SOLENT MARITIME EUROPEAN MARINE SITE SANDBANK HABITAT MAPPING PROJECT

Solent Maritime SAC—2015

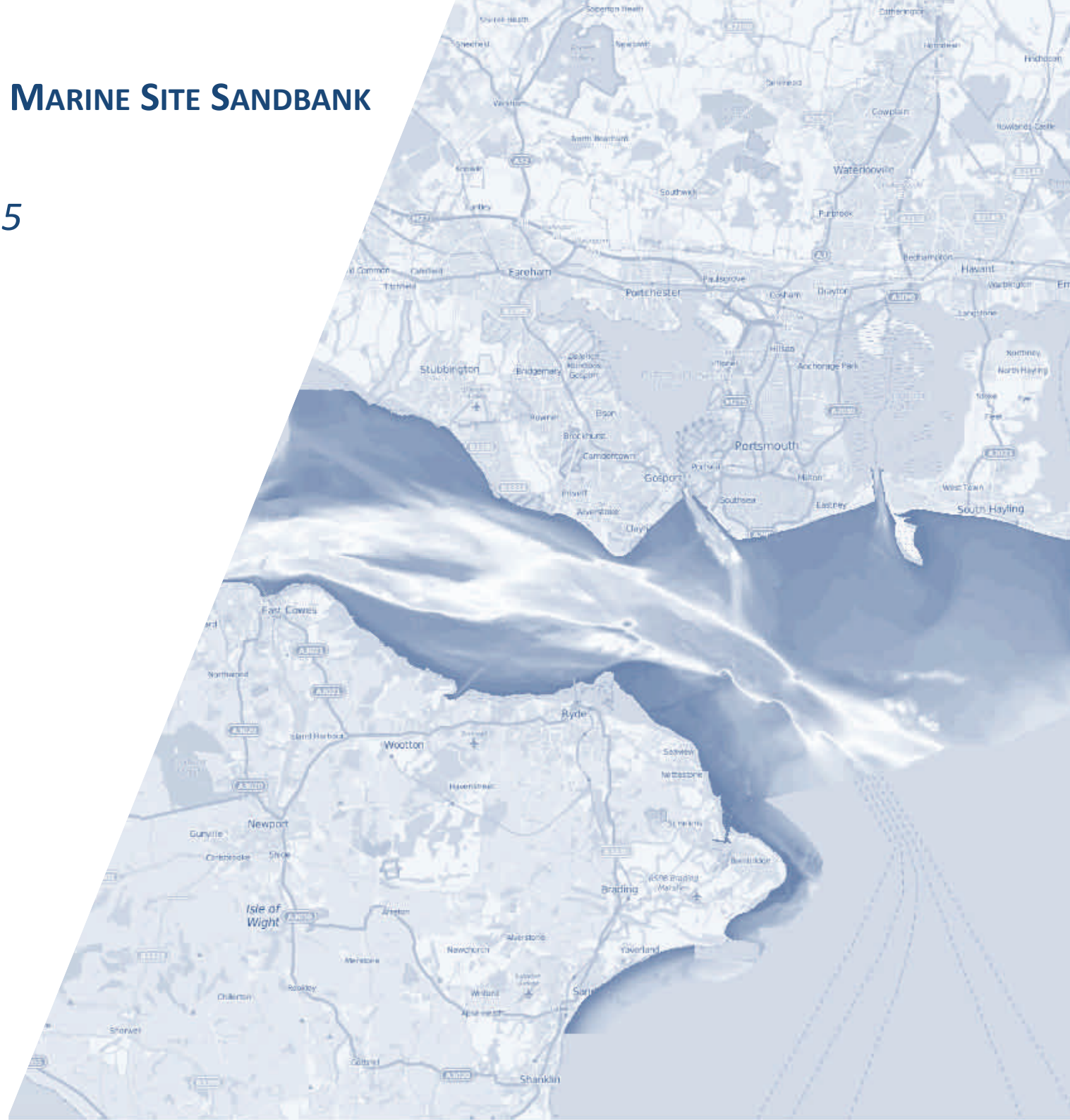**MESL**
A GARDLINE COMPANY

Prepared for

Natural England

By

Marine Ecological Surveys Limited

SOLENT MARITIME EUROPEAN MARINE SITE SANDBANK HABITAT MAPPING PROJECT		
SOLENT MARITIME SAC 2015		
Project Manager:	Daniel Brutto	
Data Analysis:	Robert Goodchild	
GIS:	Robert Goodchild	
Report Authors:	Robert Goodchild Daniel Brutto	
Report Proofing and Editing:	Robert Goodchild Daniel Brutto	
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STATEMENT

Marine Ecological Surveys Ltd (MESL) was commissioned by Natural England in April 2015 to carry out a desk based study to produce marine habitat maps for the subtidal areas within the Solent Maritime SAC, using pre-existing acoustic and ground-truth data to inform the habitat mapping exercise.

In addition the full study was designed to allow for a preliminary assessment of the site's qualifying features condition with a specific focus on the subtidal sandbanks, whilst providing data to help inform the management measures required to meet the conservation objectives of the site.

Marine Ecological Surveys Limited
Wednesday, 13 July 2016

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NON – TECHNICAL SUMMARY

Marine Ecological Surveys Ltd (MESL) was commissioned by Natural England in April 2015 to carry out a desk based study to produce marine habitat maps for the subtidal areas within the Solent Maritime SAC, using pre-existing acoustic and ground-truth data to inform the habitat mapping exercise.

The site is a complex and interesting mixture of marine and estuarine habitats with unique hydrographic regimes with up to four tides each day. The main qualifying conservation feature of interest for this desk review was the subtidal sandbanks previously identified within the site as part of a 2007 site monitoring survey conducted by EMU Ltd.

The key findings of this desk based study are:

- A total of 13 different Folk sediment groups were recorded with the subtidal sediments of the Solent Maritime SAC, with muddy gravels (mG) being the most commonly sampled category, closely followed by sandy mud (sM).
- The largest sediment group identified in terms of area was slightly gravelly sand ((g)S) which itself represents 28.6% of the total area mapped, largely found in the open coast section between Chichester and Langstone Harbours.
- A total of 10 habitat types were identified within the site, the most common in terms of total area mapped was 'Infralittoral fine sand' (A5.23), which represented 55% of the total area mapped.
- 836.2 Ha of subtidal sandbanks were identified within the SAC as part of this project, in comparison to the 358.7 Ha mapped in 2007.
- The average percentage gravel, sand and silt of the site as a whole gives values of 24.8% gravel, 40.6% sand and 34.5% silt. These values place the site as gravelly muddy sand (gmS) within the folk classification system.
- A total of 2000.9 Ha of subtidal sands and gravels was recorded in the site in 2015, up from 406.5 Ha recorded in 2007.

- *Zostera* spp. seagrass beds have been surveyed throughout the site since 2008, the largest total area (subtidal and Intertidal beds) recorded in a single year was 166 Ha in 2013. However, this is largely a reflection of survey effort opposed to increasing distribution of seagrass across the site. The total area of subtidal seagrass beds identified throughout the site to date totals 134.3 Ha.
- The habitat maps created are subject to a number of limitation and caveats largely due to the lack of geophysical acoustic data in the majority of the site, precluding the ability to accurately delineate boundaries between habitats.

A. Introduction

Marine Ecological Surveys Ltd (MESL) has been commissioned by Natural England to carry out a desk based study to produce marine habitat maps for the subtidal areas within the Solent Maritime SAC, using available acoustic and ground-truth data to inform the habitat mapping exercise.

The study was designed to allow for a condition assessment of the site's qualifying features with a specific focus on the subtidal sandbanks, whilst providing data to help inform future management measures of the site.

A.1. Solent Maritime Special Area of Conservation (SAC)

The Solent Maritime SAC encompasses a major estuarine system on the south coast of England, with four coastal plain estuaries (Yar, Medina, King's Quay Shore, Hamble) and four bar-built estuaries (Newtown Harbour, Beaulieu, Langstone Harbour, Chichester Harbour). Figure 1 shows the locations of the various estuaries and the boundaries of the Solent Maritime SAC.

The Solent and its inlets are unique in Britain and Europe for their hydrographic regime of four tides each day, and for the complexity of the marine and estuarine habitats present within the area. Sediment habitats within the estuaries include extensive estuarine flats, often with intertidal areas supporting eelgrass *Zostera* spp. and green macroalgae, sand and shingle spits, and natural shoreline transitions. The mudflats range from low and variable salinity in the upper reaches of the estuaries to very sheltered almost fully marine muds in Chichester and Langstone Harbours. As well as occurring within the estuaries, mudflats and sandflats are found throughout the Solent and form the predominant intertidal substrates.

Unusual features which have previously been found within the SAC include the presence of very rare sponges in the Yar estuary and a sandy 'reef' of the polychaete *Sabellaria spinulosa* on the steep eastern side of the entrance to Chichester Harbour.

The main qualifying conservation feature of interest for this desk review was the 'Sandbanks which are slightly covered by seawater all the time'. These shallow seabed features occur around the Solent Maritime SAC, particularly in the large harbours.

The infaunal communities which typically colonise the sandbanks are often dominated by burrowing fauna including annelids, crustaceans, bivalve molluscs and echinoderms. Where coarse, stable material is present, attached species may include foliose algae, hydroids, bryozoans and ascidians. Mobile fauna found at the surface of the sandbanks may include shrimps, prosobranch molluscs, crabs and fish, with it being suggested that these areas may be important nursery sites for fish and feeding grounds for seabirds.

Subtidal sands and gravels and muddy sand can be found accompanying sandbanks and form as bars and/or spits shaped by the predominant west to east tidal flow. These communities may be mobile and transitional to coarser or finer sediment communities.

A number of sub-features associated with the sandbanks found in the Solent Maritime SAC include:

Subtidal gravelly sand and sand - a mix of subtidal gravel and sand can be found along the north coast of the Isle of Wight between Yarmouth and Gurnard Ledge and on the South Hampshire coast to the west of Needs Ore in the mouth of the Beaulieu River. Subtidal sand can be found in the mouths of Langstone and Chichester Harbours, the Beaulieu River (outside Needs Ore) and off the north coast of the Isle of Wight at Thorness Bay (Velegrakis, 2000).

Subtidal muddy sand - can be found in a number of places around the Solent, in particular, the lower reaches of the River Hamble, the northern half of Langstone Harbour, and centrally in Chichester Harbour and also in the upper tidal reaches of the River Medina (Velegrakis, 2000).

Subtidal eelgrass *Zostera marina* beds - *Z. marina* beds occur on firm sand, sometimes mixed sediments and are predominately found below the low water spring tidal limit. Patches have been identified around the Solent including to the west of Needs Ore, between Newtown and Gurnard point, and to the east of the mouth of the Medina River on the north coast of the Isle of Wight (Tubbs, 1999). *Zostera* spp. is also an important

food source for wildfowl including the dark-bellied brent goose and wigeon which feed on intertidal beds.

A.2. OBJECTIVES

The key objectives of this desk based project fall into three main categories which are as follows:

1. To analyse the multibeam and backscatter data available from the CCO, as well as any available biological data, and create GIS habitat maps to show the following:

    - Range and distribution of habitats.
    - Sediment character (particle size).

2. Use the data collated to provide a preliminary assessment of the condition of subtidal sandbanks feature, in accordance with Common Standards Guidance, against the baseline dataset (Emu, 2007).

3. To report the findings of the project in a succinct report using appropriate GIS outputs.

A.3. PREVIOUS REPORTING

In 2006 Emu Ltd were commissioned by Natural England to carry out an acoustic and ecological survey of the subtidal zone within the Solent Maritime SAC, with a remit to produce data and maps characterising the overall subtidal seabed surface topography, surface sediment composition and the main subtidal habitat types.

Habitat types were designated according to a combination of the characteristic species present, seabed type and water depths. The seabed sediment boundaries were interpreted from the sidescan mosaiced images and the habitat type boundaries were overlain to produce habitat type maps for the subtidal region.

An assessment of the extent and condition of the SAC was carried out as part of the reporting exercise which stated that the SAC "*does not appear to have undergone any major change since the SAC designation. Any exceptions to this are seen to be a result of natural variation and variation in the interpretation of the extant data available in previous reports*".
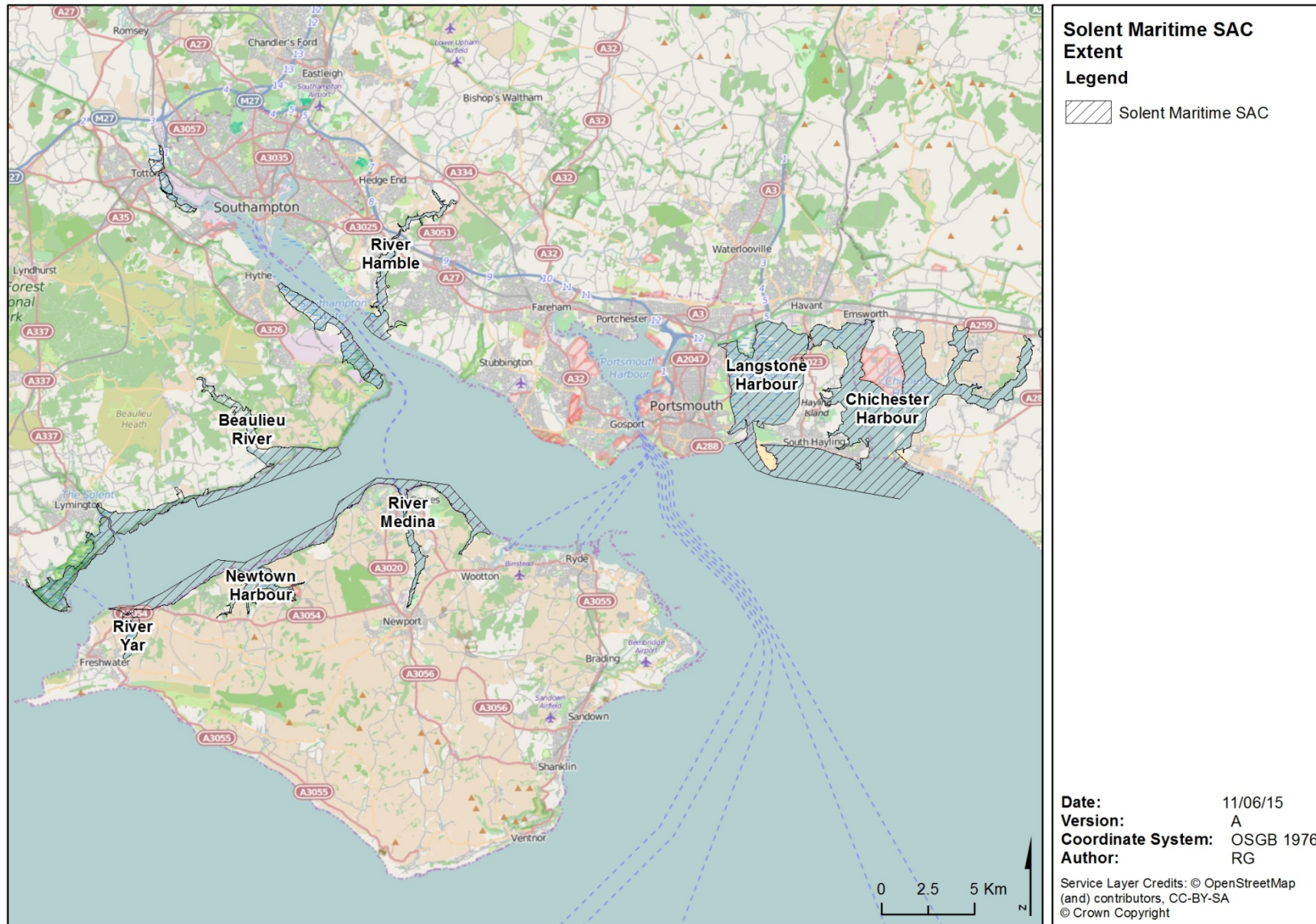
Figure 1, Location of the Solent Maritime SAC.

B. Methodology

B.1. Existing Datasets

A number of existing geophysical acoustic and biological ground-truthed datasets were made available to the project from a number of sources, the available survey data is listed below:

- Environment Agency (2013) Subtidal grab survey of the Solent Maritime SAC for condition monitoring and Water Framework Directive (WFD) monitoring.
- Environment Agency (2014) Grab survey of subtidal habitats in the Solent for rMCZ verification and SAC condition monitoring.
- Channel Coastal Observatory (CCO) – Multibeam hydrographic data from 2010-2013. The data cover western Solent up to Selsey Bill, waters around the Isle of Wight, Christchurch Bay and Hurst Narrows.
- Hampshire & Isle of Wight Wildlife Trust (2013) Inventory of Eelgrass beds in Hampshire and the Isle of Wight.
- EMU (2007) Survey of the Subtidal Sediments of the Solent Maritime SAC.

These datasets underpinned the habitat and sediment mapping exercise though their coverage ranged throughout the site.

High resolution bathymetry and backscatter data was provided by the CCO from its database of geophysical datasets. The bathymetry data provided covered an area surrounding the Isle of Wight and the eastern portion of the Solent; unfortunately the dataset didn't extend into any of the estuaries or extend up Southampton Water. Backscatter data was available for the eastern portion of the Solent which was co-acquired with the bathymetry data but unfortunately was not available from the bathymetry collected around the Isle of Wight. Figure 2 shows the bathymetry and backscatter data provided by the CCO. No Side Scan Sonar (SSS) data was available for this project.

To establish 100% coverage of bathymetry for the Solent Maritime SAC, a national bathymetry dataset at a resolution of one arc second created by the UK Hydrographic Office (UKHO) was used to assist with the mapping in areas where no CCO bathymetry data existed.

Particle Size Analysis (PSA) and infaunal samples were collected between 2011 and 2014 by Natural England and the Environment Agency, often as part of site monitoring commitments. Table 1 shows the number of each sample type sampled from within the Solent Maritime SAC. The distribution of samples available within the Solent Maritime SAC boundary is shown in Figure 3. The figure shows that the majority of sample stations are found within a few estuaries and also highlights that whole regions of the SAC do not contain ground-truthed sample data such as Eling and Bury Marshes.

Table 1, Showing the number of PSA and Infaunal samples available to the project.

Sample Type	Number of Samples
PSA	91
Infaunal Sample	103

Seagrass data dating back to 2008 was made available from the Hampshire & Isle of Wight Wildlife Trust collected on *Zostera marina* and *Zostera noltii* beds from within the Solent Maritime SAC.
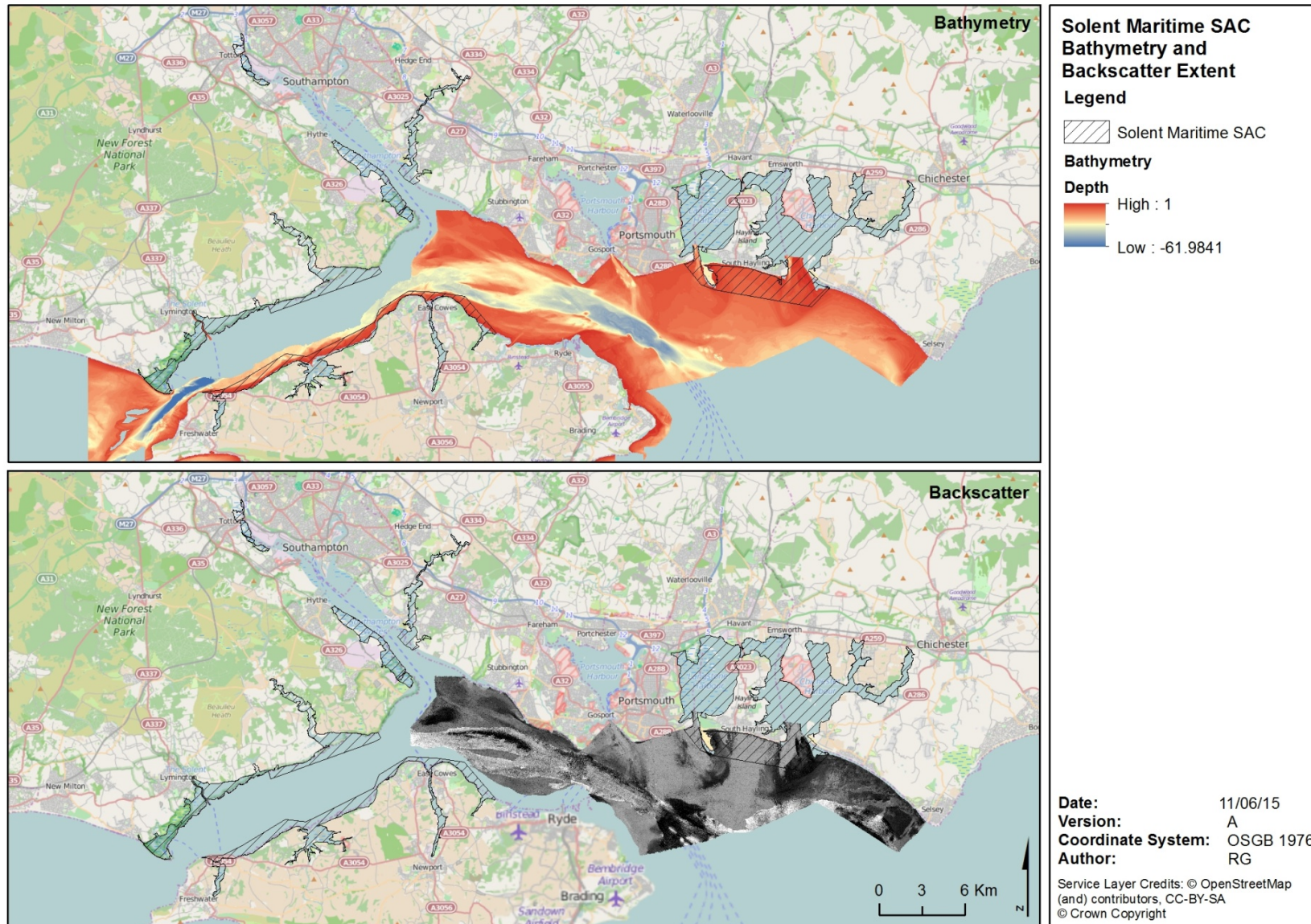
Figure 2, Extent of the bathymetry and backscatter data provided by the CCO.
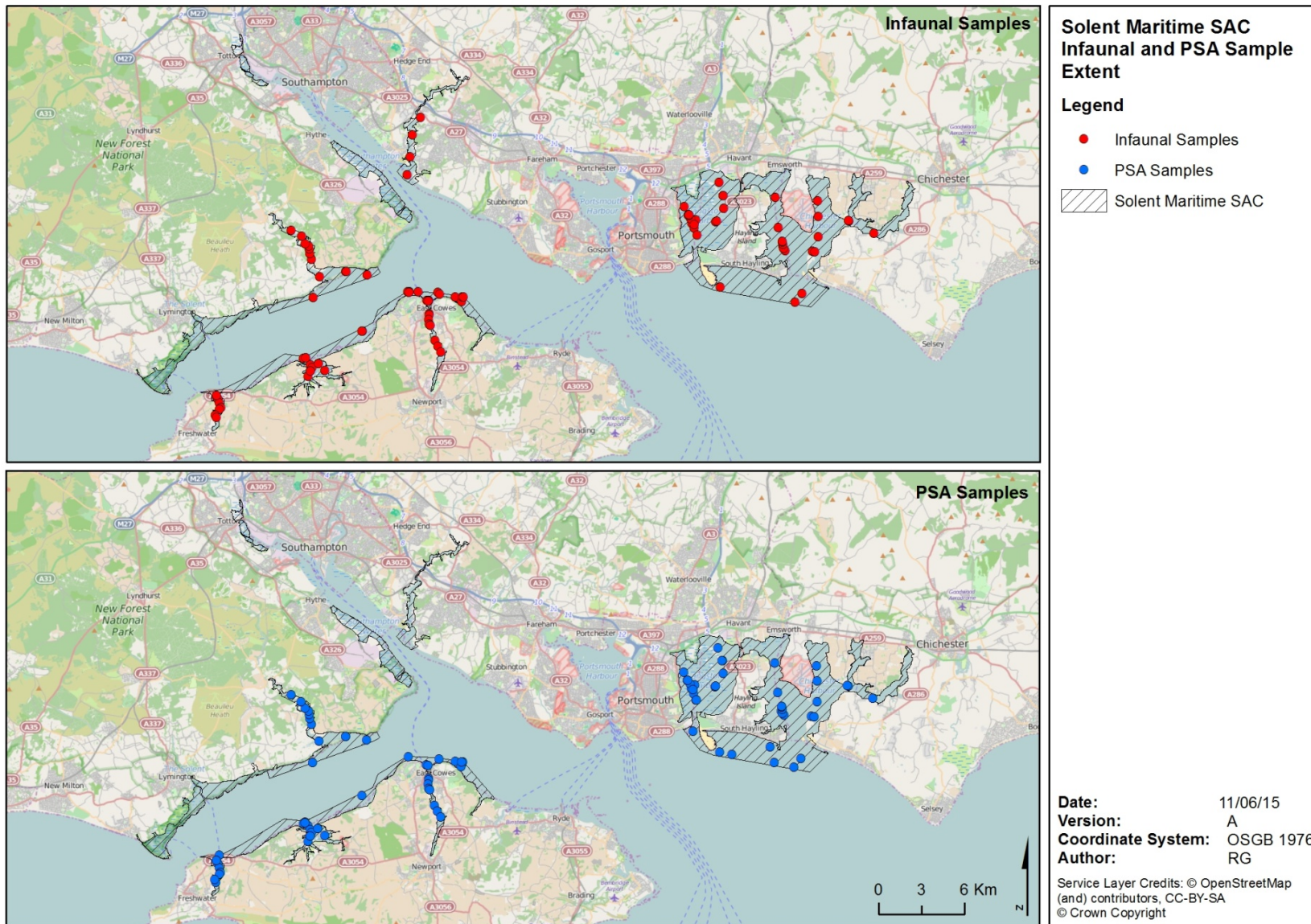
Figure 3, Distribution of available Infaunal and PSA samples across the Solent Maritime SAC.

B.2. INFAUNAL SAMPLE PROCESSING

A number of the infaunal samples, particularly those resulting from WFD monitoring had been split into 0.5 and 1mm fractions, therefore to ensure consistency, these fractions were summed for each sample so that all of the infaunal samples were sieved to the same aperture and therefore comparable.

B.3. PSA SAMPLE PROCESSING

All of the available PSA data were summarised into percentage silt (<0.063mm), sand (0.063-<2mm) and gravel (≥2mm), allowing them to be positioned within the Folk triangle (Folk, 1954) as shown in Figure 4. These data were used for the description and classification of subtidal sediments found within the SAC.

GRAVEL

80

PERCENTAGE GRAVEL
(not to scale)

30

5

1

G

mG   msG   sG

gM   gmS   gS

(g)M   (g)sM   (g)mS   (g)S

M   sM   mS   S

1:9   1:1   9:1

MUD   SAND

SAND:MUD RATIO
(not to scale)

M _____ Mud
sM _____ Sandy mud
(g)M _____ Slightly gravelly mud
(g)sM _____ Slightly gravelly sandy mud
gM _____ Gravelly mud
S _____ Sand
mS _____ Muddy sand
(g)S _____ Slightly gravelly sand
(g)mS _____ Slightly gravelly muddy sand
gmS _____ Gravelly muddy sand
gS _____ Gravelly sand
G _____ Gravel
mG _____ Muddy gravel
msG _____ Muddy sandy gravel
sG _____ Sandy gravel

Figure 4, Folk classification triangle of sediments (Folk, 1954)

B.4. STATISTICAL ANALYSIS

Multivariate statistical analysis was utilised as a guide to assist in the allocation of habitat types to the infaunal sample stations. All multivariate analysis was carried out using the PRIMER V6 software package (Clarke & Warwick 2001, Clarke & Gorley 2001).

The multivariate techniques include the following sub-routines within PRIMER V6:-

Hierarchical Cluster Analysis
Cluster analysis aims to find "natural groupings" such that samples within a group are more similar to each other than samples in different groups. The most commonly used clustering techniques are the hierarchical agglomerative methods. These start with a similarity matrix and "fuse" the samples into groups and the groups into larger clusters, starting with the highest mutual similarities then gradually lowering the similarity level at which groups are formed until all of the samples a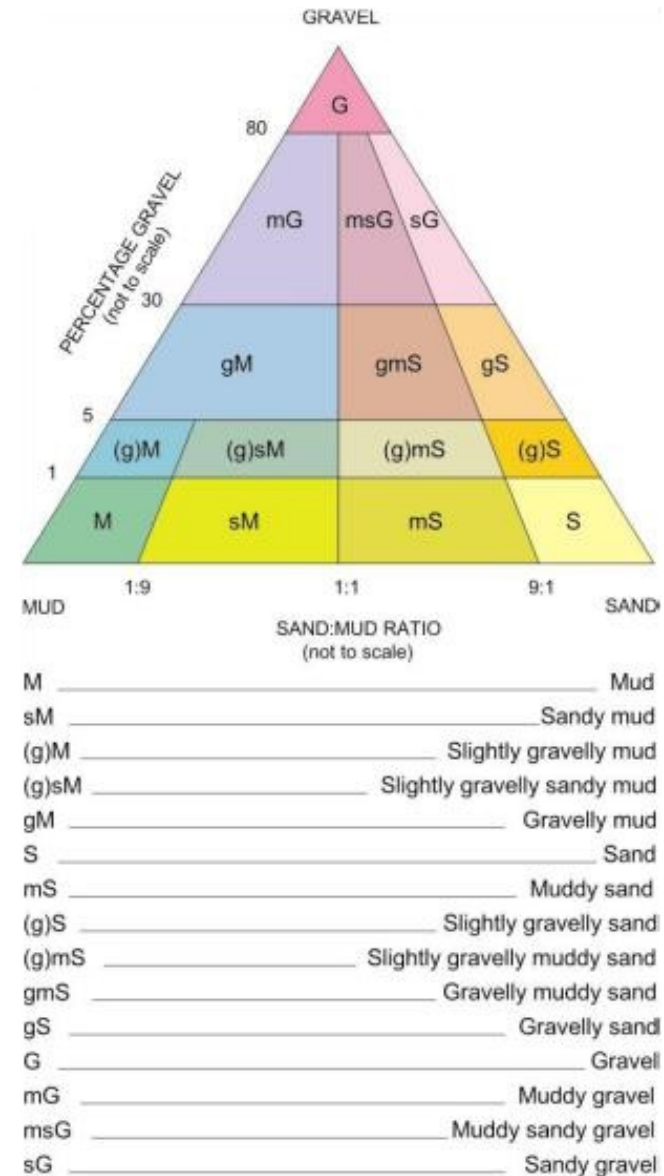re contained in a single cluster. The results of hierarchical clustering are represented by a tree diagram or dendrogram, with the *x*-axis representing the full set of samples and the *y*-axis representing the similarity level at which the groups are considered to have fused.

The SIMPROF Test
A similarity profile permutation test (SIMPROF) looks for statistically significant evidence of genuine clusters in samples. Tests are performed at every node of a completed dendrogram, testing whether the group that has been subdivided has 'significant' internal structure.

Multidimensional Scaling (MDS) Ordination
This technique allows the construction of a configuration of the samples in multidimensional space. This configuration attempts to position the samples as accurately as possible to reflect their similarity. For example, if sample 1 has a greater similarity to sample 2 than it does to sample 3 then sample 1 will be positioned more closely to sample 2 than it is to sample 3. This "map" of the relative similarities between samples is then plotted in two dimensions. It is important to remember that this two-dimensional plot is a representation of a multidimensional picture. When large numbers of samples are analysed, or datasets that include samples that are very different to one another the accuracy of the plot may be reduced. A measure of this stress on the two-dimensional

representation is given on the MDS plot. Stress values <0.2 correspond to a good ordination; values between 0.2 and 0.3 give a useful two-dimensional picture but one should not place too much reliance on the fine details of the plot; stress >0.3 indicates that the samples are close to being positioned in an arbitrary manner and should not be regarded as necessarily similar to one another.

The SIMPER routine
The SIMPER routine allows comparisons between groups of samples to be made. Following the comparison of similarities between groups the taxa (or particle size fractions) responsible for the dissimilarities between sites are sub-listed in decreasing order of importance in order to facilitate the discrimination of the groups. This routine also provides information on the species responsible for within-site similarities and their contribution to the internal similarity of the group.

B.5. THEMATIC MAPS (GIS)

All of the GIS maps featured in this report were generated using ARC GIS Version 10.2 or 10.3.

B.6. INTERPRETATION METHODOLOGY

The generalised methodology in producing the habitat maps was to use the acoustic geophysical datasets to delineate the boundaries of the various sediments habitats found across the area of interest and to use these boundaries in conjunction with the ground truthed infaunal samples to classify habitat types using the European Nature Information System (EUNIS).

However, limited acoustic geophysical data was available for the majority of the site, as highlighted in Figure 2. This therefore precluded the possibility of accurately delineating the detailed boundaries between differing sediment types, with the exception of the area surrounding the mouths of Langstone and Chichester Harbours where high resolution backscatter data was available.

Due to the limited geophysical data and the discrete clustering of infaunal samples shown in Figure 3, it has only been possible to map areas for which ground truthed data were available, representing a combined area of roughly three quarters of the entire site. The key areas which have been possible to map are:

- Chichester Harbour;
- Langstone Harbour;
- Beaulieu River;
- River Medina;
- Newtown Harbour;
- River Yar;
- and the River Hamble (Biotope only).

Subtidal areas of interest to be mapped were distinguished using the Solent Maritime SAC shapefile in conjunction with an Ordinance Survey (OS) shapefile of the Mean Low Water (MLW) mark to clearly define the boundaries between subtidal and intertidal habitats and the extent of habitat to be mapped within the various sections of the site.

These resulting polygons of the subtidal areas within the seven sites were subsequently split into sediment groups and habitat types with boundaries being delineated at equidistance's between conflicting sample points, with the exception of areas where high resolution backscatter data existed, used to delineate boundaries.

The definition of subtidal sandbanks which applies to the Solent Maritime SAC due to it being designated under the previous Annex 1 sandbank definition is '*Sublittoral sandbanks, permanently submerged. Water depth is seldom more than 20 m below Chart Datum. Non-vegetated sandbanks or sandbanks with vegetation belonging to the Zosteretum marinae and Cymodoceion nodosae'.*

To distinguish the distributions of any subtidal sandbanks within the SAC a combination of the habitat type map produced and the CCO bathymetry data layer were used. All habitat type polygons which inferred the presence of subtidal sandbanks, in this case 'Infralittoral fine sand' (A5.23), were overlaid (with transparency applied) onto the bathymetry data to identify sandbank features (areas of bathymetric relief) and digitised using the contours of the bathymetry layer.

C. Results

C.1. Sediment Maps

Figure 5 shows the distribution of the subtidal sediments throughout the mapped regions of the Solent Maritime SAC, coloured to the folk classification. The figure illustrates that the subtidal sediments of the SAC vary between the different sections of the site.

Predominately the upper reaches of the larger estuaries are characterised by gravel dominated sediments with varying proportions of silt, this was evident in both Chichester and Langstone Harbours. Whereas the upper reaches of the smaller estuaries such as the River Yar and Newtown River, tend to be dominated by more finer dominated sediments. Towards the mouths of the estuarine and across wider expanses of water the proportion of silt drops and was replaced by sandier and coarse sediments, due to the increased mobility of the sediments within these regions.

Table 2 shows the number of PSA samples collected in the Solent Maritime SAC which fell within each folk category and the area of the polygons of each sediment type. The table clearly shows that gravel and silt dominated PSA samples were more commonly found across the site, with muddy gravels (mG) being the most commonly sampled category, closely followed by sandy mud (sM).

Table 2 also shows the total area of each folk category mapped within the Solent Maritime SAC. The table clearly illustrates that sand dominated categories make up the vast majority of the area mapped, with the single largest category being slightly gravelly sand ((g)S) which itself represents 28.6% of the total area mapped, largely found in the open coast section between Chichester and Langstone Harbours. Silt dominated categories are the smallest group in terms of total area representing a cumulative area of 459.1 hectares (13% of total area), and are predominately found in the mid and upper section of the estuaries.

The area surrounding the mouth of Chichester harbour and a small section on the outer coast of the River Medina are dominated by sand fractions, and therefore could imply the presence of subtidal sandbanks.

The site as a whole has average values of gravel, sand and silt of 24.8% gravel, 40.6% Sand and 34.5% silt, which positions the average values as gravelly muddy Sand (gmS) within the folk triangle.

Table 2, The number of PSA samples and total area (Hectares) that fell within each folk sediment category.

Folk Group	Number PSA Samples	Total Area of polygons (Ha)
G	2	29.9
mG	17	328.4
msG	12	495.7
sG	3	197.6
gS	7	413.6
(g)S	4	1013.1
S	5	457.3
mS	5	63.4
gmS	7	85.6
sM	14	99.4
(g)sM	3	56.4
gM	10	232.1
M	2	71.2
Totals	**91**	**3543.5**
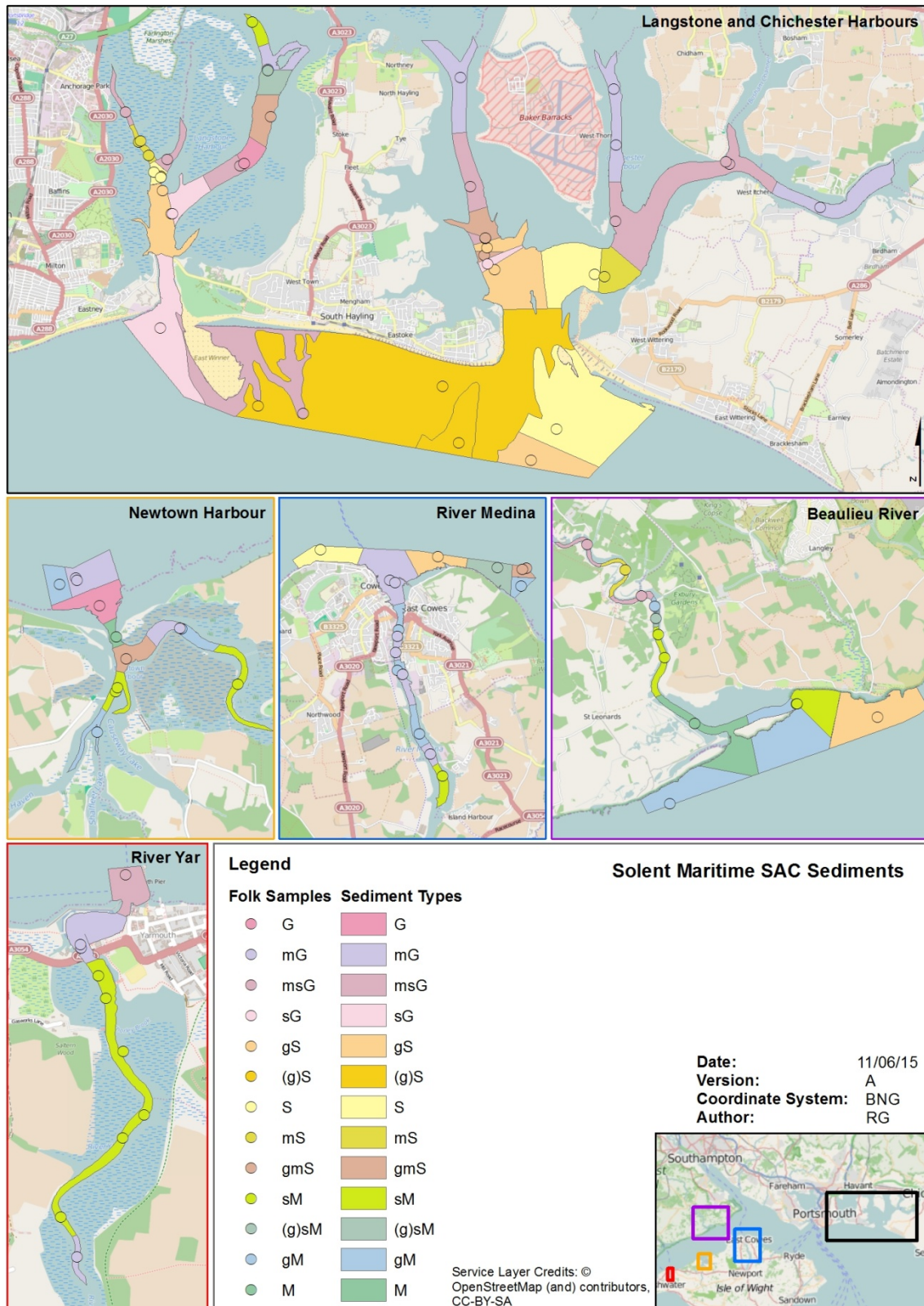
Figure 5, PSA samples and subtidal sediments mapped within the Solent Martime SAC, classified using the Folk classification system.

C.2. HABITAT MAPS

C.2.1. Multivariate Analysis

In order to assist with the habitat type mapping exercise, multivariate analysis was carried out to identify natural groupings of the infaunal assemblages sampled across the site. The analysis provides a justification for the grouping of the infaunal samples and also identifies the key taxa that contribute to the similarity of the groups, required for the allocation of more detailed habitat types.

Seven distinct faunal groups have been identified within the benthic abundance dataset, as presented in Figure 6. Figure 6 shows a group average sorting dendrogram (based on Bray-Curt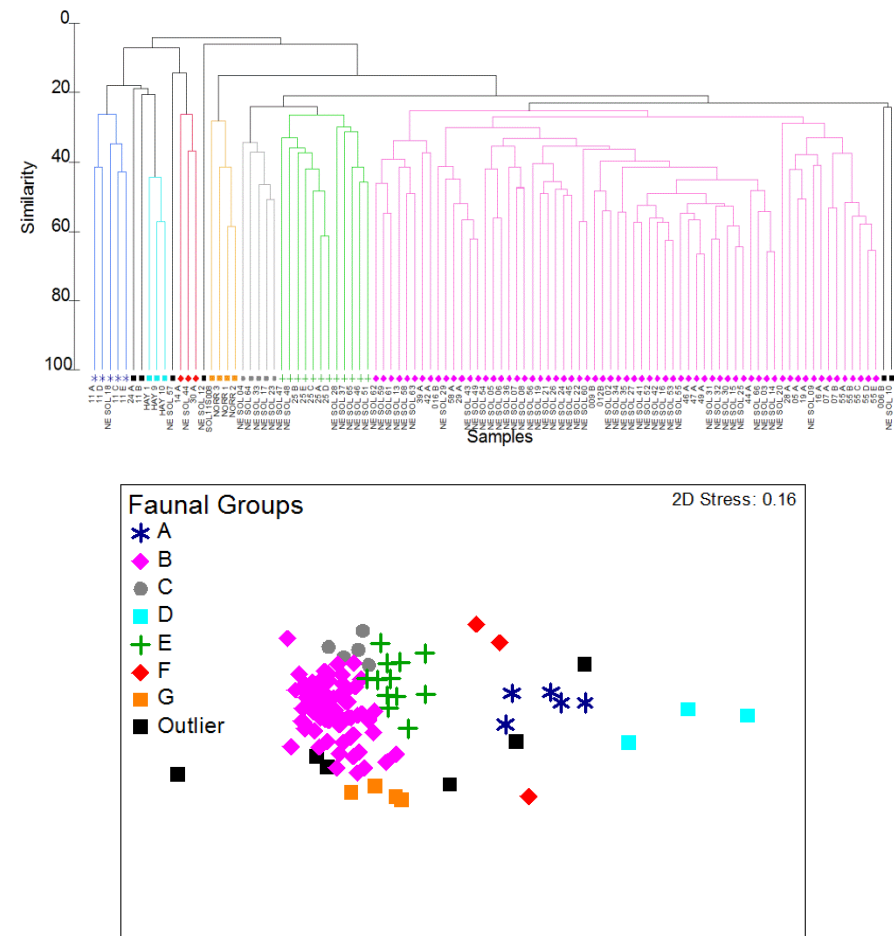is similarity of square-root transformed data) and the corresponding multidimensional scaling (MDS) plot, presented in two-dimensional format, using abundance data gathered from across the Solent Maritime SAC. The moderate 2D stress value of the MDS ordination (0.16), indicates that the two-dimensional representation provides a reliable interpretation of the interrelationships that occur between the communities sampled across the site.

The multivariate faunal groups shown in Figure 6 were derived using a slice at the 25% similarity level. In addition to the seven faunal groups identified, there was an additional 6 samples which did not group with any other samples labelled as Outliers, represented by the black squares in Figure 6.

SIMPER analysis was run on the seven multivariate groups to identify the key taxa driving the similarity within the groups. The top ten taxa (if available) which contributed to each multivariate group similarity are presented in Table 3 below.

Figure 6, A group average sorting dendrogram based on the square root transformed Bray-Curtis similarity infaunal abundance data and the corresponding multidimensional scaling (MDS) ordination, presented in two-dimensional format, sampled from the Solent Maritime SAC.

Table 3, Results of the SIMPER analysis run on the seven multivariate group identified across the Solent Maritime SAC, showing the top 10 contribution taxa (Av. Abund - Average Abundance; Contrib% - Similarty Contribution Percentage).

Group A			Group B		
Species	Av. Abund	Contrib%	Species	Av. Abund	Contrib%
Gastrosaccus spinifer	4.31	36.84	NEMATODA	29.53	23.01
NEMERTEA	1.52	16.01	Aphelochaeta marioni	21.23	15.01
Mysidae	4.26	15.06	Mediomastus fragilis	11.28	10.13
NEMATODA	1.08	9.51	Tubificoides benedii	8.69	6.19
Aphelochaeta marioni	0.83	7.27	Protocirrineris	8.25	5.73
Pontocrates arenarius	0.68	6.52	Tubificoides amplivasatus	6.39	4.12
			Melinna palmata	4.98	3.38
			Exogone naidina	3.73	2.64
			Tubificoides pseudogaster (agg)	4.5	2.56
			Capitella	3.7	2.15
Group C			Group D		
Species	Av. Abund	Contrib%	Species	Av. Abund	Contrib%
Tharyx "species A"	16.97	24.07	Gastrosaccus spinifer	2.99	45.37
NEMATODA	11.45	21.15	Bathyporeia pelagica	2.07	33.98
Aphelochaeta marioni	11.18	15.1	Nephtys cirrosa	1.15	8.49
Streblospio	7.14	11.94	Urothoe brevicornis	0.91	7.27
Tubificoides benedii	3.4	5.66			
Mediomastus fragilis	3.19	4.9			
Tharyx killariensis	4.98	4.27			
Melinna palmata	4.6	2.61			
Tubificoides pseudogaster (agg)	4.82	2.43			
Group E			Group F		
Species	Av. Abund	Contrib%	Species	Av. Abund	Contrib%
Aricidea minuta	9.5	14.24	Tanaissus lilljeborgi	2.91	14.93
Tubificoides pseudogaster (agg)	8.76	13.74	Nephtys cirrosa	1.61	14.32
NEMATODA	6.71	9.95	Gracilaria	1.14	10.13
Chaetozone gibber	6.11	6.71	NEMATODA	1.41	10.13
Aphelochaeta marioni	5.28	6.39	Aricidea minuta	1.41	10.13
Tubificoides benedii	3.64	5.08	COPEPODA	1.24	10.13
Tharyx "species A"	3.33	4.51	Cumopsis goodsiri	1	10.13
Melinna palmata	3.68	4.28	Tubificoides pseudogaster (agg)	1.22	4.77
Pygospio elegans	2.48	3.16	Bathyporeia elegans	1.53	4.77
Scoloplos armiger	1.94	2.92	Urothoe elegans	0.91	3.83
Group G					
Species	Av. Abund	Contrib%			
Crepidula fornicata	7.24	10.72			
Nucula nitidosa	5.5	8.53			
Chaetozone zetlandica	4.87	7.44			
Mediomastus fragilis	5.56	6.42			
Spirobranchus lamarcki	4.26	5.82			
Balanus crenatus	9.59	5.21			
Notomastus	2.35	4.21			
Aphelochaeta marioni	4.01	3.66			
Cirriformia tentaculata	2.1	3.44			
Achelia echinata	2.58	3.03			

C.2.2. Habitat Type Allocation

The composition and characteristics of the multivariate faunal groups are discussed below, in addition justification for the allocation of habitat types, either biotopes (EUNIS level 5) or biotope complexes (EUNIS level 4) to each group is provided.

To assist in the allocation of habitat types to multivariate groups the Joint Nature Conservation Committee (JNCC) Marine Habitat Classification Hierarchy tool was utilised (Available at: http://jncc.defra.gov.uk/marine/biotopes/hierarchy.aspx) to assign and verify quality of habitat types. The Marine Habitats Correlation Table was also used (Available at: http://jncc.defra.gov.uk/page-6767) when switching between classification systems.

Group A
Multivariate faunal group A encompassed a total of 5 samples, which were all found on the open coast section of the River Medina on sand sediment. Key taxa which contributed to the similarity of the group included the crustaceans *Gastrosaccus spinifer* and *Mysidae* and species from the phylum Nemertea.

This group was allocated the biotope 'Infralittoral mobile clean sand with sparse fauna' (A5.231), due to the sandy substrate the samples where found upon and the sparse infaunal communities sampled, as shown in Table 3.

Group B
Multivariate faunal group B was the largest of the seven groups attributed to a total of 65 samples. The samples were predominately found sheltered within the estuaries though a few were found on the open coast. The samples were found on a range of sediment types which were either silt or gravel dominated including, muddy sandy gravels (msG), sandy mud (sM) and muddy gravels (mG). Key characterising taxa within the group included species from the phylum Nematoda and the polychaetes *Aphelochaeta marioni* and *Mediomastus fragilis.*

Group B was allocated to the biotope 'Aphelochaeta spp. and *Polydora* spp. in variable salinity infralittoral mixed sediment' (A5.421). This biotope was chosen due to the mixed sediments the samples were sampled from and the high abundance of *Aphelochaeta* spp. characterising the infaunal communities within the group.

Group C
Infaunal group C was attributed to 5 sample stations, all of which were sheltered within the mid or upper reaches of estuaries. All of the samples were sampled from silt dominated sediments including slightly gravelly sandy mud ((g)sM), gravelly mud (gM) and sandy mud (sM). Key taxa characterising the group included *Tharyx* "species A", Nematodes and the polychaete *Aphelochaeta marioni.*

This infaunal group was assigned the biotope 'Aphelochaeta marioni and *Tubificoides* spp. in variable salinity infralittoral mud' (A5.322), due to all of the samples having been found on silt dominated sediments and both *Aphelochaeta marioni* and *Tubificoides* spp. being shown to be important taxa contributing to the similarity of the group as seen in Table 3 above.

Group D
Multivariate faunal group D was the joint smallest group identified, assigned to a total of 3 samples. The group was solely found on the open coast section between Chichester and Langstone harbours on sand dominated sediments including slight gravelly sand ((g)S), gravelly sand (gS) and sand (S). Table 3 shows that the infaunal communities sampled were impoverished with crustaceans *Gastrosaccus spinifer* and *Bathyporeia pelagica* being key taxa characterising the group.

The biotope 'Infralittoral mobile clean sand with sparse fauna' (A5.231) was allocated to the group, which was the same as group A. Both groups were sampled from very similar sediments and both have impoverished infaunal communities.

Group E

Group E was the second largest multivariate group identified, assigned to a total of 12 samples. The samples were predominately sampled from the mid and upper reaches of Langstone and Chichester harbours and the Beaulieu River, with the exception of one sample from the mouth of the Beaulieu River. The group was principally found upon sand dominated sediments, although a single sample was collected from muddy sandy gravels (msG). Key characterising taxa within the group included the polychaete *Aricidea minuta,* the Oligochaeta *Tubificoides pseudogaster* and species from the phylum Nematoda.

Group E was allocated the biotope '*Aphelochaeta* spp. and *Polydora* spp. in variable salinity infralittoral mixed sediment' (A5.421) which was the same as Group B. It can be seen from the MDS plot in Figure 6 that there was some level of overlap between the groups and differences between the groups are driven by abundance opposed to characterising taxa.

Group F

Multivariate group F was the joint smallest group identified with a total of 3 samples assigned to the group. The samples are found on the open coast of the River Medina and from within Langstone Harbour. The samples were found on both gravelly sand (gS) and sand (S) sediments with key taxa including *Tanaissus lilljeborgi, Nephtys cirrosa* and species from the phylum Nematoda.

This infaunal group was assigned the biotope '*Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand' (A5.233), due to the substrate the samples were found upon and the presence of *Nephtys cirrosa* as a key taxa within the infaunal assemblages.

Group G

Group G was assigned to 4 samples all collected on the open coast section of the River Medina. The 4 samples were found on a range of sediment types which were either silt or sand dominated, with key taxa characterising the group including *Crepidula fornicata*, *Nucula nitidosa* and *Chaetozone zetlandica*.

The multivariate group was assigned the biotope '*Crepidula fornicata* and *Mediomastus fragilis* in variable salinity infralittoral mixed sediment' (A5.422), due to the mixed nature of the sediments and the importance of *Crepidula fornicata* to the similarity of the group.

Outliers

A total of 6 samples did not group with any other samples and were therefore classed as outliers, however these have still been assigned a habitat type but to a low level (EUNIS level 4) as there weren't sufficient species to confidently assign a more detailed habitat type.

Table 4 below shows the 6 outlying samples and the habitat types which were attributed to each sample. The habitat types were assigned based on the substrate the samples were collected from and the geographical location of the station.

Table 4, Biotope complexes allocated to the outlying samples identified through Cluster analysis. Including the sample ID and the survey code the sample was collected from.

| Outlying Sample ID	Survey	Assigned biotope
006 B	EASWHA13	Sublittoral mixed sediment in variable salinity (estuaries) (A5.42)
NE SOL 10	NESOLENT13	Infralittoral mixed sediment (A5.43)
NE SOL 12	NESOLENT13	Sublittoral mud in variable salinity (estuaries) (A5.32)
NE SOL 57	NESOLENT13	Infralittoral fine sand (A5.23)
11 B	NESOLHAR11	Infralittoral fine sand (A5.23)
24 A	NESOLHAR11	Infralittoral fine sand (A5.23)

C.2.3. Habitat Type Mapping

A total of 10 habitat types were identified throughout the Solent Maritime SAC, which were used as the basis of the biotope mapping exercise. Figure 7 below shows the habitat types mapped throughout the site, the biotope polygons which have been digitised are at Eunis level 4 (the lowest common biotope level), but provide the best visualisation of changes in biotopes on such a dispersed site. However, the more detailed biotopes are displayed by the individual point samples.

Table 5 below shows the total area (Hectares - Ha) of each of the mapped EUNIS level 4 biotope complexes. The table shows how both 'Infralittoral fine sand' (A5.23) and 'Sublittoral mixed sediment in variable salinity (estuaries)' (A5.42) dominate the sublittoral habitats of the Solent Maritime SAC, together representing 99% of the sublittoral area mapped.

Table 5, Total area (hectares) of the 4 EUNIS level 4 biotope complexes mapped.

Eunis Level 4 Habitat Types	Total Area (Ha)
A5.23	2000.9
A5.32	27.7
A5.42	1601.8
A5.43	7.2
Totals	**3637.6**
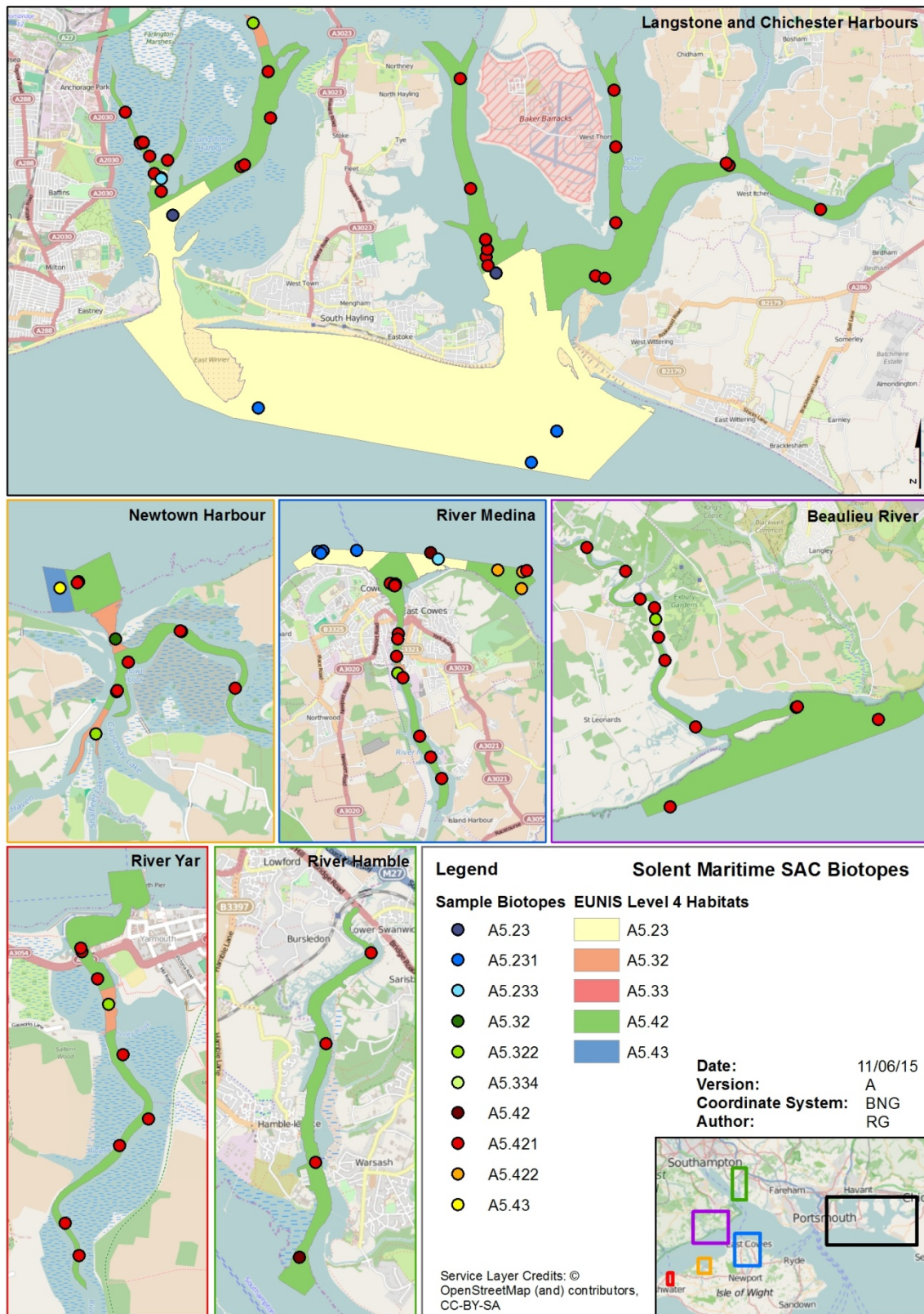
Figure 7, Habitat types (biotopes and biotope complexes) mapped throughout the Solent Maritime SAC. Points represent the individual sample points and display the highest assigned biotope levels.

C.3. CONDITION ASSESSMENT

C.3.1. Extent of Subtidal Sandbanks

The distribution of subtidal sandbanks was identified using a combination of the habitat type map produced and the high resolution CCO bathymetry data.

Figure 8 below shows the distribution of sandbanks identified as part of this project. The figure also shows the distribution of habitat types identified in 2007 which infer the presence of subtidal sandbanks. Unfortunately no explicit boundaries and no hard figures on subtidal sandbank extent were provided as part of the 2007 project.

The largest area of subtidal sandbanks identified in 2015 was surrounding the mouths of both Chichester and Langstone harbours, with the addition of a small subtidal sandbank feature identified at the mouth of the River Medina. Figure 8 also shows that the subtidal sandbanks identified in 2015 have a very similar distribution as those previously identified in 2007.

Using the habitat types to inform the sandbanks distribution a total of 358.7 hectares (Ha) were identified throughout the Solent Maritime SAC in 2007. However, a total area of 836.2 Ha of subtidal sandbanks were identified within the SAC as part of the 2015 study, over double that previously recorded in 2007. Although these large differences may be due in part to the difference in mapping techniques and underpinning data, discussed further in section D.

C.3.2. Topography

In terms of topography the target for the site was that the 'depth should not deviate significantly from the established baseline, subject to natural change' which is particularly pertinent to the sandbanks where depth is a major influence on the distribution of infaunal communities.

Unfortunately for the project a baseline dataset had not previously been produced that provided 100% coverage of the site allowing for a robust assessment in changes of depth, the 2007 data provided single beam depth soundings as a point shapefile, with approximately 150m line spacing.

However, using the available CCO bathymetry dataset a partial descriptive topographic baseline is possible in covered areas.

Chichester harbour had maximum depths of around -23 meters found at the mouth of the harbour where tidal streams scour the entrance on both the ebb and flow tides. Depths within the harbour varied between -4 and -9 meters. The open coast section between Chichester and Langstone harbours has a shallow gradient sloping down to -6 meters. Whilst Langstone Harbour had a maximum depths of -17 meters found at the mouth.

The River Medina had maximum depths at the mouth of -7 meters with depth within the estuary varying between -3 and -5 meters. The open coast section outside the estuary drops off sharply from -7 meters to -18 meters. The northern coastline section of the Isle of Wight is varied with steep gradients in areas, dropping sharply from the intertidal regions to depths of up to -27 meters.

Depths within Newtown Harbour are shallow throughout with maximum depths found at the mouth of -7 meters. The River Yar has similar depth values as Newtown Harbour with a maximum depth at the mouth of -6 meters and the depths within the estuary being very shallow, with the coastline adjacent to the estuary also being relatively shallow.

To enable a comprehensive topographic assessment of the site a robust baseline dataset firstly needs to be produced, the CCO bathymetry dataset as shown in Figure 2 is a good starting point but doesn't include any of the estuaries and harbours and doesn't extend up Southampton Water or cover the north west portion of the Solent.

In 2014 URS were commissioned to conduct a geomorphological review of the Solent Maritime SAC estuaries, as part of the project they produced Digital Terrain Models (DTM) of each of the estuaries which could be combined with the CCO data to create a more complete dataset, however it's important to note that the data which underpins these DTM's is drawn from an extremely wide array of sources with some datasets dating back to before 1970.

If the DTM's produced by URS were deemed suitable to use in conjunction with the CCO data then only a number of discrete locations would need to be subject to geophysical acoustic surveys to create a topographic baseline layer with 100% coverage, which could be used going forward to inform the management of the site.
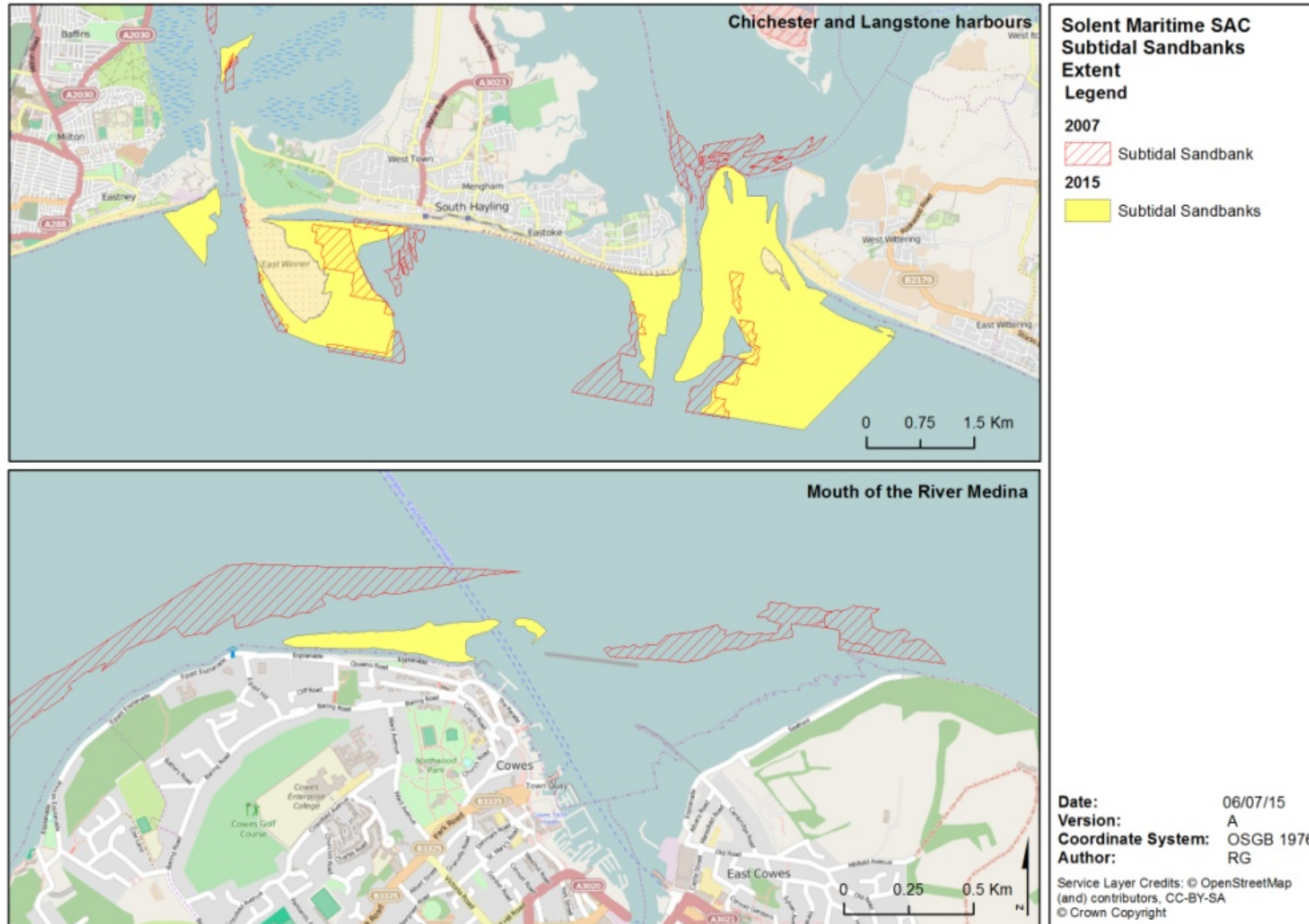
Figure 8, Distribution of Subtidal Sandbanks in the Solent Maritime SAC. Red hatched areas identified in 2007, whilst solid yellow polygons identified in 2015.

C.3.3. Sediment Character

No baseline PSA data was available for the site. The previous study on the site conducted in 2007 provided sediment descriptions based on visual inspections of the samples during the survey and no particle size distribution analysis was undertaken. It was therefore not possible to assess changes in average grain size across site over time.

A summary of the available PSA data into average percentage gravel, sand and silt of the site as a whole gives values of 24.8% gravel, 40.6% sand and 34.5% silt. These values place the site as gravelly muddy sand (gmS) within the folk classification system, highlighting the mixed sediment nature of the site. A more detailed description of the sediment character across the site can be found in Section C.1.

C.3.4. Extent of Subtidal Sands and Gravels

The presence of subtidal sands and gravel was inferred by a number of habitat types, these are presented in the UK Biodiversity Action Plan (UK BAP) – Priority Habitat Description document (Available from: http://jncc.defra.gov.uk/pdf/UKBAP_BAPHabitats-54-SubtidalSandsGravels.pdf). Within the Solent Maritime SAC the habitat types identified which represent subtidal sands and gravels included 'Infralittoral fine sand', 'Infralittoral mobile clean sand with sparse fauna' and '*Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand'.

The distribution of these habitat types are shown in Figure 9, showing that the UK BAP habitat was found at the mouths and between Chichester and Langstone harbours and the open coast section of the River Medina. The figure also shows the distribution of the habitat recorded in the 2007 surveys of the site, which shows that the habitats were found in very similar regions. Table 6 below shows the total areas of subtidal sands and gravels recorded each year, showing that over three times the total area of 2007 (406.5 Ha) was recorded in 2015 (2000.9 Ha).

Table 6, Total area (Ha) of Subtidal Sands and Gravels found in the Solent Maritime SAC.

Survey Year	Subtidal Sands and Gravels total area (Ha)
2007	406.5
2015	2000.9

However, little value can be drawn from comparisons between years due to the gross differences in mapping techniques and environmental data availability. The data products from 2015 are at a very coarse resolution due to the limited surveyed data available to underpin the habitat mapping exercise, whilst the 2007 report had a full suite of biological and geophysical data to assist in the mapping exercise, therefore resulting in a higher confidence and resolution dataset.
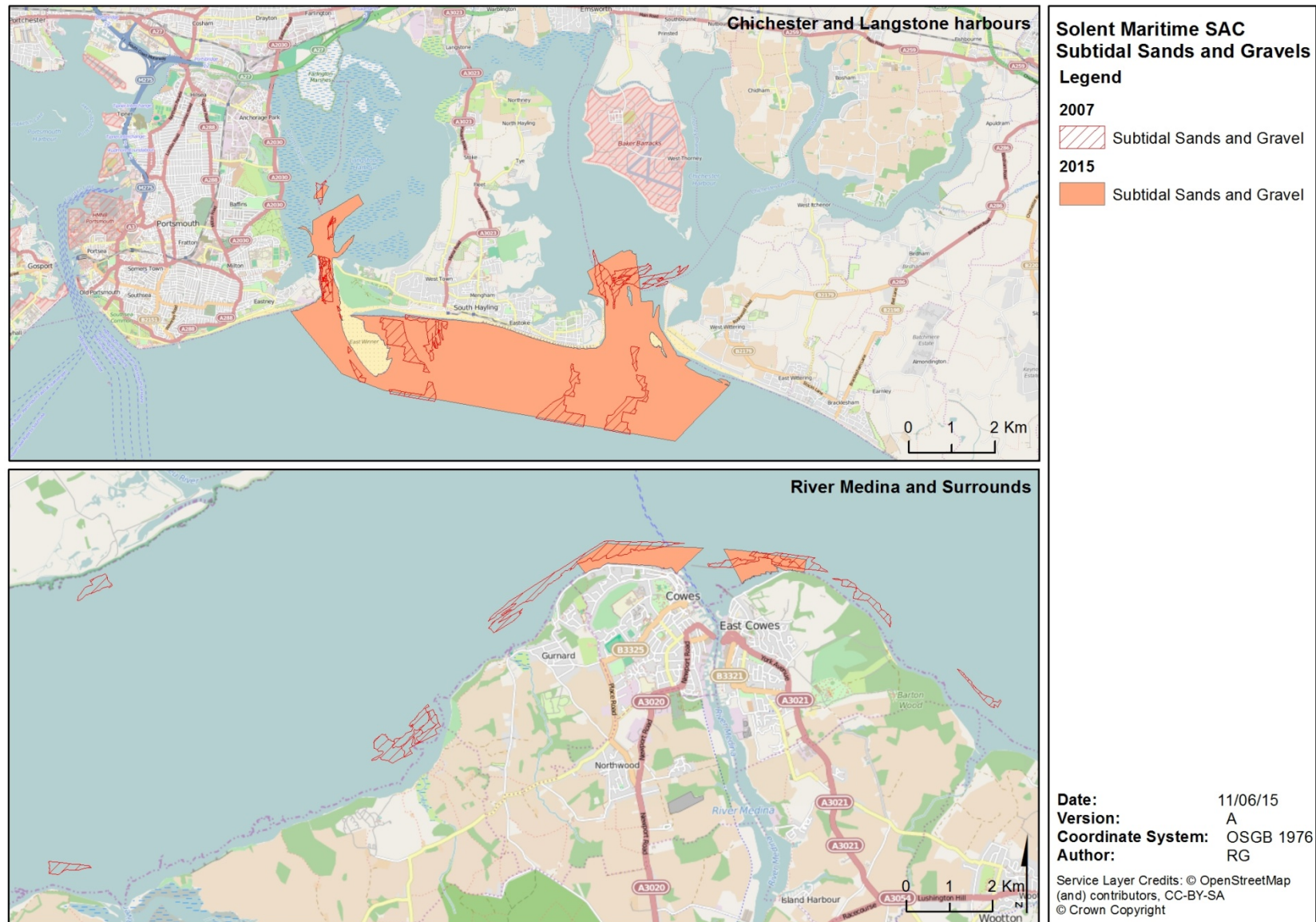
Figure 9, Distribution of Subtidal Sands and Gravels within the Solent Maritime SAC (Red hatching polygons produced in 2007 and solid orange polygons produced in 2015).

C.3.5. Extent of *Zostera marina*

Seagrass (*Zostera marina* and *Zostera noltii*) beds within the Solent Maritime SAC have been surveyed by the Hampshire & Isle of Wight Wildlife Trust since 2008.

Figure 10 shows the distribution of all the seagrass beds surveyed, coloured up based on which year each bed was last surveyed. The figure shows that the majority of the seagrass beds within the Solent Maritime SAC are found within Chichester and Langstone harbours and across the north of the Isle of Wight, although this maybe more of a reflection of survey effort opposed to distribution of seagrass across the site.

Table 7 shows the total area of seagrass (including both intertidal and subtidal beds) recorded each year since 2008, the number of seagrass beds surveyed each year, the average size of the beds surveyed and the total subtidal seagrass beds identified each year. The table shows that although the number of seagrass beds surveyed each year varies, the average area of each bed remains relatively constant with the exception of the years 2008 and 2010.

An assessment of changes in distribution of seagrass within the SAC was not possible due to different seagrass beds being surveyed each year and the historic extents of seagrass were not available, therefore no assessment of relative loss or gain in seagrass extent at a site could be gauged.

Table 7, Areas of seagrass beds surveyed each year by the Hampshire & Isle of Wight Wildlife Trust since 2008 (Total Area represents both intertidal and subtidal seagrass beds).

Survey Year	Number of Beds Surveyed	Total Area (Ha)	Average Area of Beds (Ha)	Subtidal Seagrass Areas (Ha)
2008	6	7.7	1.3	0.3
2009	1	18.0	18.0	-
2010	2	66.1	33.1	-
2011	2	31.6	15.8	31.3
2012	3	38.6	12.9	32.3
2013	14	166.0	11.9	70.4
2014	3	47.5	15.8	-
Totals	**31**	**375.5**	**-**	**134.3**
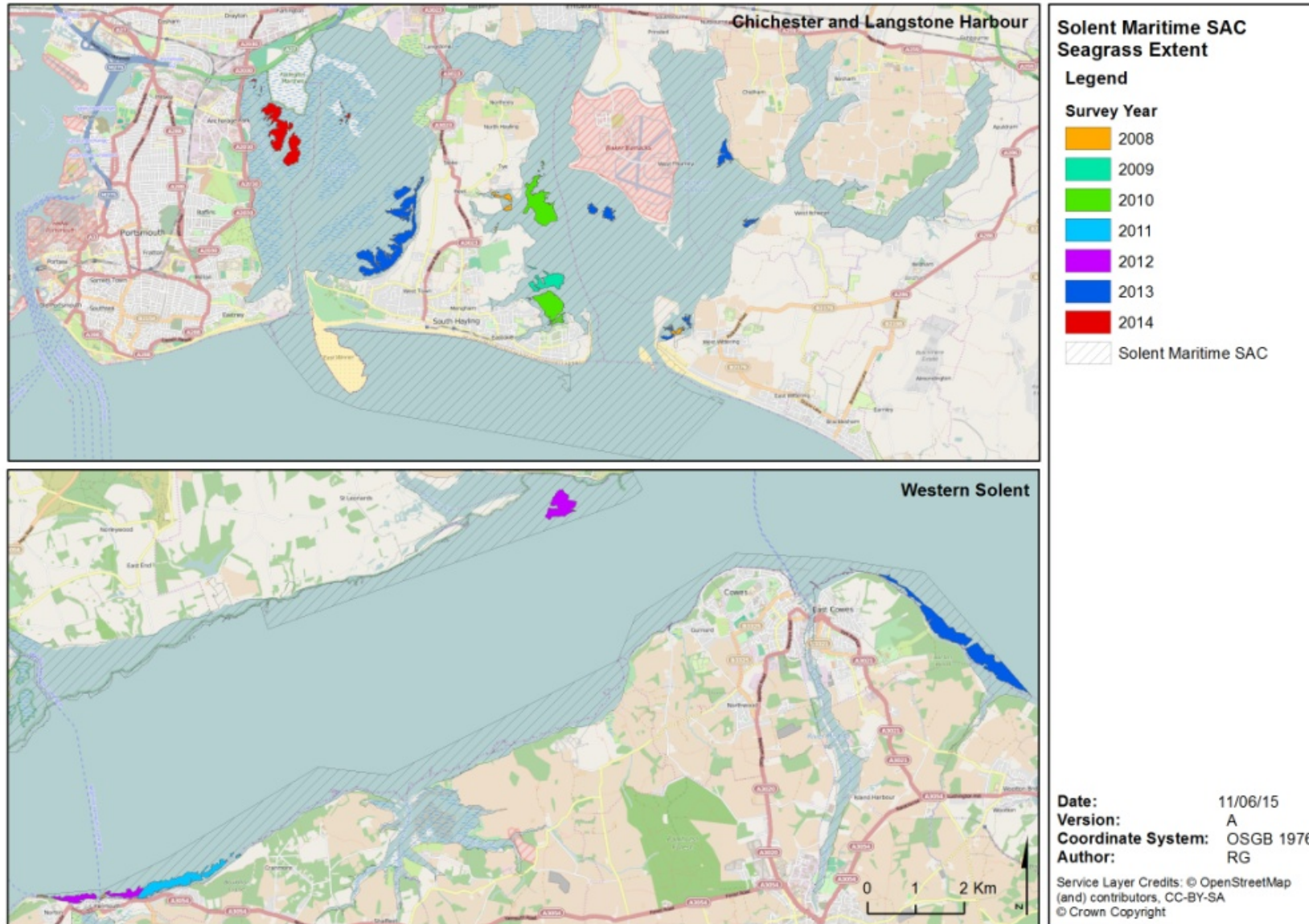
Figure 10, Seagrass beds surveyed by the Hampshire & Isle of Wight Wildlife Trust since 2008 (Including both intertidal and subtidal beds).

D. Limitations and Future Recommendations

D.1. Limitations

There are a number of limitations associated with subtidal habitat mapping and the comparative analysis of this project. The limitations associated with habitat mapping are largely due to the limited datasets available to inform the habitat and sediment maps produced for such a large and dispersed site as the Solent Maritime SAC.

One of the most apparent gaps in available data to inform the habitat mapping exercise of the site was the availability of either a Side Scan Sonar mosaic of the site, or bathymetry backscatter data. Bathymetry backscatter data was obtained for the eastern portion of the Solent, but only covered a small fraction of the Solent Maritime SAC, the vast majority of the site was without bathymetry and/or backscatter data. The lack of these datasets vastly reduced the ability to delineate boundaries between different sediment types and instead resulted in boundaries being place at equidistance intervals between samples. In addition, the sample points available were often sparsely spread throughout the site in a stochastic manner. These factors all contribute to the highly predictive nature of the resulting sediment and habitat type maps, with large swaths of the mapped sites defined by a relatively few sample points.

The mapping exercise also makes the assumption that the full spectrum of sediment types and habitat types have been sampled within the site, and that the ground truthed samples are representative of all the areas mapped.

A number of baseline datasets to help inform condition assessments of the site were also missing. There was no single topographic baseline dataset for the site that provided 100% coverage. A number of the estuaries had individual datasets, but these were independent of one another and it was often difficult to identify within the metadata the date of acquisition of the data. The lack of a baseline dataset precluded the ability to assess change in depth across the site and particularly across areas where subtidal sandbanks exist.

The seagrass data made available to the project did not allow for comparisons in seagrass distribution between years, due to differing seagrass beds surveyed each year. The dataset made reference to historic repeat surveys at a number of sites but only provided the latest extents of the seagrass bed, therefore changes in distributions at a site level were unable to be carried out without the provision of the historic extents (polygons) of the beds, to calculate percentage change in distribution.

As previously mentioned comparisons with the historic datasets of the site was difficult due to the different mapping techniques used. The 2007 project had a full suite of both biological and environmental data to inform the habitat mapping exercise and, therefore, was able to more readily distinguish boundaries between sediments/habitat types at a much finer resolution. The resulting differences in mapping resolution reduce the validity of comparisons between the two datasets, and any subsequent assessment of change in areas of habitat across the site with time.

D.2. Confidence Assessment

A MESH confidence assessment was carried out on the Solent Maritime SAC habitat type map to assess the validity and quality of the data shown with the produced map. The assessment quantifies the quality and suitability of the geophysical acoustic data, the ground-truthed samples and the interpretative techniques using a 1-3 scoring system.

A breakdown of the scores given to each section of the MESH confidence assessment is present in Appendix Table 1. The Solent Maritime SAC biotope map scored a 73, giving it a high MESH confidence rating. This high rating was largely attributed to the quality and vintage of both the geophysical acoustic data and ground- truthed samples, however the high value confidence should be treated with caution given the sparsity of ground truth data in some areas.

Additional sample stations and more extensive coverage of the geophysical data would further improve the confidence rating of the produced map.

D.3. Future Recommendations

A number of recommendations which may assist in the future management of the Solent Maritime SAC include:

- The collection of geophysical acoustic data for the majority of the site which is not currently covered by the data held by the CCO.
- The production of site wide topographic layer, to allow for temporal assessment of change in depth across the site.
- The periodic assessment of a number of reference seagrass beds to allow for an assessment of change in distribution of the beds over time, which additionally provides a proxy measurement of environmental condition of the site.
- A structured grab sample monitoring programme (including PSA), with a proportionate geographic spread of sample stations throughout all sections of the site.
- The coordinated completion of holistic, multidisciplinary monitoring surveys at discrete time intervals.

The above suggestions would all assist in the production of robust habitat maps of the SAC and would help to clearly identify the condition of the site's qualifying conservation feature, thus informing the management measures required to meet the conservation objectives of the site.

E. CONCLUSIONS

The overarching objectives of this project were to generate maps of the range and distribution of subtidal sediments, biotopes and sandbanks found within the Solent Maritime SAC and provide a preliminary assessment of the condition of the site and its features.

The following conclusions can be drawn from this report:

- A total of 13 different Folk sediment groups were recorded with the subtidal sediments of the Solent Maritime SAC, with muddy gravels (mG) being the most commonly sampled category, closely followed by sandy mud (sM).

- The largest sediment group identified in terms of area was slightly gravelly sand ((g)S) which itself represents 28.6% of the total area mapped, largely found in the open coast section between Chichester and Langstone Harbours.

- Multivariate analysis run on the benthic grab data collected within the SAC identified a total of 7 distinct multivariate groups, and 6 samples which didn't group with any other samples which were labelled as Outliers.

- A total of 10 habitat types (i.e. biotopes and biotope complexes) were identified within the site, the most common in terms of total area mapped was the biotope complex 'Infralittoral fine sand' (A5.23), which represented 55% of the total area mapped.

- 836.2 Ha of subtidal sandbanks were identified within the SAC as part of this project, in comparison to the 358.7 Ha mapped in 2007.

- The average percentage gravel, sand and silt of the site as a whole gives values of 24.8% gravel, 40.6% sand and 34.5% silt. These values place the site as gravelly muddy sand (gmS) within the folk classification system.

- A total of 2000.9 Ha of subtidal sands and gravels was recorded in the site in 2015, up from 406.5 Ha recorded in 2007, although this was likely to be due to different mapping techniques.

- *Zostera* spp. seagrass beds have been surveyed throughout the site since 2008, the largest total area (subtidal and Intertidal beds) recorded in a single year was 166 Ha in 2013. However, this is largely a reflection of survey effort opposed to increasing distribution of seagrass across the site. The total area of subtidal seagrass beds identified throughout the site to date totals 134.3 Ha.

- The habitat maps created are subject to a number of limitation and caveats largely due to the lack of geophysical acoustic data in the majority of the site, precluding the ability to accurately delineate boundaries between habitats.

- The habitat type map produced scored a 73 using the MESH confidence assessment suggesting a high confidence rating; however the high value confidence should be treated with caution given the sparsity of ground truth data in some areas.

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G. Appendices

Appendix Table 1. – MESH Confidence Assessment

Map	RemoteTechnique	RemoteCoverage	RemotePositioning	RemoteStdsApplied	RemoteVintage	BGTTechnique	PGTTechnique	GTPositioning	GTDensity	GTStdsApplied	GTVintage	GTInterpretation	RemoteInterpretation	DetailLevel	MapAccuracy	Remote score	GT score	Interpretation score	Overall score	Notes
Solent Maritime SAC Habitat Map	3	1	3	3	3	1	3	3	2	3	3	2	2	2	1	86.67	75.00	58.33	**73**	

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