures (>10cm diameter/height) as opposed to discrete patches (type 1). The critical distance between individual *S. alveolata* patches used to differentiate between an area and an individual reef will vary depending on the size of the area but between 10m-20m was found to be applicable during the current survey. However best judgement will be required to determine whether reefs in areas of very low coverage e.g. <10% should be considered as individual type 1 reefs and this will be of very low coverage e.g. <10% should be considered as individual type 1 reefs and this will be dependent on the size of the areas and time available for logging individual points.
6	Low lying patches/areas of *S.alveolata* often forming 'barnacle' like coverage on rocks/sediment and may include juvenile forms following settlement. Although this type of reef generally occurs at the margins of more developed reefs in relatively low abundance, the coverage may be highly variable (10-100%) and may in some areas form the entire reef. The above guidelines for extent and patchiness apply.
7	Low lying heavily silted and predominately dead areas of relict *S.alveolata.* Although this type of reef generally occurs at the margins of more developed reefs in relatively low abundance, the coverage may be highly variable (10-100%) and may in some areas form the entire reef. The above guidelines for extent and patchiness apply.

2.3 Data analysis

Following collection of field data on each survey, data points logged from GPS and photographs were downloaded onto a PC. Data points were imported into QGIS and overlain onto Ordnance Survey base maps. On completion of field work *S.alveolata* boundaries were digitised and all outputs were generated in QGIS v2.14.3.

3. Results

3.1 Current survey

For convenience of reporting the survey area has been split into five maps (Figure 3). These maps are as follows: **Area 1** Drigg (Figure 8), **Area 2** Braystones (Figure 9), **Area 3**

Braystones to Nethertown (Figure 10), **Area 4** North of Nethertown (Figure 11) and **Area 5** St Bees (Figure 12).

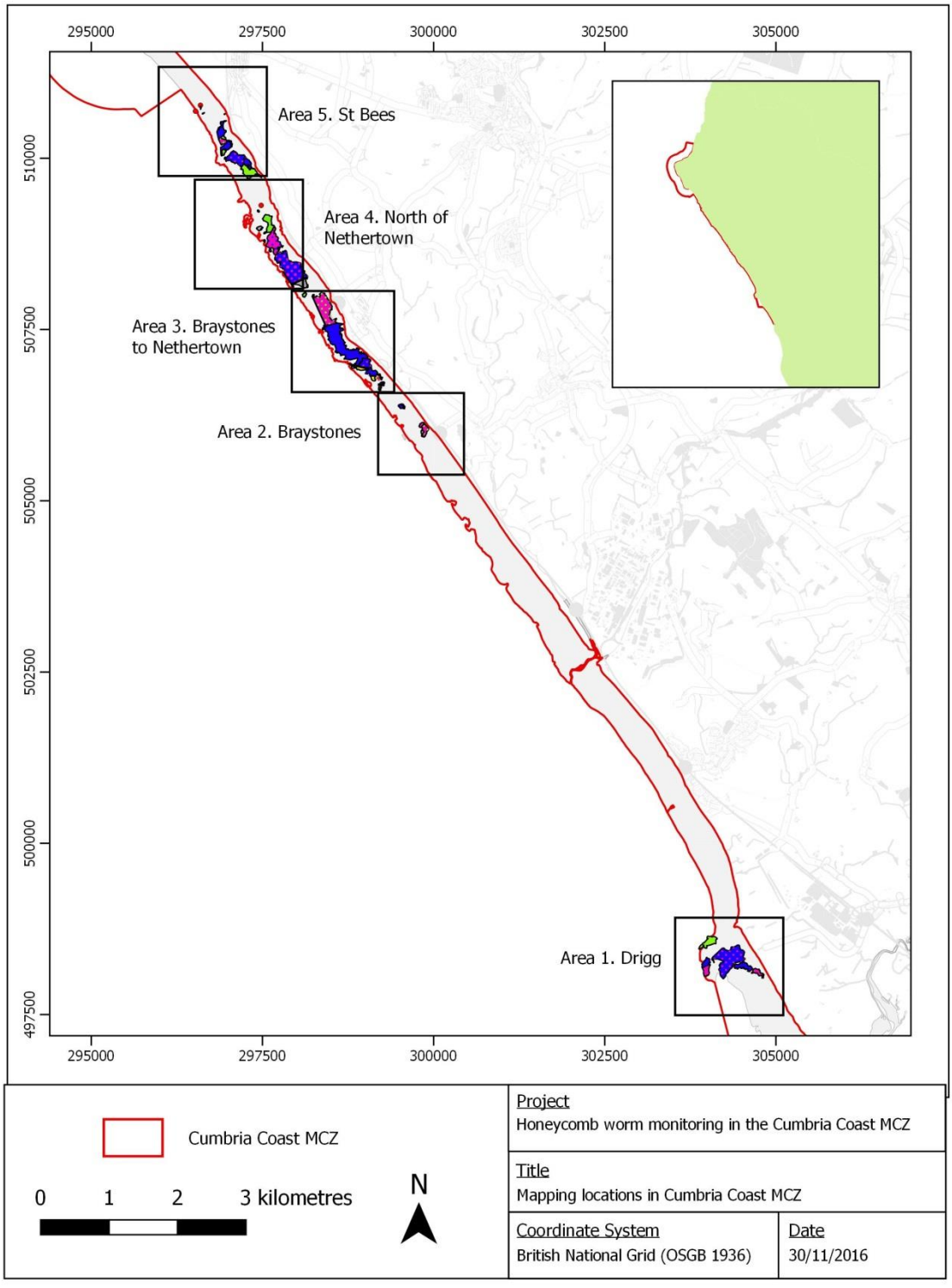

Figure 3 Mapping locations in the Cumbria Coast MCZ

As a rough guide to quality, following Allen et al. 2002 reefs were divided into three groups based on their reef types. Reefs between type two and type three-four were considered 'good quality' reefs, reefs between type four and type five-six were considered 'moderate quality' and reefs of type six and type seven were considered 'reduced-poor quality'.

Table 4 Condition of the *S. alveolata* reef in the Cumbria Coast MCZ

Area	Good (m^2)	Moderate (m^2)	Reduced/Poor (m^2)	Total (m^2)
Drigg	137,819 (75.7%)	44,218 (24.3%)	0	182,037
Braystones to St Bees	350,121 (57.8%)	187,441 (30.9%)	68,521 (11.3%)	606,113

3.1.1 Area 1: Drigg

Figure 4 General view of the shore at Drigg

On the coast at Drigg (Figure 8), there was distinct *S.alveolata* reef development on Barn Scar, with the total reef in this area of coast covering 182,037 m^2 (Table 4). *S.alveolata* was present here in a well-developed reef towards the centre of the scar, with some smaller patchier reef towards the outer edges. At Drigg, the majority of the reef area (75.7%), was considered to be in 'good condition', with the remaining (24.3%) considered to be in 'moderate condition' (Table 4). *S.alveolata* was type three/four ('good condition') in the main reef and type four/five ('moderate condition') towards the edges. No type six or seven reef ('reduced/poor') was recorded in the area.

3.1.2 Area 2-5: Braystones to St Bees

Figure 5 General view of the shore between Braystones and St Bees

On the coast between Braystones and St Bees (Figure 9-12), *S.alveolata* was present in a series of well-developed extensive reef structures occurring on the boulder/cobble fields in the intertidal area. Reefs along this stretch of coastline covered a total area of 606,113m² (Table 4). The majority of the reef in this area (57.8%) was considered to in good condition, with the remaining reef in moderate (30.9%) or reduced/poor condition (11.3%). Patchier type five (‘moderate quality’) and six and seven reef (‘reduced/poor quality’) tended to be found at the edges of the more developed reefs.

3.2 Comparisons with previous data

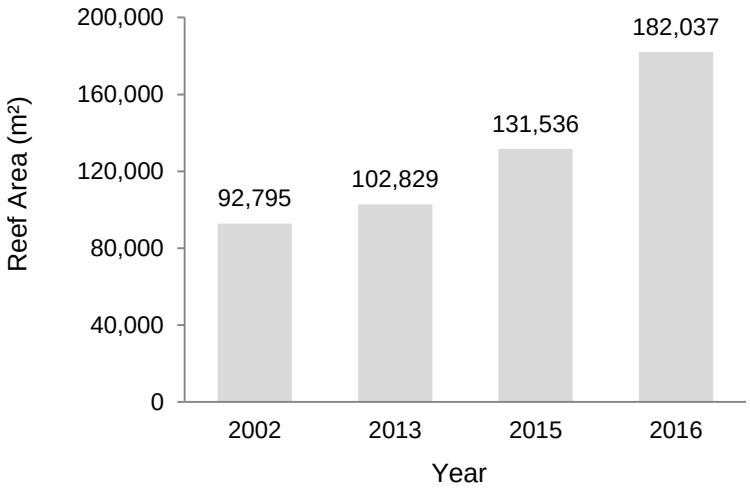

Figure 6 Total reef area of *S.alveolata* at Drigg for the years 2002 (Allen et al. 2002), 2013 (MESL and APEM, 2013), 2015 (Antill et al. 2016) and 2016.

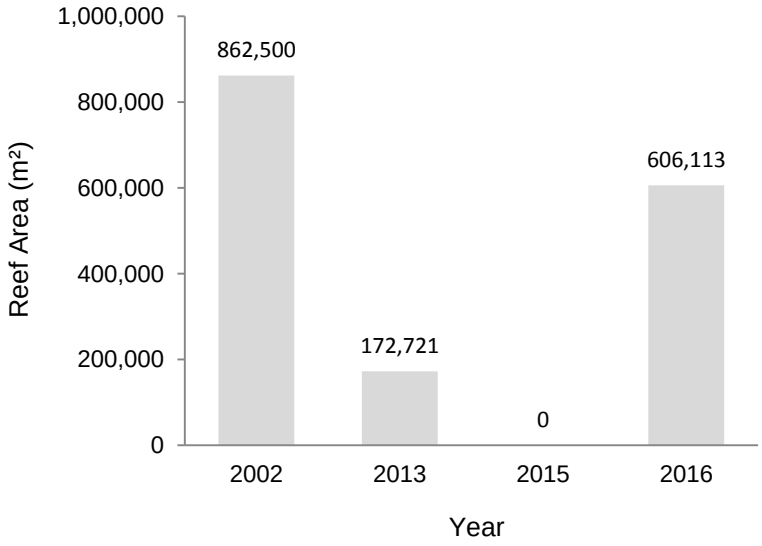

Figure 7 Total reef area of *S.alveolata* from Braystones to St Bees for the years 2002 (Allen et al. 2002), 2013 (MESL and APEM, 2013), 2015 (Antill et al. 2016) and 2016.

The reef area at Drigg increased between each survey (Figure 6), with a total increase from 92,795m² to 182,037 m², (an increase of 96.2%) between the years 2002 and 2016. The reef area between Braystones and St Bees decreased between each survey up until 2015, with a total of 0m² of reef recorded in the 2015 survey. In 2016 the reef area increased to 606,113m², a total decrease of 29.7% from 2002 (Figure 7).

4. Discussion

S. alveolata was recorded at several locations within the study site with a total of 788,150m^2 of reef recorded during the study period. Off the coast at Drigg, distinct *S.alveolata* reef development was apparent over the Barn Scar area. Here a large main patch of reef was present over the main scar area, surrounded by several patches of similar to slightly lesser quality reef. Further up the coast *S. alveolata* was found to be present in a number of reefs, with a series of extensive reef structures of variable condition occurring on the boulder/cobble fields between Braystones and St Bees. The distribution of *S.alveolata* observed during the survey shows that the scar ground within the Cumbria Coast MCZ provides extensive suitable substratum required for the establishment of *S. alveolata* colonies.

Previous studies have looked at the presence, distribution and abundance of *S. alveolata* along the Cumbrian coastline (Allen et al. 2002, Firth et al. 2015, Antill et al. 2016) and historically *S.alveolata* has been reported from all sites recorded in this survey. Cunningham et al. (1984) produced the first extensive review of the distribution of *S.alveolata* in Britain and reported large abundant colonies of *S.alveolata* reef at Drigg and Nethertown and occasional, scattered individuals of *S.alveolata* with no patches of reef at St Bees. Previous data quantifying *S.alveolata* reef extent within the MCZ is only available on a relatively short temporal scale from within the last two decades (Figure 6 and 7). Comparisons from this data show that at Drigg there appears to have been an overall increase in the extent of reef area, with the reef area continually increasing during surveys undertaken between 2002 and 2016. The reef area further up the coast between Braystones and St Bees however appears to be much more variable, with a significant decrease in the extent of *S. alveolata* recorded between 2002 and 2015, followed by an increase (albeit with a lower reef area than originally recorded) in 2016.

Comparisons over long temporal scales show that within the majority of sites on the British coastline, *S.alveolata* has demonstrated little change in abundance or distribution since the 1980's (Bush, 2016). However on shorter time scales, in areas where *S.alveolata* is found to be continually present, there is often found to be variability in its abundance and distribution (Wilson, 1971; Egerton, 2014). Therefore the differences in reef extent between surveys could be attributed to the natural cycle of reef development within *S. alveolata* populations. *S. alveolata* is a species that moves through successive cycles of development and decay from initial recruitment through to reef destruction (Wilson, 1974; Gruet, 1986). Differences in reef extent may also be attributed to differences in the survey approaches. A similar

methodology was used in the 2002 survey by Allen et al. and the current survey, and a comparison between these two surveys whilst still showing an increase in the reef area at Drigg, shows a much smaller variation in the reef area between Braystones and St Bees.

6. Conclusion and Further Work

This report provides information on the distribution, extent and condition of *S.alveolata* in the Cumbria Coast MCZ. Reefs along the Cumbrian coast form a significant component of the UK resource (Allen et al. 2002) and detailed information on the extent and quality of *S. alveolata* in the MCZ is required in order to comprehend its current status and help to understand its natural dynamics and susceptibility to change. The current survey found *S. alveolata* to be present throughout the Cumbria Coast MCZ with varying levels of abundance, ranging from small patches up to large reefs. At Barn Scar near Drigg, a distinctive development in the *S.alveolata* reef was noted as this area was been well covered by all surveys. Here a large main patch of reef was present over the main scar area, surrounded by several patches of similar to slightly lesser quality reef.

Continued regular monitoring of *S.alveolata* reefs in the area is necessary in order to identify whether any observed changes may have been caused by natural variations or other factors and to inform future management of the MCZ.

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7. Appendix

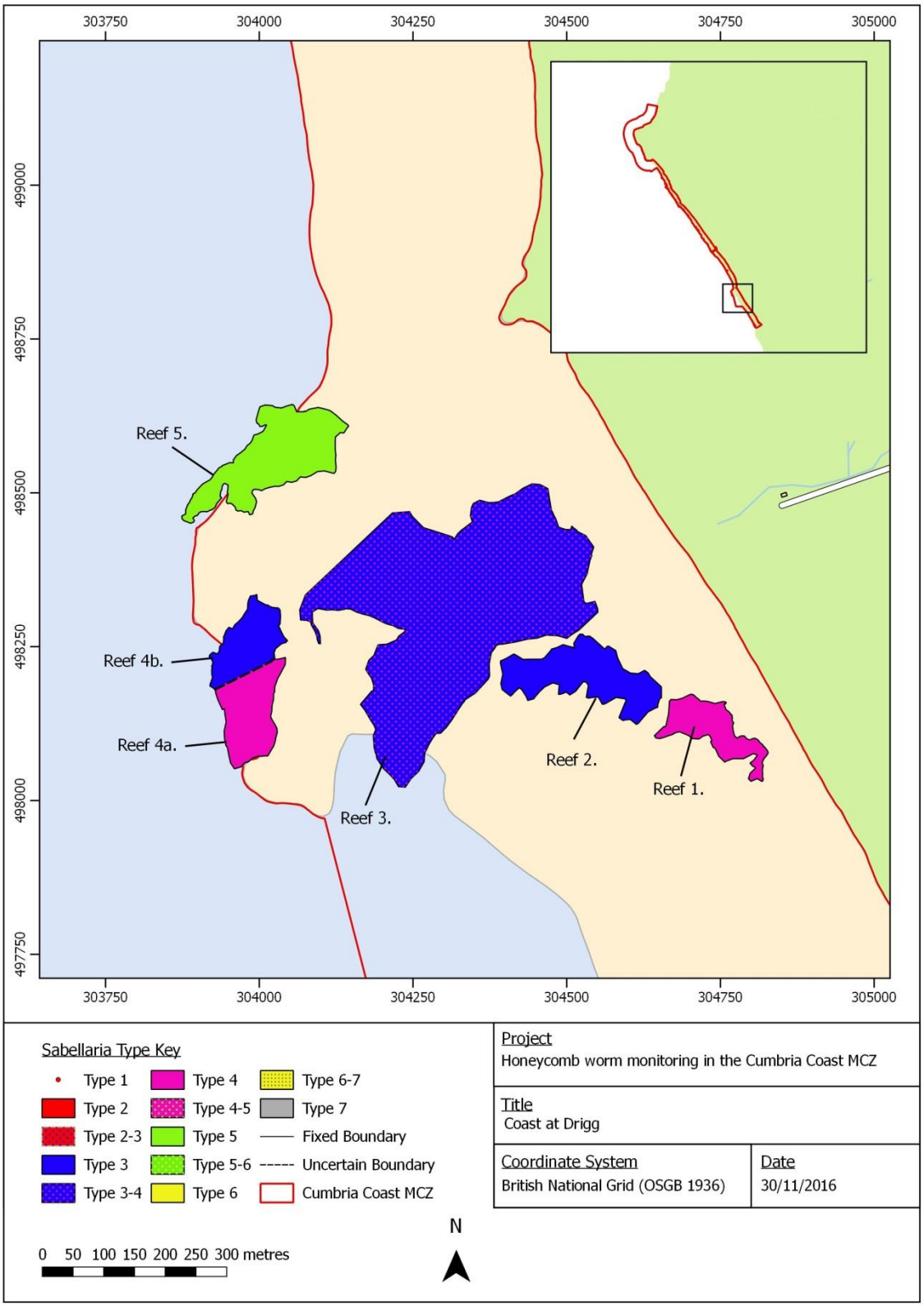

Figure 8 *S. alveolata* mapped at Drigg

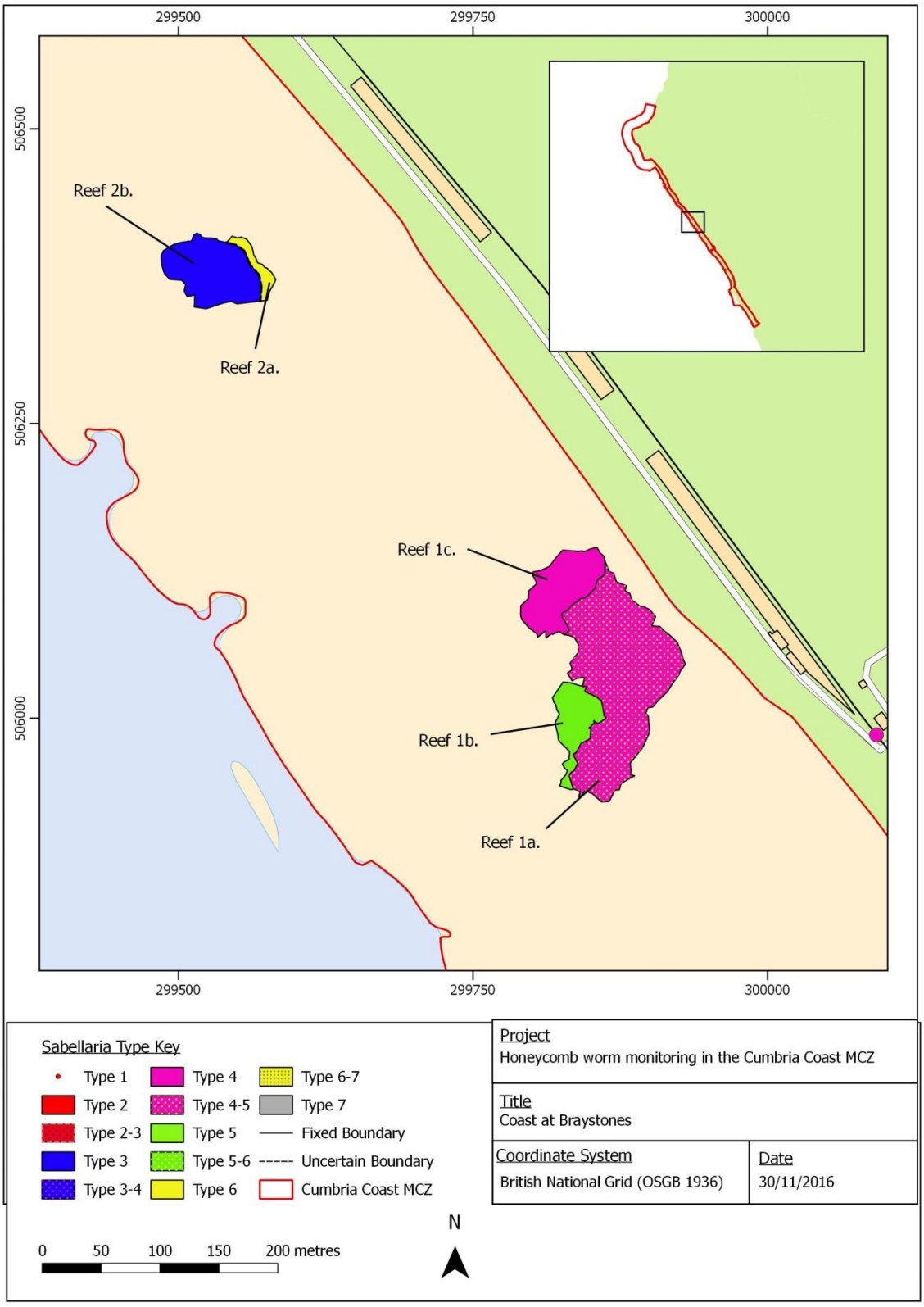

Figure 9 *S.alveolata* reef mapped at Braystones

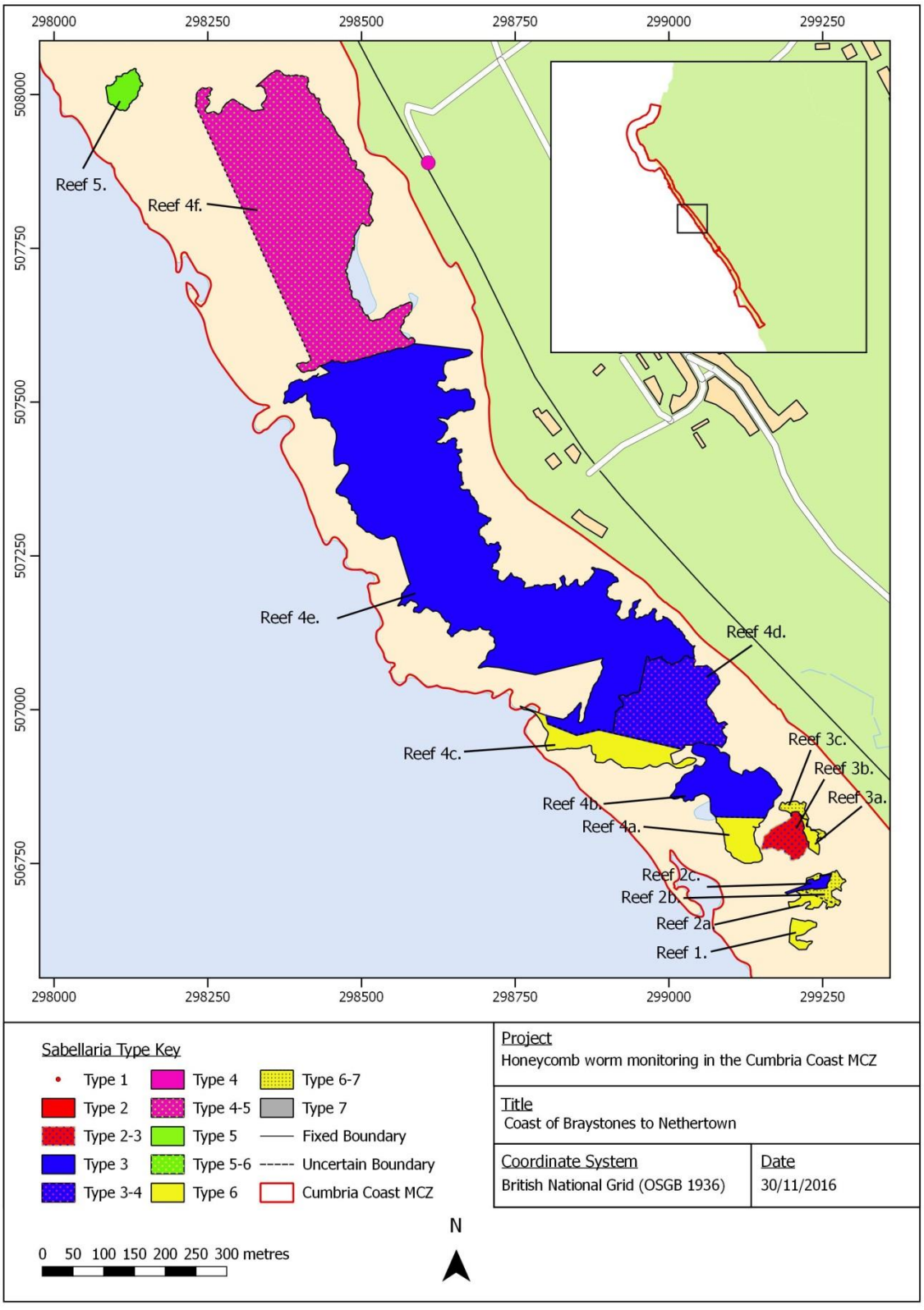

Figure 10 *S. alveolata* reef mapped at Braystones to Nethertown

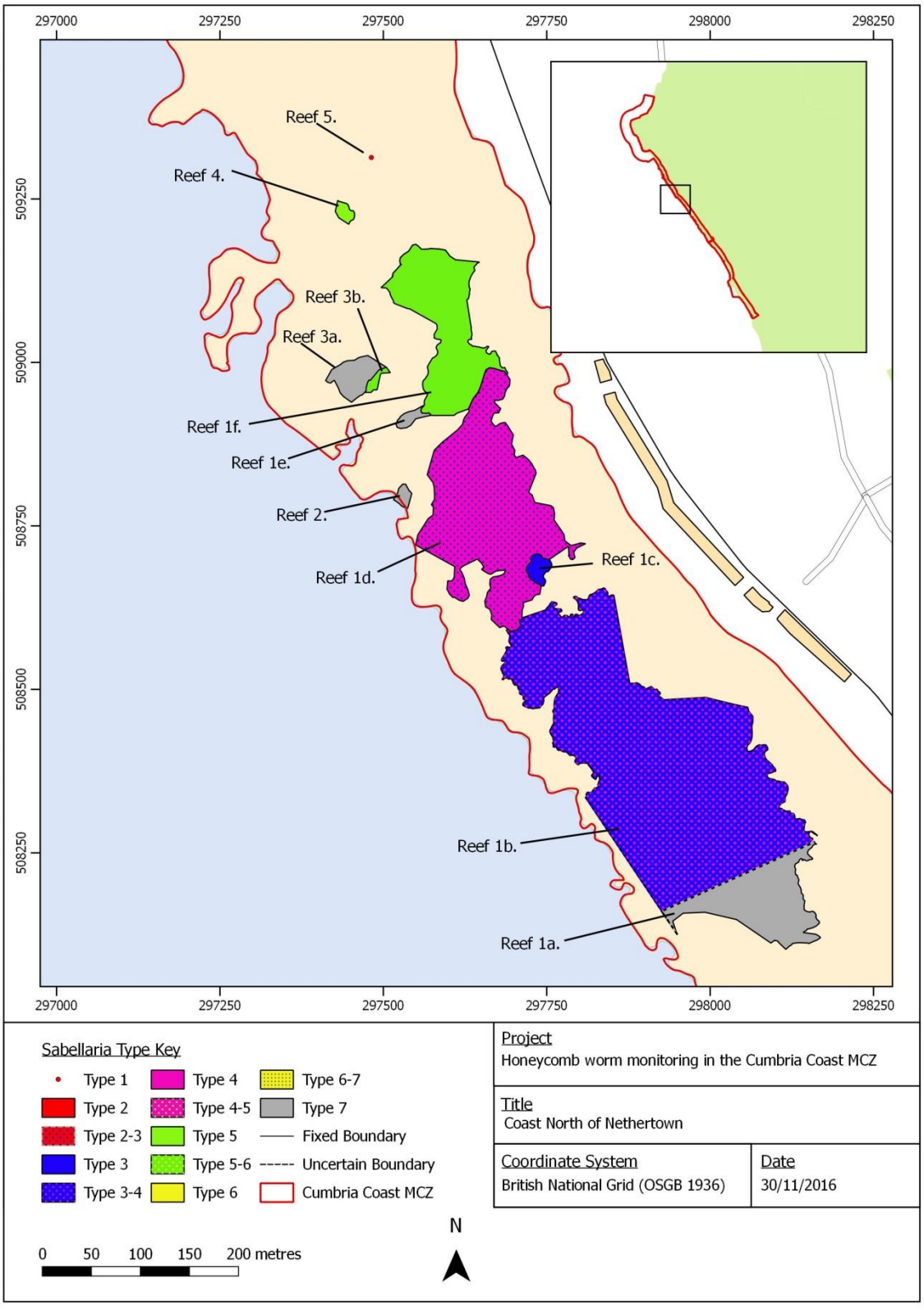

Figure 11 *S. alveolata* reef mapped at North of Nethertown

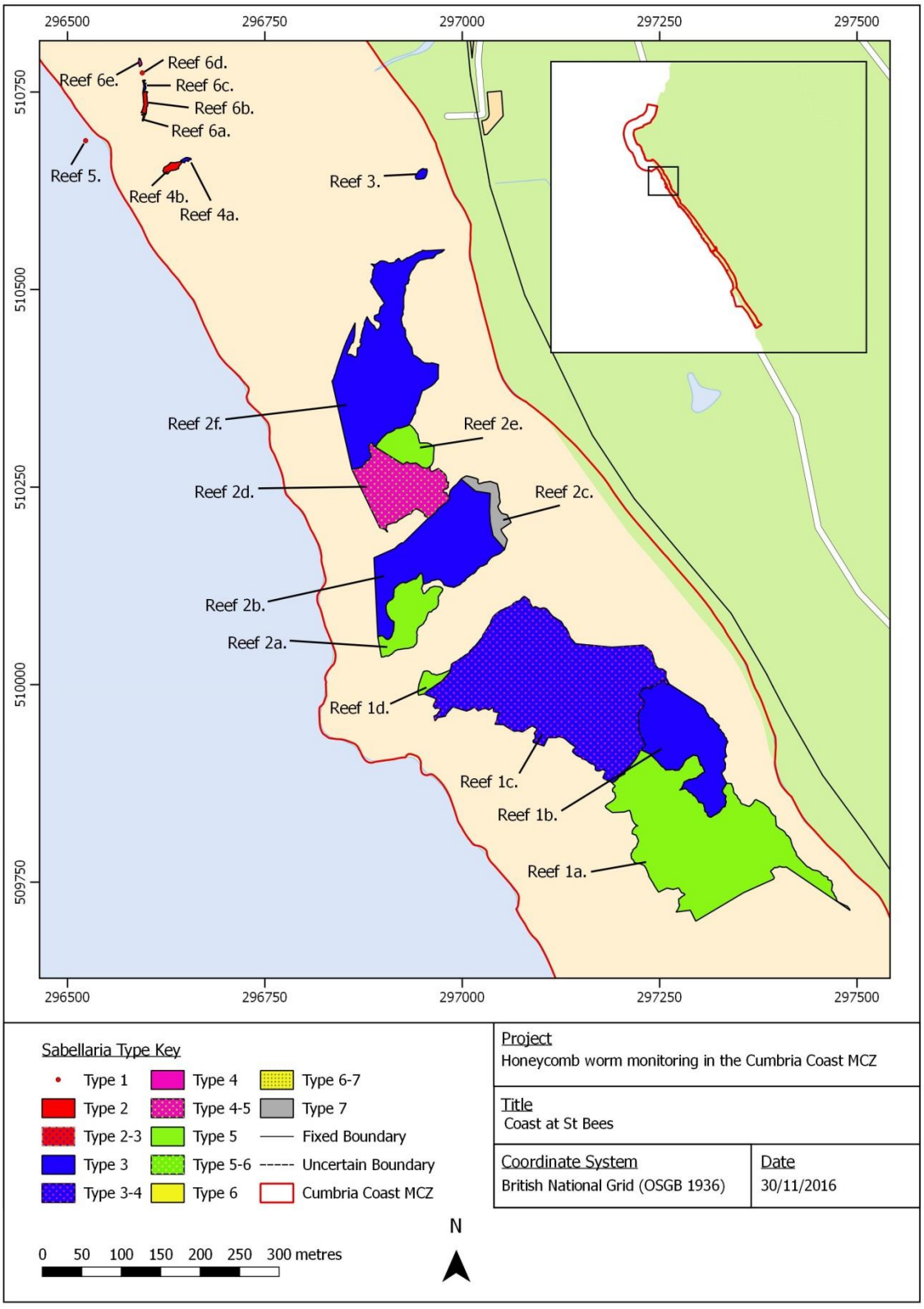

Figure 12 *S.alveolata* reef mapped at St Bees