Morecambe Bay SAC Subtidal Cobble and Boulder Skear Communities Drop-down Video Survey

Final Report

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Further information

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Natural England

Morecambe Bay SAC Subtidal Cobble and Boulder Skear Communities Drop-down Video Survey

Final Report

15th May 2015

Seastar Survey Ltd. Project Number - J/14/411

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Executive summary

Background

Morecambe Bay is an ecologically diverse area, encompassing the coastal plain estuaries of the rivers Wyre, Lune, Keer, Kent and Leven which form an extensive area of shallow coastal sediments (Sotheran and Walton, 1997). The Morecambe Bay Special Area of Conservation (SAC) was designated under the Natura 2000 programme in 2005 due to the substantial amounts of Annex I habitat present within the Bay which include; 'estuaries,' 'mudflats and sandflats not covered by water at low tide,' 'large shallow inlets and bays,' 'sandbanks which are slightly covered by sea water all the time' and 'reefs.'

In order to inform site condition monitoring, Seastar Survey Ltd. were contracted by Natural England to undertake a drop-down camera survey in the Morecambe Bay SAC in order to define the distribution and extent of any subtidal cobble and boulder skear communities present.

Main findings

- A total of 71 transects were attempted throughout the survey areas using Seastar Survey's own HD Freshwater Lens Camera System (FLCS), with a total of 528 discrete video clips achieved, 500 of which yielded usable data.
- The most commonly identified broad habitat was SS.SSa (sublittoral sands and muddy sands) with 35.5 % of seabed contacts assigned to either the broad habitat SS.SSa or the biotope complex SS.SSa.CMuSa (circalittoral muddy sand). Circalittoral mixed sediments (SS.SMx.CMx) were also frequently observed.
- Potential cobble skear habitat was observed on 40 of the 71 achieved transects.
- Cobble skear polygons to delineate the extent of potential cobble skears were created at three confidence levels. The total area covered by potential cobble skear habitat (at 50 – 60 % confidence) was found to be approximately 6.26 km^2, equivalent to 9.13 % of the total area surveyed.
- Areas of potential cobble skear habitat were concentrated primarily near the mouth of Morecambe Bay (along the edge of the SAC) and in the central and east region of Area 1. Percentage cobble coverage was found to be particularly high in Areas 2 and 3; high incidences of cobble substrate were also recorded on the 'plateau' between Areas 2 and 3 and in the central region of Area 2. Smaller areas of potential skear habitat were also identified in the northwest corner of Area 1.
- The occurrence of cobble skear within the Walney Channel (Area 4) was found to be chiefly confined to the northern section of the channel, although an area of cobble skear south of the entrance to the channel was also identified.
- Where potential cobbles and boulder skear habitats were observed, epifauna was dominated by the non-native, cryptogenic colonial ascidian *Molgula manhattensis*. These areas were assigned the biotope CR.HCR.XFa.Mol. Other fauna commonly

observed included silt- and scour-resistant species such as the bryozoans *Flustra foliacea* and *Alcyonidium diaphanum*, hydroids such *Sertularia* spp. and *Hydrallmania falcata* and encrusting fauna such as *Spirobranchus* sp. and sponges.

- A preliminary assessment of condition has been made for the cobble skear communities observed
- It is recommended that future monitoring incorporate camera deployments and infaunal sampling with broad-scale acoustic techniques to enable changes in sediment composition, including areas of cobble and boulder skears, to be readily identified.

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1. Introduction

1.1 Project background

The EU Habitats Directive aims to promote the maintenance of biodiversity, taking account of economic, social, cultural and regional requirements and sets out measures to maintain or restore natural habitats and species of European Union interest at favourable conservation status. Under the Habitats Directive, Natural England has statutory responsibility to advise relevant authorities as to the conservation objectives for European marine sites in England and to advise relevant authorities as to any operations which may cause deterioration of natural habitats or the habitats of species or disturbance of species for which these sites have been designated. This information is a key component of any management schemes which may be developed for these sites.

Morecambe Bay is an ecologically diverse area, encompassing the coastal plain estuaries of the rivers Wyre, Lune, Keer, Kent and Leven which form an extensive area of shallow coastal sediments (Sotheran and Walton, 1997). The Morecambe Bay Special Area of Conservation (SAC) was designated under the Natura 2000 programme in 2005 due to the substantial amounts of Annex I habitat present within the Bay.

The Annex I habitat 'large shallow inlets and bays' makes up 92.6 % of the SAC and is considered to be one of the best examples of this habitat type in the United Kingdom (JNCC, 2011). Additionally, the habitat 'mudflats and sandflats not covered by seawater at low tide' makes up 34.2 % of the seabed within the SAC and this area is considered of national importance (JNCC, 2011). The SAC also contains a significant proportion (28.9 %) of the habitat "sandbanks which are slightly covered by sea water all the time" makes up 28.9 % (JNCC, 2011). These habitat types together form the single largest continuous area of intertidal sand and mudflats in the UK (JNCC, 2015a). The mud and sandflats are composed of a range of sediments from muddy fine sand to well-sorted sand at the western extreme of the bay (Sotheran and Walton, 1997). These fine sediments provide habitat for a number of infaunal communities with high numbers of bivalves, crustaceans and polychaetes (English Nature, 2000).

A habitat present as a qualifying feature, but not as a primary reason for selection of the SAC, is the Annex I Habitat 'reefs' which makes up 1.03 % of the SAC (JNCC, 2015a). A reef sub-feature present in the SAC is 'subtidal boulder and cobble 'skear'' (see section 1.3.3.2). In order to help inform site condition monitoring, Seastar Survey Ltd. were contracted by Natural England to undertake a drop-down video (DDV) survey of the Morecambe Bay SAC in order to define the distribution and extent of any subtidal cobble and boulder skear communities and to establish a baseline for the site against which future condition of this reef sub-feature can be assessed.

1.2 Survey area

The general location and outline of the Morecambe Bay SAC is shown, alongside the four priority survey areas specified by Natural England, in Figure 1.1. The four Priority Areas are all located within the SAC near the mouth of Morecambe Bay, and include areas of known sandbanks (Areas 1 and 2) as well as the Lune Channel (Area 3) and the Walney Channel (Area 4).

Several recent studies have been conducted within the SAC and the adjacent offshore area on behalf of both Natural England and local commercial interests. A considerable amount of multibeam echosounder (MBES) bathymetric data and associated backscatter data have been acquired within and outside the SAC (Envision Mapping Ltd., 2012) and within the Walney Channel (ABP, 2012). These data were provided to Seastar Survey Ltd. prior to the contract in order to inform survey planning.

1.3 The environment

1.3.1 Geological and sedimentary environment

The Morecambe Bay SAC covers an area of 61,506.22 ha off the coast of Lancashire and Cumbria. The SAC encompasses the entirety of Morecambe Bay, which is the confluence of the estuaries of four major rivers within the region; the Rivers Lune, Leven, Kent and Wyre. The area of the Duddon Sands, to the north of the Furness peninsula (Walney Island), is the estuary of the river Duddon, also included in the SAC designation.

The majority of coast surrounding the Morecambe Bay SAC is low lying, with the only major cliff outcrop occurring at St Bees Head, north of the SAC. The solid geology of the underlying bedrock of the SAC is Permo-Triassic in origin (248-286 Ma) (Doody, 1996). The Lancashire coast geology is mainly composed of sandstone, whereas the Cumbrian coast comprises extensive limestone pavement. However, both within the bay and onshore, these underlie thick glacial drift deposit and Holocene alluvial deposition (Doody, 1996). The continued movement of post glacial sediments by longshore drift is a major feature within the SAC and the wider region, especially as this movement has been greatly modified by human intervention in the last 2000 years (Doody, 1996). The general seabed substrata offshore of the entrance to Morecambe Bay is dominated by muddy sand due to the generally lower speed of tidal currents in this northern area (BGS, 1996). 2010 UK SeaMap charts indicated that the mouth of the bay, adjacent to the boundary of the SAC, is primarily composed of mixed and sandy sediments, tough areas of rock are recorded along the edge of the Lune Channel and in the centre of the Bay close to Priority Area 1 (Figure 1.2).

The tidal regime within the Morecambe Bay SAC is responsible for the large scale of the post glacial sediment movements via longshore drift. This macrotidal regime produces an average tidal range of 8.4 m (Environment Agency, 2013). This range, one of the largest in the world, results in tidal currents within the bay of 0.9 – 1.0 m s^{-1} (~1.7 – 1.9 knots) during spring tides (Mason *et al*., 1999). These tidal currents propagate in an anti-clockwise rotating tidal gyre in the mouth of the bay (Mason *et al*., 1999). The resultant tidal asymmetry is the major agent for sediment transport within the SAC (Mason *et al.*, 1999). Calculations of the nature of intertidal sediment movement within the SAC show a loss of volume of ~16.1 ±4.5 x 10^6 m^3 between 1992 and 1995 (Mason *et al.*, 1999).

The Morecambe Bay estuary is open to the southwest, however it remains relatively sheltered from wave exposure due to the semi-enclosed nature of the Irish Sea, with annual significant wave heights of approximately 2 m at the mouth of the bay (BGS, 1996). Salinity within the Morecambe Bay SAC is variable, dependent on the state of the tide and the fluvial influx from the four river systems. The salinity is known to be less than 32 at the mouth of the Bay (start of the SAC), decreasing toward the east (BGS, 1996).

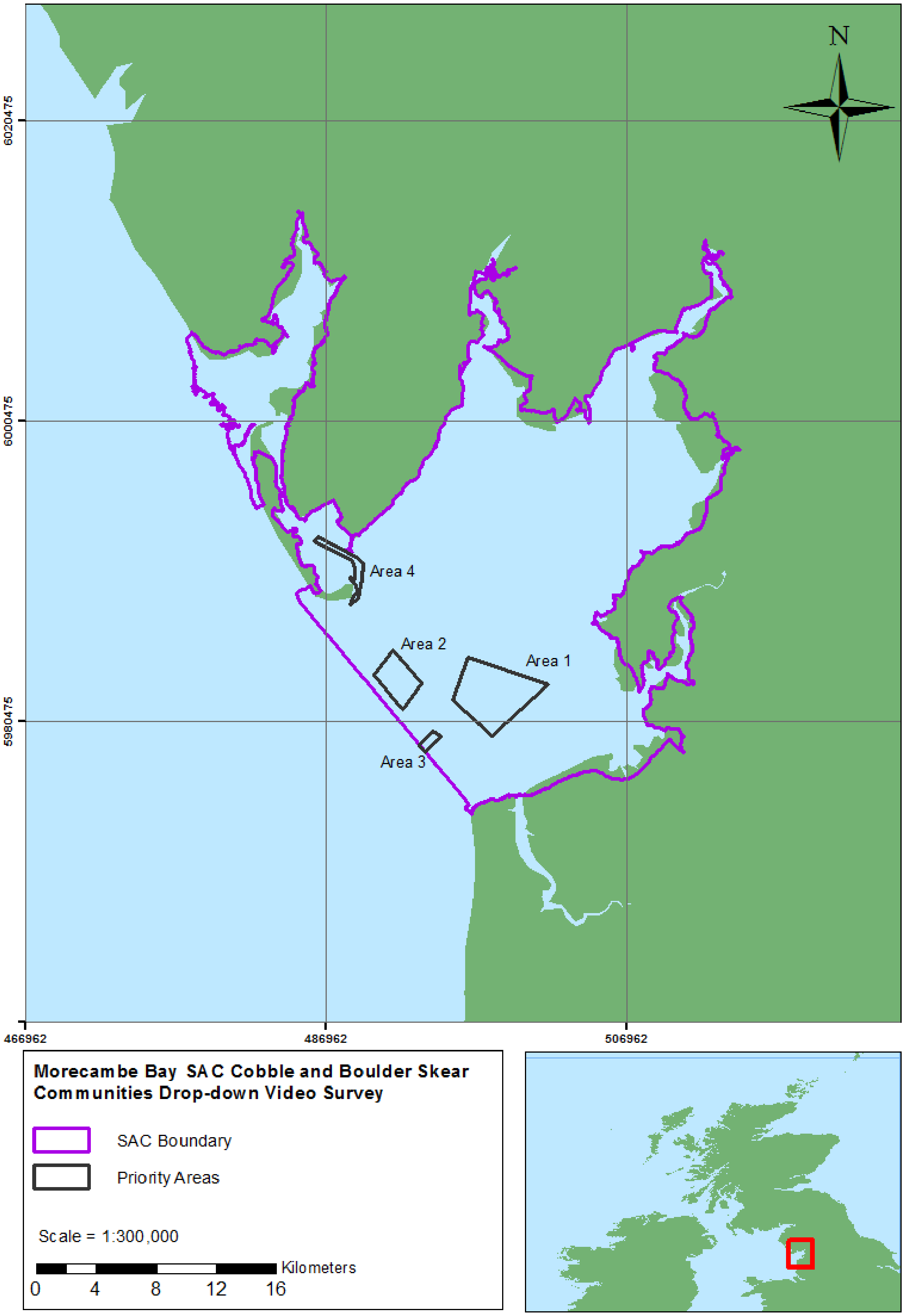

Figure 1.1: Location of the Morecambe Bay SAC and designated Priority Areas for survey

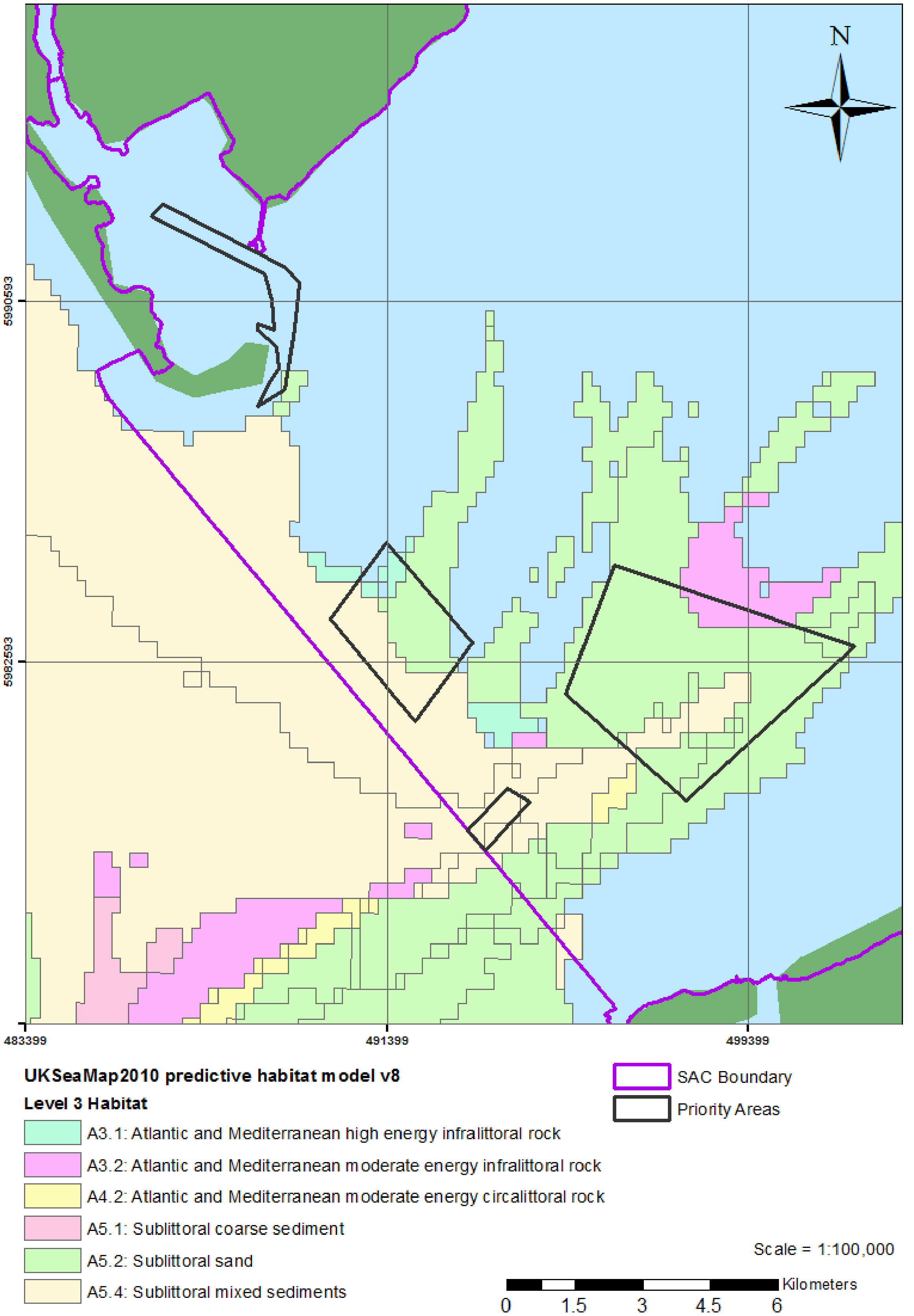

Figure 1.2: Superficial sediments in and around the Morecambe Bay SAC (SeaMap, 2010)

1.3.1.1 Bathymetry

Bathymetric data for the majority of the survey area were acquired during two separate surveys. For the southern section of Morecambe Bay SAC, covering Priority Areas 1, 2 and 3, multibeam bathymetric data with backscatter were acquired in 2012 by Envison Mapping Ltd. (Envision, 2012). A multibeam bathymetric dataset was acquired within the Walney and Piel channel (Priority Area 4) in 2012 by ABP. Figures 1.3 and 1.4 show these data in respect to the SAC and Priority survey areas.

There is a large variation in depth across the site, with Priority Area 2 located in the shallowest region of the survey area, adjacent to Morte Bank. Area 1 is located at the head of the Lune Channel and is slightly deeper than Area 2. Area 3 is located on the edge of the Lune Channel and has the greatest depth range of any of the priority Areas. The bathymetric dataset provided for Area 4, the Walney Channel, was collected separately to the main dataset and both were provided without depth band data, meaning direct comparison of depths at this site is not possible using the acoustic data.

1.3.2 Biological environment

1.3.2.1 Soft sediment communities

The seabed within the Morecambe Bay SAC is dominated by sedimentary infaunal communities, similar to those found in the wider Irish Sea region, with a low species diversity and corresponding high biomass (Irving *et al.*, 1996). Previous studies of the subtidal communities within the SAC have been limited in success or in extent. The results of three major surveys conducted within the SAC are shown in Figures 1.5 and 1.6.

A survey conducted by the Environment Agency in 2010 comprised a series of seabed sediment samples within and just offshore of the Morecambe Bay SAC. The data received by Seastar Survey Ltd. from Natural England did not include the full report, however station locations and observed sediment types were provided, and have been displayed in Figure 1.5. The majority (56 out of 97) of the samples acquired or attempted were described as fine sand or mud and 9 were shown to be coarse sand with shell fragments. Seven of the samples were described as being composed predominantly of cobbles (marked ‘G’ (‘gravel’) in Figure 1.5).

Surveys not illustrated in Figures 1.5 and 1.6 include a survey conducted by Envision Mapping Ltd. in 2008 (Envision Ltd., 2008), which involved the acquisition of drop-down video, sediment sampling and Acoustic Ground Discrimination System (ADGS) work in the waters adjacent to the Morecambe Bay SAC. The results of this survey indicate that the sediments closest to the SAC are primarily composed of muddy sands.

A study conducted by CMACS (2013) acquired one successful sediment sample within the SAC, although one other station within the SAC was abandoned station due to the presence of the UKBAP species *Sabellaria spinulosa*. The successful sample was located approximately 1 km due west of Heysham and was described as being composed of slightly gravelly sand, with the biotope **SS.SSa.MuSa.SsubNhom** (*Spisula subtruncata* and *Nephtys hombergii* in shallow muddy sand) assigned to the sample.

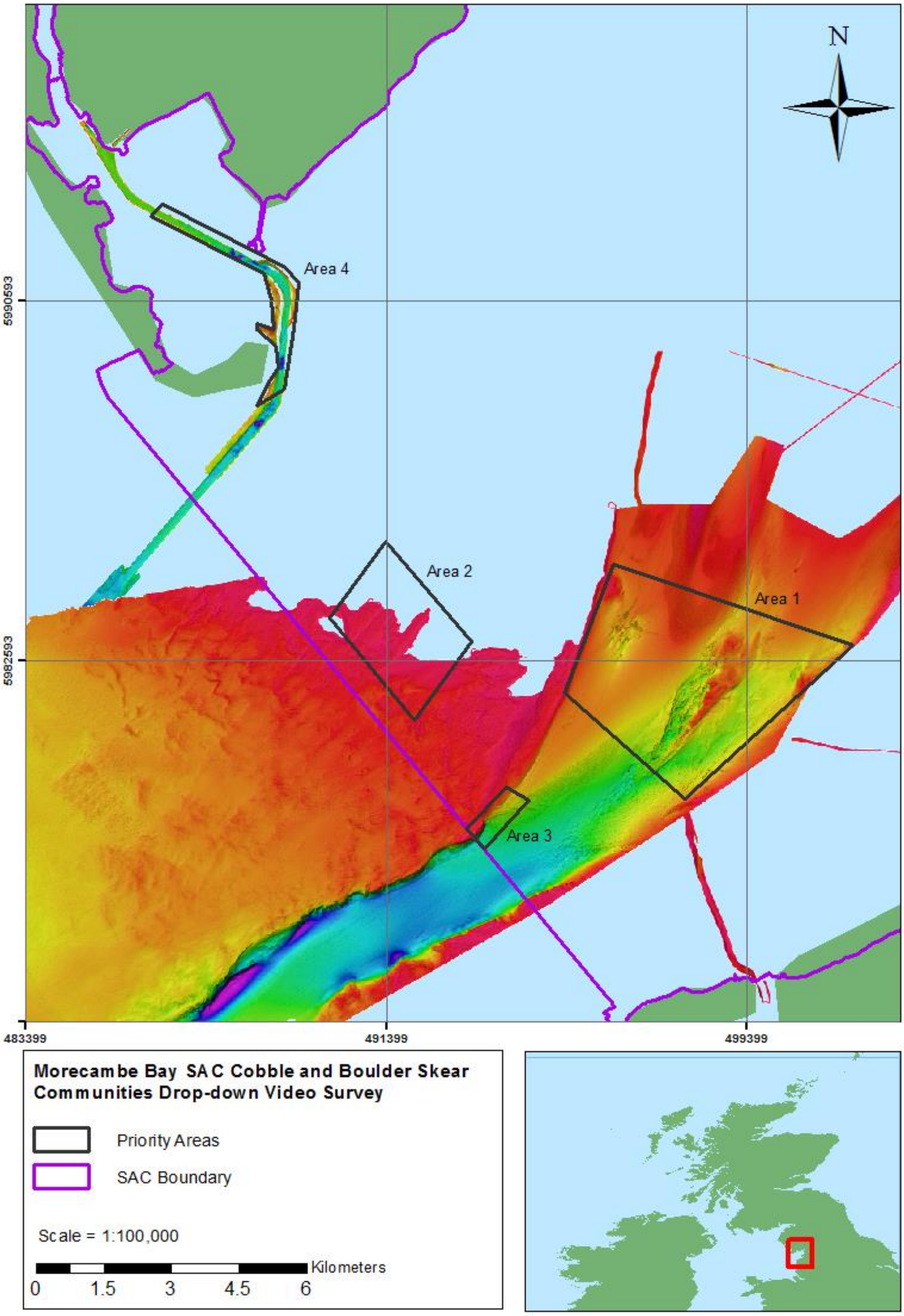

Figure 1.3: Multibeam bathymetry datasets acquired by ABP (2012) and Envison (2012) in the Morecambe Bay SAC

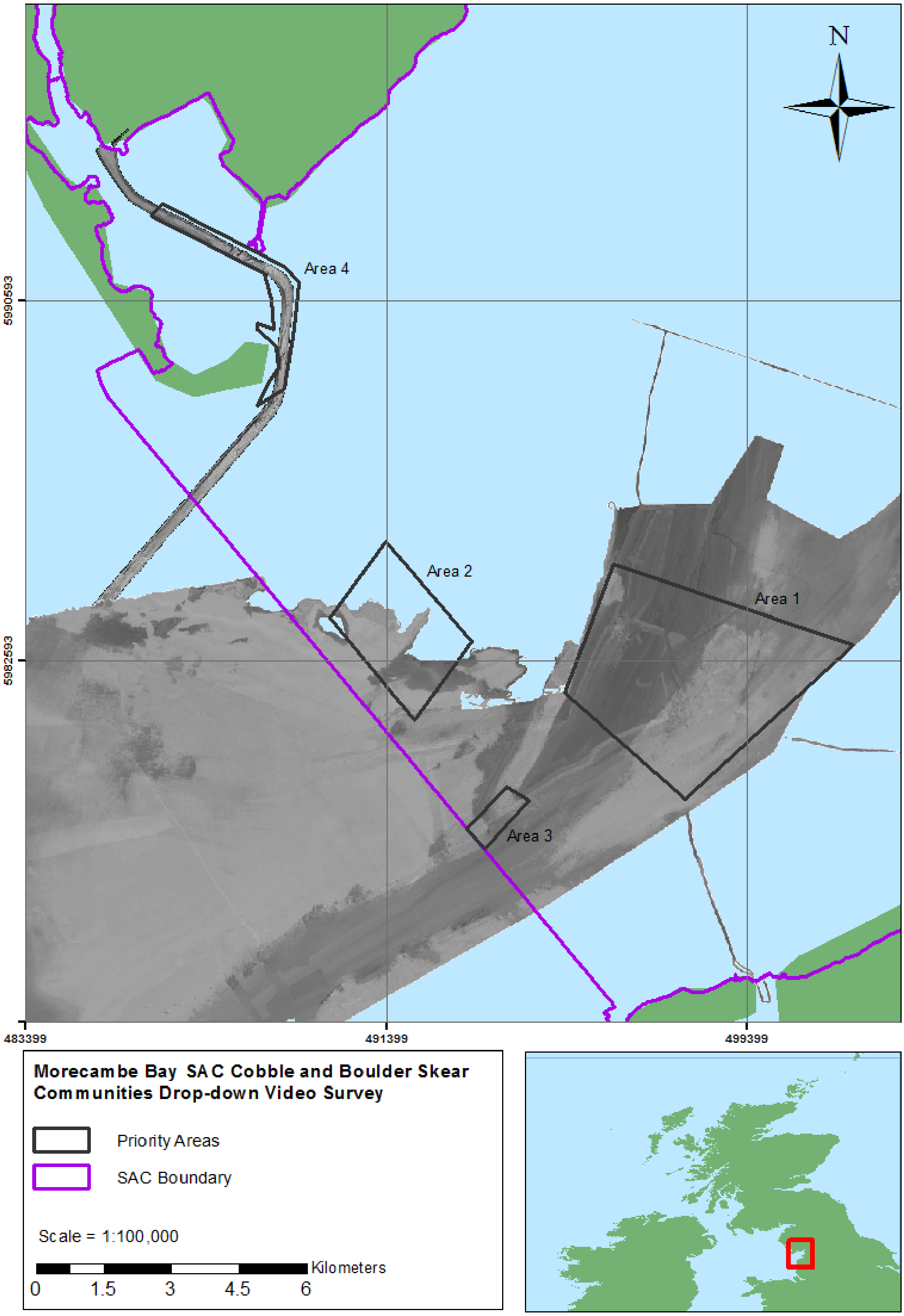

Figure 1.4: Backscatter datasets acquired by ABP (2012) and Envison (2012) in the Morecambe Bay SAC

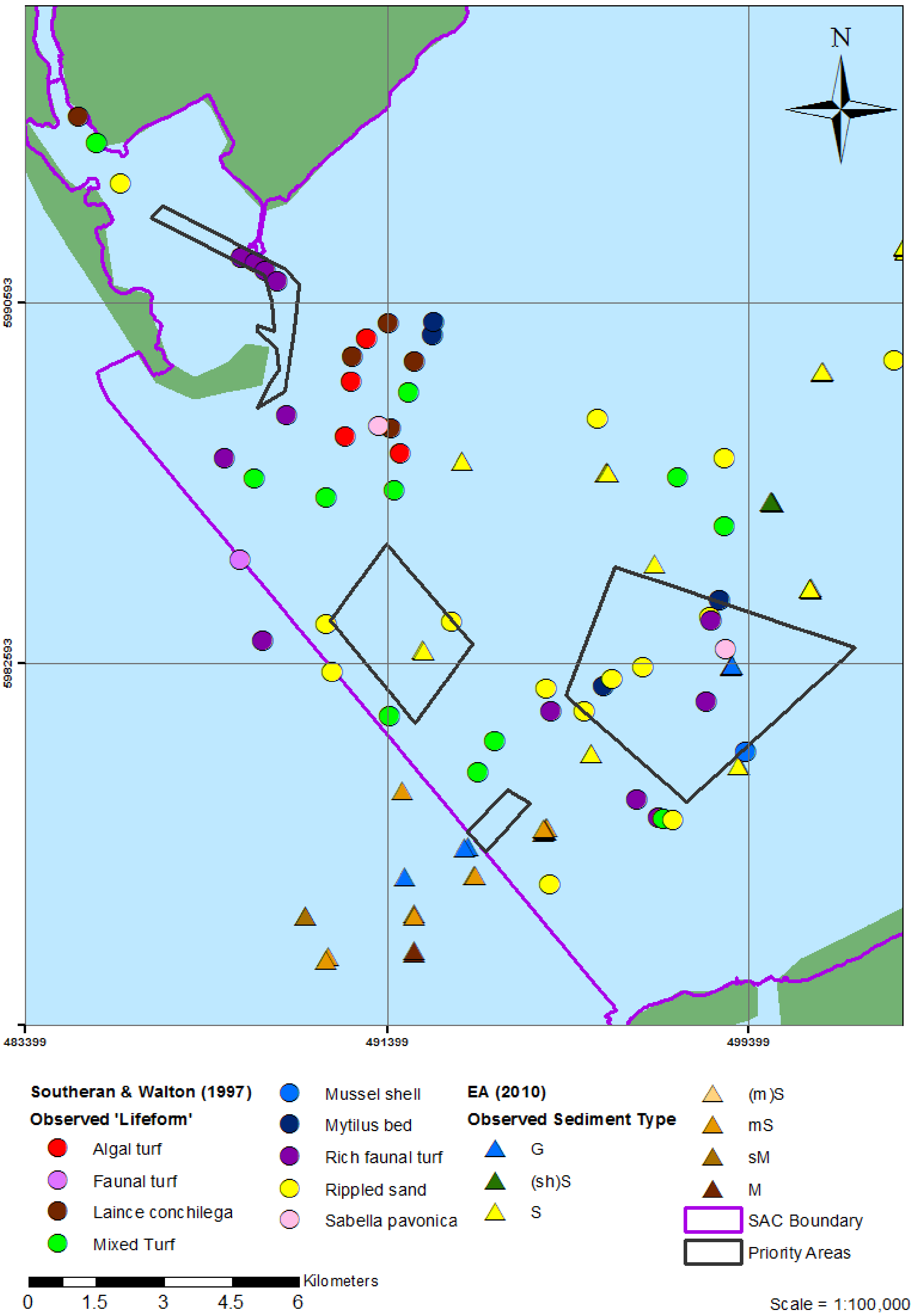

Figure 1.5: Sampling locations and general findings of surveys conducted by (i) Southeran and Walton (1997) and (ii) Environment Agency (2010) in the vicinity of the Morecambe Bay SAC

Figure 1.6: Sampling locations and general results of the survey conducted by Woombs (2000) in the Walney Channel

1.3.2.2 Cobble and boulder skear communities

The intertidal sand and mudflats within the Morecambe Bay SAC cover an area of 33,750 ha, over half of the total area of the SAC (Davidson et al., 1991). While hard substrata are limited in extent in the area, the Annex I habitat 'reefs' are a secondary qualifying feature of the SAC (JNCC, 2015a). Reefs are defined by the JNCC (2015b) in relation to SAC selection as;

Rocky marine habitats or biological concretions that rise from the seabed. They are generally subtidal but may extend as an unbroken transition into the intertidal zone, where they are exposed to the air at low tide. Intertidal areas are only included within this Annex I type where they are connected to subtidal reefs. Reefs are very variable in form and in the communities that they support. Two main types of reef can be recognised: those where animal and plant communities develop on rock or stable boulders and cobbles, and those where structure is created by the animals themselves (biogenic reefs).

Ecological subdivisions for Annex I Reef include bedrock, stony and biogenic reefs. In the Morecambe Bay SAC, areas of the seabed which are composed of cobbles and boulders on otherwise soft sediment are locally known as 'scars' or 'skears.' Perkins (1986) defines the term 'scar' (or 'skear') as;

A hard substratum emergent from the widespread areas of mobile sand and liable to periodic inundation by the sand. While some may be composed of one type of substratum, others may be a mixture of two or more.

Lancaster (2009) additionally states that scars are remnants of glacial scarring and deposition; areas of cobbles, boulders and pebbles on otherwise sandy substrata. Isolated outcrops of hard substrata in largely sedimentary environments provide discrete potential habitats for epifaunal communities (Irving, 1996).

In the Morecambe Bay area, skears have been recorded in several locations; at the mouths of the main rivers, particularly the Lune and the Wyre; at Foot Skear, which is located off the coast between Heysham and Morecambe; and in the Walney Channel (Sotheran and Walton, 1997; Woombs, 2000). Areas of rocky reef have also been identified just outside the SAC, with bedrock and boulder reef identified in the centre of the mouth of Morecambe Bay (CMACS, 2013), adjacent to the SAC boundary, and west of Walney Island. Areas of cobbles and boulders have also been observed west of Rossall Point (Envision, 2008).

Areas of rocky scar ground increase the biodiversity of the area as they support a range of other species characteristic of harder substrata which may not be otherwise present. As stated in the Favourable Condition Table (FCT) (Table 1.1), skears provide habitat for mussel beds (*Mytilus edulis*) and an internationally scarce assemblage of encrusting cushion sponges (such as *Haliclona (Haliclona) oculata, Halichondria panicea* and *Hymeniacidon perlevis*), ascidians and hydroids, as well as for aggregations of the Honeycomb worm *Sabellaria alveolata* in the intertidal (English Nature, 2000; Woombs, 2000). Areas of cobble and boulder skear located southwest of the SAC boundary have been found to be characterised by faunal turf biotopes (Envision Ltd., 2008; Figure 1.5), which is consistent with the largely opportunistic and resilient epifaunal communities expected on cobble and boulder skears (Irving, 1996).

1.4 Survey aims

The overall aim of this contract was to undertake a drop-down video survey in order to inform condition monitoring of the subtidal cobble and boulder skear communities within the Morecambe Bay SAC. The attributes to be assessed during the survey were as follows;

- Extent and distribution of subtidal boulder and cobble skear communities
- Extent and distribution of characterising biotopes
- Species composition of reef characterising biotopes
- Spatial arrangement of biotopes within the Walney / Piel channel

The data acquired were to be of sufficient quality to allow for a preliminary condition assessment of Annex I sub-features to be made, as well a comparison with previous data to assess any change in feature condition (see **Error! Reference source not found.**). A limited quantity of baseline data is available for the survey area, with the only previous study conducted in order to determine condition being that of Woombs (2000) within the Walney Channel.

Table 1.1: Attributes to be used to define the condition of the Morecambe Bay SAC sub-feature of interest ‘subtidal cobble and boulder skears’ (after English Nature, 2000).

Sub-feature	Attribute	Measure	Target	Method	Baseline
Subtidal boulder & cobble skears	Characteristic species – mussel *Mytilus edulis*.	Abundance and age/size class profile of mussels, measured periodically (frequency to be determined).	Percentage of sexually mature mussels and newly recruited mussels on beds should not fall below North Western & North Wales Sea Fisheries Committee baseline, to be established, subject to natural change.	Drop-down video	None
	Characteristic species - Mermaids glove sponge *Haliclona oculata,* Breadcrumb sponge *Halichondria panicea* and *Hymeniacidon perleve*.	Abundance (% cover) of characteristic sponge species in m^2 quadrats along two transects. Measured twice during reporting cycle.	Average abundance should not deviate significantly from an established baseline, subject to natural change.	Diving survey and / or drop-down video survey	Woombs, (2000) for Walney Channel only.

2. Methodology

The survey was conducted on board Seastar Survey's own vessel, SV '*Mariner*', and was undertaken in two phases. Phase I was mobilised on 5th of August 2014 and survey operations took place on 7th August 2014. Phase II of the survey was mobilised on 30th August 2014 and operations took place between 31st August and 9th September 2014. Mobilisation and demobilisation of the survey equipment for Phase I took place at Glasson Basin Marina, Glasson, Lancashire, on the 5th August and 8th August 2014 respectively. The mobilisation for Phase II took place at Glasson Basin Marina on the 30th August 2014 and demobilisation at Whitehaven, Cumbria, on the 10th of September 2014.

Survey operations were conducted on a total of eight days during the survey periods. There were a total of three weather days, occurring on the 6th August, 1st September and 7th September.

2.1 Overall approach to sampling design

The survey plan was designed to assess the extent and distribution of subtidal boulder and cobble skear communities within the Morecambe Bay SAC using a high resolution video camera mounted in a freshwater lens camera system. Camera stations were selected using existing acoustic data supplied to Seastar Survey by Natural England. Four priority areas were selected by Natural England as areas likely to contain subtidal cobble and boulder skear habitat. Prior to the commencement of survey operations 67 camera transects, each 300 m in length, were selected within the priority areas following interpretation and assessment of the available acoustic data and previous survey data (discussed in section 1.2.3.1) provided to Seastar Survey by Natural England. The remaining locations were selected following preliminary on-board assessment of the data collected from the pre-selected locations. The sampling strategy was designed to cover the full range of habitats, water depths and geographic extent of the survey area as well as targeting any potential feature of interest, particularly cobble and boulder skears, focussing effort on the four priority areas provided by Natural England. The proposed sampling locations are given in Appendix I and are displayed, alongside the priority survey areas, in **Error! Reference source not found.**.

Priority Area 1 is described as the Heysham Lake and Lancaster Sound area and is the largest of the four main areas. This area encompasses the mouths of the rivers Lune and Wyre. Area 2 is the second largest of the main areas of investigation and is situated in the centre of Morecambe Bay, adjacent to Morte Bank. Area 3 is a raised ridge-like feature on the northern bank of the Lune Channel and is the smallest of the main areas. Area 4 comprises the Walney Channel, a frequently dredged access channel to the major port of Barrow-in-Furness. There is historic incidence of cobble habitat that has been recorded within the Walney Channel, particularly on the northern shore (Woombs, 2000; Sotheran and Walton, 1997).

Both sets of acoustic data (Envision, 2008; ABP, 2012) were analysed during the project planning stage, and it was ensured that a minimum of one DDV transect was located on each of the observed areas of similar reflectivity and on each of the apparent bathymetric features identified (numerous ridges and suspected rocky outcrops). During the field work stage additional stations were added to the initial survey plan in areas which were deemed to be under-sampled or more heterogeneous than initially expected.

2.2 Survey strategy

2.2.1 Survey equipment

The equipment used during the Morecambe Bay SAC subtidal cobble and boulder skear community survey included:

- Hemisphere Crescent A100 DGPS
- Hypack 2011 survey management software
- Sony MiniDV recorder
- Seastar Survey Freshwater Lens Camera System including:
- Bowtech Surveyor HD video camera
- Bowtech Surface Control System
- Seatronics Ltd. SeaLED subsea lights
- Two x 150 m soft umbilicals
- Simrad CA42 hull mounted echosounder
- Roberts Fluxgate Compass

2.2.2 Horizontal control

Positioning of the vessel was achieved using a Hemisphere Crescent A100 DGPS smart antenna. This system fed raw WGS84 positions into Hypack 2011 survey management software. The WGS84 positions were then converted by Hypack 2011 into Universal Transverse Mercator (WGS84 UTM North Zone 30 (6°W - 0°) grid co-ordinates. A navigation check was carried out at the beginning the survey, where the vessel position was logged whilst alongside a known position, with all offsets measured.

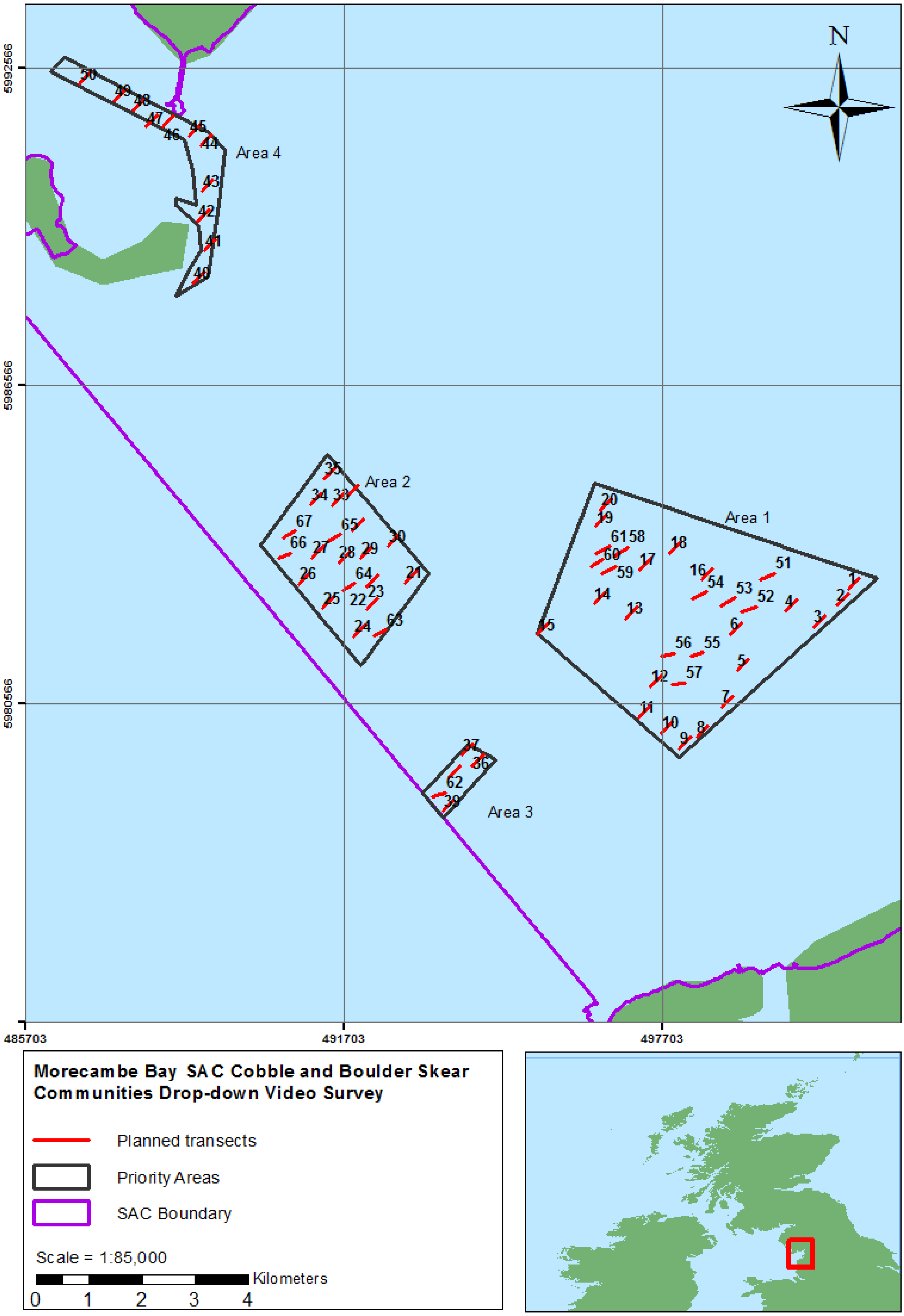

Figure 2.1: Planned video camera transect locations in the Morecambe Bay SAC 2014 survey area

2.2.3 Vertical control

SV *'Mariner'* was equipped with a Simrad CA42 chart plotter with intetgrated echosounder transducer. The raw depth under the keel was monitored and a correction added to account for the draught of the vessel. No tidal correction has been applied to the data.

2.2.4 Drop down video methodology

2.2.4.1 Freshwater lens camera system

Due to the nature of the survey environment, the client specified that a freshwater lens system was to be used. The term 'freshwater lens' refers to a system comprising an underwater video camera housed within a sealed container filled with fresh or distilled water, mounted vertically over a clear lens at the base of the housing. This system enables useable seabed video data to be collected in highly turbid conditions by reducing the path length of light through the turbid water whilst still allowing the camera to be mounted far enough from the seabed to capture an appropriate field of view.

The Seastar Survey Freshwater Lens Camera system (FLCS) was designed in house and custom-built to prioritise flexibility and reliability in challenging conditions. The system can house a variety of High Definition (1080p) subsea video cameras and allow these cameras to acquire a minimum seabed field of view of 40 x 29 cm in waters with a visibility of <10 cm.

The subsea video camera mounted within the FLCS during this survey was a Bowtech Surveyor HD digital video camera, recording HD (1080p) video with a field of view of approximately 40 x 29 cm at a frame height of 10 cm. The camera was controlled using a surface command unit (SCU) enabling direct recording of HD video to a 250 GB Hard Disk Drive (HDD) recorder. Secondary recording was achieved using a high resolution Sony MiniDV digital tape recording system. The SCU enabled real time control of optical zoom, focus and iris. Four sub-sea LED lights were also mounted on the frame to illuminate the seabed and were controlled from the surface.

2.2.4.2 Deployment methodology

Due to the nature of the strong and very irregular tidal flows within Morecambe Bay, together with the poor underwater visibility experienced throughout the survey, it was determined that the established method of towing the camera frame just above the seabed would yield no usable data. Instead the camera frame had to be landed on the seabed in order to acquire usable footage. Seastar Survey's standard deployment methodology was therefore adapted to allow for approximately one seabed landing every 50 m. These landings had minimal impact on the seabed, particularly when compared with methods such as camera sledges. Each of these seabed landings is referred to as a "seabed contact" in the following report.

The FLCS frame height was fixed at 10 cm above the seabed for the duration of this survey, as the underwater visibility was consistently <10 cm. A scale chord was attached across the field of view to aid focusing the camera and to aid sediment and species identification.

The camera was deployed over the stern of the vessel using the vessel's A-frame and winch. Two members of crew guided the frame over the stern of the vessel and the soft umbilical cable was taped to the winch wire at regular intervals to prevent excess drag and entanglement. Once the camera system was in the water and approximately 1 m above the seabed the onboard surveyor began to log navigation data. The skipper then positioned the vessel with the bow facing into the tide and approached the first drop location at the start of the transect. The vessel then came to a stop and the camera was slowly lowered to the seabed. A manual fix was then taken to record the time (UTC) and the exact position of the frame on the seabed. The lack of vessel movement resulted in minimal horizontal layback of the frame from the vessel's navigational reference point at the time of the fix. Once the camera was landed the umbilical and winch wire were paid out at an appropriate speed to compensate for vessel drift, allowing the camera to remain stationary on the seabed for sufficient time to allow for suspended sediment to clear and high quality video to be acquired.

The camera sent a continuous video feed to the surface, where the deployment was monitored and the camera was controlled by the camera operator using the surface control system. The HD system was set to record discrete seabed landings (referred to as "clips") only, and each HD track was associated with a separate seabed landing. The entirety of each transect was recorded using MiniDV tapes.

Seven video clips, at approximately 50 m intervals along each transect, were planned. This number was increased in the field when rocky scar ground habitat was encountered. The distribution of seabed landings allowed for representative footage of the seabed habitats, dominant benthic fauna, seabed features and sediment types to be captured. Where visibility was very poor (<5 cm) the camera was still deployed in order to gain an indication of seabed type.

Raw navigation data were recorded throughout the drop-down camera deployment. All camera deployment logs were synchronised to the navigation data from the GPS system. The camera operator recorded the time in UTC from the GPS at the start and end of each deployment and the time of each landing. The position of each seabed landing was then extracted from the navigation data and backed up on a separate system.

The HDD tracks were backed up at the end of each day onto an external hard drive and stored in a separate location to the back-up MiniDV tapes. Upon completion of the survey the miniDV tapes from the video camera were uploaded to a computer, edited, titled and burnt to DVD at Seastar Survey's office in Southampton.

2.3 Video analysis and habitat mapping

2.3.1 Analysis of the HD video records

The nature of the highly turbid environment within the survey areas, and the resultant required deployment methodology, resulted in a dataset comprised of discrete seabed HD video 'clips.' These video clips record a static 0.116 m^2 patch of the seabed for a period of between 30 and 60 seconds. The camera system remained stationary during this time, however the entire video clip was analysed in each case in order to record any mobile fauna present.

Video clip analysis consisted of a description of the seabed and the identification of flora and fauna to the lowest practical taxonomic level. The abundance data were recorded using the semi-quantitative SACFOR scale, however counts or percentage cover of taxa were also recorded where it was deemed useful (e.g. reef forming species etc.). Sediment categories were assigned based on the Folk Trigon and Wentworth scale (see Leeder, 1982), with boulders and cobbles being described within 'gravel', and 'rock' referring to bedrock. A broadscale habitat (BSH) type was subsequently assigned to each video segment. If applicable a Habitat Features of Conservation Importance (FOCI) category was also assigned. The presence of any Annex I habitats and associated sub-features, including reef sub-features, were recorded. In addition, where potential stony reef was recorded, an assessment of 'reefiness' was made, as according to Irving (2009), based on elevation, coverage and, where possible, extent (Table 2.1). However, without a grab survey, the fourth criterion of stony reefs could not be assessed. Any other features of interest, including anthropogenic impacts such as trawl marks or litter, were also noted. A list of the encountered fauna was produced for each site using species reference numbers as cited in the Marine Conservation Society Species Directory (Howson and Picton, 1997) with additional reference to the World Register of Marine Species (WoRMS Editorial Board, 2015) to avoid problems in species nomenclature. Video clips were assigned a biotope according to Connor *et al.* (2004) and a European Nature Information System (EUNIS) habitat classification code. The results were analysed using GIS which enabled a high level of processing, interpretation and display of substrata types, biotopes and HD video data.

The Quality Control (QC) process for the video analysis involved ongoing and post-analysis elements, as well as continuous collaboration with other Seastar Survey staff to check species identification, sediment classification and biotope classifications during the process of analysis. A senior member of staff also checked any uncertain identifications to ensure the highest possible level of data quality. The post-analysis QC process involved a re-assessment of 10 % of the data, checking the faunal / floral identification, habitat / biotope classification and data entry. Any discrepancies were discussed between analysts and agreed on prior to finalisation of the results.

Table 2.1: The main characterising features of a stony reef, after Irving (2009).

Characteristic	Not a reef	Resemblance to being a stony reef		
		Low	Medium	High
Composition	< 10 %	10 - 40 %	40 - 95 %	> 95 %
Elevation	Flat seabed	< 64 mm	64 mm - 5 m	> 5 m
Extent	< 25 m^2	> 25 m^2		
Biota	Dominated by infaunal species			> 80 % of species epifauna

2.3.2 Biotope and skear mapping

The assigned biotopes for each discrete HD video clip were incorporated into the GIS and the relevant positions checked against the proposed locations for positional quality control. The data were then superimposed over the acoustic data (both MBES and backscatter). The principal of habitat mapping is based on the acquisition of video (or sediment sampling) data which enables areas of consistent reflectivity, areas of consistent depths or bathymetric features to be ground-truthed. The ground-truthing of the acoustic data enables a substrate type or biotope to be assigned to areas of consistent reflectivity (principally using sidescan sonar data) or bathymetry with varying levels of confidence. This assignment is illustrated by creating a layer of polygon shape files within the GIS to create habitat maps.

2.3.2.1 Broadscale biotope mapping

The first stage of biotope mapping involved the delineation of broadscale habitat and biotope types. The biotope mapping process would be usually achieved by ground-truthing areas of consistent reflectivity identified from sidescan sonar acoustic data, however the acoustic dataset provided by the client consisted of multibeam bathymetry and associated backscatter data. Due to the inherent uncertainty associated with backscatter data and the lack of associated metadata (see section 4.2.3), these data were used in conjunction with the bathymetric dataset to delineate the broadscale biotopes within areas dominated by a single biotope or biotope complex.

2.3.2.2 Cobble and boulder skear mapping

Once the broadscale biotopes had been mapped the next stage of analysis involved the mapping of areas of cobble and boulder skear. Areas of potential cobble and boulder skear were delineated based on percentage cobble composition, assigned biotope and reflectivity and / or bathymetric features.

Three levels of confidence were assigned to the cobble and boulder skear polygons, in order to provide levels of accuracy in prediction of these habitats of interest. Habitat polygons at point source (i.e. a single video clip) are estimated >90 % accurate (confidence level 1). Confidence level 2 (areas immediately surrounding point source data) was assigned with 70 – 80 % confidence. These polygons were generated by extending a 50 m radius from any point source at which the seabed was shown to be composed of greater than 10 % cobbles, or from seabed contacts at which cobble coverage was recorded as <10 % but which were located within 50 m of a contact with >50 % cobbles. Level three polygons were assigned a confidence level of 50 – 70 %, and have been delineated by extending areas of level two polygons along bathymetric features and areas of similar reflectivity.

3. Results

3.1 HD video analysis – ground-truthing

A total of 71 transects were completed in the Morecambe Bay SAC survey areas. This included 66 of the 67 proposed camera transects. Transect 13 was not attempted due to time limitations and due to the fact that the area had been ground-truthed by other transects. Twenty-three of the planned 67 transects were relocated whilst in the field, so as to provide further coverage of the SAC and to target specific areas where achieved field data indicated possible cobble and boulder skear habitat.

In total 27 transects were completed in Area 1, 13 transects were completed in Area 2, 6 transects in Area 3 and 13 in Area 4 (the Walney Channel). Twelve transects were located outside of the main areas of interest. In total 528 discrete seabed video clips were recorded, 500 of which yielded usable data. Figure 3.1 shows the locations of all the achieved seabed landings and the full logs with all locations are given in Appendix II. Over 8.5 hours of seabed video footage were obtained.

Underwater visibility was very poor throughout the survey, varying – depending on the state of the tide – from between approximately 5 cm and 20 cm. Given the very poor underwater visibility conditions experienced throughout the survey area, the quality of the data acquired was very high overall. All obvious variations in acoustic reflectivity and bathymetric features of interest noted on the acoustic datasets were investigated, thus allowing for a comprehensive ground-truthing of these data.

In order to better acquire data of areas of potential cobble skear habitat, 23 transects were relocated, particularly in the area between the Lune Deep (Priority Area 3) and Priority Area 2. These transects were given the suffix 'a' after their transect number to denote relocation.

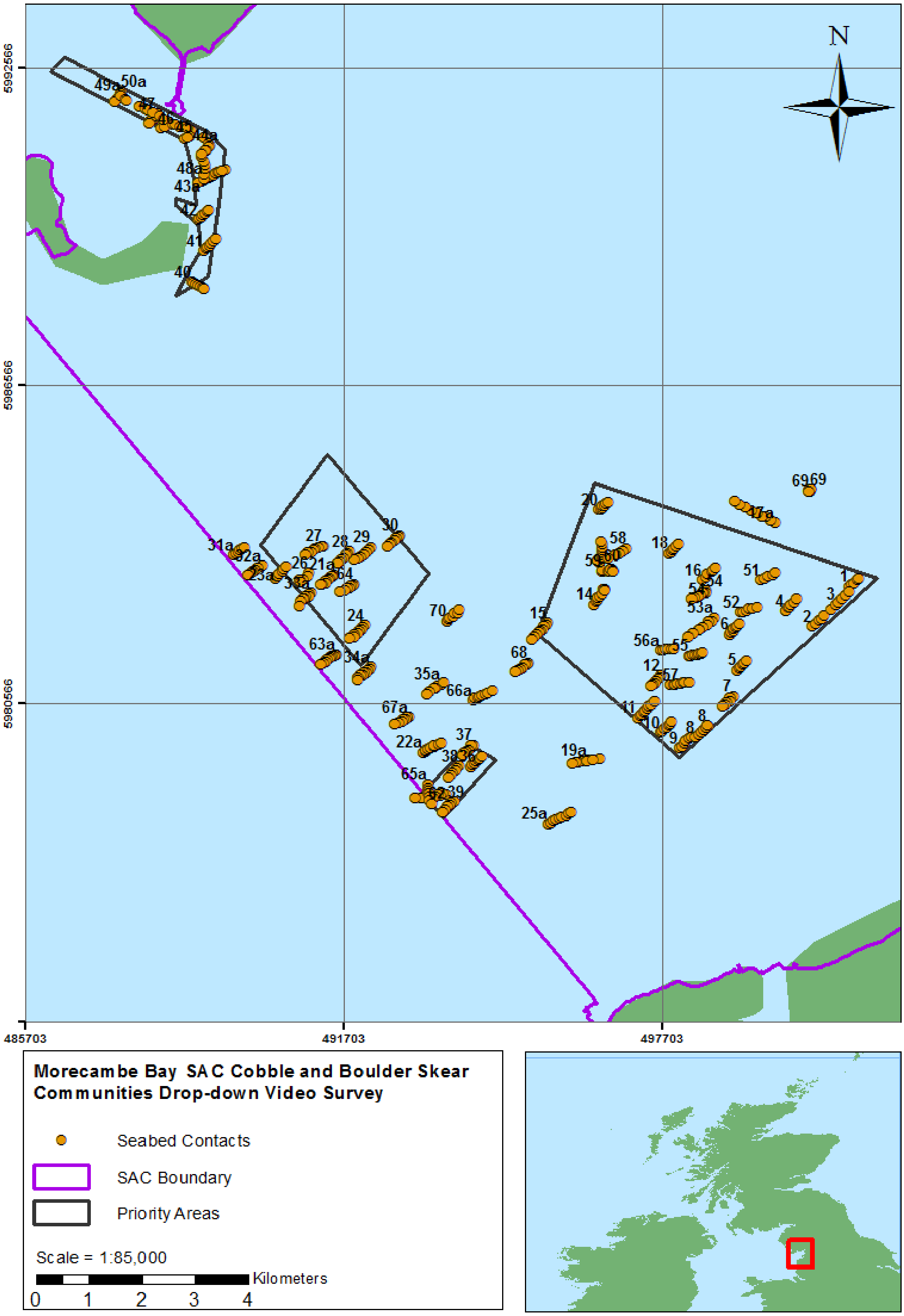

Figure 3.1: Seabed landings achieved in the 2014 drop-down video survey of Morecambe Bay SAC

3.1.1 General description of the biological communities observed

The survey area was found to be generally characterised by sandy sediments. A total of 17 broad habitat types, biotope complexes and biotopes were identified (a glossary of the identified habitat types is found in Appendix III, and a full list of the taxa identified is shown in in Appendix IV). Example screenshots of video data from the survey are given in Figure 3.2 and the distribution of the identified habitat types is shown in Figure 3.3 and Figure 3.4. It should be noted that several biotope assignments have been left at the 'broad habitat type' level (level 2 in the MNCR classification). This is due primarily to a lack of information; soft sediment biotopes should be classified largely based on infaunal data rather than sediment characteristics alone. Furthermore, the assignment of mixed sediment and sandy or muddy biotopes was based solely on the assessment of the person undertaking the analysis. Without supporting data from sediment sample analysis there can be some uncertainty in the assessment of the quantities of sand and mud present. As a result some biotopes may be subject to change.

The most commonly identified broad habitat was **SS.SSa** (sublittoral sands and muddy sands) with 35.5 % of seabed contacts assigned to either the broad habitat **SS.SSa** or the biotope complex **SS.SSa.CMuSa** (circalittoral muddy sand). These sandy sediments were widely distributed throughout the survey area and were generally found to coincide with bathymetric features resembling sublittoral sandbanks. Circalittoral mixed sediments (**SS.SMx.CMx**) were also frequently observed, being assigned to 25.7 % of all video clips. The eastern sections of the survey area, particularly the eastern-most parts of Priority Area 1, including the Lune Channel, were dominated by mixed sediments.

Cobble (and, less frequently, boulder) skear communities were frequently observed throughout the survey area, with cobbles and other coarse substrata recorded on 40 of the 71 transects. The western section of the survey area, particularly Priority Area 2, was found to be dominated by coarser substrata. Cobble skear communities were also observed along the prominent bathymetric ridges in Priority Area 2 and along the steep Lune Channel edge in Priority Area 3.

Due to the paucity of observed fauna, many of the video clips featuring coarse substrata were assigned the biotope complex **SS.SCS.CCS** (circalittoral coarse sediment), however where cobbles and boulders were more dense, fauna was dominated by the ascidian *Molgula manhattensis*. These video clips were assigned the high energy circalittoral rock biotope **CR.HCR.XFa.Mol** (*Molgula manhattensis* with a hydroid and bryozoan turf on tide-swept moderately wave-exposed circalittoral rock). Where the bryozoan *Flustra foliacea* was also observed, the biotope **CR.HCR.XFa.FluCoAs** (*Flustra foliacea* and colonial ascidians on tide-swept moderately wave-exposed circalittoral rock) was assigned. Other predominant fauna identified in areas of cobble and boulder skear included encrusting sponge species (discussed further in section 3.3.2.5), serpulid worms (likely *Spirobranchus* spp.), the bryozoan *Alcyonidium diaphanum* and the common starfish *Asterias rubens*.

The seabed in the Walney Channel was found to be heterogeneous, with frequent patches of sublittoral sands and infralittoral mixed sediment found along edges of the channel, particularly in the northern section. Coarse sediments were frequently observed in the centre of the channel, with biotope complexes such as **SS.SCS.CCS** and the broad habitat type **SS.SMx** dominating the area.

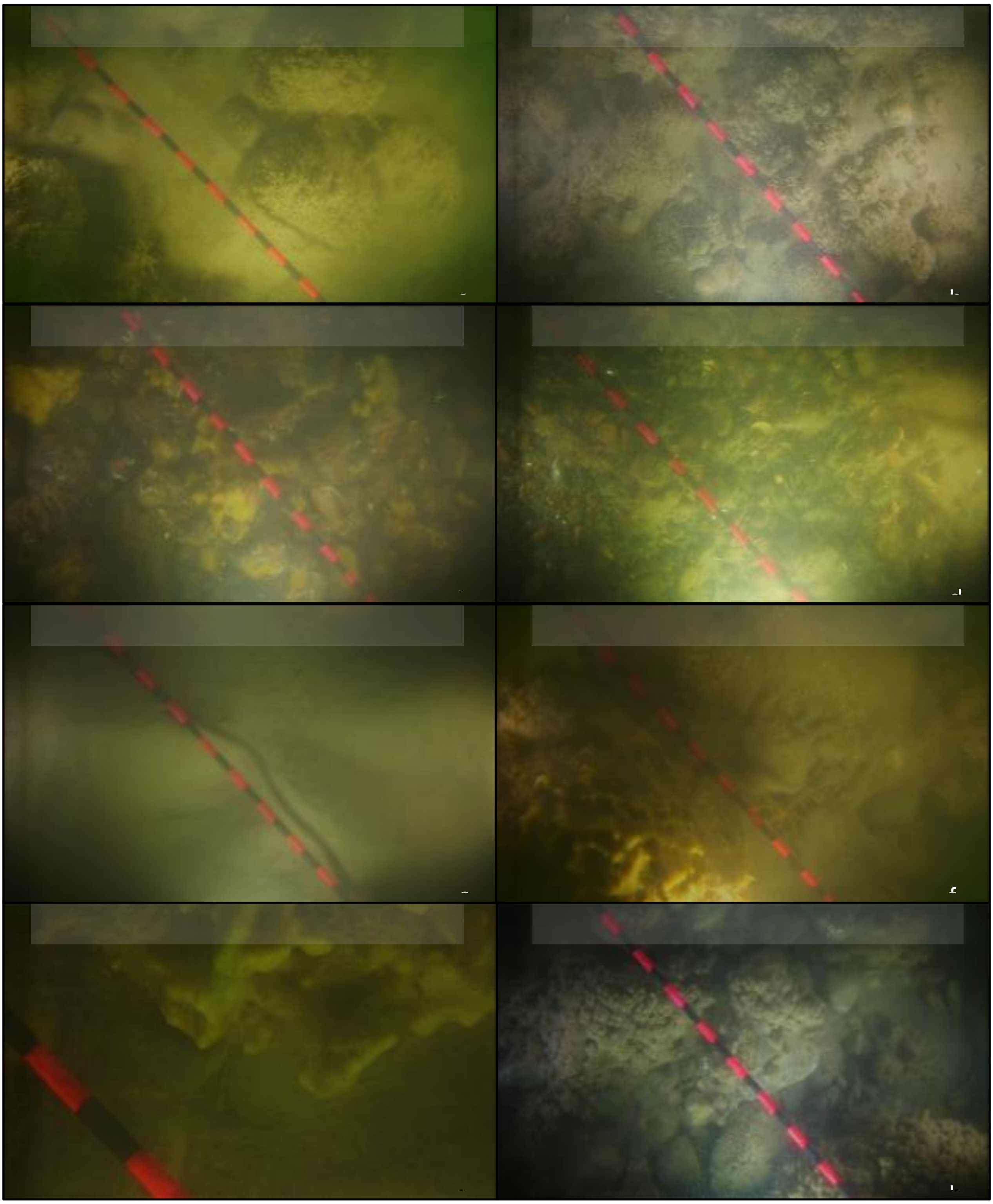

Figure 3.2: Representative screenshots from high definition video showing some of the different substrata observed within the Morecambe Bay SAC; (a) *Molgula manhattensis* and sparse faunal turf on sand-scoured cobbles and gravel; (b) *M. manhattensis* on highly silted pebbles and cobbles; (c) coarse sediment with encrusting sponge and serpulids; (d) coarse sand, gravel and pebbles with sparse encrusting fauna; (e) sandy mud with *Sepiola atlantica*; (f) *M. manhattensis*, encrusting sponge and sparse faunal turf on sand-scoured boulders, cobbles and pebbles; (g) close-up image of encrusting sponge on cobbles; (h) *M. manhattensis* with *Spriobranchus* sp. and *Alcyonidium diaphanum* silty cobbles and gravel. Scale bar in increments of 2 cm.

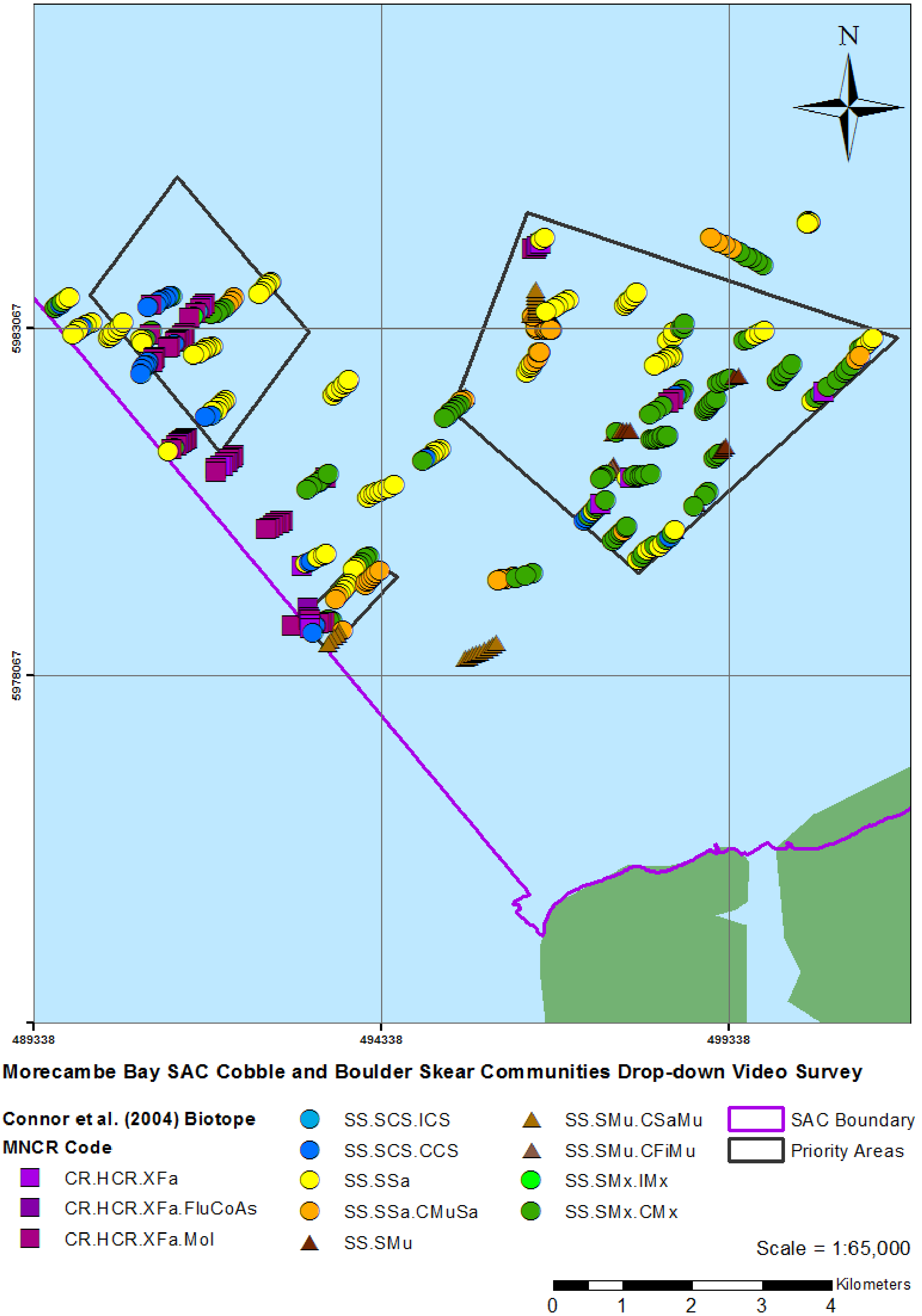

Figure 3.3: Distribution of observed MNCR biotopes (Connor *et al*., 2004) in the Morecambe Bay SAC in 2014 in and around Priority Areas 1 to 3. Each data point represents a single video clip.

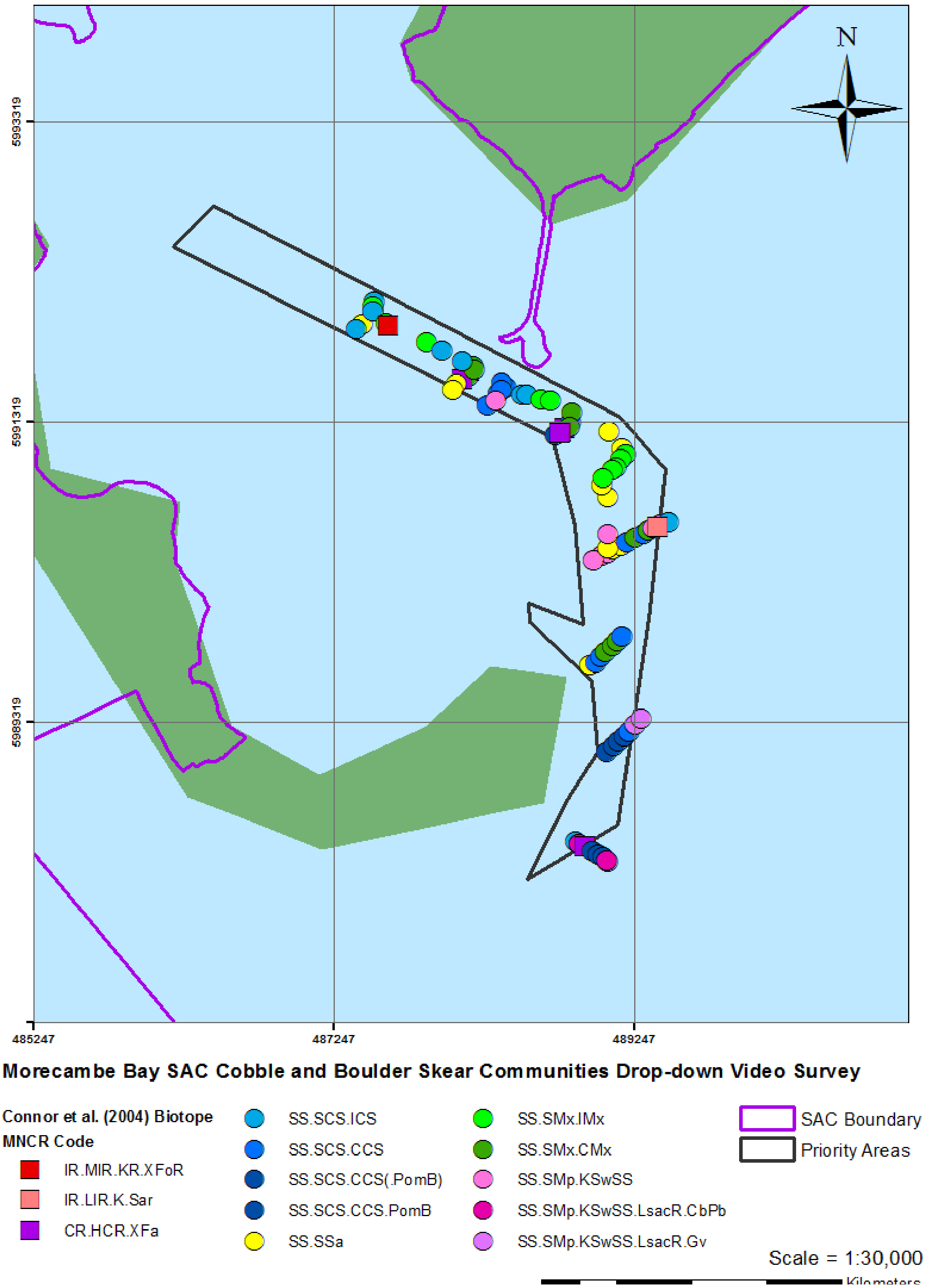

Figure 3.4: Distribution of observed MNCR biotopes (Connor *et al.*, 2004) in the Morecambe Bay SAC in 2014 in and around Priority Areas 4 (The Walney Channel). Each data point represents a single video clip.

3.1.2 The biological community of Priority Area 1

Priority Area 1 was found to be dominated by the biotope complex **SS.SMx.CMx** (circalittoral mixed sediment) and the broad habitat types **SS.SMu** (sublittoral cohesive mud and sandy mud communities) and **SS.SSa** (sublittoral sands and muddy sands). The **SS.SSa** habitats were generally located in the western parts of Area 1, the northern part of which could be a potential Annex I subtidal sandbank feature, although due to lack of depth information this classification is uncertain. Faunal abundance and diversity observed at stations in this area were low.

In the northwest of Area 1 two bathymetric features were identified; a raised potentially rocky outcrop and an area containing numerous small raised mounds. Video data from transect 20 indicated that the potential rocky feature consisted of cobbles dominated by the mixed faunal turf biotope **CR.HCR.XFa.Mol** (*Molgula manhattensis* with a hydroid and bryozoan turf on tide-swept moderately wave-exposed circalittoral rock). The fauna observed was more diverse than otherwise encountered within Area 1 and was dominated by the colonial ascidian *M. mahattensis,* the bryozoan *F. foliacea* and the hydroid *Sertularia* spp.. The area of small mounds to the south of the cobble outcrop was ground-truthed by five transects (58, 59, 60, 61a and 14), however all video data in this area indicated that the seabed was composed of sands, muddy sands and sandy muds with very sparse associated epifauna. It is therefore unclear what these bathymetric features may have been.

In the central eastern region of Area 1 is a prominent bathymetric feature (associated with the beginning of the Lune Channel) which was found to correspond with a change in dominant habitat type. The channel was found to be characterised by circalittoral mixed sediments (**SS.SMx.CMx**), with patches of coarser sediments associated with a lower reflectivity depression or scour feature in the centre of this area. Fauna was generally dominated by hydroids, the common starfish *A. rubens* and hermit crabs (Paguridae), although patchy aggregations of the colonial ascidian *M. mahattensis* were also observed. The potential scour features were found to be characterised by the habitat type **SS.SMu** and the biotope complexes **SS.SMu.CSaMu** (circalittoral sandy mud) and **SS.SMu.CFiMu** (circalittoral fine mud).

3.1.3 The biological community of Priority Area 2

Priority Area 2 was found to be relatively patchy, with a variety of seabed reflectivity and variations in depth identified. Prominent seabed features, such as megaripples, were identified throughout. A potential sandbank feature was identified in the southeast of Area 2, associated with raised bathymetry, varying reflectivity and prominent megaripple seabed features. The dominant substrata identified using video data from this area (e.g. transects 24 and 64) were sublittoral sands and muddy sands (**SS.SSa**). Similar substrata were observed in the western corner of Area 2, associated with a gap in the acoustic data and a corresponding a rise in bathymetry; it is possible that this area also constitutes a potential Annex I sublittoral sandbank feature.

The rest of Area 2 was rather more heterogeneous, with patches of coarse sand and gravel (**SS.SCS.CCS**) and mixed sediments (**SS.SMx.CMx**) recorded. These sediments were characterised by a sparse epifaunal community dominated by the keel worm *Spirobranchus* sp..

Areas of cobble skear were also observed in Area 2; in many cases these were classified as the biotope complex **SS.SCS.CCS** due to a lack of epifauna, however where aggregations of the colonial ascidian *M. mahattensis* were observed on silty cobbles the biotope **CR.HCR.XFa.Mol** was assigned. This biotope was generally associated with bathymetric 'ridges' running southwest / northeast through Area 2. Other fauna associated with this habitat included encrusting sponges and hydroids such as *Sertularia* sp. and *Hydrallmania falcata*.

3.1.4 The biological community of Priority Area 3

Priority Area 3 was situated on the edge of the Lune Channel, covering the very steep slope of the channel side. The channel seabed in Area 3 was found to be composed of sandy muds and muddy sands (**SS.SMu.CSaMu** and **SS.SSa.CMuSa**). Fauna observed in this area included polychaetes (including *Sabella pavonina* tubes) and the brittlestar *Ophiura ophiura*. To the north of the channel the seabed was found to be a matrix of sand, mud and mixed sediment types.

At the edge of the channel in the south of Area 3 there a prominent bathymetric feature associated with high reflectivity. This feature was found to be primarily composed of cobble skear habitat, with the biotopes the biotopes **CR.HCR.XFa.Mol** and **CR.HCR.XFa.FluCoAs** (*Flustra foliacea* and colonial ascidians on tide-swept moderately wave-exposed circalittoral rock). The colonial ascidian *M. mahattensis* was characteristic of both of these biotopes, however where *F. foliacea* was recorded as common or abundant the biotope **CR.HCR.XFa.FluCoAs** was considered more appropriate.

3.1.5 The biological community of Priority Area 4 – the Walney Channel

The biological communities of the Walney Channel were found to be distinct from the wider Morecambe Bay SAC in their composition and the heterogeneity of habitat types encountered. Nine of the ten transects conducted in this area were orientated across the channel in order to investigate seabed habitats across a range of depths.

The acoustic data indicated the presence of coarser sediment in the central section of the channel. In the northern part of Area 4 the deeper central part of the channel was found to be a mix of coarse and mixed sediments, with fauna dominated by *Spirobranchus* spp., *Hydrallmania falcata* and encrusting sponges. While no transects were conducted further up the channel than transect 49, interpretation of the acoustic data in conjunction with ground-truthing data indicated that the seabed was also likely composed of coarse sands and gravels.

The sediments in southern parts of the channel were generally found to be finer. Biotopes in the biotope complex **SS.SMp.KSwSS** (kelp and seaweed communities on sublittoral sediment) were recorded along the southern bank of the 'dog-leg' corner of the channel, where the community was dominated by filamentous and foliose red algae attached to mixed gravelly sediments. The invasive species *Sargassum muticum* was observed at one station (transect 43a); the biotope **IR.LIR.K.Sar** (*Sargassum muticum* on shallow slightly tide-swept infralittoral mixed substrata) was therefore assigned.

Two areas of cobble-dominated substrate were observed in Area 4, extending from the north bank into the centre of the channel (transects 45 and 47). These areas were classified either as the biotope complex **SS.SMx.CMx** or as the *M. mahattensis* dominated **CR.HCR.XFa.Mol**.

3.1.6 Biological communities observed outside of the Priority Areas

In-field reviews of acoustic data and ground-truthing data acquired to date indicated the probable presence of cobble and boulder skear habitat in several areas outside of the assigned Priority Areas, including; on the plateau between priority survey areas 2 and 3; in an area north of Area 1; and an area south of Area 2. Seventeen additional transects were therefore conducted over these areas and on any other bathymetric features of interest.

Cobbles or coarse substrata were identified on 6 of these 17 transects. The areas of cobble skear observed were generally dominated by *M. mahattensis* (**CR.HCR.XFa.Mol**). Areas of bathymetric highs were shown to be generally composed of fine sediment habitats, such as the broad habitat type **SS.SSa** (transects 70 and 66a), and the mixed biotope complex **SS.SMx.CMx**.

Additional transects were also conducted in the central and southern edge of the Lune Channel (south of Priority Area 1 and east of Priority Area 3; transects 25a and 19a) in order to provide information on the substrata and habitats present within this largely un-sampled feature. These two transects were dominated by soft sediments, with the seabed at transect 25a, in the centre of the Lune Channel, composed of circalittoral sandy mud (**SS.SMu.CSaMu**).

3.2 Biotope mapping of the survey areas

In order to create a biotope map of the surveyed areas of the Morecambe Bay SAC it was necessary to use both the bathymetry and backscatter datasets in conjunction with the ground-truthing survey data. The incorporation of the geophysical datasets and the ground-truthing data into ArcView GIS allowed for a more detailed assessment of the habitats in the survey area. The interpretation of all the available data revealed a heterogeneous seabed environment which was difficult to accurately delineate, not least due to apparent gain changes with depth in the backscatter data.

Initially areas of similar backscatter reflectivity were identified. The broadscale habitat (BSH) types of video clips were then displayed on top of the acoustic data in ArcGIS in order to allow interpretation of the sediment types of each kind of reflectivity in order to provide a low resolution overview of the superficial geology within the survey area. This information is displayed in Figure 3.5 and Figure 3.6, which illustrate the heterogeneous nature of the substrates observed within the survey area.

Subtidal sands dominated large patches of shallow seabed in centre of the survey area (the top of the Lune Channel) and in the region of potential Annex I sandbank features in the west of Area 1. These habitats correspond with areas of lower reflectivity (see Figure 3.6). In Area 2 subtidal coarse sediments covered a higher proportion of the seabed.

Subtidal mud and subtidal mixed sediments were found to dominate within in the Lune Channel and the centre and eastern regions of Priority Area 1. These BSH types correspond with higher seabed reflectivity. The central section of Area 1 appears to comprise mixed sediment habitat types (**A5.4**) alongside a potential outcrop of high energy circalittoral rock (**A4.1**) coinciding with an area of shallower bathymetry. Areas of BSH **A4.1** are concentrated on the plateau to the north of the Lune Channel, running from the edge of the channel in Area 3 in a northwesterly direction, following prominent bathymetric ridges. It should be noted however that in this case ‘high energy circalittoral rock’ corresponds to areas of cobble and boulder hard substrate, rather than bedrock.

The Walney Channel (Priority Area 4) was found to be dominated by subtidal coarse and mixed sediments (**A5.1** and **A5.4**), though subtidal sand (**A5.2**) was also present.

Sediment habitat polygons were initially created based on these data. More detailed polygons were achieved by viewing the biotopes assigned to the individual video clips over the sediment polygons. Boundaries were created around areas dominated by a single biotope, biotope complex or broad habitat type.

The exact positions of the boundaries between different biotopes were often difficult to determine, as biotope boundaries observed were frequently transitional in nature. The patchiness of some biotopes identified in the analysis also resulted in difficulties in determining the exact location of boundaries between biotopes, with patchy biotopes occasionally being incorporated into the more dominant surrounding biotope. In addition, changes in biotope were not always mirrored by changes in reflectivity (for example, areas of mixed sediment and areas of coarse sediment appeared to be very similar), further hampering the assignment of biotope boundaries. In these cases, “best estimates” of the biotope boundary positions were made based solely on the distribution of biotopes assigned to video data. Due to the heterogeneous nature of the seabed within the survey area, some polygons were assigned a ‘matrix’ of two broad habitat types or biotope complexes; this was also the case for regions where changes in reflectivity did not reflect observed habitat types.

An example of the mapping process is illustrated in Figure 3.7, which shows an area of raised seabed with a distinct sediment boundary (inferred from the change in reflectivity, although backscatter changes may also be a reflection of changing depth). The biotopes assigned to the video clips crossing this boundary match well with the change in reflectivity, with the higher reflectivity area being composed of the biotope complex **CR.HCR.XFa** and the lower reflectivity area characterised by sandy sediments.

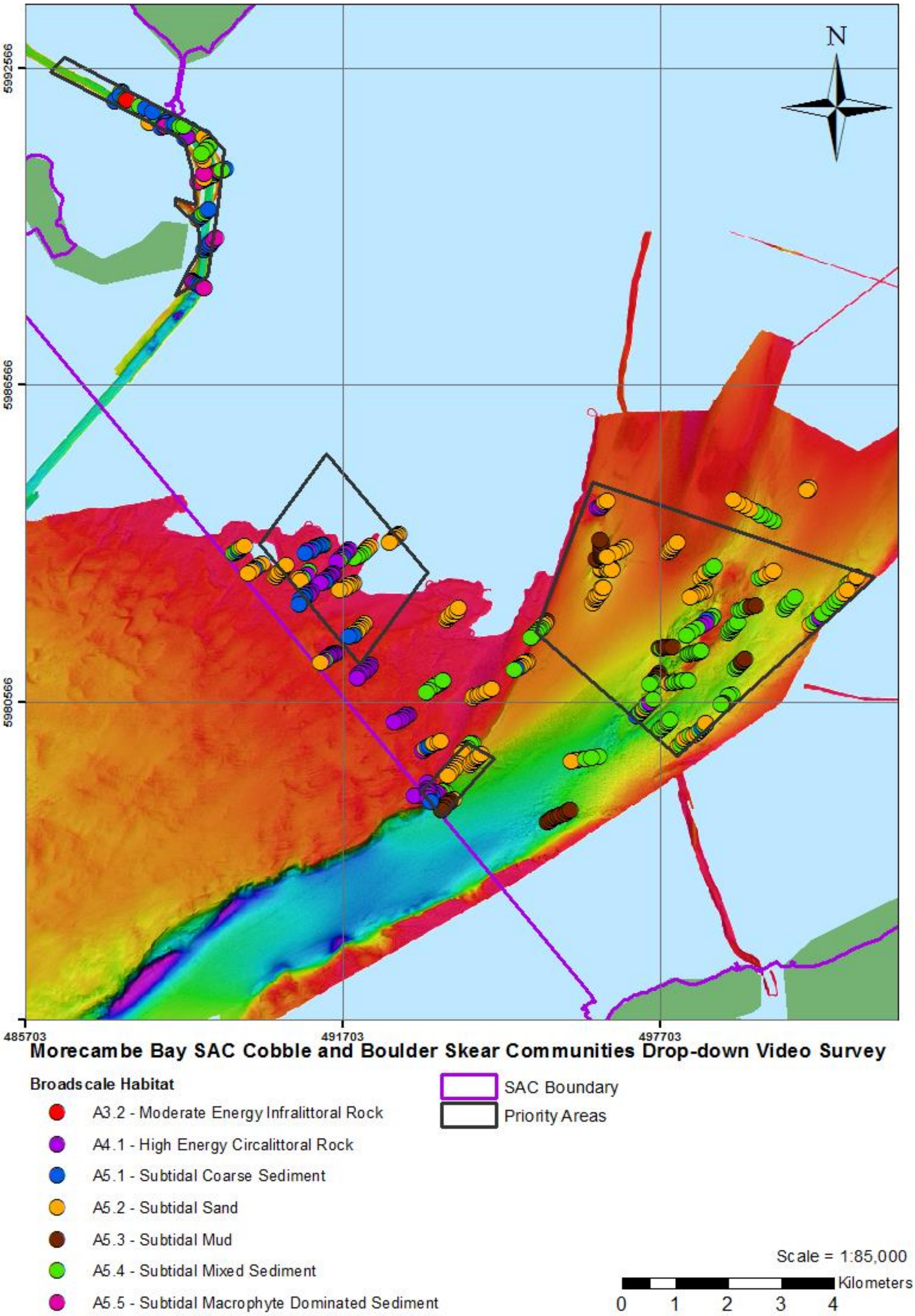

Figure 3.5: Broadscale habitats assigned to each seabed contact in the 2014 Morecambe Bay SAC DDV survey, overlaying MBES data collected by previous surveys.

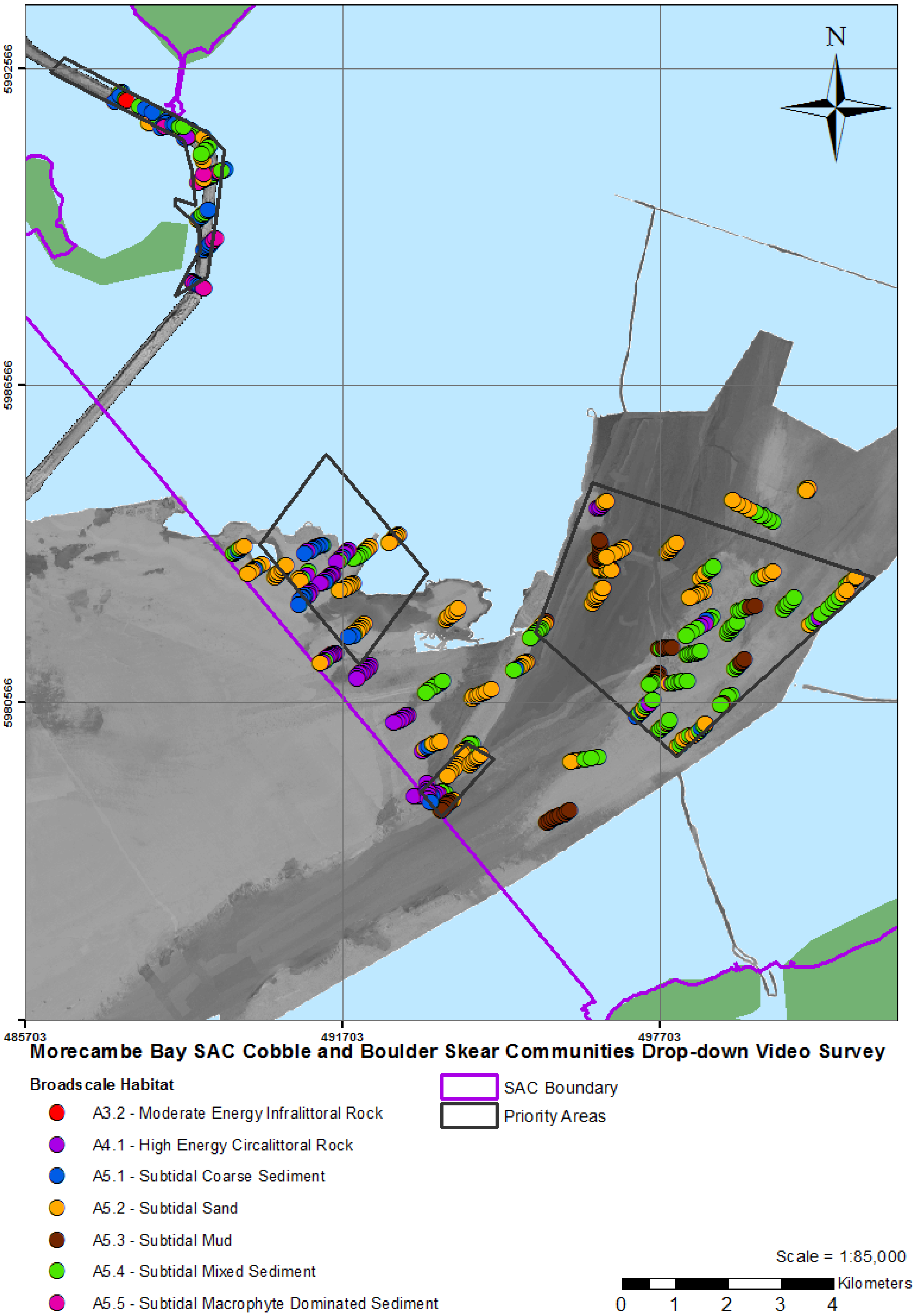

Figure 3.6: Broadscale habitats assigned to each seabed contact in the 2014 Morecambe Bay SAC DDV survey, overlaying backscatter data collected by previous surveys.

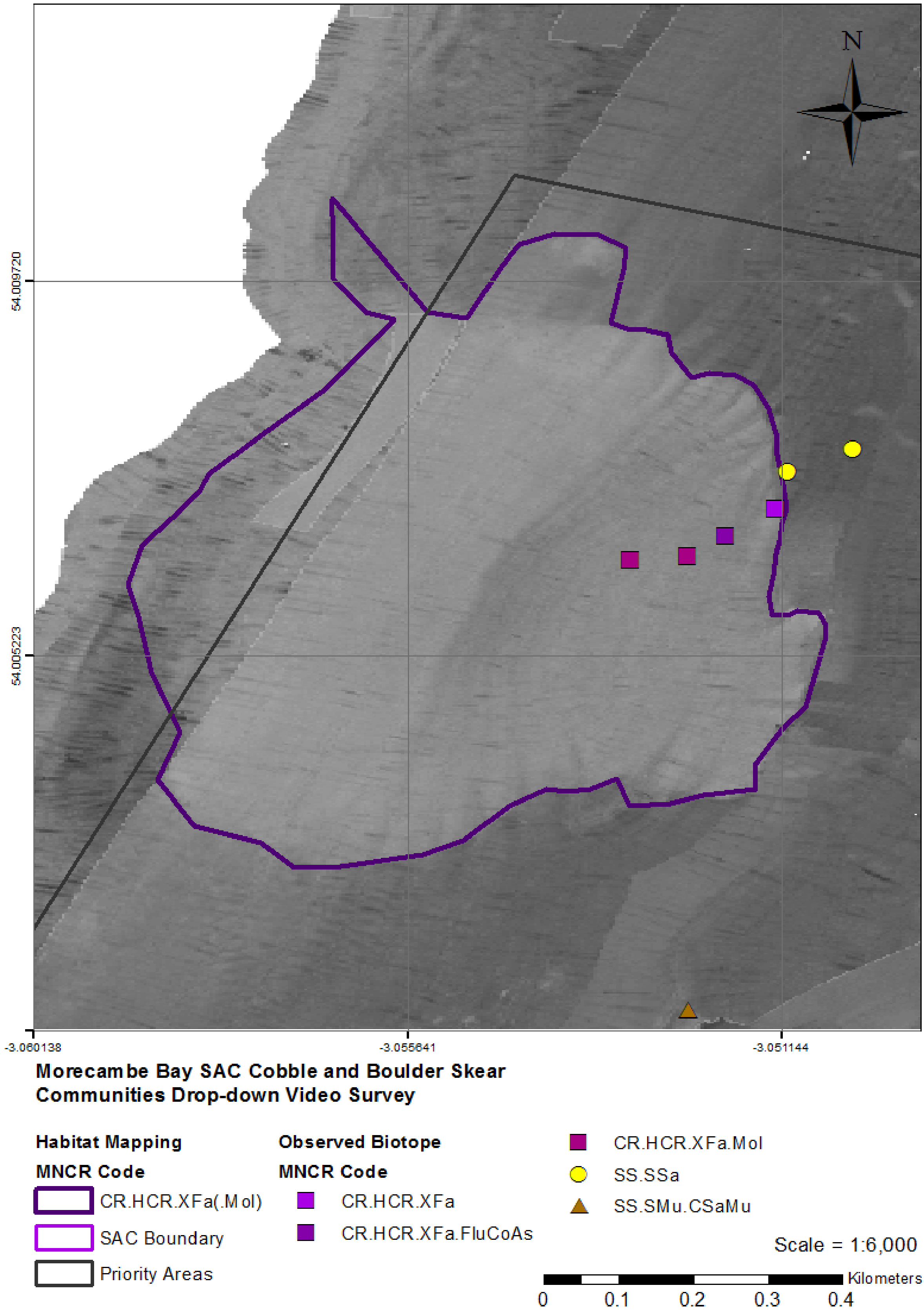

Figure 3.7: Example of biotope mapping using backscatter data in conjunction with drop-down video data; area of stronger reflectivity within priority Area 1 coincident with a change in observed substrata and community

The resultant broadscale biotope map is shown in Figure 3.8 – 3.13. Table 3.1 lists the total area (in km^2) covered by each identified habitat type.

The majority of the survey area was found to be dominated by the main habitat type **SS.SSa**, which covered 52.1 % of the mapped area. Small patches of the biotope complex **SS.SSa.CMuSa** were identified within this area but were not distinguishable from the surrounding seabed using the backscatter data.

Other biotope complexes identified include; large areas of mixed sediments (**SS.SMx**; green polygons), which made up 29.5 % of the mapped area; and areas of fine sandy mud in the Lune Channel (**SS.SMu**; brown polygons), which included the identified biotope complexes **SS.SMu.CSaMu** and **SS.SMu.CFiMu**. Large regions of Areas 2 and 3 (as well as the plateau between them) are defined by the coarser habitat types **SS.SCS.CCS** and **CR.HCR.XFa**, as well as the habitat matrix **CR.HCR.XFa / SS.SMx**.

Table 3.1: Total area in square kilometres of each biotope, biotope complex or main habitat type assigned during the creation of the broadscale biotope map of the survey area

Biotope / Biotope Complex Polygons	**Total Area (km^2)**
SS.SSa	34.19
SS.SMx	19.35
SS.SMu	5.43
CR.HCR.XFa(.Mol)	2.42
CR.HCR.XFa / SS.SMx	1.95
SS.SCS.CCS	1.73
SS.SCS / SS.SMx	0.44
IR.MIR.KR / SS.SMx.IMx	0.12
SS.SMp.KSwSS.LsacR.CbPb	0.05
Total area mapped	**65.68**

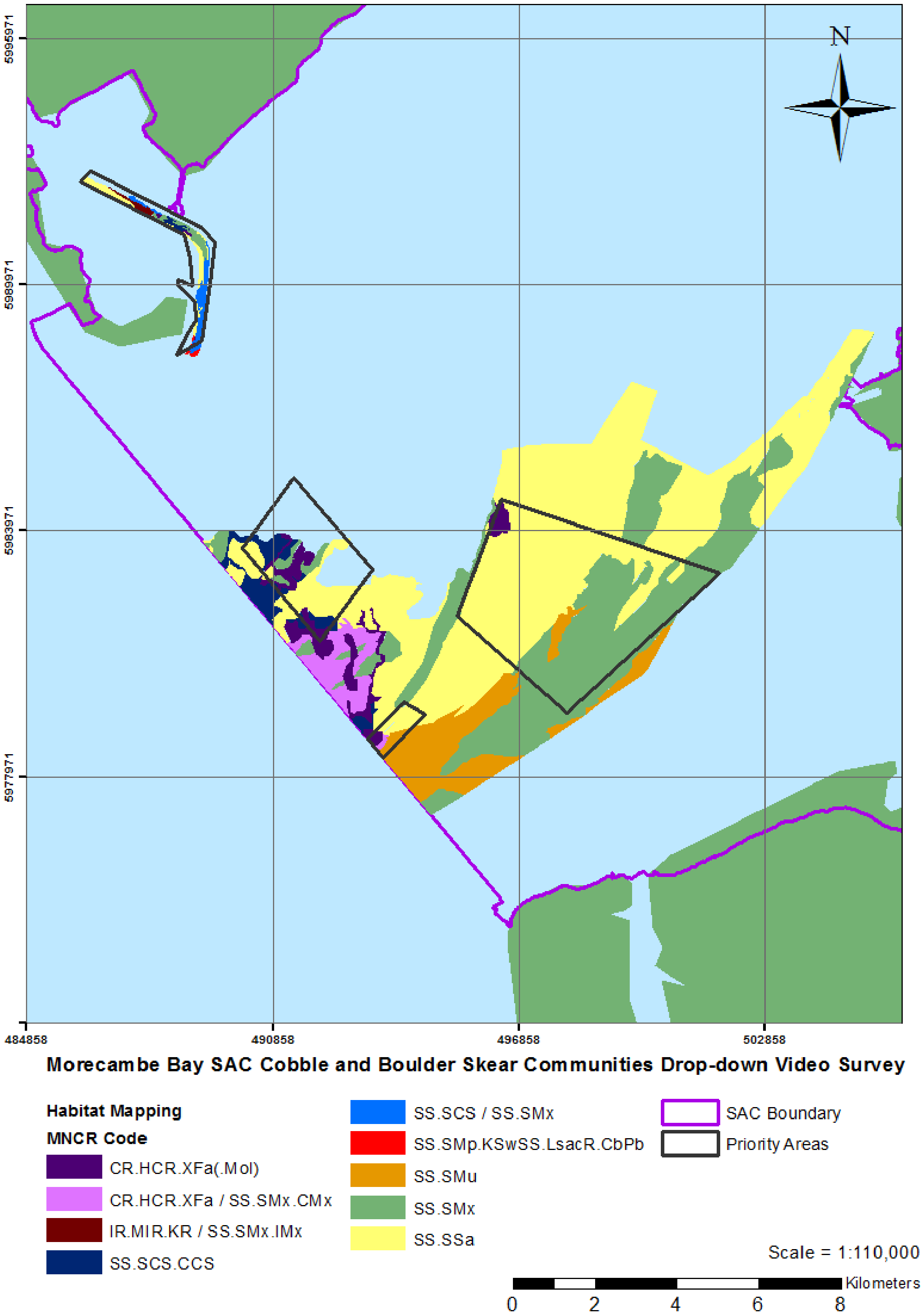

Figure 3.8: Broadscale habitat / biotope map of the Morecambe Bay SAC 2014 survey areas

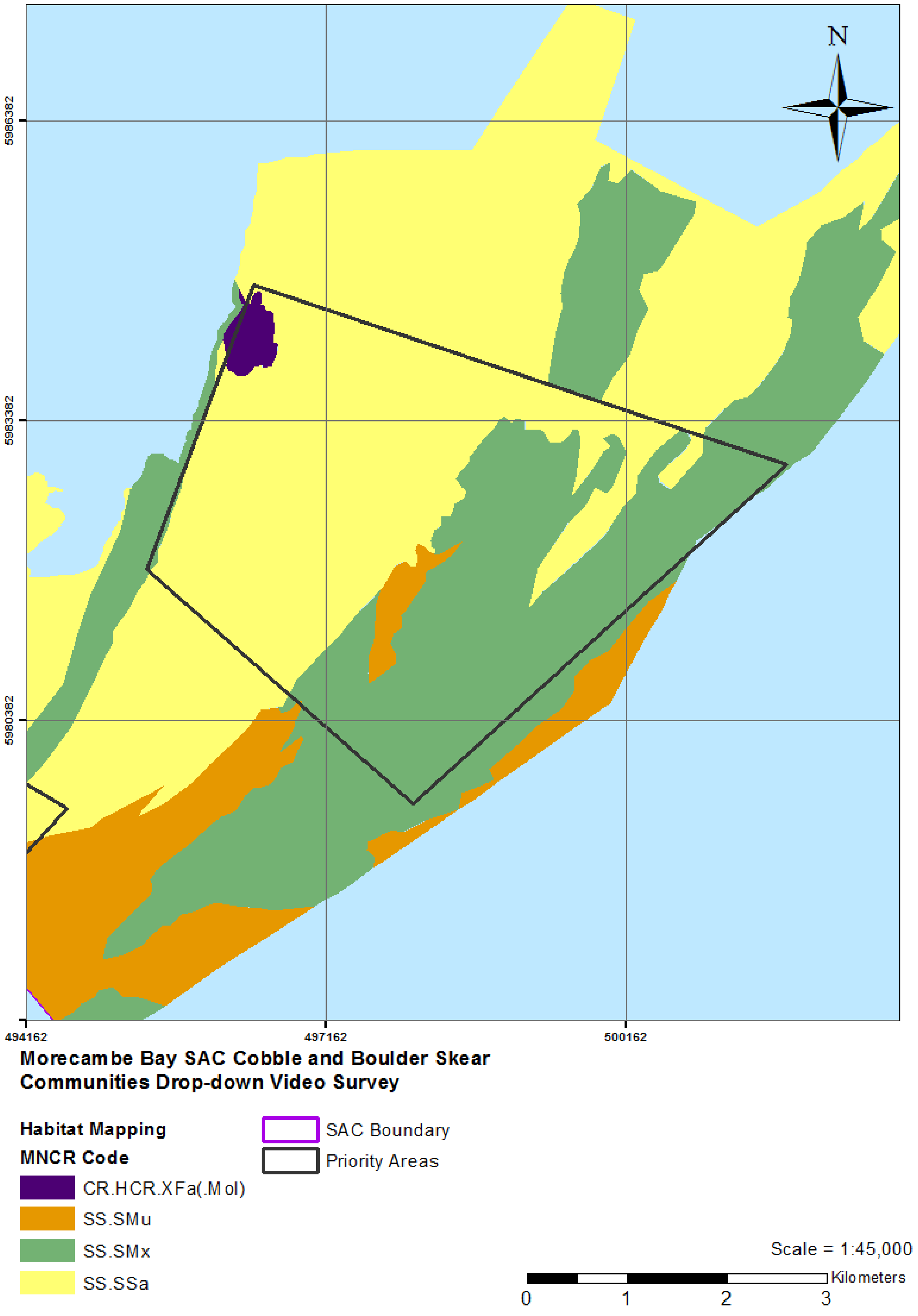

Figure 3.9: Broadscale habitat / biotope map of the Morecambe Bay SAC 2014 Priority Area 1

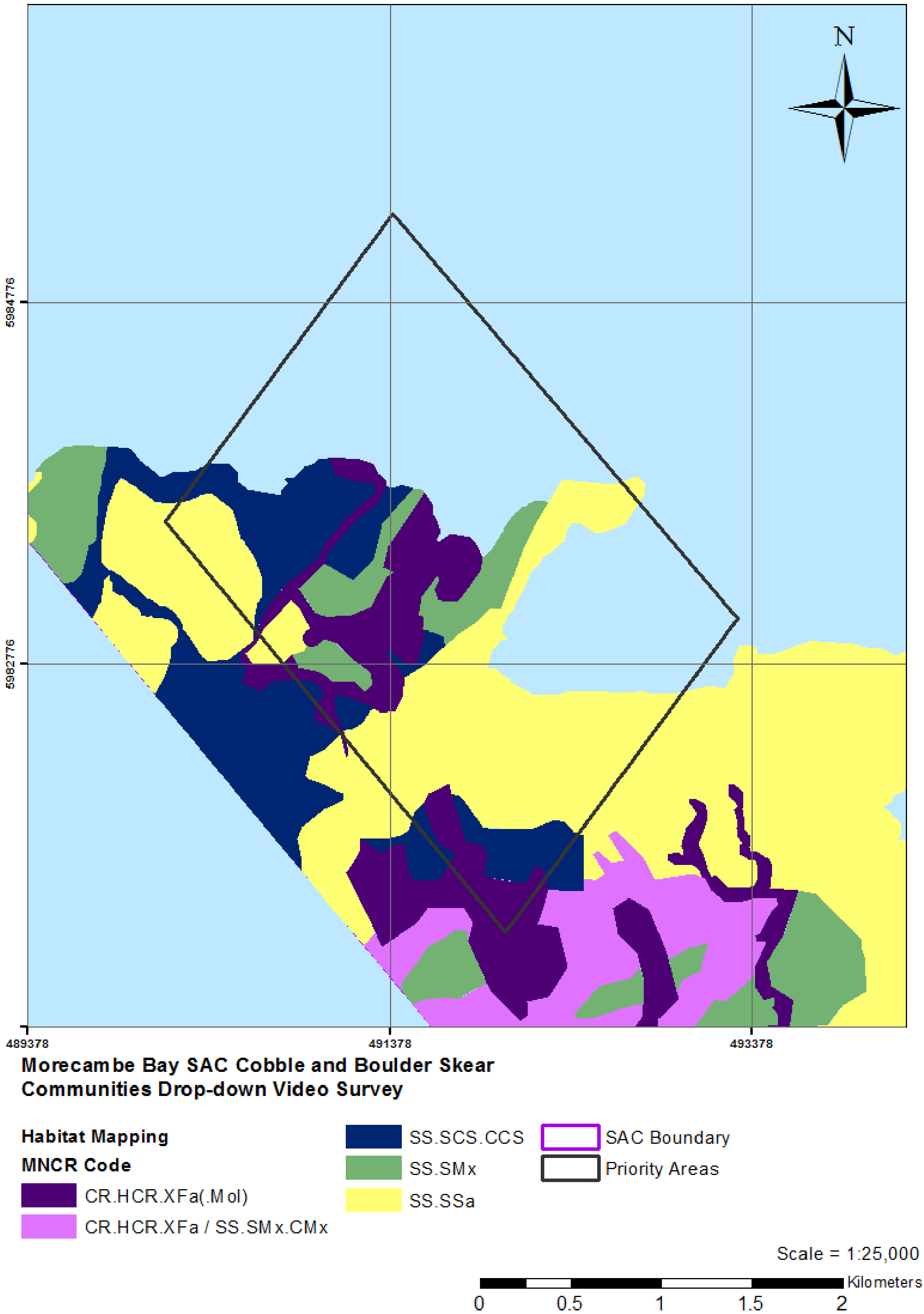

Figure 3.10: Broadscale habitat / biotope map of the Morecambe Bay SAC 2014 Priority Area 2

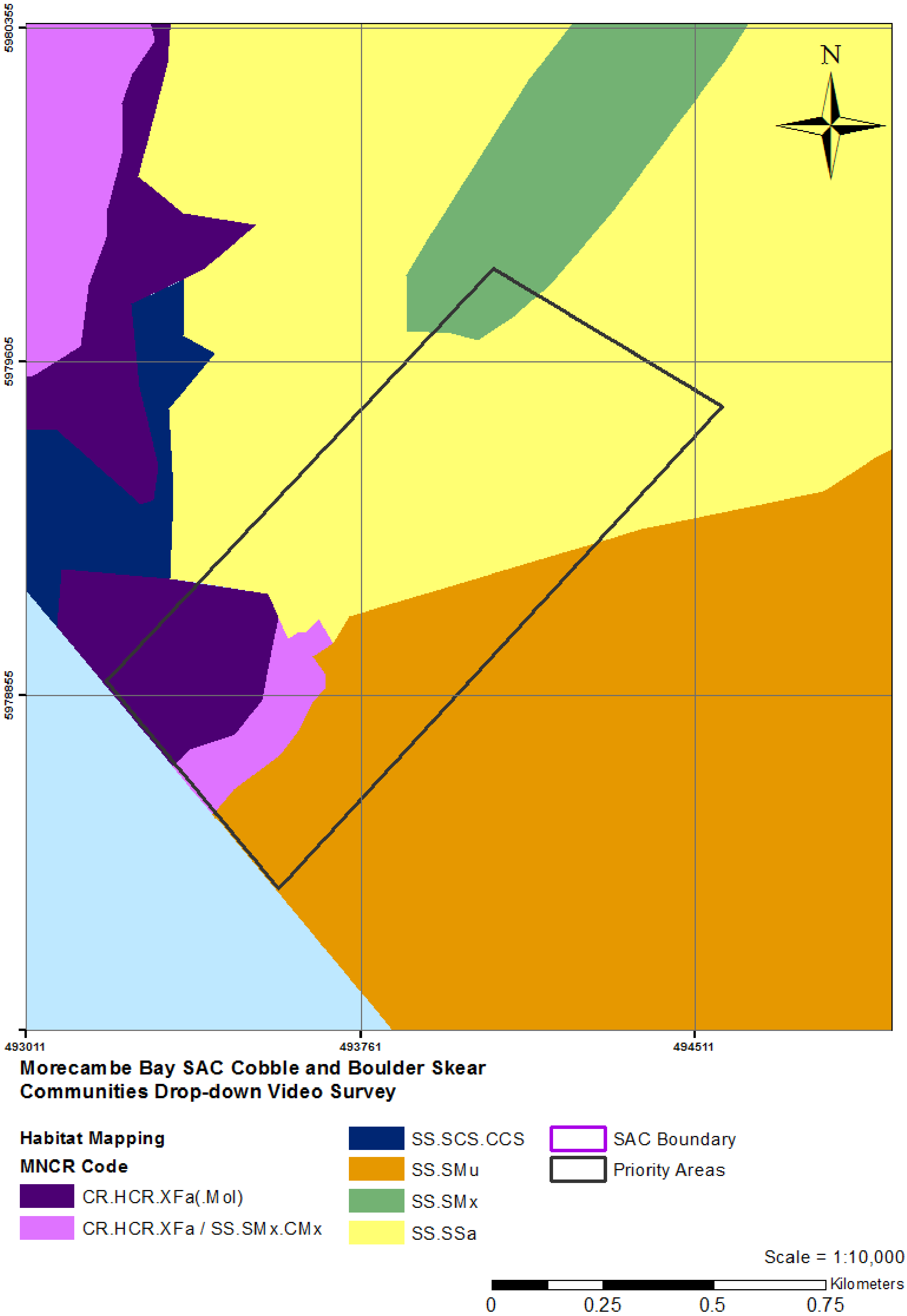

Figure 3.11: Broadscale habitat / biotope map of the Morecambe Bay SAC 2014 Priority Area 3

Figure 3.12: Broadscale habitat / biotope map of the Morecambe Bay SAC 2014 Priority Area 4 (the Walney Channel)

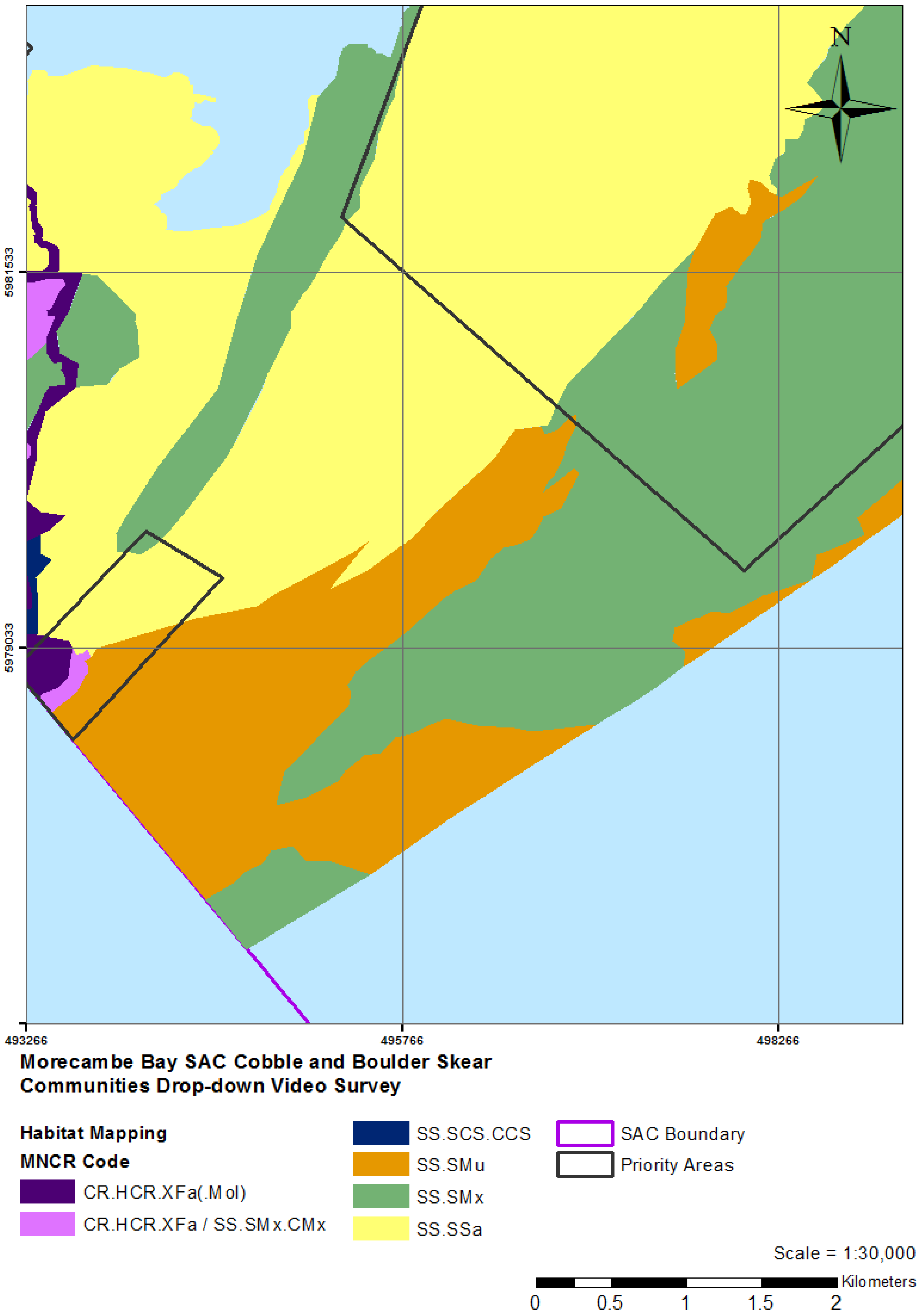

Figure 3.13: Broadscale habitat / biotope map of the Morecambe Bay SAC 2014 Lune Channel survey area

3.3 Distribution, extent and composition of Annex I reef habitat

Potential reef features were observed throughout the survey area. All potential reef features observed consisted of stony reef; areas of cobbles and boulders on otherwise soft sediment, i.e. cobble or boulder skears. Therefore, all habitat described as 'stony reef' falls into the cobble and boulder skear sub-feature, together with some areas of cobbles which would not qualify as stony reef according to Irving *et al.* (2009) due to low coverage (< 10 %). Some potential Annex I subtidal sandbank features were also observed, however without precise depth information these cannot be accurately assessed. The following section will therefore discuss the mapping of the extent and distribution of cobble and boulder skear communities only.

3.3.1 Delineation of potential cobble and boulder skear communities

In order to fully define and map the extent of cobble and boulder skear communities within the survey area it was necessary to establish the density of cobble and boulder substrata at each of the seabed contacts. The percentage of the seabed covered by cobbles at each seabed contact is shown in Figure 3.14 and Figure 3.15.

Areas of potential cobble and boulder skear communities were delineated to three levels of confidence. Point source records (i.e. discrete seabed contacts) with over 10 % cobble or boulder coverage are regarded as confidence level one (assigned 90 % confidence). The minimum 10 % coverage was based on the guidelines for assessment of stony reefs by Irving (2009). The distribution of these confidence level one locations are shown in Figure 3.16 and Figure 3.17.

Level two polygons (70 – 80 % confidence) were created by generating 50 m buffer zones around any level one point source (Figure 3.18 and Figure 3.19).

The final stage of cobble and boulder skear mapping involved examination of the level two polygons over the acoustic and habitat map data, in a similar manner to the mapping of biotope polygons. The resulting potential cobble skear habitat level 3 polygons (50 – 70 % confidence) are shown in Figure 3.20 and Figure 3.21. Where areas of similar reflectivity were observed but had not been sufficiently ground-truthed to extrapolate the polygon on the basis of reflectivity alone, the bathymetric data were taken into account and the polygon was extended to include the entirety of the bathymetric feature (such as a ridge, channel edge, or depression). Figure 3.22 illustrates the process of assigning level 3 polygons using bathymetric data.

3.3.2 Distribution and extent of cobble and boulder skear features

A total of 165 seabed contacts were identified as potential cobble and boulder skear habitat. The total area covered by cobble and skear habitat polygons is given in Table 3.2.

Identified areas of potential cobble skear habitat were generally associated with raised areas of bathymetry and with higher levels of reflectivity in the backscatter data, attributed to coarser substrates.

Cobble skear habitat was primarily located near the mouth of Morecambe Bay (along the edge of the SAC) and in the central and east region of Area 1. Percentage cobble coverage was found to be particularly high in Areas 2 and 3; the bathymetric high in Area 3 was found to be composed primarily of cobbles (between 75 – 95 % of the visible seabed), and high incidences of cobble substrate were also recorded on the ‘plateau’ between Areas 2 and 3 and in the central region of Area 2. Within the potential scour feature in the central east region of Area 1, close to the head of the Lune Channel, an area of mixed sediments were observed which were found to display high percentage cobble composition. Smaller areas of potential skear habitat were also identified in the northwest corner of Area 1

The occurrence of cobble skear within the Walney Channel (Area 4) was found to be chiefly confined to the northern section of the channel, although an area of cobble skear south of the entrance to the channel was also identified.

Table 3.2: Total area covered by deliniated areas of cobble and boulder skear

Cobble and Boulder Skear Habitat Confidence Level	Total No. / Area (km^2)
Level 1 (no. of seabed contacts)	165
Level 2	0.83
Level 3	6.26

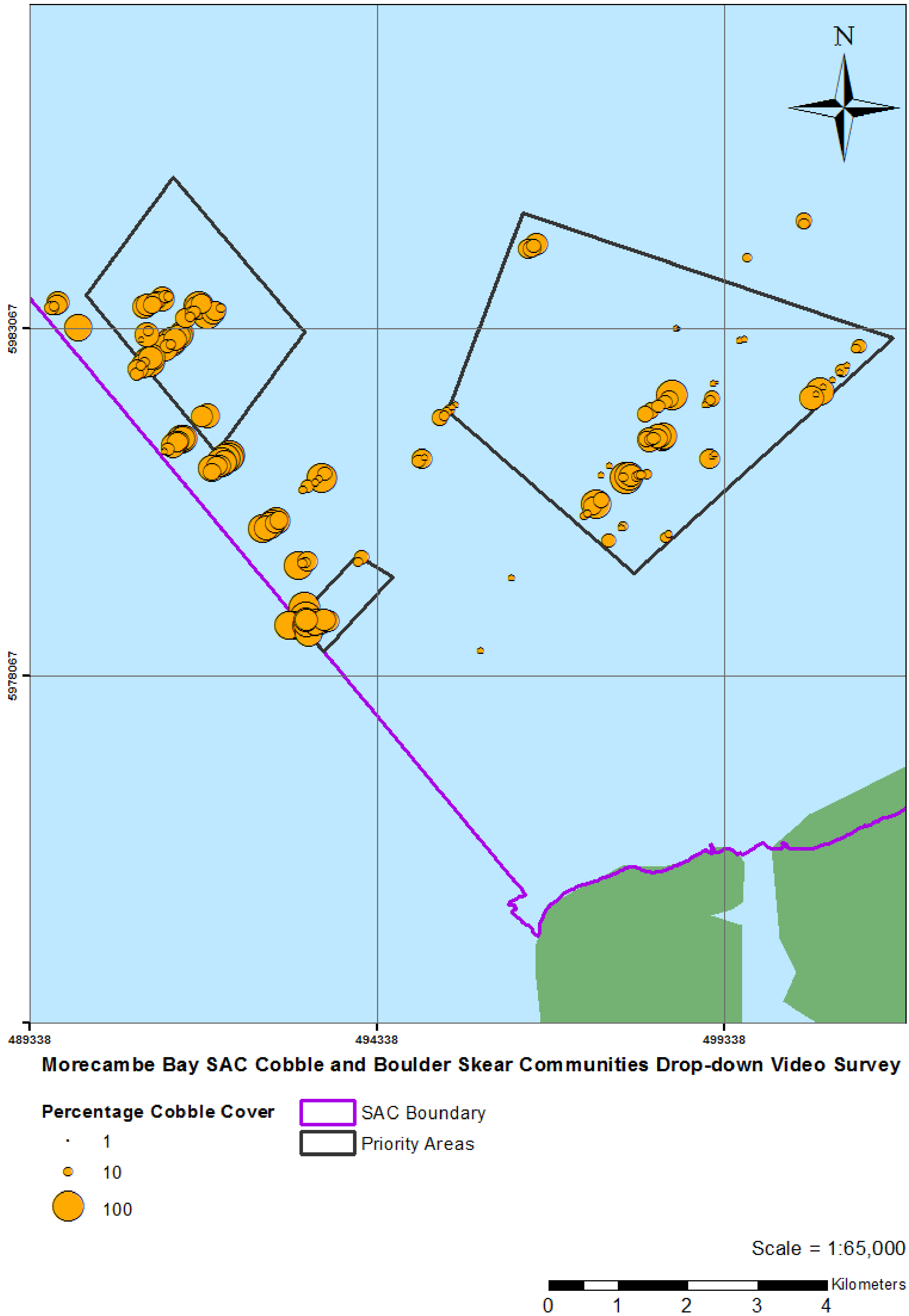

Figure 3.14: Percentage cover of cobbles and boulders observed in each video clip captured in Priority Areas 1 – 3 in the Morecambe Bay SAC 2014 survey

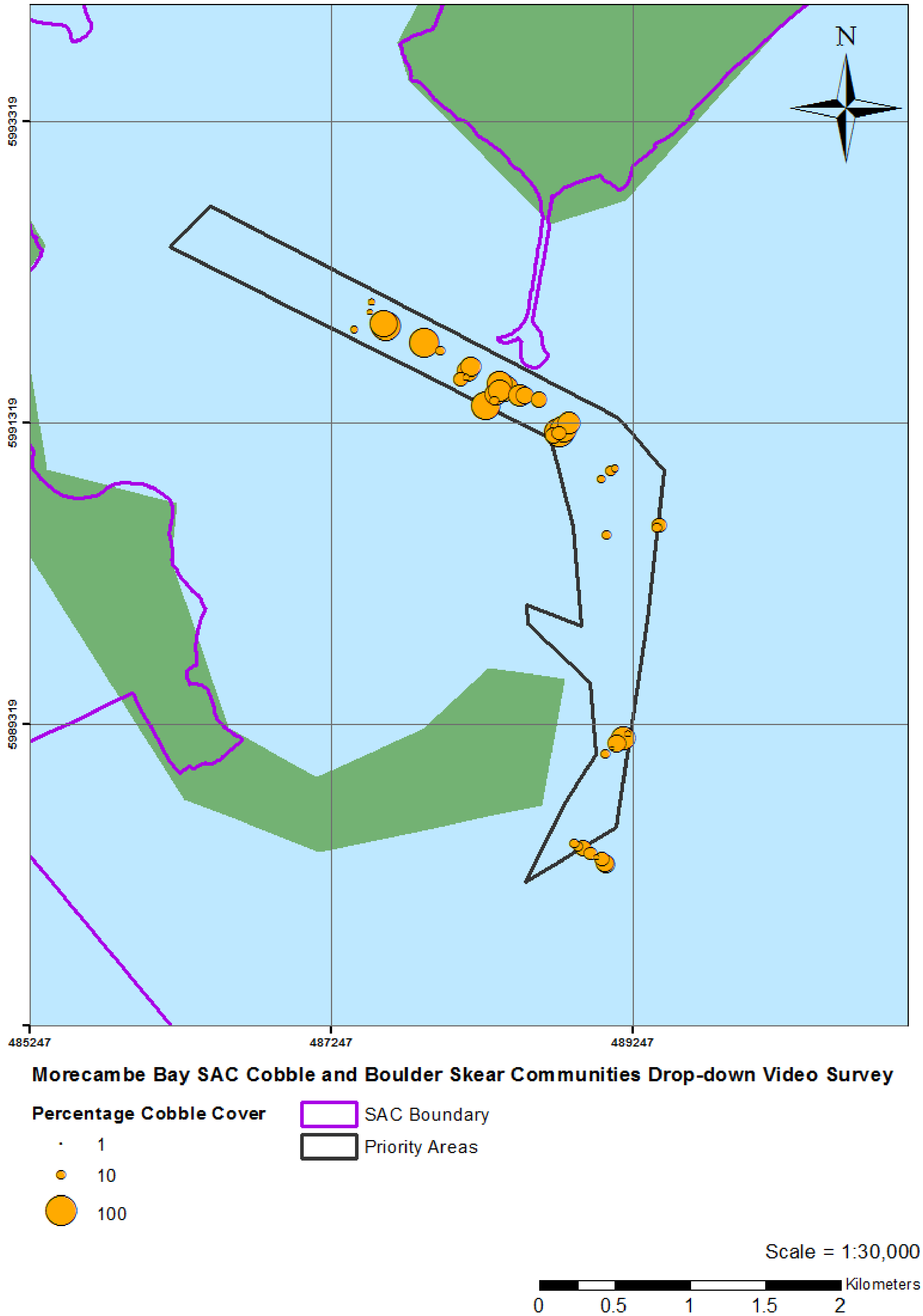

Figure 3.15: Percentage cover of cobbles and boulders observed in each video clip captured in Priority Area 4 in the Morecambe Bay SAC 2014 survey

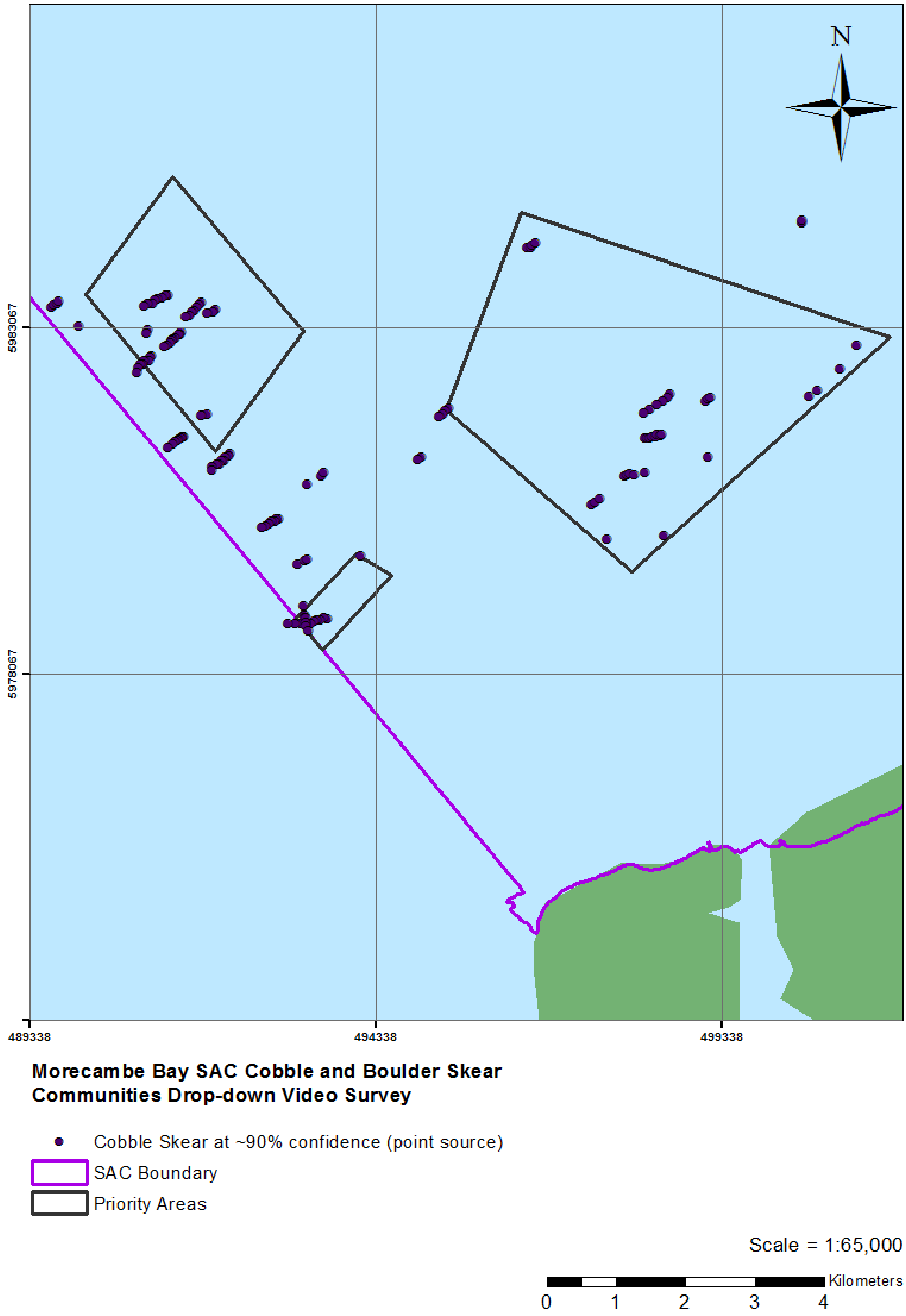

Figure 3.16: The distribution of confidence level one (point source) cobble and boulder skear habitats identified in and around Priority Areas 1 – 3 in the Morecambe Bay SAC 2014 survey

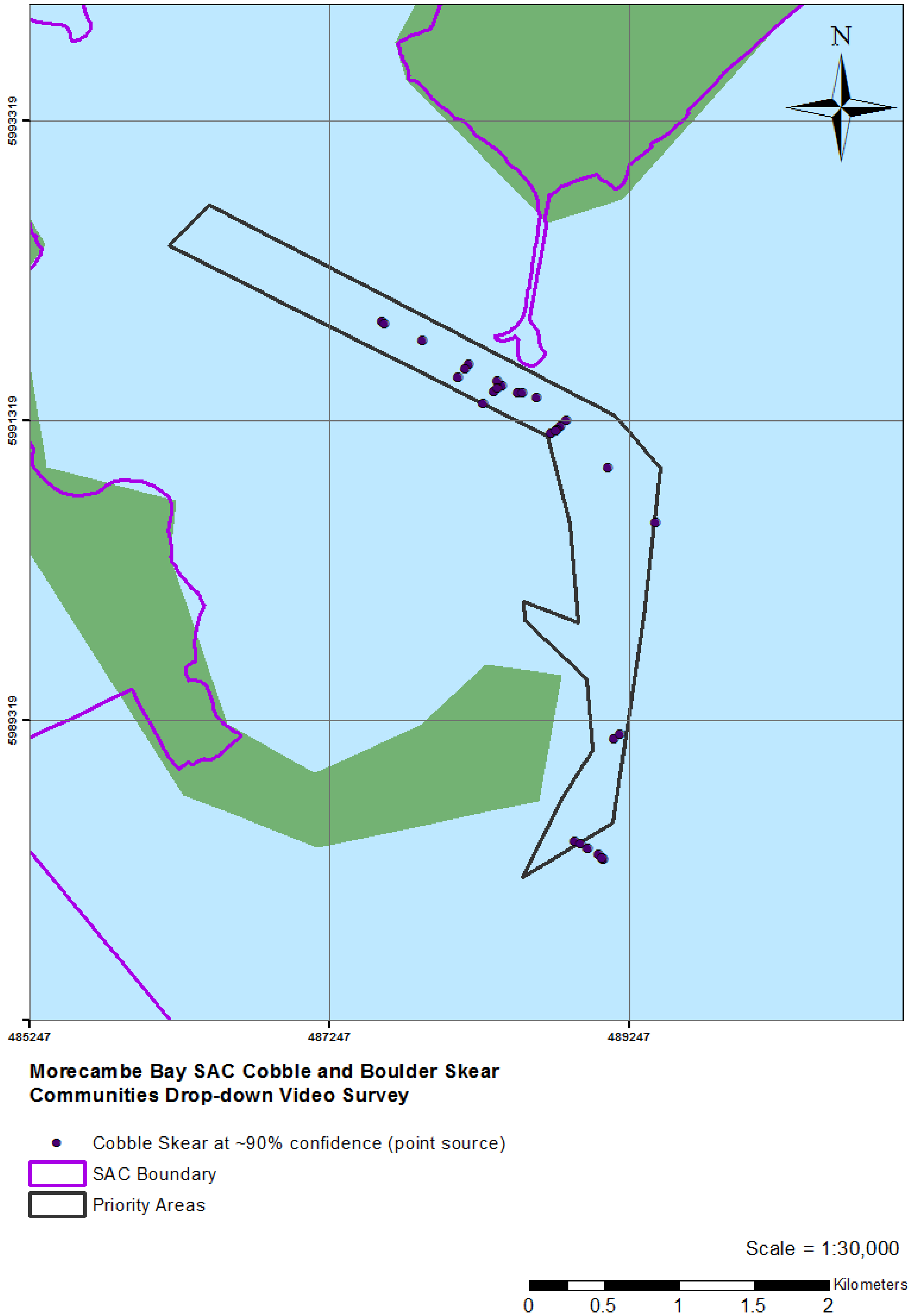

Figure 3.17: The distribution of confidence level one (point source) cobble and boulder skear habitats identified in and around Priority Area 4 in the Morecambe Bay SAC 2014 survey

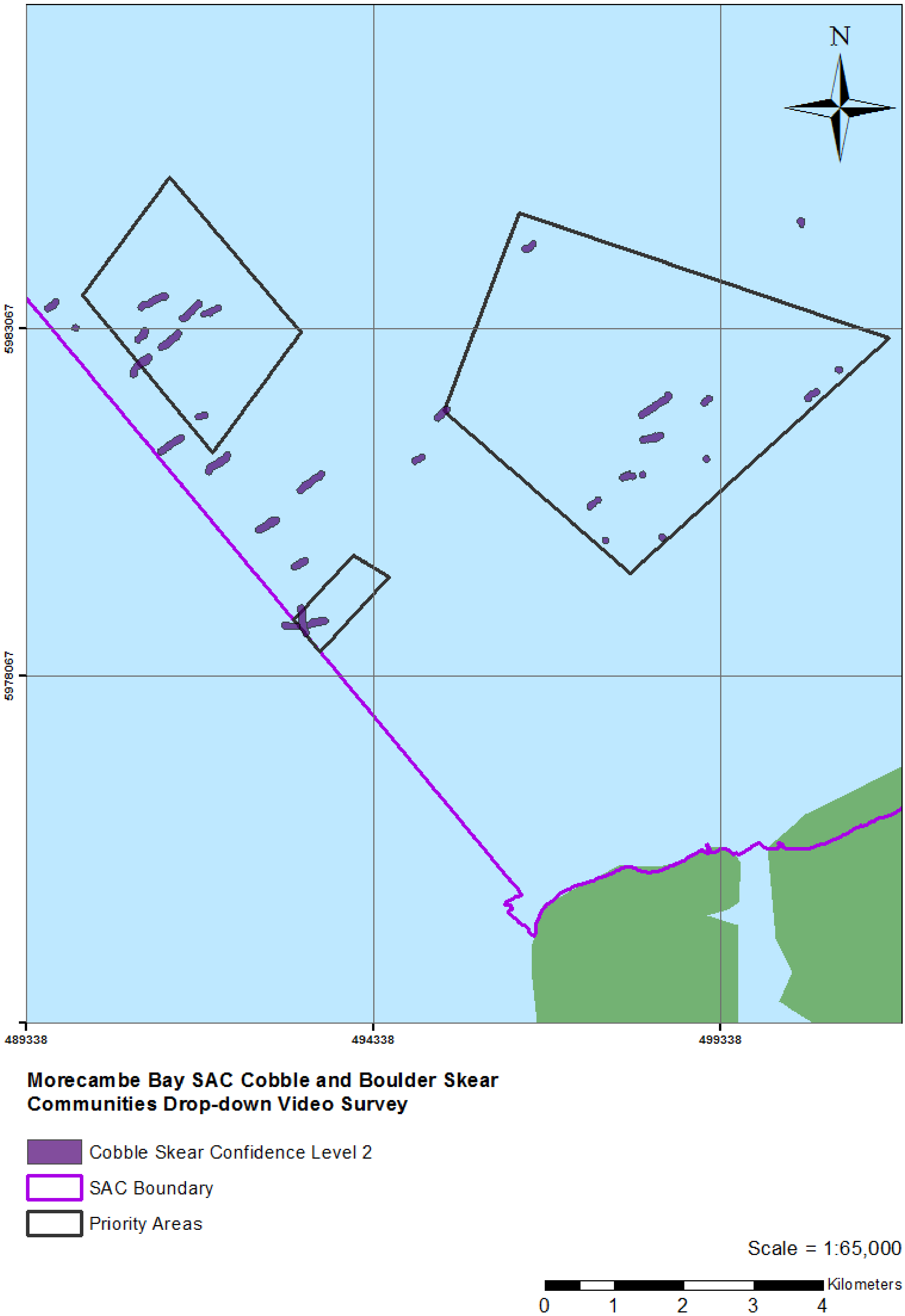

Figure 3.18: The distribution of confidence level two (50 m radius ellipsoids) cobble and boulder skear habitats identified in and around Priority Areas 1 – 3 in the Morecambe Bay SAC 2014 survey

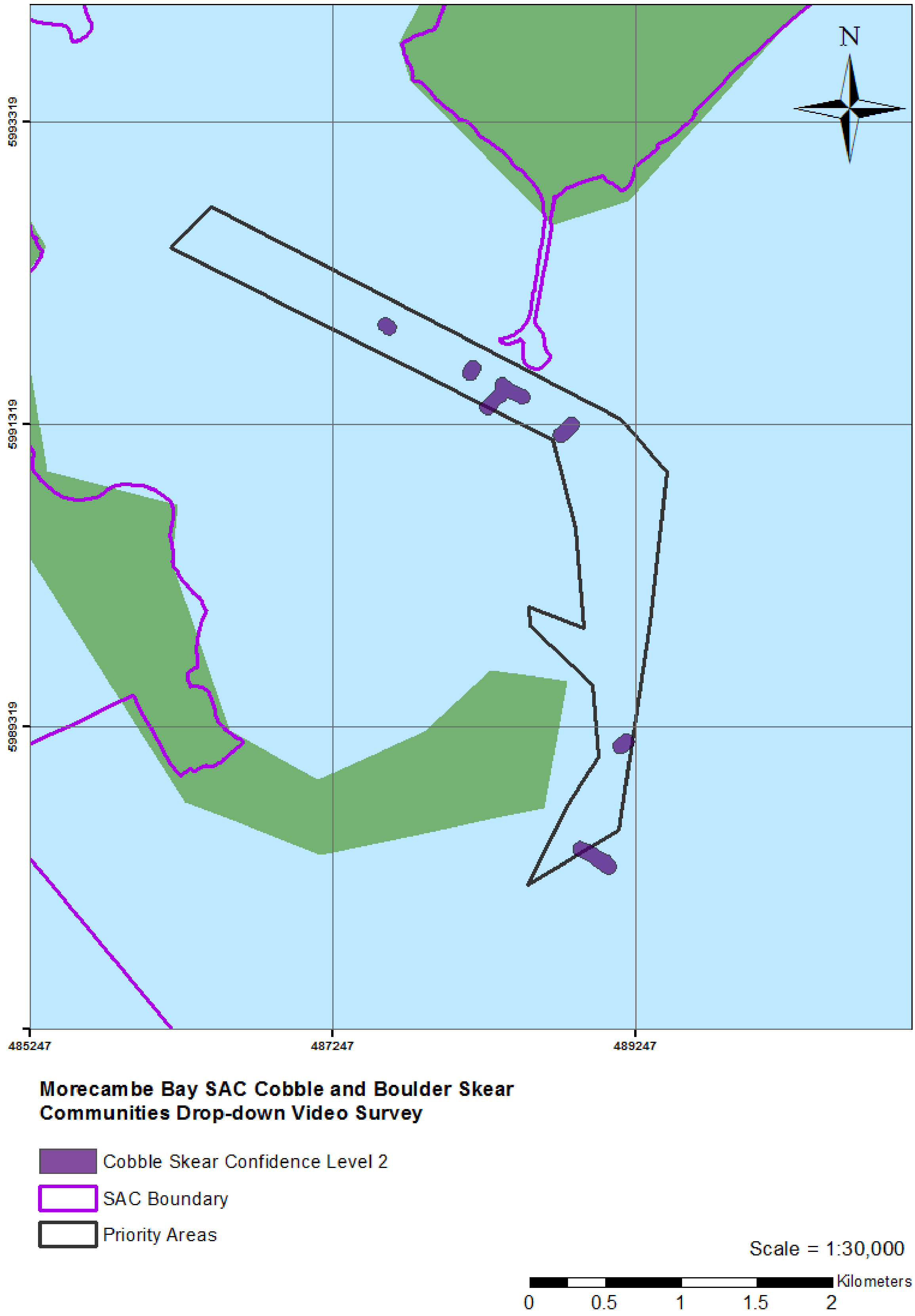

Figure 3.19: The distribution of confidence level two (50 m radius ellipsoids) cobble and boulder skear habitats identified in and around Priority Area 4 in the Morecambe Bay SAC 2014 survey

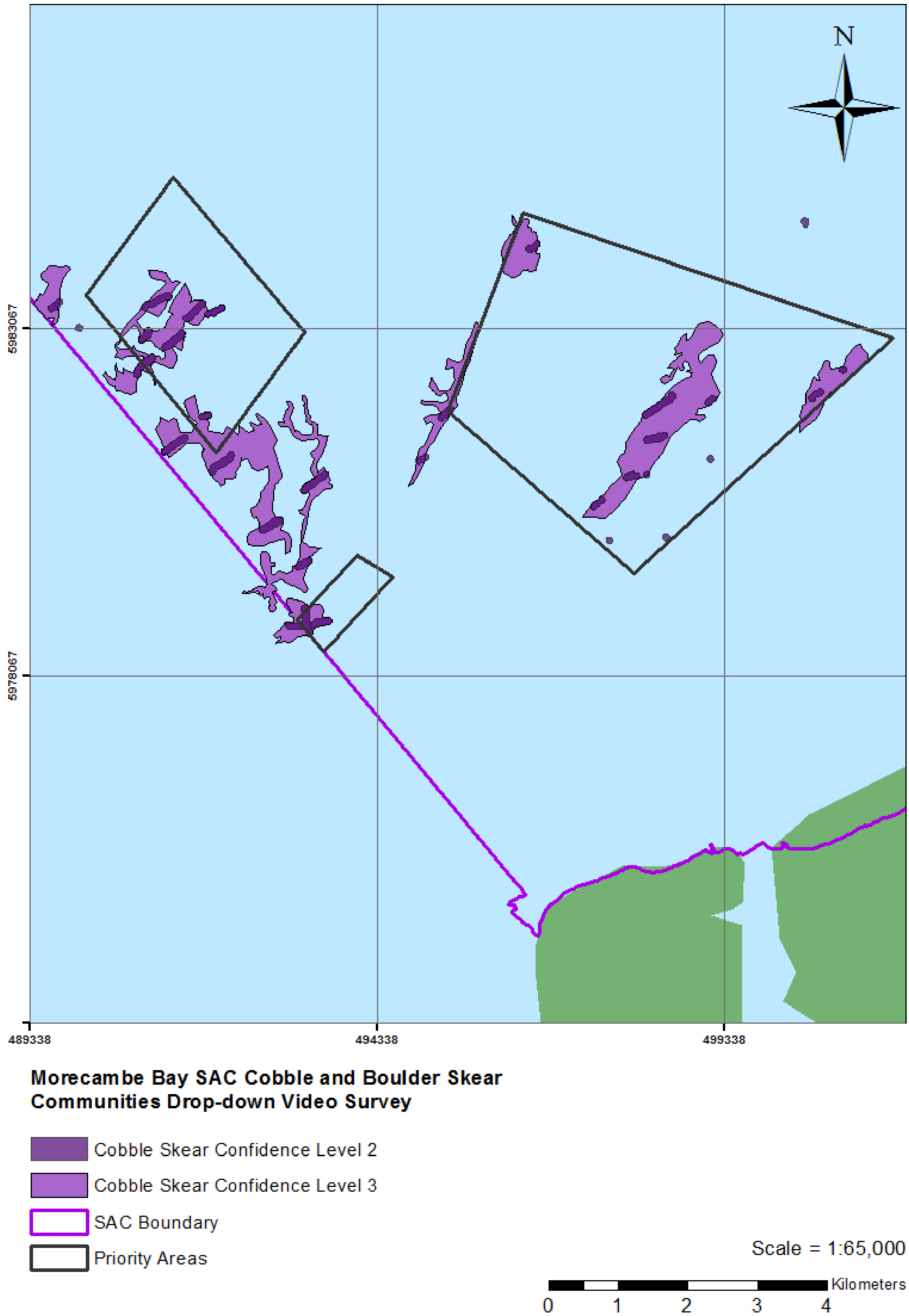

Figure 3.20: The distribution of confidence level two (50 m radius ellipsoids) and level three (extension along seabed feature or areas of common reflectivity) cobble and boulder skear habitats identified in and around Priority Areas 1 – 3 in the Morecambe Bay SAC 2014 survey

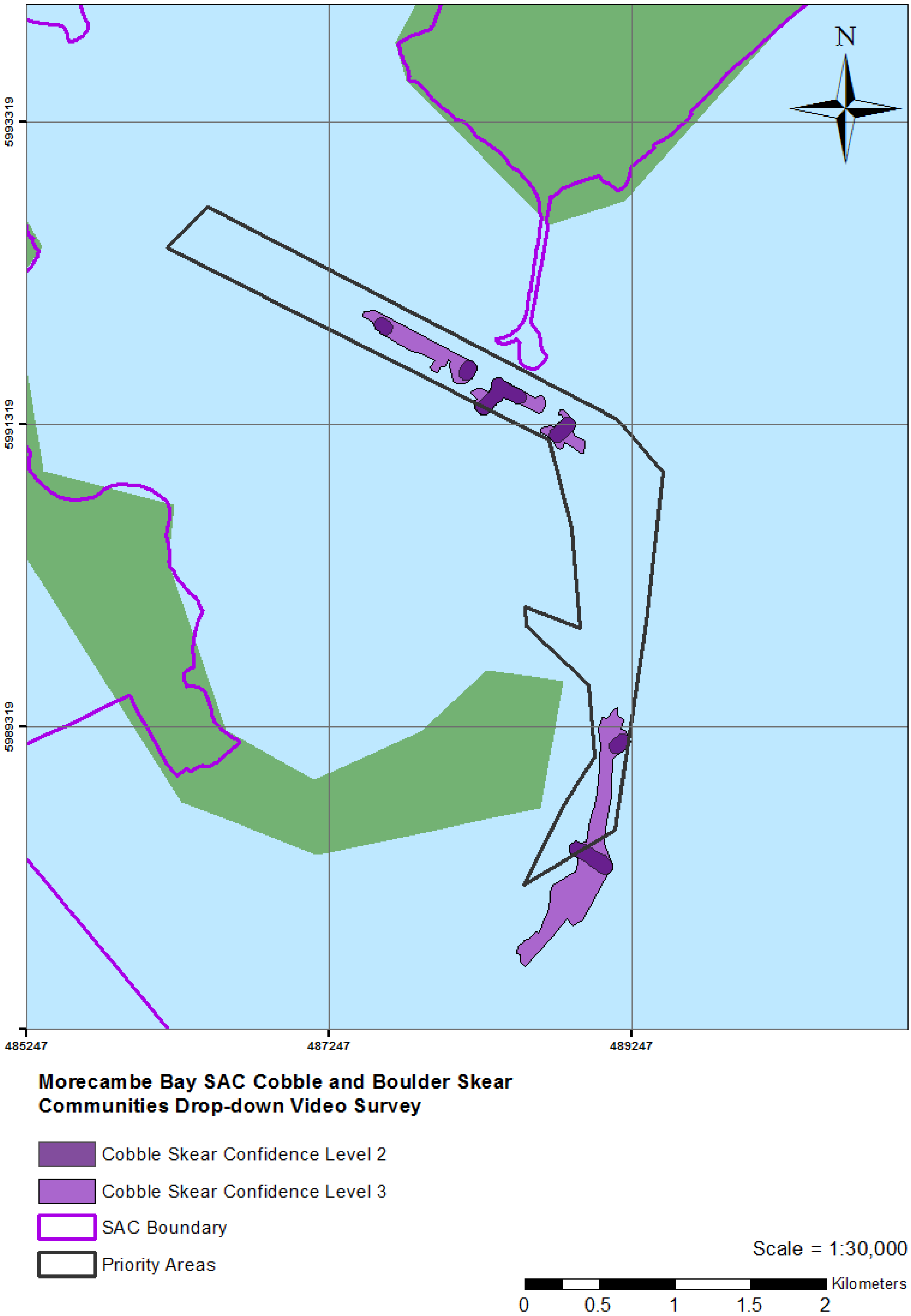

Figure 3.21: The distribution of confidence level two (50 m radius ellipsoids) and level three (extension along seabed feature or areas of common reflectivity) cobble and boulder skear habitats identified in and around Priority Area 4 in the Morecambe Bay SAC 2014 survey

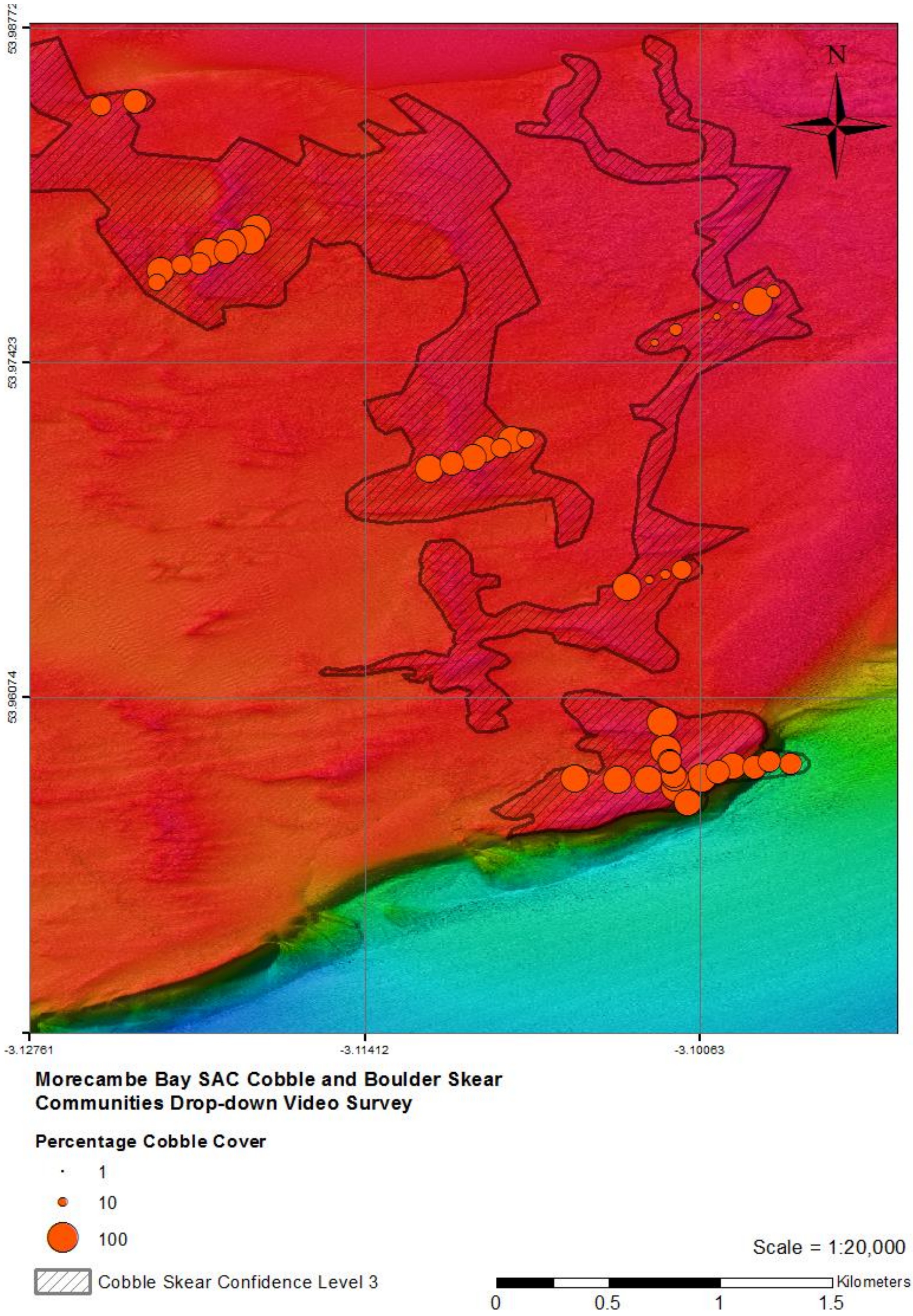

Figure 3.22: Example of delineation of confidence level three polygons based upon bathymetric features and cobble / boulder substrate percentage

3.3.3 The general biological community of potential cobble and boulder skear habitat

The observed potential cobble and boulder skear communities were generally classified as one of three biotope complexes; **SS.SMx.CMx** (circalittoral mixed sediment); **SS.SCS.CCS** (circalittoral coarse sediment); and **CR.HCR.XFa** (mixed faunal turf communities). The most commonly assigned faunal turf biotopes were **CR.HCR.XFa**.**Mol** (*Molgula manhattensis* with a hydroid and bryozoan turf on tide-swept moderately wave-exposed circalittoral rock) and **CR.HCR.XFa.FluCoAs** (*Flustra foliacea* and colonial ascidians on tide-swept moderately wave-exposed circalittoral rock). These two biotopes (and the associated biotope complex) were assigned to 72 of the 525 seabed contacts (13.7% of all contacts).

Areas of cobble and boulder skear assigned to the biotope complexes **SS.SMx.CMx** and **SS.SCS.CCS** were very similar, being characterised by sparse fauna, however they were differentiated by the degree of siltation. Areas of faunal turf biotopes were generally associated with bathymetric highs and were dominated by the colonial ascidian *M. manhattensis* and silt- and scour-resistant species such as the bryozoans *F. foliacea* and *A. diaphanum* and the hydroids *Sertularia* spp. and *H. falcata*.

In the Walney Channel the observed habitats were patchier than elsewhere in the SAC, however similar biotope complexes were assigned to areas of potential cobble skear ground. The biotope complex most frequently assigned to potential cobble skears in the Walney Channel was **SS.SCS.CCS**, although the habitat map polygon assigned to these areas was a matrix of the broad habitat types **SS.SCS** and **SS.SMx**, due to the lack of distinct changes in reflectivity between these two sediment types. The areas designated **SS.SCS.CCS** were characterised by sparse encrusting fauna, including *Spirobranchus* spp. and encrusting sponges.

Small patches of potential cobble skear assigned to the biotope complex **CR.HCR.XFa** were also identified in the Walney channel. Fauna in this area was dominated by *M. manhattensis* and hydroids.

3.3.3.1 Characterising cobble and boulder skear species

The most common species observed on areas of potential cobble and boulder skear was the colonial ascidian *M. manhattensis*. This non-native, crytptogenic species is known to be tolerant of varying salinities, high turbidity and high levels of organics (Zvyagintsev *et al*., 2003; Haydar *et al.*, 2010). It was observed in very high abundances throughout the survey area, particularly where cobbles exhibited a high degree of siltation.

Species diversity on area of potential cobble skear ground was generally low, with *M. manhattensis* dominating most areas of hard substrate. Other species associated with potential skear ground included silt- and scour-resistant species such as; the bryozoans *F.*

foliacea, *Vesicularia spinosa* and *A. diaphanum;* hydroids including *Sertularia* spp. and *H. falcata* as well as unidentified short hydroid turf; and encrusting sponges.

The three species of sponge listed as characteristic species to be monitored (see Favourable Condition Table in section 1.4) were not recorded, however unidentified encrusting sponges were observed at four stations in the central section of Area 2 (transects 21, 27, 28 and 33), three stations in Area 1 (particularly at station 20 in the northwest corner of Area 1) and at the majority of the transects conducted in the Walney Channel (particularly stations 40, 45, 46 and 49). It is possible that the sponges observed were *Halichondria panicea* (or *Hymeniacidon perleve*, though this is unlikely due to colouration) however this could not be confirmed due to poor underwater visibility and the lack of physical sampling. The third species of characteristic sponge, *Haliclona oculata*, is more readily identifiable and was not recorded as present anywhere in the survey area. The abundance of the observed sponges was rare to frequent, with highest densities recorded in the northern section of Area 4, particularly south of Roa Island, and south of the Walney Channel.

4. Discussion

4.1 Survey methodology

The use of an integrated approach to study an area of seabed has been shown to be successful in many studies (e.g. Bett and Masson, 1998; Axelsson, 2003; Masson *et al.*, 2003; Brown *et al.*, 2004; Axelsson *et al.*, 2006; O'Dell *et al.*, 2013). The use of underwater video data in surveys has been shown to be cost-effective with large areas being covered in a relatively short time (Brown *et al.*, 2004; Stevens and Connolly, 2005). A number of studies have concluded that video data are appropriate for the assessment of the presence and extent of biotopes (Service and Golding, 2001) as well as ground-truthing of acoustic images (Brown *et al.*, 2002; Brown *et al.*, 2004). There is, however, some loss in taxonomic resolution when using photography rather than biological sampling techniques (e.g. Stevens and Connolly, 2005) and some video records are not of a sufficient quality to allow biotope classifications to be carried out. Still photography and sediment sampling should be carried out simultaneously to supply meaningful data (Hiscock and Seeley, 2006) but in the current survey this was not possible due to the poor underwater visibility and to the focus of the survey being hard substrata, namely rocky scar ground and reef features.

Additional sampling effort is required in the survey areas in order to increase coverage, to improve understanding of the habitats and species and to improve the confidence in the maps illustrating the extent of the observed features. Ideally camera deployments and infaunal sampling should be carried out in the SAC in conjunction with broadscale acoustic techniques in order to allow very conspicuous changes in habitat distribution to become apparent. Due to the limitations of backscatter data it is particularly recommended that sidescan sonar data be acquired in the survey area in order to enable changes in sediment composition, including areas of cobble and boulder skears, to be more easily identified. Any further camera work should be conducted during and following periods of calm weather and on neap tides so that poor underwater visibility does not hamper survey effort.

4.2 Survey Limitations

The survey methodology and equipment employed were selected specifically to allow for collection of high quality data in very strong tidal conditions and limited underwater visibility. Despite this, the poor underwater visibility encountered slightly hampered species identification and biotope assignment.

4.2.1 Visibility and coverage

The major limitation was the lack of continuous seabed footage over the proposed transects. Due to the poor underwater visibility in Morecambe Bay the camera had to be within a maximum of 20 cm from the seabed in order for the seabed to be visible. Flying the camera frame at this height above the seabed proved to be impossible. Furthermore, data acquired using such a method would be of little use. The decision was therefore taken to modify the methodology to focus on the landing of the camera frame on the seabed, allowing over a minute of seabed time to be recorded at a series of separate locations, approximately 50 m apart, along each transect. This was a time-consuming process and as such it was only feasible to have a maximum of 10 landings per transect in order to keep total transect time under 30 minutes in duration. In addition, this methodology has made estimates of extent of seabed features more problematic.

Coverage of the survey area was tailored to locate areas of possible cobble or boulder skear habitat. If a type of acoustic return had been ground-truthed and found to be of a sandy or mixed substrate the area was not investigated further.

4.2.2 Weather conditions

The survey area is very susceptible to north-westerly, westerly and south-westerly winds and swells. The area was deemed unworkable in such winds of Force 4 or greater, or a swell of greater than 0.5 m significant. The Met Office Inshore Waters Forecast was used to monitor weather forecasts and the decision to work was based on these forecasts.

A total of three weather days were taken during the survey. The first of these was during Phase 1, on the 6th of August 2014 where the wind blew SW force 5 making deployment of system impossible. The second of these weather days occurred during Phase 2 on the 1st of September 2014 (transit to site but unable to deploy) and the third was incurred on the 7th of September, whereupon the weather forecast was Force 4 – 5 from the NW and the swell was recorded at 0.75 m.

4.2.3. Limitations in analysis

The acoustic data provided which covered Priority Areas 1 to 4 were acquired in 2012, approximately two years prior to the DDV ground-truthing undertaken during the current survey. In an area such as the Morecambe Bay SAC, with high levels of sediment transport, it is likely that the potential sandbank features identified have moved. Depth band information were also not provided with the dataset, making comment on actual depths of surveyed locations impossible. Higher levels of confidence were therefore assigned to the video data than to the acoustic. If a conflict in sediment type (i.e. predicted rocky outcrop shown by more than one video clip to be sand or mud) occurred then the habitat was mapped according to the video clip biotope.

Backscatter data are acquired simultaneously from modern MBES systems, providing an indication of seabed roughness dependent on a number of factors including frequency and source level of the acoustic instrument as well as substrate composition (Collier and McGonigle, 2011). Backscatter data derived from multibeam bathymetry systems are useful in determining seabed composition, however this is balanced by a lack of resolution compared with sidescan sonar data (Collier and McGonigle, 2011). The various parameters associated with the collection and processing of the backscatter dataset, such as gain variations, were not provided; the confidence in the constancy of the reflectivity types shown was therefore reduced.

4.2.4 Discrepancies between the geophysical data and survey results

The interpretation of the multibeam and backscatter data and the subsequent ground-truthing resulted in some discrepancies in the boundaries between different habitats and / or biotopes. This discrepancy has a number of possible explanations including: (i) positioning of camera frame relative to navigation data; (ii) positioning of the boundaries of biotope and habitat classifications; and (iii) changes in the seabed of the survey area in the time between acoustic data collection and acquisition of the ground-truthing data (see above).

(i) Positioning of camera frame relative to navigation data

During survey operations, no lay-back error was calculated for the camera frame position in relation to the vessel as the deployment methodology required that the camera frame be deployed vertically from the A-frame. It was on occasion difficult to determine the exact moment of contact with the seabed due to e.g. strong tidal currents or poor underwater visibility. Slight inaccuracies (up to ~ 5 m) in the position of the video clips were therefore possible.

(ii) Biotope and habitat classifications

The exact positions of the boundaries between different biotopes were often difficult to determine as some boundaries are transitional in nature. The patchiness and change in observed sediment types, combined with the discrete nature of the data acquired, resulted in some difficulties in determining the exact boundary between biotopes. Some of the boundaries identified using the video data therefore did not correspond exactly with those identified using the acoustic data. Overall, however, the results were good.

4.3 Confidence assessment

In this study, attempts have been made to minimise interpolation of the data as much as possible. However, as with many similar studies, ground-truth coverage is not as extensive as perhaps desired. In order to illustrate the quality and interpretation of the data, confidence ratings were assigned to the figures.

4.3.1 Confidence in biotope assignment

Underwater video photography has been demonstrated to be appropriate for the assessment of the presence and extent of marine biotopes, however the quality of the data and biotope recorded from video tapes relies heavily on the identification skills of the person scoring the video data (Holt *et al*., 2001). The classification of biotopes is also somewhat subjective and not all seabed environments ‘fit’ the biotope classification scheme resulting in some biotopes being classified to 'best fit' the communities present (Holt *et al*., 2001).

4.3.2 Confidence in mapping cobble and boulder skear habitat

The confidence assessment for the three levels of cobble and boulder skear habitat has been generated in part using the MESH confidence assessment score sheet, taking into account attributes of the acoustic data, the ground-truthing data and the mapping techniques. The values obtained from the MESH score sheet were reduced according to Seastar Survey's internally accepted levels of confidence for mapping habitats using backscatter data only.

The level of certainty of the interpretation of the seabed environment and habitat polygons at point source (i.e. a single video clip) is estimated at 90 – 100 % accurate (level 1). Confidence level 2 (areas immediately surrounding point source data) have been assigned with 70 – 80 % confidence, and were generated by extending a 50 m radius from any point source data at which the seabed has been shown to be composed of greater than 10 % cobbles (or < 10 % if within 50 m of a data point with more than 50 % cobbles).

Confidence level three polygons were assigned a confidence level of between 50% and 70%, and have been delineated by extending areas of level two polygons along bathymetric features and areas of similar reflectivity.

4.4 Comparisons with previous studies

The usefulness of comparisons with previous studies is limited by various factors. For example, the methods employed and the distributions of sampling points are not the same between surveys. Furthermore, the quality of the data obtained (e.g. quality of video recording) varies between studies, as does the compatibility of the biotopes listed in Connor *et al.* (2004). As such any findings or trends from comparisons with previous surveys must be treated with caution. Such comparisons may however be useful in attempting to assess feature condition.

There is very little published information, particularly concerning epifaunal communities, regarding the sublittoral regions of the Morecambe Bay SAC. Areas of habitat described as 'rich faunal turf' and 'mixed turf' on cobbles and boulders were identified by Sotheran and Walton (1997). Some of these sites coincide with areas of cobble skear identified in the present study, for example along the western edge of Priority Area 1, in the region between Areas 2 and 3, and in the northern section of Area 4. The fauna observed by Sotheran and Walton (1997) differed from the fauna observed in the current study, with large sponges such as *Cliona celata* and the polychaete *Sabella pavonina* commonly recorded. In the present study, areas of cobble were instead dominated by the non-native cryptogenic species *Molgula manhattensis*. While the distribution of cobble skear habitat may not have altered between the two surveys, (though further investigation is required to confirm this as the areas of interest differed between the two surveys), it appears that the faunal community has undergone potentially significant change.

Sotheran and Walton (1997) also identified patches of mussel (*Mytilus edulis*) bed in the SAC, specifically in Area 1 and southeast of the Walney Channel. While the latter was not investigated in the present study, no evidence of mussel beds were observed.

The Walney Channel (Priority Area 4 in the present study) was characterised by Woombs (2000) as highly patchy, a similar finding to that of the present study. However, in areas where the current study identified species-poor coarse sediment (including cobble skear ground) Woombs (2000) described a large area of the (now outdated) biotope **CR.ECR.BS.CuSH** (cushion sponges, hydroids and ascidians on tide-swept sheltered circalittoral rock) alongside the brittlestar dominated **CR.MCR.Bri.Oph** (*Ophiothrix fragilis* brittlestar beds). It is possible that the areas of cobble skear habitat assigned to the coarse sediment biotope complex with patches of faunal turf biotopes (**CR.HCR.XFa**) in the current study are impoverished versions of the previously identified **CR.ECR.BS.CuSH** biotope; occasional to frequent unidentified yellow encrusting sponges were recorded in the present study in the same areas in which Woombs (2000) observed dense *Halichondria panicea* and other sponges. It is therefore possible this habitat has deteriorated, although further study is required in order to confirm this. The other species present in this area in both studies are fairly consistent between the two surveys, with the hydroids *Hydrallmania falcata* and *Sertularia* spp. (*argentea* / *cupressina*) and the peacock worm *S. pavonina* recorded in both surveys. In contrast to the 2000 survey, no brittlestar beds were observed in the Walney Channel; it is likely that these are in fact transient features, as was suggested by Woombs (2000).

4.5 Condition monitoring – subtidal cobble and boulder skear sub-feature

The 2014 survey of the Morecambe Bay SAC collected data for the re-establishment of a baseline of the extent of Annex I reef habitat, including the rocky scar ground sub-feature, in order to aid condition monitoring. In addition, the data enabled an assessment of change against previously collected datasets and thereby an initial assessment of feature condition. The results and achievements of the survey, including a preliminary condition assessment, are given in Table 4.1, together with recommendations for future monitoring.

4.6 Recommendations for future monitoring

There are several habitats and species within the Morecambe Bay SAC requiring future monitoring measures. The current survey collected considerable amounts of baseline data but additional baseline data are required in order to enable future monitoring of all the habitats and species present in the survey areas. It is recommended that additional ground-truthing survey work using a freshwater lens camera system is completed in order to acquire more data and achieve increased coverage of the seabed environment, therefore allowing a higher confidence in the detail of the habitat maps. Ideally survey work would be conducted during and following periods of calm weather conditions and during neap tides so that poor underwater visibility does not hamper survey effort.

Camera deployments and infaunal sampling using a 0.1 m^2 sediment grab sampler should be carried out in conjunction with broad-scale acoustic techniques to allow very conspicuous changes in habitat distribution to become apparent. It is particularly recommended that sidescan sonar survey work be conducted. This would enable changes in sediment composition, including areas of rocky scar ground, to be more readily identified. Future subtidal surveys of the Morecambe SAC should see ‘permanent’ transects established in order to enable repeat monitoring to take place. Further surveys (dive and / or Hamon grab) should also be conducted in the Walney Channel in order to identify the encrusting sponge species encountered during this current study so that more accurate condition assessments can be made. Additionally, it is recommended that the biotope **CR.HCR.XFa.Mol** is incorporated into the favourable condition assessment criteria as an attribute to be monitored, as this appears to have replaced other faunal turf biotopes as the dominant community associated with cobble skears in the SAC.

Table 4.1: Favourable condition assessment table with recommended measures and attributes post-2014 survey (from Natural England, 2014)

Sub-feature	Attribute	Measure	Target	Method	2014 Survey Results / Achievements	Recommendations (2015)
Subtidal boulder & cobble skears	Characteristic species - Mussels *Mytilus edulis*.	Abundance and age/size class profile of mussels, measured periodically (frequency to be determined).	Percentage of sexually mature mussels and newly recruited mussels on beds should not fall below North Western & North Wales Sea Fisheries Committee baseline, to be established, subject to natural change.	Drop down video	- Seventy-one transects were successfully surveyed within the Morecambe Bay SAC with a large geographic spread across the four Priority Survey Areas. - No historic sites known to be representative of this attribute were visited. - No instances of this attribute were encountered.	- In conjunction with further acoustic data acquisition, historic sites should be revisited using a freshwater lens camera system and the SAC investigated for instances of this attribute.
	Characteristic species - Mermaids glove sponge *Haliclona oculata*, Breadcrumb sponge *Halichondria panicea* and	Abundance (% cover) of characteristic sponge species in m^2 quadrats along two transects. Measured twice during reporting cycle.	Average abundance should not deviate significantly from an established baseline, subject to natural change.	Diving survey and / or Drop down video survey	- Seventy-one transects were successfully surveyed within the Morecambe Bay SAC with a large geographic spread across the four Priority Survey Areas. - Encrusting sponge species were identified at 17 transects,	- Diver survey within the Walney Channel is recommended to provide for identification of the sponge species now present within the SAC.

Sub-feature	Attribute	Measure	Target	Method	2014 Survey Results / Achievements	Recommendations (2015)
	Hymeniacidon perleve.				including 8 within the Walney Channel, ranging in abundance from Rare to Frequent.	- Future surveys should aim to use a Hamon grab at camera locations to acquire specimens of these species.
	Characteristic biotope - **CR.HCR.XFa. Mol**	Extent of biotope type on cobble and boulder skear habitat. Abundance of *Molgula manhattensis* and associated hydroid species	To be established	Drop down video survey and acoustic data acquisition	- This biotope was identified at 51 discrete seabed contacts throughout the survey area and is associated with areas defined as cobble or boulder skear habitat.	- It is recommended that this biotope be included as an attribute for definition of the sub-feature cobble and boulder skears

4.7 Conclusions

The drop-down video survey of the Morecambe Bay SAC survey areas aimed to assess the extent and distribution of subtidal cobble and boulder skear communities and was successfully completed in two phases in 2014. A total of 71 transects were attempted throughout the survey areas, with focus on four Priority Areas assigned by Natural England, using Seastar Survey's own HD Freshwater Lens Camera System (FLCS), with a total of 528 discrete video clips achieved, 500 of which yielded usable data. Underwater visibility was very poor throughout the survey (generally 5 – 20 cm).

The most commonly identified broad habitat was **SS.SSa** (sublittoral sands and muddy sands) with 35.5 % of seabed contacts assigned to either the broad habitat **SS.SSa** or the biotope complex **SS.SSa.CMuSa** (circalittoral muddy sand). Circalittoral mixed sediments (**SS.SMx.CMx**) were also frequently observed.

Cobble (and, less frequently, boulder) skear communities were frequently observed throughout the survey area, with cobbles and other coarse substrata recorded on 40 of the 71 transects. Cobble skear polygons to delineate the extent of potential cobble skears were created at three confidence levels. The total area covered by potential cobble skear habitat (at 50 – 60 % confidence) was found to be approximately 6.26 km^2, equivalent to 9.13 % of the total area surveyed.

Where potential cobbles and boulder skear habitats were observed, epifauna was dominated by the non-native, cryptogenic colonial ascidian *Molgula manhattensis*. These areas were assigned the biotope **CR.HCR.XFa.Mol** (*Molgula manhattensis* with a hydroid and bryozoan turf on tide-swept moderately wave-exposed circalittoral rock). It is possible that the diversity of fauna on cobble skear habitat in the SAC has declined, with *M. manhattensis* dominating rather than the 'rich faunal turf' described by Sotheran and Walton (1997). The areas of cobble skear habitat in the Walney Channel may also have exhibited decline, with the density and diversity of the observed sponge community lower than was described by Woombs (2000). There are however problems with direct comparison, due to the difficulties of identifying sponge species in low visibility conditions from video data alone.

The condition monitoring attribute species *Mytillus edulis* was not identified at any location across the surveyed area. In order to further future condition monitoring, it is suggested that the biotope **CR.HCR.XFa.Mol** be included as a characterising biotope attribute of the Annex I sub-feature 'cobble and boulder skear.'

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Appendices

Appendix I: Proposed and achieved drop-down camera locations for the 2014 Morecambe Bay SAC Survey.

Proposed drop-down camera transect locations (all positions WGS84; SOL = start of line; EOL= end of line).

Station No.	SOL Latitude	SOL Longitude	EOL Latitude	EOL Longitude
1	53.99291	-2.98127	53.99482	-2.97803
2	53.99024	-2.98465	53.99214	-2.98141
3	53.98651	-2.99140	53.98842	-2.98816
4	53.98924	-2.99940	53.99115	-2.99617
5	53.97911	-3.01319	53.98102	-3.00996
6	53.98532	-3.01525	53.98723	-3.01202
7	53.97290	-3.01773	53.97481	-3.01450
8	53.96779	-3.02496	53.96969	-3.02173
9	53.96587	-3.02983	53.96778	-3.02660
10	53.96853	-3.03516	53.97044	-3.03193
11	53.97111	-3.04155	53.97302	-3.03832
12	53.97635	-3.03824	53.97826	-3.03500
13	53.98791	-3.04531	53.98982	-3.04208
14	53.99044	-3.05452	53.99235	-3.05129
15	53.98515	-3.07095	53.98705	-3.06771
16	53.99444	-3.02351	53.99634	-3.02027
17	53.99620	-3.04149	53.99811	-3.03826
18	53.99904	-3.03274	54.00094	-3.02951
19	54.00354	-3.05408	54.00545	-3.05085
20	54.00629	-3.05278	54.00820	-3.04955
21	53.99394	-3.10885	53.99584	-3.10561
22	53.98936	-3.12002	53.99127	-3.11679
23	53.99329	-3.11993	53.99520	-3.11670
24	53.98481	-3.12353	53.98672	-3.12030
25	53.98951	-3.13266	53.99142	-3.12943
26	53.99365	-3.13953	53.99556	-3.13630
27	53.99815	-3.13560	54.00005	-3.13237
28	53.99732	-3.12798	53.99923	-3.12475
29	53.99810	-3.12169	54.00001	-3.11846
30	54.00008	-3.11380	54.00199	-3.11056
31	54.00285	-3.12416	54.00476	-3.12093
32	54.00853	-3.12546	54.01044	-3.12223
33	54.00704	-3.12977	54.00894	-3.12653
34	54.00717	-3.13614	54.00908	-3.13291

Station No.	SOL Latitude	SOL Longitude	EOL Latitude	EOL Longitude
35	54.01164	-3.13222	54.01355	-3.12899
36	53.96289	-3.08955	53.96480	-3.08632
37	53.96469	-3.09245	53.96660	-3.08922
38	53.96101	-3.09633	53.96292	-3.09311
39	53.95519	-3.09788	53.95710	-3.09466
40	54.04469	-3.17008	54.04660	-3.16684
41	54.05018	-3.16684	54.05209	-3.16361
42	54.05522	-3.16876	54.05713	-3.16552
43	54.06030	-3.16756	54.06222	-3.16433
44	54.06793	-3.16797	54.06984	-3.16474
45	54.06962	-3.17139	54.07153	-3.16816
46	54.07119	-3.17898	54.07310	-3.17574
47	54.07126	-3.18386	54.07317	-3.18063
48	54.07402	-3.18752	54.07593	-3.18429
49	54.07557	-3.19292	54.07748	-3.18969
50	54.07840	-3.20314	54.08031	-3.19990
51	53.99556	-3.00242	53.99457	-3.00666
52	53.98997	-3.00782	53.98899	-3.01220
53	53.99149	-3.01398	53.99016	-3.01807
54	53.99246	-3.02226	53.99135	-3.02611
55	53.98214	-3.02313	53.98159	-3.02666
56	53.98202	-3.03134	53.98158	-3.03503
57	53.97698	-3.02835	53.97673	-3.03209
58	54.00005	-3.04471	53.99862	-3.04870
59	53.99665	-3.04819	53.99547	-3.05228
60	53.99787	-3.05193	53.99683	-3.05545
61	54.00012	-3.04992	53.99889	-3.05405
62	53.95834	-3.09720	53.95762	-3.10081
63	53.98591	-3.11451	53.98488	-3.11796
64	53.99377	-3.12328	53.99269	-3.12685
65	54.00210	-3.12754	54.00096	-3.13134
66	53.99899	-3.14208	53.99804	-3.14550
67	54.00270	-3.14042	54.00151	-3.14391

Achieved drop-down camera transect locations (all positions WGS84; SOL = start of line; EOL= end of line).

Station No.	SOL Latitude	SOL Longitude	EOL Latitude	EOL Longitude
1	53.99337	-2.98098	53.99476	-2.97818
2	53.98664	-2.99143	53.9894	-2.98613
3	53.99033	-2.98457	53.99251	-2.98093
4	53.98926	-2.99924	53.99136	-2.99595
5	53.97917	-3.0131	53.98076	-3.01031
6	53.9853	-3.01515	53.98696	-3.01255
7	53.97478	-3.01433	53.97307	-3.0174
8	53.96976	-3.02182	53.96975	-3.02139
8	53.96774	-3.02509	53.96983	-3.02162
9	53.96599	-3.02976	53.96788	-3.02616
10	53.96858	-3.03522	53.97043	-3.03211
11	53.97109	-3.04175	53.97384	-3.03696
12	53.97826	-3.03517	53.97648	-3.03805
14	53.99032	-3.05429	53.99275	-3.05129
15	53.98714	-3.06773	53.98448	-3.07223
16	53.99446	-3.0232	53.99662	-3.01951
18	53.999	-3.03277	54.00062	-3.03001
20	54.00638	-3.05296	54.00771	-3.0503
24	53.98673	-3.12032	53.98459	-3.12475
26	53.99564	-3.13656	53.99405	-3.13869
28	53.99922	-3.12476	53.99731	-3.12819
29	53.99999	-3.11854	53.99789	-3.12351
30	54.00197	-3.11032	54.00009	-3.11371
36	53.9628	-3.08956	53.96463	-3.08644
37	53.96644	-3.08887	53.96478	-3.09221
38	53.9629	-3.09324	53.96089	-3.09627
39	53.95686	-3.09446	53.95506	-3.09783
40	54.04487	-3.17015	54.0437	-3.16693
41	54.05021	-3.16698	54.05221	-3.16349
42	54.0554	-3.16868	54.05715	-3.16546
45	54.06963	-3.17135	54.06935	-3.17186
46	54.07099	-3.17926	54.07128	-3.17841
47	54.07331	-3.18073	54.07338	-3.18043
51	53.99447	-3.00642	53.99576	-3.00208
52	53.98899	-3.0123	53.98978	-3.00749
54	53.99266	-3.02218	53.99266	-3.02218
54	53.9924	-3.02224	53.99126	-3.02624
55	53.98161	-3.02694	53.98217	-3.02325
57	53.97672	-3.03225	53.97712	-3.02705
58	53.99981	-3.04497	53.99814	-3.05014
59	53.996	-3.05199	53.99588	-3.04902
60	53.99794	-3.05182	53.99767	-3.05322

Station No.	SOL Latitude	SOL Longitude	EOL Latitude	EOL Longitude
62	53.95811	-3.09697	53.9575	-3.10569
64	53.99372	-3.12328	53.99252	-3.12744
68	53.98036	-3.07311	53.97886	-3.07717
69	54.00983	-2.99202	54.00996	-2.9923
69	54.00959	-2.9923	54.00958	-2.99245
70	53.98748	-3.09673	53.98939	-3.09322
17a	54.00421	-3.00227	54.0078	-3.01388
19a	53.96391	-3.05617	53.96403	-3.05455
21a	53.99535	-3.12934	53.99355	-3.13294
22a	53.96519	-3.10356	53.9667	-3.09817
23a	53.99473	-3.14604	53.99676	-3.14307
25a	53.95314	-3.06751	53.95516	-3.06068
31a	53.9986	-3.15799	53.99996	-3.15488
32a	53.99677	-3.14988	53.99516	-3.15392
33a	53.99222	-3.13578	53.99006	-3.1391
34a	53.97964	-3.11848	53.97746	-3.12246
35a	53.97671	-3.09827	53.97711	-3.09767
36a	54.00014	-3.13223	53.99877	-3.1374
43a	54.06202	-3.16756	54.06369	-3.16178
44a	54.06809	-3.16511	54.06663	-3.16743
48a	54.06243	-3.16699	54.06619	-3.16755
49a	54.07656	-3.19088	54.06845	-3.16553
50a	54.07717	-3.1908	54.07555	-3.1926
53a	53.9881	-3.01984	53.98487	-3.02727
56a	53.98249	-3.03516	53.9828	-3.03129
61a	53.99809	-3.05193	54.00096	-3.05226
63a	53.98181	-3.12862	53.98009	-3.13302
65a	53.95977	-3.10215	53.95654	-3.1011
66a	53.97405	-3.08917	53.97576	-3.08346
67a	53.97113	-3.10763	53.96995	-3.11152

Appendix II: Drop-down video survey logs detailing achieved 'seabed contacts' in the Morecambe Bay 2014 drop-down video survey

Seastar Survey Ltd			
Morecambe Bay DDV Survey			
Log of seabed contacts / video clips			
WGS 1984 UTM Zone 30N (6ºW - 0º)			
Client	Natural England	**Job No.**	J/14/411
Location	Morecambe Bay SAC	**Vessel**	SV Mariner

Date	Sample #	Station	Time (UTC)	Easting	Northing	Latitude	Longitude	Depth	HDD Track	Tape #
07/08/2014	411_01_01#01	1	11:32:37	501246	5982785			17	5	1
07/08/2014	411_01_01#02	1	11:35:04	501294	5982824			17	5_01	1
07/08/2014	411_01_01#03	1	11:39:35	501334	5982839			17	5_02	1
07/08/2014	411_01_01#04	1	11:43:50	501399	5982910	53.99450	-2.97866	17	5_03	1
07/08/2014	411_01_01#05	1	11:50:11	501431	5982939	53.99476	-2.97818	17	5_04	1
07/08/2014	411_02_01#1	2	12:13:46	500562	5982036	53.98664	-2.99143	10	7	2
07/08/2014	411_02_01#2	2	12:17:12	500609	5982078	53.98703	-2.99071	10	7_01	2
07/08/2014	411_02_01#3	2	12:21:26	500676	5982140	53.98758	-2.98969	10	7_02/03	2
07/08/2014	411_02_01#4	2	12:25:18	500728	5982172	53.98787	-2.98890	10	7_03	2
07/08/2014	411_02_01#5	2	12:28:48	500776	5982245	53.98852	-2.98816	10	7_04/05	2
07/08/2014	411_02_01#6	2	12:34:01	500910	5982342	53.98940	-2.98613	8	7_06	2
07/08/2014	411_02_01#7	3	12:37:25	501012	5982446	53.99033	-2.98457	8	7_07	2
07/08/2014	411_02_01#8	3	12:41:12	501055	5982485	53.99069	-2.98391	8	7_08	2
07/08/2014	411_02_01#9	3	12:44:36	501124	5982552	53.99128	-2.98285	13	7_09	2
07/08/2014	411_02_01#10	3	12:48:02	501189	5982626	53.99195	-2.98186	13	7_10	2
07/08/2014	411_02_01#11	3	12:51:34	501250	5982689	53.99251	-2.98093	13	7_11	2
07/08/2014	411_03_01#1	4	13:46:34	500050	5982327	53.98926	-2.99924	17	9_01	2

Date	Sample #	Station	Time (UTC)	Easting	Northing	Latitude	Longitude	Depth	HDD Track	Tape #
07/08/2014	411_03_01#1b	4	13:48:09	500058	5982332	53.98931	-2.99911	17	9_02	2
07/08/2014	411_03_01#2	4	13:51:54	500103	5982395	53.98987	-2.99843	17	9_03	2
07/08/2014	411_03_01#3	4	13:53:53	500114	5982402	53.98994	-2.99826	15	9_04	2
07/08/2014	411_03_01#4	4	13:56:54	500153	5982444	53.99032	-2.99767	15	9_05	2
07/08/2014	411_03_01#5	4	13:59:58	500207	5982495	53.99078	-2.99685	15	9_06	2
07/08/2014	411_03_01#6	4	14:03:03	500266	5982560	53.99136	-2.99595	15	9_07	2
07/08/2014	411_04_01#1	51	14:26:30	499579	5982907	53.99447	-3.00642	11	10_1	3
07/08/2014	411_04_01#2	51	14:29:52	499649	5982933	53.99471	-3.00536	11	10_2	3
07/08/2014	411_04_01#3	51	14:33:18	499729	5982979	53.99513	-3.00414	11	10_3	3
07/08/2014	411_04_01#4	51	14:36:14	499805	5983005	53.99536	-3.00297	11	10_4	3
07/08/2014	411_04_01#5	51	14:39:43	499863	5983050	53.99576	-3.00208	11	10_5	3
07/08/2014	411_05_01#1	16	15:08:45	498479	5982906	53.99446	-3.02320	15	11_1	3
07/08/2014	411_05_01#2	16	15:14:11	498553	5982963	53.99498	-3.02206	15	11_2	3
07/08/2014	411_05_01#3	16	15:16:26	498567	5983024	53.99552	-3.02186	15	11_3	3
07/08/2014	411_05_01#4	16	15:20:18	498671	5983076	53.99600	-3.02028	15	11_4	3
07/08/2014	411_05_01#5	16	15:22:40	498694	5983084	53.99606	-3.01992	15	11_5	3
07/08/2014	411_05_01#6	16	15:26:36	498721	5983146	53.99662	-3.01951	15	11_6	3
07/08/2014	411_06_01#1									
07/08/2014	411_06_02#1	54	16:20:48	498545.71	5982705.31	53.99266	-3.02218			
31/08/2014	411_07_01	52	NA	NA	NA			NA	16	4
31/08/2014	411_07_02	52	NA	NA	NA			NA	16	4
31/08/2014	411_07_02	52	NA	NA	NA			NA	16	4
31/08/2014	411_07_04	52	NA	NA	NA			NA	16	4
01/09/2014	411_08_04	65	NA	NA	NA			NA		
01/09/2014	411_08_04	65	NA	NA	NA			NA		
01/09/2014	411_08_04	65	NA	NA	NA			NA		

Date	Sample #	Station	Time (UTC)	Easting	Northing	Latitude	Longitude	Depth	HDD Track	Tape #
01/09/2014	411_08_04	65	NA	NA	NA			NA		
02/09/2014	411_09_01#1	6	09:04:38	499006	5981887	53.98530	-3.01515	16	20	4
02/09/2014	411_09_01#2	6	09:08:08	499018	5981921	53.98561	-3.01497	16.2	21	4
02/09/2014	411_09_01#3	6	09:11:47	499060	5981941	53.98579	-3.01433	16.6	22	4
02/09/2014	411_09_01#4	6	09:15:08	499077	5981980	53.98615	-3.01407	16	23	4
02/09/2014	411_09_01#5	6	09:20:15	499111	5982012	53.98643	-3.01355	14	24	4
02/09/2014	411_09_01#6	6	09:25:38	499139	5982042	53.98670	-3.01313	11	25	4
02/09/2014	411_09_01#7	6	09:30:58	499177	5982071	53.98696	-3.01255	10.5	26	4
02/09/2014	411_10_01#1	52	09:36:57	499194	5982297	53.98899	-3.01230	9.5	NA	4
02/09/2014	411_10_01#2	52	09:41:07	499254	5982309	53.98910	-3.01137	9.5	28	4
02/09/2014	411_10_01#3	52	09:45:43	499311	5982337	53.98935	-3.01050	11.4	29	4
02/09/2014	411_10_01#4	52	09:49:37	499370	5982365	53.98961	-3.00961	13.2	30	4
02/09/2014	411_10_01#5	52	09:52:54	499430	5982378	53.98972	-3.00869	15	3`	4
02/09/2014	411_10_01#6	52	09:58:44	499509	5982385	53.98978	-3.00749	17	32	4
02/09/2014	411_11_01 SOL	5	10:16:20	499133	5981200	53.97914	-3.01323			
02/09/2014	411_11_01#1	5	10:17:01	499141	5981205	53.97917	-3.01310	22.3	33	5
02/09/2014	411_11_01#2	5	10:20:01	499175	5981242	53.97951	-3.01258	23	34	5
02/09/2014	411_11_01#3	5	10:25:35	499207	5981271	53.97977	-3.01209	22.6	35	5
02/09/2014	411_11_01#4	5	10:30:12	499241	5981308	53.98010	-3.01158	22	36	5
02/09/2014	411_11_01#5	5	10:32:40	499281	5981349	53.98047	-3.01097	23.9	37	5
02/09/2014	411_11_01#6	5	10:37:37	499324	5981381	53.98076	-3.01031	20.7	38	5
02/09/2014	411_12_01#1	7	11:04:13	499060	5980716	53.97478	-3.01433	22	39	5
02/09/2014	411_12_01#2	7	11:09:44	499002	5980679	53.97445	-3.01521	22	40	5
02/09/2014	411_12_01#3	7	11:13:11	498991	5980625	53.97396	-3.01538	21	41	5
02/09/2014	411_12_01#4	7	11:17:16	498925	5980607	53.97380	-3.01640	16	42	5
02/09/2014	411_12_01#5	7	11:20:23	498899	5980553	53.97332	-3.01679	21	43	5
02/09/2014	411_12_01#6	7	11:25:18	498859	5980525	53.97307	-3.01740	21	44	5
02/09/2014	411_13_02#1	8	11:41:19	498569	5980157	53.96976	-3.02182	18.3	45	6

Date	Sample #	Station	Time (UTC)	Easting	Northing	Latitude	Longitude	Depth	HDD Track	Tape #
02/09/2014	411_13_02#2	8	12:07:05	498581	5980155	53.96974	-3.02164	18.3	46	6
02/09/2014	411_13_02#3	8	12:08:05	498597	5980157	53.96975	-3.02139	18.3	47	6
02/09/2014	411_14_01#1	37	14:47:22	494170	5979792	53.96644	-3.08887	14.4	49	6
02/09/2014	411_14_01#2	37	14:51:52	494125	5979777	53.96631	-3.08956	12.4	50	6
02/09/2014	411_14_01#3	37	14:54:51	494073	5979706	53.96567	-3.09035	12	51	6
02/09/2014	411_14_01#4	37	14:57:33	494023	5979682	53.96545	-3.09111	12	52	6
02/09/2014	411_14_01#5	37	15:00:19	493981	5979647	53.96514	-3.09174	12	53	6
02/09/2014	411_14_01#6	37	15:04:18	493950	5979607	53.96478	-3.09221	12	54	6
02/09/2014	411_15_01#1	38	15:11:08	493883	5979398	53.96290	-3.09324	15.1	5	6
02/09/2014	411_15_01#2	38	15:13:53	493849	5979358	53.96254	-3.09375	16.5	56	6
02/09/2014	411_15_01#3	38	15:17:37	493816	5979305	53.96207	-3.09425	18.5	57	6
02/09/2014	411_15_01#4	38	15:20:34	493753	5979270	53.96175	-3.09522	16.8	58	6
02/09/2014	411_15_01#5	38	15:22:48	493726	5979224	53.96133	-3.09562	17	59	6
02/09/2014	411_15_01#6	38	15:24:59	493683	5979175	53.96089	-3.09627	18.2	60	6
02/09/2014	411_16_01#1	62	15:39:03	493638	5978865	53.95811	-3.09697	35	61	Tape 6 (From tape time 00:47:53 to End of tape) - then Tape 7
02/09/2014	411_16_01#2	62	15:42:23	493581	5978876	53.95821	-3.09782	30	62	
02/09/2014	411_16_01#3	62	15:46:21	493540	5978847	53.95795	-3.09845	19	63	
02/09/2014	411_16_01#4	62	15:50:19	493485	5978854	53.95801	-3.09930	11	64	
02/09/2014	411_16_01#5	62	15:52:29	493444	5978827	53.95776	-3.09992	10.5	65	
02/09/2014	411_16_01#6	62	15:55:16	493404	5978804	53.95755	-3.10052	8	66	
02/09/2014	411_16_01#7	62	15:59:29	493331	5978803	53.95755	-3.10164	6.4	67	
02/09/2014	411_16_01#8	62	16:03:49	493259	5978789	53.95742	-3.10274	9	68	
02/09/2014	411_16_01#9	62	16:07:58	493179	5978789	53.95742	-3.10396	10.6	69	
02/09/2014	411_16_01#10	62	16:14:12	493065	5978799	53.95750	-3.10569	11	70	
02/09/2014	411_17_01#1	39	16:35:21	493802	5978726	53.95686	-3.09446	37	71	7
02/09/2014	411_17_01#2	39	16:37:34	493744	5978711	53.95673	-3.09534	38.6	72	7
02/09/2014	411_17_01#3	39	16:41:15	493722	5978652	53.95620	-3.09568	39	73	7

Date	Sample #	Station	Time (UTC)	Easting	Northing	Latitude	Longitude	Depth	HDD Track	Tape #
02/09/2014	411_17_01#4	39	16:43:58	493671	5978628	53.95598	-3.09645	39	74	7
02/09/2014	411_17_01#5	39	16:47:34	493623	5978566	53.95542	-3.09718	40	75	7
02/09/2014	411_17_01#6	39	16:50:42	493580	5978526	53.95506	-3.09783	41	76	7
02/09/2014	411_18_01#1	36	17:22:23	494124	5979386	53.96280	-3.08956	25	77	7
02/09/2014	411_18_01#2	36	17:25:59	494145	5979430	53.96319	-3.08924	23.5	78	7
02/09/2014	411_18_01#3	36	17:30:20	494180	5979447	53.96334	-3.08871	23	79	7
02/09/2014	411_18_01#4	36	17:33:35	494211	5979491	53.96374	-3.08824	21	80	7
02/09/2014	411_18_01#5	36	17:37:14	494247	5979517	53.96398	-3.08770	21	81	7
02/09/2014	411_18_01#6	36	17:40:41	494278	5979549	53.96426	-3.08722	19.8	82	7
02/09/2014	411_18_01#7	36	17:44:35	494329	5979589	53.96463	-3.08644	18	83	7
03/09/2014	411_19_01#1	14	09:09:19	496441	5982446	53.99032	-3.05429	11.9	1	8
03/09/2014	411_19_01#2	14	09:14:07	496472	5982505	53.99085	-3.05381	11.6	2	8
03/09/2014	411_19_01#3	14	09:18:19	496507	5982525	53.99103	-3.05328	11	3	8
03/09/2014	411_19_01#4	14	09:22:37	496506	5982567	53.99141	-3.05329	11	4	8
03/09/2014	411_19_01#5	14	09:29:17	496545	5982600	53.99170	-3.05270	11	5	8
03/09/2014	411_19_01#6	14	09:33:27	496600	5982652	53.99218	-3.05186	11.2	6	8
03/09/2014	411_19_01#7	14	09:39:04	496630	5982733	53.99290	-3.05140	11	7	8
03/09/2014	411_19_01#8	14	09:43:12	496610	5982729	53.99286	-3.05171	11	8	8
03/09/2014	411_19_01#9	14	09:47:24	496624	5982740	53.99296	-3.05149	11	9	8
03/09/2014	411_19_01#10	14	09:49:15	496641	5982738	53.99294	-3.05124	11	10	8
03/09/2014	411_19_01#11	14	09:50:50	496637	5982716	53.99275	-3.05129	11	11 -No HD	8
03/09/2014	411_20_01#1	59	10:14:43	496592	5983078	53.99600	-3.05199	10	12	8
03/09/2014	411_20_01#2	59	10:17:50	496587	5983076	53.99598	-3.05206	10	13	8
03/09/2014	411_20_01#3	59	10:20:46	496593	5983071	53.99594	-3.05197	10	14	8
03/09/2014	411_20_01#4	59	10:23:48	496583	5983091	53.99612	-3.05213	10	15	8
03/09/2014	411_20_01#5	59	10:29:40	496710	5983068	53.99591	-3.05019	9	16	8
03/09/2014	411_20_01#6	59	10:32:33	496722	5983061	53.99585	-3.05000	10	17	8
03/09/2014	411_20_01#7	59	10:35:21	496731	5983079	53.99601	-3.04986	9	18	8

Date	Sample #	Station	Time (UTC)	Easting	Northing	Latitude	Longitude	Depth	HDD Track	Tape #
03/09/2014	411_20_01#8	59	10:38:59	496757	5983125	53.99643	-3.04946	9	19	8
03/09/2014	411_20_01#9	59	10:41:08	496763	5983112	53.99631	-3.04938	9	20	8
03/09/2014	411_20_01#10	59	10:44:14	496756	5983109	53.99628	-3.04949	9	21	9
03/09/2014	411_20_01#11	59	10:48:37	496792	5983085	53.99606	-3.04893	9.8	22	9
03/09/2014	411_20_01#12	59	10:50:27	496798	5983070	53.99593	-3.04884	9	23	9
03/09/2014	411_20_01#13	59	10:52:41	496787	5983065	53.99588	-3.04902	9	24	9
03/09/2014	411_21_01#1	60	11:02:45	496603	5983294	53.99794	-3.05182	9	25	9
03/09/2014	411_21_01#2	60	11:07:25	496601	5983289	53.99789	-3.05185	8.9	26	9
03/09/2014	411_21_01#3	60	11:10:47	496599	5983308	53.99807	-3.05189	9	27	9
03/09/2014	411_21_01#4	60	11:15:00	496526	5983245	53.99750	-3.05299	9	28	9
03/09/2014	411_21_01#5	60	11:20:06	496537	5983252	53.99756	-3.05283	9	29	9
03/09/2014	411_21_01#6	60	11:25:57	496510	5983266	53.99769	-3.05324	9	30	9
03/09/2014	411_21_01#7	60	11:26:55	496512	5983264	53.99767	-3.05322	9	30	9
03/09/2014	411_22_01#1	61#2	11:33:36	496596	5983311	53.99809	-3.05193	8.8	31	9
03/09/2014	411_22_01#2	61#2	11:35:19	496596	5983344	53.99839	-3.05192	8	32	9
03/09/2014	411_22_01#3	61#2	11:37:25	496593	5983393	53.99884	-3.05197	8.6	33	9
03/09/2014	411_22_01#4	61#2	11:39:13	496593	5983435	53.99921	-3.05197	8.6	34	9
03/09/2014	411_22_01#5	61#2	11:41:35	496582	5983478	53.99960	-3.05215	8.7	35	9
03/09/2014	411_22_01#6	61#2	11:43:33	496589	5983523	54.00000	-3.05204	8	36	9
03/09/2014	411_22_01#7	61#2	11:45:51	496586	5983587	54.00058	-3.05208	8.7	37	9
03/09/2014	411_22_01#8	61#2	11:48:36	496574	5983630	54.00096	-3.05226	8.7	38	9
03/09/2014	411_23_01#1	56#2	12:16:46	497695	5981574	53.98249	-3.03516	18	39	10
03/09/2014	411_23_01#2	56#2	12:21:24	497737	5981589	53.98262	-3.03452	17	40	10
03/09/2014	411_23_01#3	56#2	12:25:21	497795	5981597	53.98270	-3.03362	20	41	10
03/09/2014	411_23_01#4	56#2	12:29:33	497833	5981599	53.98272	-3.03305	22	42	10
03/09/2014	411_23_01#5	56#2	12:33:34	497891	5981605	53.98277	-3.03216	21	43	10
03/09/2014	411_23_01#6	56#2	12:37:47	497948	5981609	53.98280	-3.03129	24	44	10

Date	Sample #	Station	Time (UTC)	Easting	Northing	Latitude	Longitude	Depth	HDD Track	Tape #
03/09/2014	411_24_01#1	12	12:55:25	497693	5981104	53.97826	-3.03517	26	45	10
03/09/2014	411_24_01#2	12	13:00:02	497675	5981068	53.97794	-3.03545	27.8	46	10
03/09/2014	411_24_01#3	12	13:04:08	497642	5981036	53.97765	-3.03595	26	47	10
03/09/2014	411_24_01#4	12	13:08:27	497603	5980999	53.97732	-3.03654	27	48	10
03/09/2014	411_24_01#5	12	13:13:41	497574	5980960	53.97697	-3.03700	27	49	10
03/09/2014	411_24_01#6	12	13:17:51	497533	5980931	53.97671	-3.03762	21	50	10
03/09/2014	411_24_01#7	12	13:24:40	497505	5980906	53.97648	-3.03805	21	51	10
09/09/2014			10:21:50							
03/09/2014	411_25_01#1	15	14:55:20	495559	5982093	53.98714	-3.06773	11	52	11
03/09/2014	411_25_01#2	15	14:57:58	495543	5982055	53.98679	-3.06797	11	53	11
03/09/2014	411_25_01#3	15	15:01:26	495496	5982027	53.98655	-3.06869	10	54	11
03/09/2014	411_25_01#4	15	15:04:31	495473	5981978	53.98611	-3.06904	11	55	11
03/09/2014	411_25_01#5	15	15:08:46	495423	5981950	53.98585	-3.06980	9	56	11
03/09/2014	411_25_01#6	15	15:12:21	495396	5981912	53.98551	-3.07022	8	57	11
03/09/2014	411_25_01#7	15	15:16:16	495346	5981881	53.98523	-3.07098	8	58	11
03/09/2014	411_25_01#8	15	15:19:06	495306	5981830	53.98477	-3.07159	9	59	11
03/09/2014	411_25_01#9	15	15:23:07	495264	5981797	53.98448	-3.07223	8	60	11
03/09/2014	411_26_01#1	68	15:41:00	495206	5981339	53.98036	-3.07311	12.8	61	11
03/09/2014	411_26_01#2	68	15:43:48	495166	5981316	53.98015	-3.07371	12	62	11
03/09/2014	411_26_01#3	68	15:46:38	495126	5981307	53.98007	-3.07432	12	63	11
03/09/2014	411_26_01#4	68	15:49:50	495088	5981256	53.97961	-3.07491	11	64	11
03/09/2014	411_26_01#5	68	15:52:18	495039	5981227	53.97936	-3.07564	10	65	11
03/09/2014	411_26_01#6	68	15:55:04	494994	5981199	53.97910	-3.07633	9	66	11
03/09/2014	411_26_01#7	68	15:58:57	494939	5981172	53.97886	-3.07717	10	67	11
03/09/2014	411_27_01#1	30	16:32:16	492769	5983747	54.00197	-3.11032	7	68	12
03/09/2014	411_27_01#2	30	16:35:41	492737	5983727	54.00180	-3.11081	7.4	69	12
03/09/2014	411_27_01#3	30	16:38:54	492701	5983696	54.00152	-3.11136	7	70	12
03/09/2014	411_27_01#4	30	16:41:51	492675	5983660	54.00119	-3.11175	7	71	12

Date	Sample #	Station	Time (UTC)	Easting	Northing	Latitude	Longitude	Depth	HDD Track	Tape #
03/09/2014	411_27_01#5	30	16:44:30	492618	5983620	54.00083	-3.11262	7	72	12
03/09/2014	411_27_01#6	30	16:48:47	492593	5983579	54.00046	-3.11300	7	73	12
03/09/2014	411_27_01#7	30	16:51:57	492546	5983538	54.00009	-3.11371	NA	NA	NA
03/09/2014	411_28_01#1	29	17:02:49	492230	5983527	53.99999	-3.11854	8	74	12
03/09/2014	411_28_01#2	29	17:07:18	492191	5983475	53.99952	-3.11913	9	75	12
03/09/2014	411_28_01#3	29	17:10:35	492137	5983423	53.99905	-3.11996	9	76	12
03/09/2014	411_28_01#4	29	17:13:29	492092	5983378	53.99865	-3.12064	9	77	12
03/09/2014	411_28_01#5	29	17:17:36	492019	5983343	53.99833	-3.12175	9	78	12
03/09/2014	411_28_01#6	29	17:19:47	491980	5983310	53.99804	-3.12234	9	79	12
03/09/2014	411_28_01#7	29	17:23:23	491903	5983294	53.99789	-3.12351	8.5	80	12
03/09/2014	411_29_01#1	26	17:37:04	491048	5983045	53.99564	-3.13656	8	81	12
03/09/2014	411_29_01#2	26	17:40:18	491024	5982988	53.99512	-3.13691	8.5	82	12
03/09/2014	411_29_01#3	26	17:43:43	490950	5982924	53.99455	-3.13805	9.5	83	12
03/09/2014	411_29_01#4	26	17:49:10	490881	5982924	53.99455	-3.13910	9	85	12
03/09/2014	411_29_01#5	26	17:51:09	490908	5982869	53.99405	-3.13869	9	86	12
04/09/2014	411_30_01#1	23#2	10:23:51	490426	5982945	53.99473	-3.14604	4.5	88	13
04/09/2014	411_30_01#2	23#2	10:26:31	490446	5982983	53.99507	-3.14574	4.5	89	13
04/09/2014	411_30_01#3	23#2	10:29:17	490478	5982982	53.99507	-3.14525	4.5	90	13
04/09/2014	411_30_01#4	23#2	10:31:28	490497	5983027	53.99547	-3.14495	4	91	13
04/09/2014	411_30_01#5	23#2	10:33:57	490551	5983072	53.99587	-3.14413	4.7	No HD	13
04/09/2014	411_30_01#6	23#2	10:36:31	490593	5983120	53.99631	-3.14349	4.5	92	13
04/09/2014	411_30_01#7	23#2	10:38:41	490621	5983171	53.99676	-3.14307	4	93	13
04/09/2014	411_31_01#1	32#2	10:45:09	490175	5983173	53.99677	-3.14988	4	94	13
04/09/2014	411_31_01#2	32#2	10:48:42	490099	5983128	53.99637	-3.15103	4.5	95	13
04/09/2014	411_31_01#3	32#2	10:50:38	490044	5983092	53.99604	-3.15187	4	96	13
04/09/2014	411_31_01#4	32#2	10:52:47	489995	5983080	53.99593	-3.15262	4.2	97	13

Date	Sample #	Station	Time (UTC)	Easting	Northing	Latitude	Longitude	Depth	HDD Track	Tape #
04/09/2014	411_31_01#5	32#2	10:55:48	489979	5983052	53.99568	-3.15286	4.6	98	13
04/09/2014	411_31_01#6	32#2	10:59:41	489910	5982994	53.99516	-3.15392	5	99	13
04/09/2014	411_32_01#1	31#2	11:42:57	489643	5983377	53.99860	-3.15799	5	1	13
04/09/2014	411_32_01#2	31#2	11:46:33	489680	5983408	53.99888	-3.15744	5	2	13
04/09/2014	411_32_01#3	31#2	11:49:36	489727	5983421	53.99899	-3.15672	5	3	13
04/09/2014	411_32_01#4	31#2	11:52:05	489753	5983467	53.99940	-3.15632	5	4	13
04/09/2014	411_32_01#5	31#2	11:55:19	489798	5983493	53.99964	-3.15563	5	NA	13
04/09/2014	411_32_01#6	31#2	11:58:09	489848	5983529	53.99996	-3.15488	4.2	5	13
04/09/2014	411_33_01#1	28	12:51:47	491822	5983442	53.99922	-3.12476	2.7	6	14
04/09/2014	411_33_01#2	28	12:54:17	491785	5983414	53.99897	-3.12532	2.2	7	14
04/09/2014	411_33_01#3	28	12:56:43	491752	5983378	53.99865	-3.12583	2.5	8	14
04/09/2014	411_33_01#4	28	12:59:09	491711	5983329	53.99820	-3.12645	2.5	9	14
04/09/2014	411_33_01#5	28	13:01:36	491670	5983298	53.99793	-3.12707	3.4	10	14
04/09/2014	411_33_01#6	28	13:04:11	491651	5983254	53.99753	-3.12737	3.9	11	14
04/09/2014	411_33_01#7	28	13:06:06	491597	5983230	53.99731	-3.12819	4.4	12	14
04/09/2014	411_34_01#1	21#2	13:12:38	491521	5983012	53.99535	-3.12934	4.1	13	14
04/09/2014	411_34_01#2	21#2	13:16:55	491507	5982971	53.99498	-3.12955	3.9	14	14
04/09/2014	411_34_01#3	21#2	13:20:44	491492	5982973	53.99499	-3.12977	3.7	15	14
04/09/2014	411_34_01#4	21#2	13:23:19	491435	5982931	53.99462	-3.13065	3.4	16	14
04/09/2014	411_34_01#5	21#2	13:26:14	491407	5982911	53.99444	-3.13108	3.5	17	14
04/09/2014	411_34_01#6	21#2	13:29:17	491382	5982890	53.99425	-3.13145	4	18	14
04/09/2014	411_34_01#7	21#2	13:32:23	491366	5982853	53.99392	-3.13170	4	19	14
04/09/2014	411_34_01#8	21#2	13:35:06	491315	5982827	53.99369	-3.13247	3.7	20	14
04/09/2014	411_34_01#9	21#2	13:37:57	491285	5982812	53.99355	-3.13294	3.8	21	14
04/09/2014	411_35_01#1	33#2	13:48:38	491098	5982665	53.99222	-3.13578	4.5	22	14
04/09/2014	411_35_01#2	33#2	13:52:28	491069	5982648	53.99207	-3.13623	3.5	23	14
04/09/2014	411_35_01#3	33#2	13:54:54	491050	5982606	53.99169	-3.13651	3.4	24	14

Date	Sample #	Station	Time (UTC)	Easting	Northing	Latitude	Longitude	Depth	HDD Track	Tape #
04/09/2014	411_35_01#4	33#2	13:58:03	490986	5982600	53.99164	-3.13748	4.5	25	14
04/09/2014	411_35_01#5	33#2	14:01:13	490972	5982551	53.99120	-3.13771	5.5	26	14
04/09/2014	411_35_01#6	33#2	14:04:15	490939	5982548	53.99117	-3.13820	6	27	14
04/09/2014	411_35_01#7	33#2	14:07:25	490904	5982503	53.99077	-3.13874	6	28	15
04/09/2014	411_35_01#8	33#2	14:10:34	490880	5982424	53.99006	-3.13910	5.8	29	15
04/09/2014	411_36_01#1	36#1	14:29:10	491333	5983545	54.00014	-3.13223	5.5	30	15
04/09/2014	411_36_01#2	36#1	14:33:48	491295	5983544	54.00013	-3.13280	5	31	15
04/09/2014	411_36_01#3	36#1	14:37:53	491239	5983519	53.99990	-3.13366	5.8	32	15
04/09/2014	411_36_01#4	36#1	14:43:41	491181	5983491	53.99965	-3.13454	5.8	33	15
04/09/2014	411_36_01#5	36#1	14:47:16	491136	5983469	53.99945	-3.13522	5.7	34	15
04/09/2014	411_36_01#6	36#1	14:54:12	491101	5983432	53.99912	-3.13575	5.6	35	15
04/09/2014	411_36_01#7	36#1	14:57:43	491033	5983429	53.99909	-3.13679	5	36	15
04/09/2014	411_36_01#8	36#1	15:00:45	490993	5983394	53.99877	-3.13740	5.9	37	15
04/09/2014	411_37_01#1	64	15:20:38	491918	5982830	53.99372	-3.12328	5.8	38	16
04/09/2014	411_37_01#2	64	15:23:40	491888	5982805	53.99350	-3.12373	5.7	39	16
04/09/2014	411_37_01#3	64	15:26:51	491835	5982807	53.99351	-3.12454	5.9	40	16
04/09/2014	411_37_01#4	64	15:30:03	491822	5982766	53.99314	-3.12473	6	41	16
04/09/2014	411_37_01#5	64	15:34:16	491770	5982749	53.99299	-3.12553	6	42	16
04/09/2014	411_37_01#6	64	15:37:47	491731	5982716	53.99269	-3.12613	6.4	43	16
04/09/2014	411_37_01#7	64	15:41:32	491645	5982697	53.99252	-3.12744	7	44	16
04/09/2014	411_38_01#1	24	16:31:10	492111	5982052	53.98673	-3.12032	8.6	45	16
04/09/2014	411_38_01#2	24	16:34:28	492070	5982012	53.98637	-3.12093	9	46	16
04/09/2014	411_38_01#3	24	16:37:28	492038	5981975	53.98604	-3.12143	9.5	47	16
04/09/2014	411_38_01#4	24	16:40:04	491997	5981949	53.98580	-3.12205	9.9	48	16
04/09/2014	411_38_01#5	24	16:42:36	491981	5981899	53.98535	-3.12230	10	49	16
04/09/2014	411_38_01#6	24	16:46:09	491921	5981886	53.98523	-3.12321	10	50	16
04/09/2014	411_38_01#7	24	16:49:02	491908	5981833	53.98476	-3.12340	9.8	51	16

Date	Sample #	Station	Time (UTC)	Easting	Northing	Latitude	Longitude	Depth	HDD Track	Tape #
04/09/2014	411_38_01#8	24	16:53:25	491820	5981815	53.98459	-3.12475	10	52	16
04/09/2014	411_39_01#1	34#2	17:10:03	492230	5981263	53.97964	-3.11848	10	53	17
04/09/2014	411_39_01#2	34#2	17:13:33	492214	5981216	53.97922	-3.11872	10	55	17
04/09/2014	411_39_01#3	34#2	17:17:28	492164	5981199	53.97906	-3.11948	8.3	56	17
04/09/2014	411_39_01#4	34#2	17:20:10	492148	5981162	53.97873	-3.11972	8	57	17
04/09/2014	411_39_01#5	34#2	17:23:19	492103	5981155	53.97866	-3.12041	9	58	17
04/09/2014	411_39_01#6	34#2	17:26:52	492080	5981109	53.97826	-3.12076	10.5	59	17
04/09/2014	411_39_01#7	34#2	17:30:59	492033	5981104	53.97821	-3.12148	11	60	17
04/09/2014	411_39_01#8	34#2	17:35:21	491979	5981076	53.97796	-3.12231	11	61	17
04/09/2014	411_39_01#9	34#2	17:39:22	491969	5981021	53.97746	-3.12246	10.5	61	17
04/09/2014	411_40_01#1	66#2	17:59:34	494151	5980638	53.97405	-3.08917	8.5	62	17
04/09/2014	411_40_01#2	66#2	18:01:57	494190	5980683	53.97445	-3.08859	8.6	63	17
04/09/2014	411_40_01#3	66#2	18:03:41	494245	5980684	53.97447	-3.08775	8.7	64	17
04/09/2014	411_40_01#4	66#2	18:05:25	494281	5980718	53.97477	-3.08720	8.6	65	17
04/09/2014	411_40_01#5	66#2	18:07:07	494330	5980724	53.97482	-3.08645	8.8	66	17
04/09/2014	411_40_01#6	66#2	18:09:14	494378	5980757	53.97512	-3.08572	9	67	17
04/09/2014	411_40_01#7	66#2	18:11:51	494441	5980775	53.97528	-3.08476	9.4	68	17
04/09/2014	411_40_01#8	66#2	18:14:02	494526	5980828	53.97576	-3.08346	9.9	69	17
05/09/2014	411_41_01#1	54	08:00:08	498542	5982676	53.99240	-3.02224	22.5	1	18
05/09/2014	411_41_01#2	54	08:03:46	498493	5982671	53.99235	-3.02298	20	2	18
05/09/2014	411_41_01#3	54	08:04:24	498489	5982671	53.99235	-3.02305	20	2	18
05/09/2014	411_41_01#4	54	08:06:34	498442	5982629	53.99198	-3.02376	22	3	18
05/09/2014	411_41_01#5	54	08:09:47	498383	5982607	53.99178	-3.02467	22	4	18
05/09/2014	411_41_01#6	54	08:12:29	498332	5982581	53.99154	-3.02544	21	5	18
05/09/2014	411_41_01#7	54	08:14:48	498279	5982549	53.99126	-3.02624	21.4	6	18
05/09/2014	411_42_01#1	53#2	08:28:20	498699	5982197	53.98810	-3.01984	13	7	18
05/09/2014	411_42_01#2	53#2	08:31:10	498658	5982134	53.98752	-3.02046	11.7	8	18
05/09/2014	411_42_01#3	53#2	08:33:28	498597	5982122	53.98742	-3.02140	14.4	9	18

Date	Sample #	Station	Time (UTC)	Easting	Northing	Latitude	Longitude	Depth	HDD Track	Tape #
05/09/2014	411_42_01#4	53#2	08:36:18	498562	5982057	53.98684	-3.02193	22	10	18
05/09/2014	411_42_01#5	53#2	08:40:19	498484	5982018	53.98648	-3.02312	24.6	11	18
05/09/2014	411_42_01#6	53#2	08:42:43	498413	5981969	53.98604	-3.02421	22	12	18
05/09/2014	411_42_01#7	53#2	08:42:56	498408	5981966	53.98601	-3.02428	22	12	18
05/09/2014	411_42_01#8	53#2	08:47:14	498309	5981900	53.98542	-3.02578	26.3	13	18
05/09/2014	411_42_01#9	53#2	08:50:19	498212	5981838	53.98487	-3.02727	25	14	18
05/09/2014	411_43_01#1	55	09:10:23	498233	5981476	53.98161	-3.02694	22	15	19
05/09/2014	411_43_01#2	55	09:13:41	498260	5981484	53.98168	-3.02653	22	16	19
05/09/2014	411_43_01#3	55	09:16:21	498309	5981485	53.98169	-3.02578	20.1	17	19
05/09/2014	411_43_01#4	55	09:21:06	498342	5981505	53.98187	-3.02528	16.1	18	19
05/09/2014	411_43_01#5	55	09:24:58	498384	5981490	53.98173	-3.02464	10.6	19	19
05/09/2014	411_43_01#6	55	09:28:22	498405	5981526	53.98206	-3.02433	11.8	20	19
05/09/2014	411_43_01#7	55	09:30:46	498449	5981519	53.98200	-3.02366	10.8	21	19
05/09/2014	411_43_01#8	55	09:34:15	498476	5981539	53.98217	-3.02325	10.6	22	19
05/09/2014	411_44_01#1	57	09:53:02	497885	5980932	53.97672	-3.03225	27.5	23	19
05/09/2014	411_44_01#2	57	09:58:26	497942	5980936	53.97676	-3.03138	19.7	24	19
05/09/2014	411_44_01#3	57	10:01:56	497974	5980944	53.97683	-3.03089	15	25	19
05/09/2014	411_44_01#4	57	10:05:26	498006	5980964	53.97701	-3.03041	16.8	26	19
05/09/2014	411_44_01#5	57	10:10:21	498075	5980954	53.97692	-3.02934	17	27	19
05/09/2014	411_44_01#6	57	10:12:58	498112	5980969	53.97705	-3.02878	17	28	19
05/09/2014	411_44_01#7	57	10:17:18	498150	5980968	53.97704	-3.02821	17.4	29	19
05/09/2014	411_44_01#8	57	10:20:51	498226	5980976	53.97712	-3.02705	20.7	30	19
09/09/2014			10:21:50							
05/09/2014	411_45_01#1	11	11:02:23	497261	5980306	53.97109	-3.04175	26.2	31	20
05/09/2014	411_45_01#2	11	11:05:24	497301	5980345	53.97144	-3.04115	26.2	32	20
05/09/2014	411_45_01#3	11	11:08:56	497334	5980376	53.97172	-3.04064	24.6	33	20
05/09/2014	411_45_01#4	11	11:11:50	497369	5980410	53.97202	-3.04011	28.6	34	20

Date	Sample #	Station	Time (UTC)	Easting	Northing	Latitude	Longitude	Depth	HDD Track	Tape #
05/09/2014	411_45_01#5	11	11:14:55	497404	5980449	53.97237	-3.03958	30.6	35	20
05/09/2014	411_45_01#6	11	11:20:14	497437	5980475	53.97261	-3.03907	26.1	36	20
05/09/2014	411_45_01#7	11	11:23:59	497466	5980518	53.97300	-3.03864	26.2	37	20
05/09/2014	411_45_01#8	11	11:28:01	497504	5980554	53.97332	-3.03805	23.8	38	20
05/09/2014	411_45_01#9	11	11:33:48	497576	5980612	53.97384	-3.03696	26.2	39	20
05/09/2014	411_46_01#1	10	11:51:04	497690	5980027	53.96858	-3.03522	24	40	20
05/09/2014	411_46_01#2	10	11:54:05	497718	5980060	53.96888	-3.03479	23.9	41	20
05/09/2014	411_46_01#3	10	11:58:43	497764	5980098	53.96922	-3.03409	23.8	42	20
05/09/2014	411_46_01#4	10	12:02:15	497797	5980132	53.96953	-3.03358	23.2	43	20
05/09/2014	411_46_01#5	10	12:08:37	497842	5980159	53.96977	-3.03289	23.5	44	20
05/09/2014	411_46_01#6	10	12:12:30	497870	5980202	53.97016	-3.03247	24	45	20
05/09/2014	411_46_01#7	10	12:15:15	497894	5980232	53.97043	-3.03211	24.5	46	20
05/09/2014	411_47_01#1	9	12:31:48	498048	5979738	53.96599	-3.02976	16.5	47	21
05/09/2014	411_47_01#2	9	12:34:11	498093	5979772	53.96629	-3.02907	15.8	48	21
05/09/2014	411_47_01#3	9	12:36:23	498134	5979823	53.96675	-3.02845	17.4	49	21
05/09/2014	411_47_01#4	9	12:39:12	498177	5979874	53.96721	-3.02778	17.8	50	21
05/09/2014	411_47_01#5	9	12:41:18	498232	5979913	53.96757	-3.02695	18	51	21
05/09/2014	411_47_01#6	9	12:44:09	498284	5979949	53.96788	-3.02616	17.8	52	21
05/09/2014	411_48_01#1	8	12:47:28	498354	5979933	53.96774	-3.02509	13.4	53	21
05/09/2014	411_48_01#2	8	12:50:06	498405	5979980	53.96817	-3.02431	17.4	54	21
05/09/2014	411_48_01#3	8	12:52:29	498455	5980027	53.96859	-3.02356	14.3	55	21
05/09/2014	411_48_01#4	8	12:54:39	498506	5980074	53.96901	-3.02278	16.1	56	21
05/09/2014	411_48_01#5	8	12:57:16	498548	5980118	53.96940	-3.02213	16	57	21
05/09/2014	411_48_01#6	8	13:00:47	498582	5980165	53.96983	-3.02162	18.2	58	21
05/09/2014	411_49_01#1	22#2	14:03:56	493206	5979654	53.96519	-3.10356	5.6	59	21
05/09/2014	411_49_01#2	22#2	14:05:44	493255	5979666	53.96530	-3.10281	5.8	60	21
05/09/2014	411_49_01#3	22#2	14:08:10	493265	5979686	53.96548	-3.10266	5.7	61	21

Date	Sample #	Station	Time (UTC)	Easting	Northing	Latitude	Longitude	Depth	HDD Track	Tape #
05/09/2014	411_49_01#4	22#2	14:10:18	493308	5979712	53.96571	-3.10200	6.1	62	21
05/09/2014	411_49_01#5	22#2	14:12:16	493353	5979734	53.96591	-3.10132	6.2	63	21
05/09/2014	411_49_01#6	22#2	14:14:25	493430	5979765	53.96620	-3.10015	6.3	64	21
05/09/2014	411_49_01#7	22#2	14:16:17	493429	5979778	53.96631	-3.10017	6.3	65	21
05/09/2014	411_49_01#8	22#2	14:18:09	493520	5979815	53.96664	-3.09877	5.9	66	21
05/09/2014	411_49_01#9	22#2	14:20:06	493560	5979822	53.96670	-3.09817	5.9	67	21
05/09/2014	411_50_01#1	65#2	14:34:50	493298	5979051	53.95977	-3.10215	5.1	69	22
05/09/2014	411_50_01#2	65#2	14:36:45	493311	5978979	53.95913	-3.10194	5.1	70	22
05/09/2014	411_50_01#3	65#2	14:38:33	493308	5978925	53.95864	-3.10199	5.5	71	22
05/09/2014	411_50_01#4	65#2	14:40:12	493315	5978878	53.95822	-3.10188	5.4	72	22
05/09/2014	411_50_01#5	65#2	14:42:41	493321	5978875	53.95820	-3.10179	5.4	73	22
05/09/2014	411_50_01#6	65#2	14:44:33	493328	5978811	53.95762	-3.10168	4.4	74	22
05/09/2014	411_50_01#7	65#2	14:46:17	493334	5978759	53.95715	-3.10158	3.7	75	22
05/09/2014	411_50_01#8	65#2	14:48:26	493366	5978691	53.95654	-3.10110	8.2	76	22
05/09/2014	411_51_01#1	67#2	15:23:33	492940	5980315	53.97113	-3.10763	7	77	22
05/09/2014	411_51_01#2	67#2	15:26:32	492905	5980310	53.97108	-3.10816	7	78	22
05/09/2014	411_51_01#3	67#2	15:28:12	492903	5980317	53.97115	-3.10819	7	79	22
05/09/2014	411_51_01#4	67#2	15:30:25	492874	5980279	53.97081	-3.10863	6.6	80	22
05/09/2014	411_51_01#5	67#2	15:33:34	492832	5980273	53.97076	-3.10928	6.2	81	22
05/09/2014	411_51_01#6	67#2	15:35:47	492801	5980239	53.97044	-3.10974	5.4	82	22
05/09/2014	411_51_01#7	67#2	15:38:27	492744	5980212	53.97020	-3.11062	6	83	22
05/09/2014	411_51_01#8	67#2	15:40:39	492685	5980184	53.96995	-3.11152	6.9	84	22
06/09/2014	411_52_01#1	69	08:26:53	500523	5984615	54.00983	-2.99202	13.2	2	23
06/09/2014	411_52_01#2	69	08:31:15	500509	5984602	54.00971	-2.99223	13	3	23
06/09/2014	411_52_01#3	69	08:34:07	500481	5984611	54.00979	-2.99266	13	4	23
06/09/2014	411_52_01#4	69	08:36:45	500507	5984587	54.00958	-2.99226	13.8	5	23
06/09/2014	411_52_01#5	69	08:38:50	No Target	No Target			13.5	6	23

Date	Sample #	Station	Time (UTC)	Easting	Northing	Latitude	Longitude	Depth	HDD Track	Tape #
06/09/2014	411_52_01#6	69	08:41:52	500505	5984629	54.00996	-2.99230	13	7	23
06/09/2014	411_53_01#1	17#2	09:22:39	499851	5983990	54.00421	-3.00227	15.8	8	23
06/09/2014	411_53_01#2	17#2	09:25:07	499759	5984040	54.00466	-3.00368	16.5	9	23
06/09/2014	411_53_01#3	17#2	09:27:55	499670	5984096	54.00516	-3.00504	17.4	10	23
06/09/2014	411_53_01#4	17#2	09:30:29	499602	5984111	54.00530	-3.00608	18.5	11	23
06/09/2014	411_53_01#5	17#2	09:33:24	499507	5984176	54.00588	-3.00751	18.6	12	23
06/09/2014	411_53_01#6	17#2	09:36:40	499396	5984228	54.00635	-3.00922	17.9	13	23
06/09/2014	411_53_01#7	17#2	09:38:58	499291	5984290	54.00691	-3.01082	16	14	23
06/09/2014	411_53_01#8	17#2	09:41:31	499190	5984327	54.00724	-3.01236	13.9	15	23
06/09/2014	411_53_01#9	17#2	09:45:37	499091	5984390	54.00780	-3.01388	12.5	16	23
06/09/2014	411_54_01#1	20	10:09:38	496529	5984233	54.00638	-3.05296	10.5	17	24
06/09/2014	411_54_01#2	20	10:14:06	496574	5984237	54.00642	-3.05227	11	18	24
06/09/2014	411_54_01#3	20	10:17:52	496603	5984265	54.00667	-3.05183	11.2	19	24
06/09/2014	411_54_01#4	20	10:22:30	496595	5984307	54.00704	-3.05196	11.3	20	24
06/09/2014	411_54_01#5	20	10:24:52	496643	5984302	54.00700	-3.05122	11.5	21	24
06/09/2014	411_54_01#6	20	10:28:10	496652	5984350	54.00744	-3.05108	12	22	24
06/09/2014	411_54_01#7	20	10:30:55	496704	5984381	54.00771	-3.05030	11.7	23	24
06/09/2014	411_55_01#1	18	10:57:34	497852	5983411	53.99900	-3.03277	10.6	24	24
06/09/2014	411_55_01#2	18	11:00:10	497888	5983437	53.99924	-3.03223	10	25	24
06/09/2014	411_55_01#3	18	11:03:04	497908	5983473	53.99956	-3.03191	10.2	26	24
06/09/2014	411_55_01#4	18	11:05:39	497946	5983499	53.99979	-3.03133	10.2	27	24
06/09/2014	411_55_01#5	18	11:09:23	497988	5983539	54.00015	-3.03070	10.3	28	24
06/09/2014	411_55_01#6	18	11:13:14	498033	5983591	54.00062	-3.03001	10.4	29	24
06/09/2014	411_56_01#1	58	11:30:37	497052	5983501	53.99981	-3.04497	11.5	30	25
06/09/2014	411_56_01#2	58	11:34:50	496973	5983464	53.99947	-3.04618	10	31	25
06/09/2014	411_56_01#3	58	11:37:19	496897	5983414	53.99902	-3.04734	11.4	32	25
06/09/2014	411_56_01#4	58	11:39:52	496843	5983381	53.99873	-3.04817	11.5	33	25
06/09/2014	411_56_01#5	58	11:43:21	496713	5983316	53.99814	-3.05014	11.3	34	25

Date	Sample #	Station	Time (UTC)	Easting	Northing	Latitude	Longitude	Depth	HDD Track	Tape #
06/09/2014	411_57_01#1	70	12:21:37	493658	5982133	53.98748	-3.09673	4	35	25
06/09/2014	411_57_01#2	70	12:21:59	493662	5982123	53.98739	-3.09667	4	35	25
06/09/2014	411_57_01#3	70	12:24:10	493697	5982169	53.98781	-3.09612	4.2	NA	25
06/09/2014	411_57_01#4	70	12:26:28	493706	5982189	53.98799	-3.09599	4.3	36	25
06/09/2014	411_57_01#5	70	12:28:59	493773	5982224	53.98830	-3.09497	4.3	NA	25
06/09/2014	411_57_01#6	70	12:31:15	493805	5982279	53.98879	-3.09448	4.3	37	25
06/09/2014	411_57_01#7	70	12:33:23	493865	5982290	53.98889	-3.09357	4	38	25
06/09/2014	411_57_01#8	70	12:35:23	493888	5982345	53.98939	-3.09322	3.7	39	25
06/09/2014	411_58_01#1	69	13:31:23	500505	5984588	54.00959	-2.99230	8.3	40	25
06/09/2014	411_58_01#2	69	13:32:47	500515	5984612	54.00980	-2.99215	8.3	41	25
06/09/2014	411_58_01#3	69	13:33:59	500520	5984617	54.00984	-2.99207	8	42	25
06/09/2014	411_58_01#4	69	13:36:02	500495	5984588	54.00958	-2.99245	7.9	43	25
08/09/2014	411_58B_01#1	19#2	09:42:03	496315	5979508	53.96391	-3.05617	38	2	25
08/09/2014	411_58B_01#2	19#2	09:44:49	496282	5979482	53.96368	-3.05666	38.4	3	25
08/09/2014	411_58B_01#3	19#2	09:47:56	496248	5979499	53.96383	-3.05719	38.1	4	25
08/09/2014	411_58B_01#4	19#2	09:51:00	496200	5979493	53.96377	-3.05792	39.4	5	25
08/09/2014	411_58B_01#5	19#2	09:54:26	496150	5979475	53.96362	-3.05868	38.2	6	25
08/09/2014	411_58B_01#6	19#2	09:58:02	496090	5979476	53.96362	-3.05960	38	7	25
08/09/2014	411_58B_01#7	19#2	10:02:08	496026	5979453	53.96342	-3.06057	38	8	25
08/09/2014	411_58B_01#8	19#2	10:09:17	496294	5979486	53.96372	-3.05649	38	9	25
08/09/2014	411_58B_01#9	19#2	10:17:25	496537	5979547	53.96426	-3.05278	37	10	26
08/09/2014	411_58B_01#10	19#2	10:22:25	496421	5979521	53.96403	-3.05455	37.3	11	26
08/09/2014	411_59_01#1	35#2	10:53:23	493555	5980935	53.97671	-3.09827	9.3	12	26
08/09/2014	411_59_01#2	35#2	10:55:08	493493	5980916	53.97654	-3.09921	10.2	13	26
08/09/2014	411_59_01#3	35#2	10:57:23	493443	5980868	53.97611	-3.09997	11.8	NA	26
08/09/2014	411_59_01#4	35#2	11:02:52	493428	5980857	53.97601	-3.10020	11.3	14	26
08/09/2014	411_59_01#5	35#2	11:08:17	493340	5980809	53.97558	-3.10155	10	16	26

Date	Sample #	Station	Time (UTC)	Easting	Northing	Latitude	Longitude	Depth	HDD Track	Tape #
08/09/2014	411_59_01#6	35#2	11:10:28	493283	5980750	53.97504	-3.10241	11.3	17	26
08/09/2014	411_59_01#7	35#2	11:17:34	493594	5980980	53.97711	-3.09767	9.8	18	26
08/09/2014	411_60_01#1	40	13:00:11	488859	5988527	54.04487	-3.17015	5.3	19	26
08/09/2014	411_60_01#2	40	13:17:34	488882	5988512	54.04474	-3.16979	5	20	26
08/09/2014	411_60_01#3	40	13:19:45	488922	5988492	54.04456	-3.16918	9.4	21	26
08/09/2014	411_60_01#4	40	13:22:36	488974	5988464	54.04430	-3.16839	9.6	22	26
08/09/2014	411_60_01#5	40	13:23:31	489007	5988439	54.04408	-3.16788	9	23	26
08/09/2014	411_60_01#6	40	13:26:32	489044	5988424	54.04395	-3.16731	8.1	24	26
08/09/2014	411_60_01#7	40	13:28:40	489075	5988394	54.04367	-3.16684	6.8	25	26
08/09/2014	411_60_01#8	40	13:29:17	489069	5988397	54.04370	-3.16693	6	25	26
08/09/2014	411_61_01#1	41	13:54:43	489068	5989121	54.05021	-3.16698	10.1	26	27
08/09/2014	411_61_01#2	41	14:05:27	489116	5989161	54.05057	-3.16624	10.2	28	27
08/09/2014	411_61_01#3	41	14:07:52	489149	5989192	54.05085	-3.16574	11.8	29	27
08/09/2014	411_61_01#4	41	14:12:32	489187	5989222	54.05112	-3.16516	9.9	30	27
08/09/2014	411_61_01#5	41	14:14:27	489214	5989260	54.05146	-3.16475	6.1	31	27
08/09/2014	411_61_01#6	41	14:17:24	489258	5989308	54.05189	-3.16408	2.6	32	27
08/09/2014	411_61_01#7	41	14:19:18	489297	5989343	54.05221	-3.16349	2.6	33	27
08/09/2014	411_62_01#1	42	14:32:08	488958	5989699	54.05540	-3.16868	3.7	34	27
08/09/2014	411_62_01#2	42	14:34:23	488998	5989720	54.05559	-3.16807	5.2	35	27
08/09/2014	411_62_01#3	42	14:35:53	489028	5989754	54.05589	-3.16761	5.7	36	27
08/09/2014	411_62_01#4	42	14:38:09	489062	5989793	54.05625	-3.16709	6.1	37	27
08/09/2014	411_62_01#5	42	14:40:49	489103	5989827	54.05656	-3.16647	7.8	38	27
08/09/2014	411_62_01#6	42	14:42:43	489138	5989863	54.05688	-3.16594	7.2	39	27
08/09/2014	411_62_01#7	42	14:44:47	489169	5989893	54.05715	-3.16546	8.2	40	27
08/09/2014	411_63_01#1	45	15:09:23	488787	5991283	54.06963	-3.17135	8.2	41	27
08/09/2014	411_63_01#2	45	15:11:45	488827	5991319	54.06996	-3.17074	8.5	42	27
08/09/2014	411_63_01#3	45	15:14:32	488833	5991387	54.07058	-3.17064	6.4	43	27
08/09/2014	411_63_01#4	45	15:17:27	488817	5991292	54.06972	-3.17090	8	44	27

Date	Sample #	Station	Time (UTC)	Easting	Northing	Latitude	Longitude	Depth	HDD Track	Tape #
08/09/2014	411_63_01#5	45	15:19:44	488763	5991258	54.06941	-3.17172	6.4	45	27
08/09/2014	411_63_01#6	45	15:22:39	488726	5991233	54.06919	-3.17227	3.7	46	27
08/09/2014	411_63_01#7	45	15:24:24	488753	5991252	54.06935	-3.17186	5.2	47	27
08/09/2014	411_64_01#1	47	15:31:41	488174	5991694	54.07331	-3.18073	3.1	48	28
08/09/2014	411_64_01#2	47	15:35:26	488157	5991662	54.07303	-3.18100	5.8	49	28
08/09/2014	411_64_01#3	47	15:38:11	488145	5991627	54.07271	-3.18118	7	50	28
08/09/2014	411_64_01#4	47	15:40:23	488107	5991608	54.07254	-3.18175	9.3	51	28
08/09/2014	411_64_01#5	47	15:43:18	488066	5991573	54.07223	-3.18237	9.6	52	28
08/09/2014	411_64_01#6	47	15:45:49	488044	5991539	54.07192	-3.18271	4.7	53	28
08/09/2014	411_64_01#7	47	15:52:14	488182	5991670	54.07310	-3.18061	5.9	54	28
08/09/2014	411_64_01#8	47	15:54:40	488194	5991701	54.07338	-3.18043	4	55	28
08/09/2014	411_65_01#1	25#2	17:35:34	495570	5978310	53.95314	-3.06751	35	56	28
08/09/2014	411_65_01#2	25#2	17:38:57	495621	5978334	53.95335	-3.06673	33	57	28
08/09/2014	411_65_01#3	25#2	17:42:02	495670	5978363	53.95362	-3.06598	32.6	58	28
08/09/2014	411_65_01#4	25#2	17:44:36	495718	5978392	53.95388	-3.06525	33	59	28
08/09/2014	411_65_01#5	25#2	17:46:52	495780	5978403	53.95398	-3.06431	31.4	60	28
08/09/2014	411_65_01#6	25#2	17:48:27	495837	5978433	53.95425	-3.06343	30.5	61	28
08/09/2014	411_65_01#7	25#2	17:50:39	495909	5978463	53.95452	-3.06234	25.8	62	28
08/09/2014	411_65_01#8	25#2	17:52:25	495964	5978499	53.95484	-3.06150	28.6	63	28
08/09/2014	411_65_01#9	25#2	17:54:47	496018	5978535	53.95516	-3.06068	26.6	64	28
09/09/2014	411_66_01#1	63#2	10:25:50	491566	5981505	53.98181	-3.12862	12	1	29
09/09/2014	411_66_01#2	63#2	10:28:28	491547	5981493	53.98170	-3.12890	12	2	29
09/09/2014	411_66_01#3	63#2	10:30:53	491526	5981475	53.98154	-3.12922	12	3	29
09/09/2014	411_66_01#4	63#2	10:33:08	491492	5981463	53.98143	-3.12974	12.8	4	29
09/09/2014	411_66_01#5	63#2	10:35:19	491472	5981440	53.98122	-3.13004	12.6	5	29
09/09/2014	411_66_01#6	63#2	10:38:19	491442	5981426	53.98109	-3.13050	12.6	6	29
09/09/2014	411_66_01#7	63#2	10:41:05	491400	5981395	53.98082	-3.13115	12.9	7	29

Date	Sample #	Station	Time (UTC)	Easting	Northing	Latitude	Longitude	Depth	HDD Track	Tape #
09/09/2014	411_66_01#8	63#2	10:43:31	491363	5981368	53.98057	-3.13171	13.4	8	29
09/09/2014	411_66_01#9	63#2	10:46:43	491325	5981343	53.98035	-3.13228	13.3	9	29
09/09/2014	411_66_01#10	63#2	10:49:30	491277	5981315	53.98009	-3.13302	13	10	29
09/09/2014	411_67_01#1	43#2	12:13:21	489033	5990435	54.06202	-3.16756	8.9	11	29
09/09/2014	411_67_01#2	43#2	12:15:22	489076	5990445	54.06211	-3.16691	9.8	12	29
09/09/2014	411_67_01#3	43#2	12:17:19	489105	5990470	54.06234	-3.16645	10	13	29
09/09/2014	411_67_01#4	43#2	12:20:37	489161	5990499	54.06260	-3.16561	10.8	14	29
09/09/2014	411_67_01#5	43#2	12:25:06	488976	5990397	54.06168	-3.16843	8.6	15	29
09/09/2014	411_67_01#6	43#2	12:29:25	489205	5990522	54.06280	-3.16494	12	16	29
09/09/2014	411_67_01#7	43#2	12:31:37	489253	5990549	54.06304	-3.16420	12.4	17	29
09/09/2014	411_67_01#8	43#2	12:33:45	489310	5990575	54.06328	-3.16334	9.4	18	29
09/09/2014	411_67_01#9	43#2	12:35:57	489342	5990599	54.06350	-3.16285	8.3	19	29
09/09/2014	411_67_01#10	43#2	12:37:48	489379	5990612	54.06362	-3.16227	7.8	20	29
09/09/2014	411_67_01#11	43#2	12:40:22	489427	5990637	54.06385	-3.16155	6.2	21	29
09/09/2014	411_67_01#12	43#2	12:42:53	489477	5990654	54.06400	-3.16078	5.2	22	29
09/09/2014	411_67_01#13	43#2	12:46:54	489411	5990620	54.06369	-3.16178	6.2	23	29
09/09/2014	411_68_01#1	48#2	12:58:20	489070	5990481	54.06243	-3.16699	7.2	24	29
09/09/2014	411_68_01#2	48#2	13:01:42	489074	5990572	54.06325	-3.16693	7.2	25	29
09/09/2014	411_68_01#3	48#2	13:04:59	489097	5990669	54.06412	-3.16659	6.4	26	29
09/09/2014	411_68_01#4	48#2	13:07:41	489094	5990733	54.06470	-3.16664	7.2	NA	29
09/09/2014	411_68_01#5	48#2	13:10:05	489072	5990820	54.06548	-3.16697	6	28	29
09/09/2014	411_68_01#6	48#2	13:12:22	489035	5990899	54.06619	-3.16755	6.6	29	29
09/09/2014	Overfalls		13:21:06	488756	5991188	54.06878	-3.17182			
09/09/2014	411_69_01#1	46	13:31:23	488269	5991435	54.07099	-3.17926	5	31	29
09/09/2014	411_69_02#1	46	13:39:39	488397	5991551	54.07204	-3.17732	7.3	32	29
09/09/2014	411_69_02#2	46	13:41:40	488369	5991582	54.07232	-3.17775	7.6	33	29
09/09/2014	411_69_02#3	46	13:44:30	488346	5991509	54.07166	-3.17809	9	34	29
09/09/2014	411_69_02#4	46	13:47:16	488371	5991536	54.07190	-3.17771	9.8	35	29

Date	Sample #	Station	Time (UTC)	Easting	Northing	Latitude	Longitude	Depth	HDD Track	Tape #
09/09/2014	411_69_02#5	46	13:51:50	488325	5991467	54.07128	-3.17841	11.4	36	29
09/09/2014	411_70_01#1	50#2	14:59:33	487516	5992124	54.07717	-3.19080	2.3	37	29
09/09/2014	411_70_01#2	50#2	15:02:11	487510	5992061	54.07660	-3.19090	5.3	No HD	29
09/09/2014	411_70_01#3	50#2	15:04:46	487506	5992093	54.07689	-3.19096	4	38	29
09/09/2014	411_70_01#4	50#2	15:06:32	487503	5992040	54.07641	-3.19101	5.5	39	29
09/09/2014	411_70_01#5	50#2	15:08:55	487460	5992013	54.07617	-3.19165	6.5	40	29
09/09/2014	411_70_01#6	50#2	15:11:39	487442	5991976	54.07584	-3.19193	6.6	41	29
09/09/2014	411_70_01#7	50#2	15:14:42	487398	5991944	54.07555	-3.19260	6	42	29
09/09/2014	411_71_01#1	49#2	15:23:27	487511	5992056	54.07656	-3.19088	3.1	43	30
09/09/2014	411_71_01#2	49#2	15:25:21	487595	5991978	54.07585	-3.18959	6.7	44	30
09/09/2014	411_71_01#3	49#2	15:26:16	487616	5991961	54.07570	-3.18926	4.4	45	30
09/09/2014	411_71_01#4	49#2	15:30:50	487864	5991856	54.07477	-3.18548	3.3	46	30
09/09/2014	411_71_01#5	49#2	15:33:46	487974	5991795	54.07422	-3.18379	5.8	47	30
09/09/2014	411_71_01#6	49#2	15:35:59	488029	5991773	54.07402	-3.18296	8.3	48	30
09/09/2014	411_71_01#7	49#2	15:38:08	488103	5991730	54.07364	-3.18182	2.8	49	30
09/09/2014	411_71_01#8	49#2	15:41:10	488252	5991659	54.07300	-3.17953	7.5	50	30
09/09/2014	411_71_01#9	49#2	15:43:49	488317	5991591	54.07239	-3.17854	5.5	51	30
09/09/2014	411_71_01#10	49#2	15:46:31	488499	5991504	54.07162	-3.17576	6.2	52	30
09/09/2014	411_71_01#11	49#2	15:47:36	488534	5991503	54.07161	-3.17522	2.2	53	30
09/09/2014	411_71_01#12	49#2	15:49:30	488626	5991472	54.07133	-3.17382	3.5	54	30
09/09/2014	411_71_01#13	49#2	15:51:21	488690	5991465	54.07127	-3.17284	5.3	55	30
09/09/2014	411_71_01#14	49#2	15:53:10	488770	5991433	54.07098	-3.17162	NA	56	30
09/09/2014	411_71_01#16	49#2	15:59:12	489078	5991256	54.06940	-3.16689	4.1	58	30
09/09/2014	411_71_01#17	49#2	16:01:29	489168	5991150	54.06845	-3.16553	4.9	59	30
09/09/2014	411_72_01#1	44#2	16:08:35	489195	5991110	54.06809	-3.16511	5.4	60	30
09/09/2014	411_72_01#2	44#2	16:12:58	489158	5991077	54.06780	-3.16567	6.1	61	30

Date	Sample #	Station	Time (UTC)	Easting	Northing	Latitude	Longitude	Depth	HDD Track	Tape #
09/09/2014	411_72_01#3	44#2	16:16:10	489130	5991018	54.06726	-3.16610	5.8	62	30
09/09/2014	411_72_01#4	44#2	16:20:31	489104	5991006	54.06715	-3.16650	6.1	63	30
09/09/2014	411_72_01#5	44#2	16:23:13	489043	5990948	54.06663	-3.16743	6.4	64	30

Appendix III: Broad habitat types, biotopes complexes and biotopes identified using video data collected from the Morecambe Bay SAC in 2014.

IR.MIR.KR.XFoR	Dense foliose red seaweeds on silty moderately exposed infralittoral rock
IR.LIR.K.Sar	*Sargassum muticum* on shallow slightly tide-swept infralittoral mixed substrata
CR.HCR.XFa	Mixed faunal turf communities
CR.HCR.XFa.FluCoAs	*Flustra foliacea* and colonial ascidians on tide-swept moderately wave-exposed circalittoral rock
CR.HCR.XFa.Mol	*Molgula manhattensis* with a hydroid and bryozoan turf on tide-swept moderately wave-exposed circalittoral rock
SS.SCS.ICS	Infralittoral coarse sediment
SS.SCS.CCS	Circalittoral coarse sediment
SS.SCS.CCS.PomB	*Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles
SS.SSa	Sublittoral sands and muddy sands
SS.SSa.CMuSa	Circalittoral muddy sand
SS.SMu	Sublittoral cohesive mud and sandy mud communities
SS.SMu.CSaMu	Circalittoral sandy mud
SS.SMu.CFiMu	Circalittoral fine mud
SS.SMx.IMx	Infralittoral mixed sediment
SS.SMx.CMx	Circalittoral mixed sediment
SS.SMp.KSwSS	Kelp and seaweed communities on sublittoral sediment
SS.SMp.KSwSS.LsacR.CbPb	Red seaweeds and kelps on tide-swept mobile infralittoral cobbles and pebbles
SS.SMp.KSwSS.LsacR.Gv	*Laminaria saccharina* and robust red algae on infralittoral gravel and pebble

Appendix IV: Full list of taxa identified in the video data collected during the 2014 Morecambe Bay SAC survey

MCS alpha	MCS num	Genus / species	Qualifier
C	1	Porifera	encrusting
C	1	Porifera	erect
C	414	Suberites	sp
C	1085	*Myxilla incrustans*	
D	58	Hydrozoa	turf
D	58	Hydrozoa	
D	163	Tubularia	sp
D	166	*Tubularia indivisa*	
D	424	*Hydrallmania falcata*	
D	433	*Sertularia*	sp
D	462	*Nemertesia*	sp
D	463	*Nemertesia antennina*	
D	597	*Alcyonium digitatum*	
D	662	Actiniaria	
D	682	Urticina	sp
D	684	*Urticina felina*	
D	711	Sagartiidae	
D	713	*Sagartia elegans*	
P	2	Polychaeta	tube
P	2	Polychaeta	tube / cast
P	1320	*Sabella pavonina*	
P	1339	*Spirobranchus*	sp; tube
R	15	Thoracica	
S	1293	Caridea	
S	1383	*Crangon crangon*	
S	1445	Paguridae	
S	1485	Brachyura	
S	1512	Majidae	
S	1529	*Macropodia*	sp
S	1568	Portunoidea	
S	1577	*Liocarcinus*	sp
S	1589	*Necora puber*	
W	708	*Buccinum undatum*	
W	1416	*Coryphella*	sp.
W	2329	*Sepiola atlantica*	
Y	1	Bryozoa	encrusting
Y	1	Bryozoa	turf
Y	76	*Alcyonidium diaphanum*	
Y	131	*Vesicularia spinosa*	
Y	187	*Flustra foliacea*	
ZB	18	Asteroidea	
ZB	75	Crossaster papposus	
ZB	100	Asterias rubens	

MCS alpha	MCS num	Genus / species	Qualifier
ZB	167	Ophiura	sp.
ZB	168	Ophiura albida	
ZB	170	Ophiura ophiura	
ZD	2	ASCIDIACEA	colonial
ZD	2	ASCIDIACEA	small solitary
ZD	120	Dendrodoa grossularia	
ZD	151	Molgula manhattensis	colonial
ZG	7	Teleostei	
ZG	291	Agonus cataphractus	
ZG	451	*Callionymus lyra*	
ZG	455	Gobiidae	
ZG	545	Pleuronectiformes	
ZM	1	Rhodophyta	encrusting
ZM	1	Rhodophyta	filamentous
ZM	1	Rhodophyta	foliose
ZM	1	Rhodophyta	
ZM	319	*Calliblepharis ciliata*	
ZR	2	Phaeophyceae	
ZR	338	Laminariales	
ZR	346	*Chorda filum*	
ZR	349	Laminaria	sp.
ZR	360	Fucales	
ZR	376	*Fucus*	sp.
ZR	393	*Sargassum muticum*	
ZS	1	Chlorophyta	

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