Intertidal sediment surveys of Langstone Harbour SSSI, Ryde Sands and Wootton Creek SSSI and Newtown Harbour SSSI

Final Report

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Peter Thomas, Søren Pears, Dr Marc Hubble, Dr Rafael Pérez-Dominguez

Client:	**Natural England**
Address:	**2nd Floor, Cromwell House** **15 Andover Road** **Winchester** **SO23 7BT**
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Project Director:	**Dr Rafael Pérez-Domínguez**
Project Manager:	**Peter Thomas**
GIS:	**Søren Pears**

APEM Ltd
Riverview
A17 Embankment Business Park
Heaton Mersey
Stockport
SK4 3GN

Tel: 0161 442 8938
Fax: 0161 432 6083

Registered in England No. 2530851

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Executive Summary

APEM was commissioned by Natural England to conduct an intertidal survey of the habitats and their notable communities within the Langstone Harbour Site of Special Scientific Interest (SSSI), Ryde Sands and Wootton Creek SSSI and Newtown Harbour SSSI to provide data to inform condition monitoring assessments. The objective of the survey was to conduct a Phase I survey to determine biotope distribution with 100% coverage of each SSSI and Phase II core sampling to provide quantitative data for biota and particle size distribution at sample stations in the intertidal zone. Survey results were compared against previous assessments to make an assessment of change in condition of the intertidal features/sub-features of the SSSIs.

Within the Langstone Harbour SSSI, eight SSSI units were targeted for quantitative core sampling and a single sampling station was targeted within each transect in each SSSI unit. At Wootton Creek, Units 1-6 were targeted for core sampling, each with one sampling station Within the Ryde Sands SSSI seven units were surveyed with one sampling station in Units 16 and 17 and two sampling stations along single transects for Units 11, 12, 13 and 14. Twenty two transects across 19 SSSI units were selected for sampling to provide representative coverage of the intertidal biotopes within Newtown Harbour SSSI. Ten transects had one mid-shore sampling station whilst the other twelve each had two sampling stations (one on the low shore and one mid-shore). In total 180 cores were acquired for benthic faunal analysis and 60 samples collected for particle size analysis.

For Langstone Harbour SSSI, sampling stations were found to primarily comprise of a high percentage of mud with some sand, although stations L6 and L7 were found to be more gravelly in nature. Sand content was very high at Ryde with very little or no mud/fine sediments. At the stations in Wootton Creek the percentage of mud in sediments was much higher than sand and stations were typically either classed as Gravelly mud, Slightly gravelly mud or Sandy mud. In Newtown Harbour most sampling stations possessed little gravel material with a general trend towards more muddy sediments with some sand.

The gastropod mollusc *Peringia ulvae* was the most abundant species across the samples collected, contributing over 30% of total abundance. Nematode worms and several annelid polychaetes (*Tharyx “*species A”, *Capitella* and *Praxillella affinis*) and the oligochaete *Tubificoides benedii* comprised the majority of the remaining abundance across the survey. Overall, given the varying nature of sediment composition, the intertidal areas within the SSSIs were found to be reasonably diverse, with some impoverished areas. Abundance of individuals was relatively high, but most deriving from a relatively small number of taxa, with the majority of taxa present in low abundance. Benthic invertebrate communities were therefore relatively rich, but not evenly distributed across sampling stations.

No protected or nationally rare taxa were recorded during the survey, although several species of interest were found to be present. Several commercially valuable taxa were also noted, including brown shrimp *Crangon crangon* and cockles *Cerastoderma edule*.

Fifteen different biotopes were identified within the Langstone Harbour SSSI during the Phase I survey, including a number of biotope variants not currently described in the national classification (Connor *et al*., 2004). The predominant biotope across much of Langstone Harbour was A2.312 *Hediste diversicolor* and *Macoma balthica* in littoral sandy mud (LS.LMu.MEst.HedMac), which was found across the north east and western areas of the harbour inclusive of Units 3, 7, 10 and 13. The saltmarsh biotope complex A2.5

(LS.LMp.Sm) was present within the north central area of the harbour with a large area of A2.6111 seagrass beds (*Zostera noltii*) in littoral muddy sand (LS.LMp.LSgr.Znol) in the north west and occasional patches to the south east.

Within Ryde Sands and Wootton Creek SSSI a total of 22 different biotopes (including variants) were denoted. Wootton Creek was predominantly characterised by A2.3223 *Hediste diversicolor* and oligochaetes in littoral mud(LS.LMu.UEst.Hed.Ol). Along Ryde Sands, biotope variation was considerable, with a range of sandier sediments supporting differing benthic invertebrate communities e.g. A2.241 *Macoma balthica* and *Arenicola marina* in muddy sand shores (LS.LSa.MuSa.MacAre). There were also patches of coarse substratum supporting algal species, typically A1.3132 “*Fucus vesiculosus* on mid eulittoral mixed substrata” (LR.LLR.Fves.X) and *Z. noltii* beds were present at Unit 13.

A total of 23 different biotopes were present in Newtown Harbour. The coastline was typically dominated by A2.231 “polychaetes in littoral fine sand” (LS.LSa.FiSa.Po), especially on the lower shore, while a large proportion of the creeks and channels within the harbour consisted of A2.3 littoral mud (LS.LMu) with saltmarsh biotopes dominating the upper shores, especially in the east. There were also several large areas of A2.323 *Tubificoides* and other oligochaetes in littoral mud (LS.LMu.UEst.Tben) within the centre of the SSSI. Other soft and hard sediment biotopes were found in patches, with increased macroalgae in some of the south western SSSI units.

During the field survey of Langstone Harbour the presence of the invasive, non-native species (INNS) *Austrominius modestus* (Australasian barnacle) was recorded in SSSI Units 3, 6, 7 and 10 with the INNS American slipper limpet (*Crepidula fornicata*) in Unit 3. *A. modestus* was also observed in the field at SSSI Units 1 and 75 at Newtown Harbour.

Significant anthropogenic disturbance was noted throughout units along the eastern side of Langstone Harbour SSSI, in the form of bait digging. A range of recreational activities such as use of personal water craft were present across all SSSIs. There was significant public use of the intertidal zone at Ryde Sands in Units 13 to 17 which are key tourist beaches.

Comparison of historical data (ERT, 2006; CMACS, 2012) and the current findings within Langstone Harbour indicated that the composition of much of the harbour has remained similar although variation in environmental conditions and natural change over time has resulted in some changes at finer scales with shifts in some community assemblages. The faunal data indicated that the same dominant taxa found previously were again prevalent during in the current survey. The majority of the harbour continues to consist of fine sediment supporting a variety of polychaete assemblages. Saltmarsh and *Z. noltii* biotopes were recorded during the 2012 (CMACS, 2012) and current surveys. No previous historical data was available for Ryde Sands and Wootton Creek SSSI. Historical data was also limited for Newtown Harbour SSSI, with only two locations sampled in 2006 and 2012 (ERT, 2006; CMACS, 2012). A broad comparison found that sediments and faunal communities appear to have remained broadly similar, although some variation has occurred over time.

The overall condition assessment found that the condition of the SSSIs has remained similar to that recorded in previous surveys; however, confidence in the assessment is limited due to a lack of suitable historic data. Consequently, the current assessment enables a broad indication of condition based on previous data currently available, but going forward it provides more detailed quantitative baseline data and biotope mapping outputs for each SSSI for future condition assessments.

1. Introduction

1.1 Background

APEM was commissioned by Natural England to conduct an intertidal survey of the habitats and their notable communities within the Langstone Harbour Site of Special Scientific Interest (SSSI), Ryde Sands and Wootton Creek SSSI and Newtown Harbour SSSI.

Langstone Harbour SSSI, Ryde Sands and Wootton Creek SSSI and Newtown Creek SSSI are designated as SSSIs under Section 28 of the Wildlife and Countryside Act 1981. All three sites are also classified as Special Protection Areas (SPAs) under Article 4.2 of the EU Directive (79/409/EEC) for supporting populations of European importance of migratory bird species, and as Ramsar sites designated under the Convention on Wetlands of International Importance (Ramsar Convention). Langstone Harbour and Newtown Harbour are also part of the Solent Maritime Special Area of Conservation (SAC) designated under the Habitats Directive (92/43/EEC).

Condition assessments of SSSIs are conducted on a six yearly cycle and this survey was part of a monitoring programme to provide data to assess the intertidal mudflats and sandflats SSSI feature/sub-features and associated attributes to inform assessment. Historic data sets were considered to determine any changes in feature attributes against conservation objectives for the surveyed sites.

This interpretative report outlines the survey methods used, areas surveyed and data obtained. The report highlights notable species/habitats recorded and anthropogenic pressures observed, and provides an initial indication of whether conservation targets for feature attributes have been met.

1.2 Survey area

The location of the three SSSIs is indicated in Figure 1.

1.2.1 Langstone Harbour SSSI

Langstone Harbour is a tidal basin which at high water resembles an almost landlocked lake (Natural England, 1985). At low water, extensive mud flats are exposed, drained by three main channels which unite to make a common and narrow exit to the sea. Langstone Harbour is the middle of three extensive and connected tidal basins (Portsmouth, Langstone and Chichester Harbours). At the time of SSSI notification, the harbour included one of the largest areas of mixed saltmarsh on the south coast, extensive cord-grass *Spartina anglica* marsh, and extensive beds of eelgrass *Zostera* species. The intertidal beds of common eelgrass *Zostera marina* and the nationally scarce dwarf eelgrass *Zostera noltii* are among the largest in Britain (Natural England, 1985).

1.2.2 Ryde Sands and Wootton Creek SSSI

The Ryde Sands and Wootton Creek SSSI extends some ten kilometres along the sheltered north-eastern shore of the Isle of Wight (NE, 1995b). At low water a particularly wide range of intertidal sediments are exposed over this stretch of coastline, grading from the fine estuarine muds of Wootton Creek, through cobbles and boulders at Pelhamfield to the extensive sand flats at Ryde which reach a maximum width of almost two kilometres.

The intertidal area is an important component of the Solent estuarine system which supports internationally important over-wintering populations of wildfowl and waders, and important breeding populations of waders, gulls and terns. Ryde Sands also supports extensive beds of eelgrass. Beds of *Z. noltii* and *Z. marina* extend to approximately 20 hectares in area on the upper shore of Ryde East Sands, and *Z. marina* is additionally found at low water. The eelgrass beds are an important intertidal food resource for Brent Geese and contribute greatly to the diversity of the sandflats by trapping and accumulating sediment, thus modifying the intertidal profile. Within the beds, high densities of amphipods and polychaete worms are found, and the sand mason *Lanice conchilega* is found in high abundances associated with eelgrass roots (Natural England, 1995b).

1.2.3 Newtown Harbour SSSI

Newtown Harbour includes extensive areas of estuarine mudflats and saltmarsh that form a dendritic pattern of tidal creeks which make up the estuary (NE, 1995a). Surrounding and sloping down to the estuary are extensive areas of unimproved grassland, woodland and scrub, interspersed with ponds and hedgerows. The harbour mouth and adjacent open coast consists of rapidly eroding vegetated cliffs, sand and shingle spits, beaches and large areas of intertidal mud, sand, and shingle which are important geomorphological features. The intertidal areas are largely un-vegetated although beds of eelgrass, including *Z. noltii*, occur locally. The mudflats support a rich invertebrate fauna which provides a food resource for the internationally important estuarine bird populations (NE, 1995a).

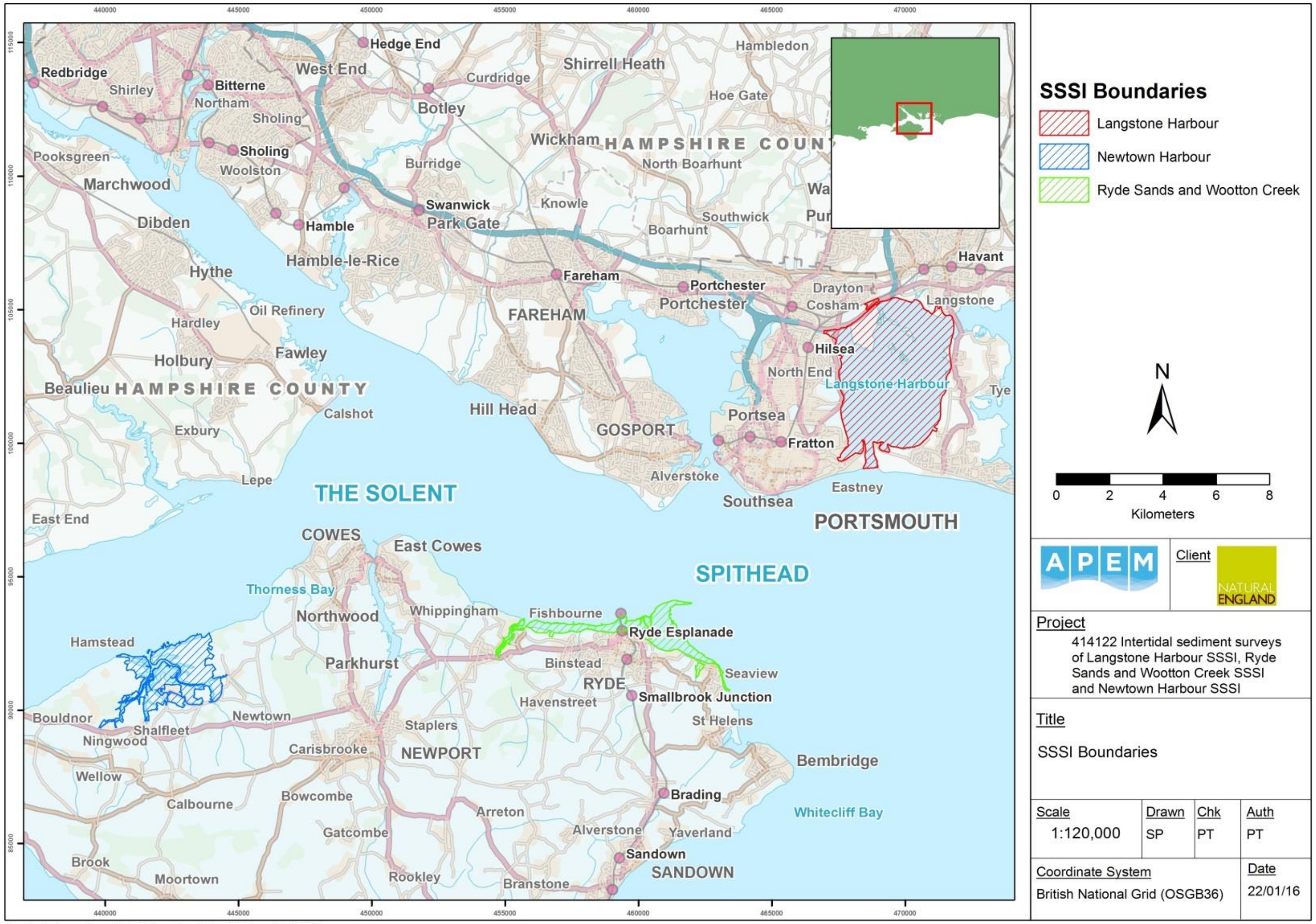


Figure 1: Locations of Langstone Harbour, Ryde Sands and Wootton Creek and Newtown Harbour SSSIs on the south coast of England.

1.3 Objectives

The objective of the current survey was to conduct Phase I survey to determine biotope distribution with 100% coverage of each SSSI, and quantitative core sampling (Phase II survey) to provide data for biota and particle size distribution at discrete sample stations in the intertidal zone.

Specific aims were to:

- Map the main sediment types and their associated communities (biotopes) within Langstone Harbour SSSI, Ryde Sands and Wootton Creek SSSI and Newtown Harbour SSSI;
- Acquire standardised samples for infaunal and PSA analysis across all intertidal SSSI units; and
- Record any observed anthropogenic influences potentially affecting features within SSSI units.
- Undertake an initial condition assessment for each SSSI.

2. Methods

2.1 Survey design and sampling strategy

The survey strategy incorporated intertidal Phase I walkover (Wyn & Brazier, 2001) and quantitative coring (Phase II survey) (Davies *et al.,* 2001). The Phase I biotope allocation approach provided a broad characterisation of the communities present within the SSSIs and enabled the production of biotope maps for each of the SSSI units. The Phase II methods provided quantitative species composition and abundance data for specific sample stations which were suitable for the application of robust statistical analyses.

Due to the extensive areas of soft mud/sand a hovercraft was utilised within the Ryde Sands and Wootton Creek SSSI and Langstone SSSI to increase efficiency of sampling and minimise potential health and safety risks associated with working on soft sediments. Within Newtown Creek SSSI a shallow draft boat with outboard motor was used due to permission constraints for hovercraft operation.

2.1.1 Sampling stations

Sampling stations were targeted based on effective coverage of SSSI units, availability of previous survey data, site access, and biological and environmental conditions.

In each SSSI the whole of the site was covered by the Phase I biotope survey, with coring at the sample stations. All sampling station locations were agreed in consultation with the Natural England project lead. The agreed survey strategy incorporated some transects with two coring stations (mid and lower shore), with others having one coring station (mid-shore). Shore height was based on mean sea level (MSL) for the mid shore and the position of the water edge (+/- 2 hours form the predicted low water) for the lower shore. Details of the sampling design at each SSSI are provided in Table 1.

Within the Langstone Harbour SSSI, eight of the fourteen SSSI units were targeted for core sampling (all of the units with intertidal sediments were sampled). A single station was sampled within each transect in each SSSI unit. The current project aimed to build on data acquired during a previous survey of Langstone Harbour by the Environment Agency (EA, 2014) and therefore sampling effort was reduced in Langstone Harbour compared to the other two SSSIs. Unit 7 was inaccessible via hovercraft due to the presence of an oyster bed (Figure 2) and was surveyed by foot.

At Ryde Sands and Wootton Creek SSSI, sampling within the Wootton Creek area targeted all six units (1-6) for core sampling, each with one sampling station (Figure 3). The target station for Unit 4 was relocated further south as access permissions were not provided by the landowners for the three more northerly sections of the unit. Across the remaining SSSI units, which could broadly be referred to as Ryde Sands, Units 16 and 17 each featured a single sampling station whilst two sampling stations along single transects were targeted for Units 11, 12, 13 and 14 (Figure 4).

Within Newton Harbour SSSI a total of twenty two transects across nineteen SSSI Units were selected for sampling. Ten transects had one mid-shore sampling station whilst the other twelve each had two (one on the low shore and one mid-shore) (Figure 5).

Table 1: Target core sampling stations and sampling effort at each SSSI

Site	SSSI Units With One Station	Number of Transects With One Station	SSSI Units With Two Stations	Number of Transects With Two Stations	Total Infauna Samples	Total PSA Samples
Langstone Harbour	3, 6, 7, 9, 10, 11, 13, 14	8	None	None	24	8
Ryde Sands to Wootton Creek	1, 2, 3, 4, 5, 6, 16, 17	8	7, 11, 12, 13, 14	5	54	18
Newtown Harbour	13, 17, 19, 29, 32, 33, 40, 66, 80	10	1, 8, 24, 25, 41, 47, 57, 59, 66, 67, 75	12	102	34

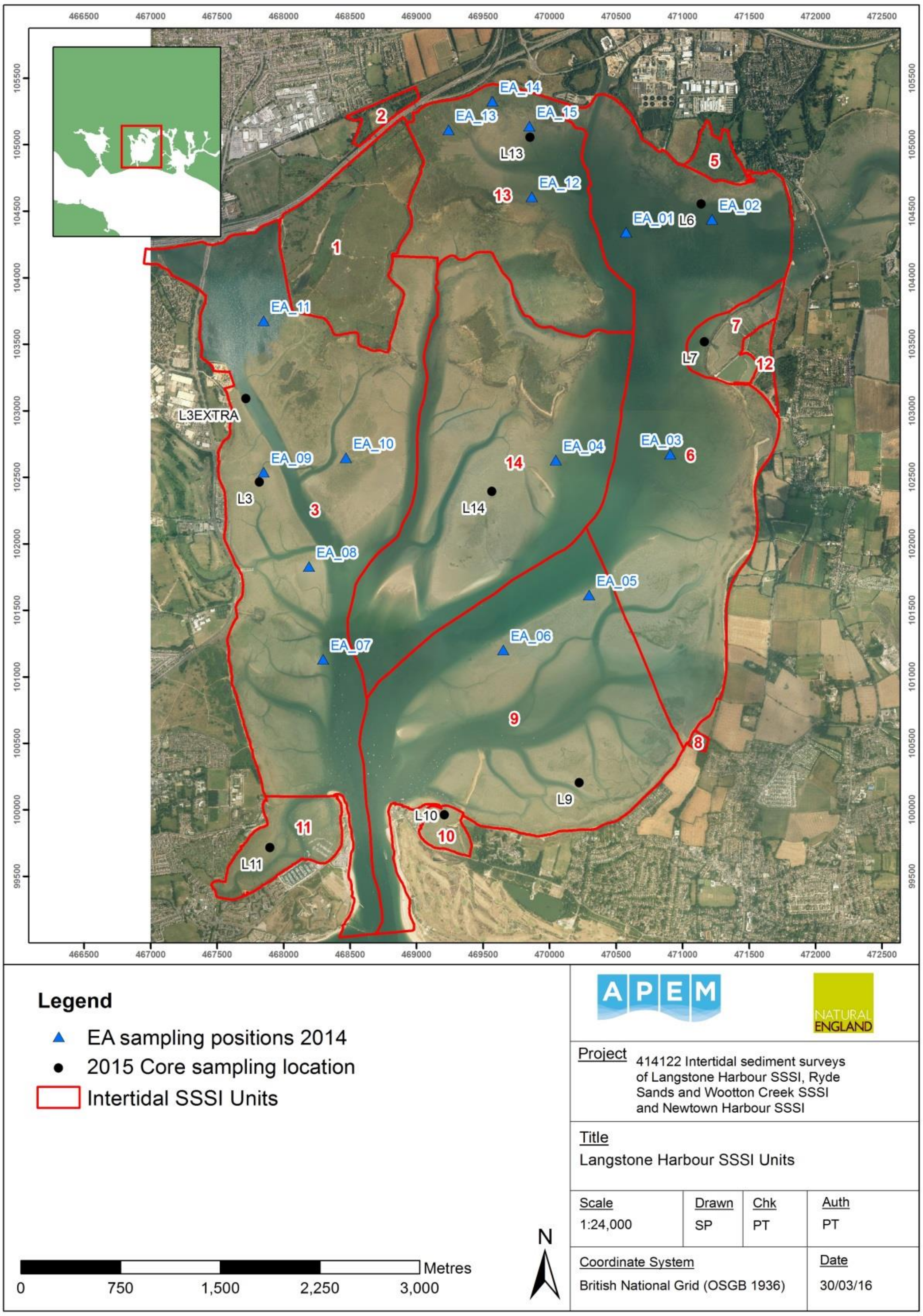


Figure 2: Langstone Harbour SSSI 2014 and 2015 sampling stations and SSSI units.

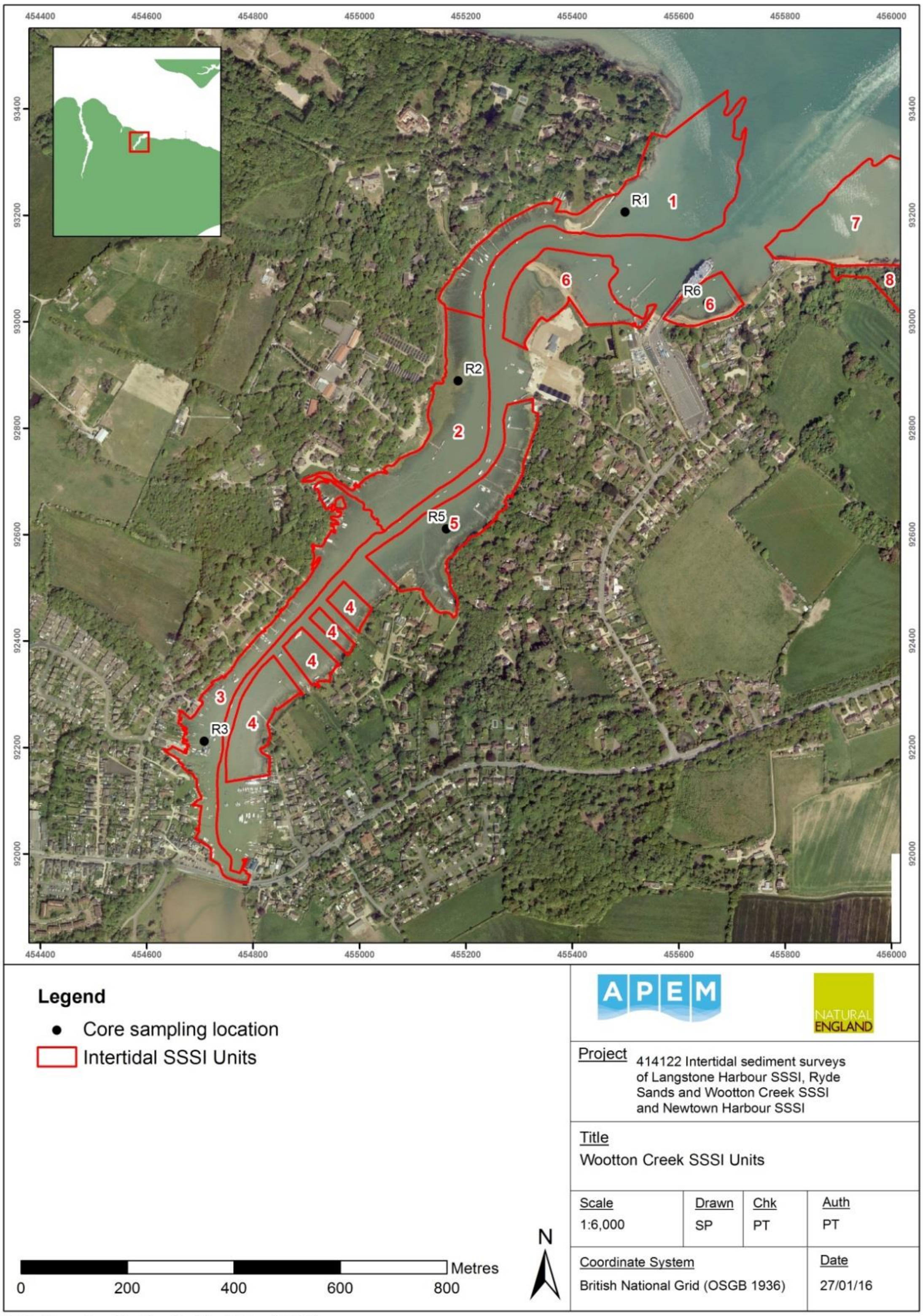


Figure 3: Wootton Creek 2015 sampling stations and SSSI units.

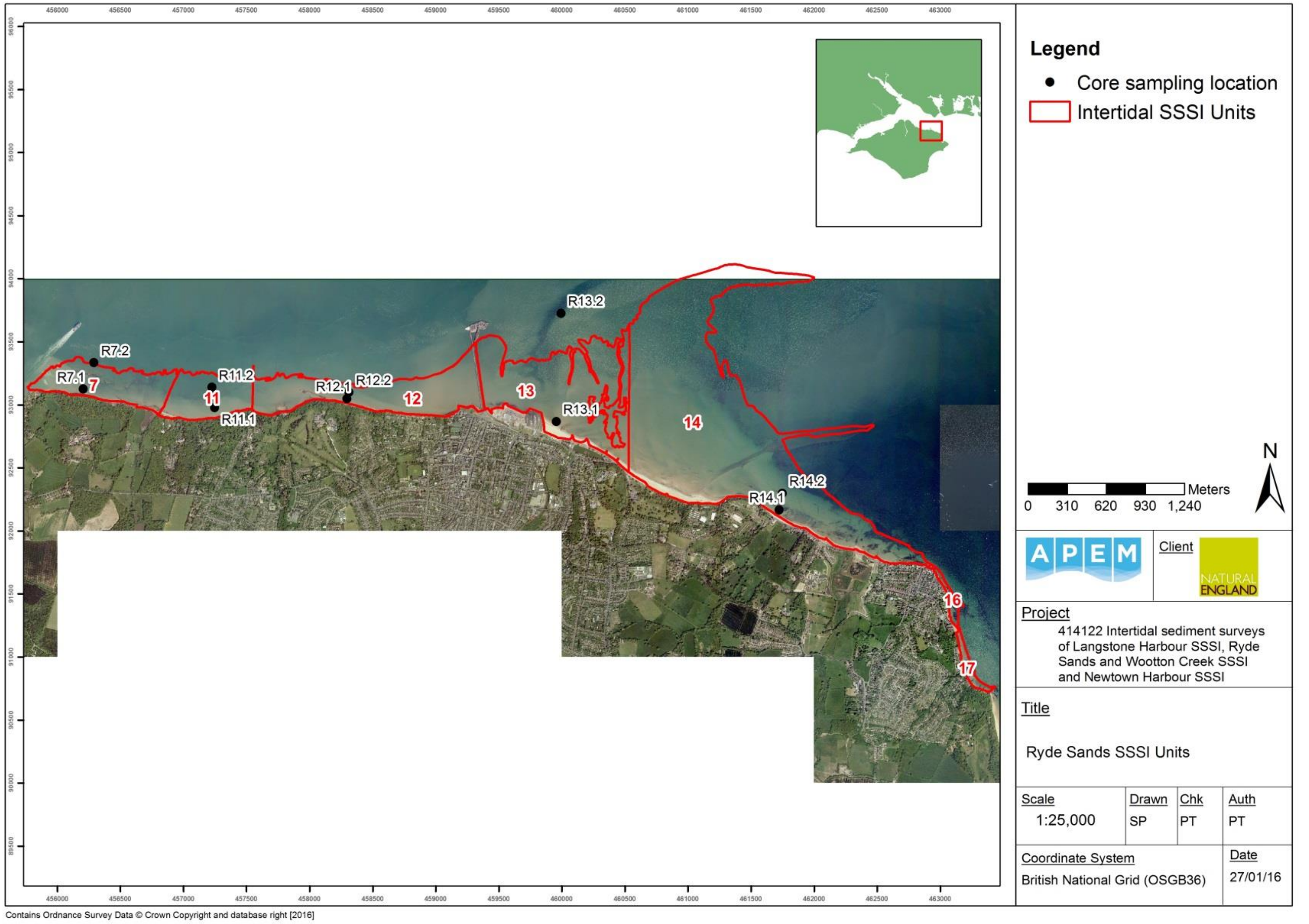


Figure 4: Ryde Sands 2015 sampling stations and SSSI units (Wootton Creek to the west).

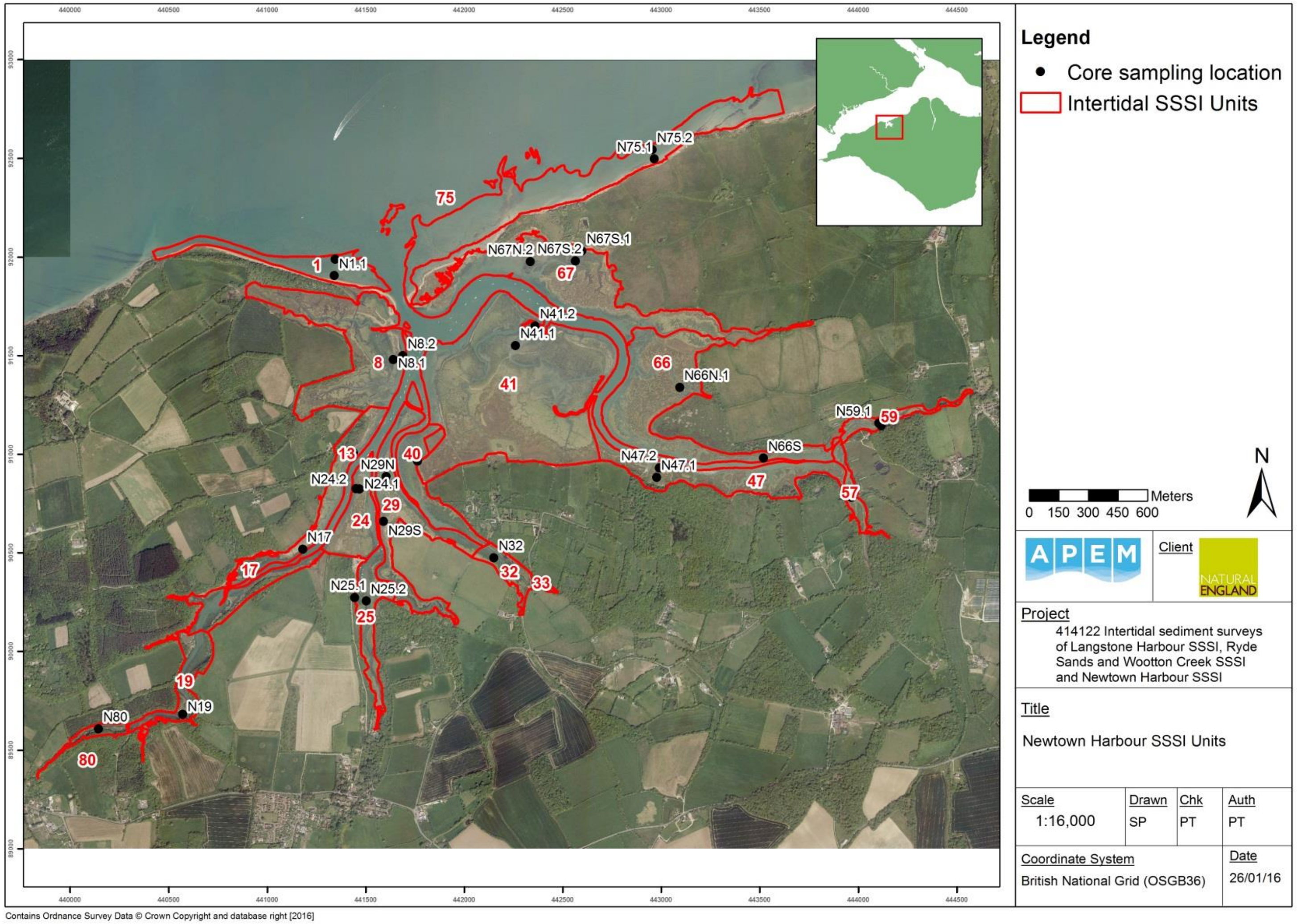


Figure 5: Newtown Harbour SSSI 2015 sampling stations and SSSI units.

2.1.2 Phase I survey design

The Phase I survey recorded the range and extent of biotopes present in intertidal areas by assigning biotopes *in situ* according to the CCW Handbook for Marine Intertidal Phase I mapping surveys, Marine Monitoring Handbook (Wyn & Brazier, 2001), CSM (Connor *et al.,* 2004) guidance and JNCC biotope allocation guidance (JNCC, 2010).

Aerial imagery, provided by Natural England, was used to produce preliminary wire-frame maps of the distribution of broad scale habitats in preparation for Phase I mapping (Wyn *et al.,* 2006). They also helped to identify appropriate sampling points and help consider access locations across the sites for the field team to use.

During the Phase I survey a series of ad-hoc sampling stations were selected covering each biotope and sediment type encountered and coordinates were recorded using a hand held differential GPS device. At each of these stations a 0.01 m^2 core was taken by hand to a depth of 15 cm, sieved through a 0.5 mm sieve and examined *in situ,* with any conspicuous species identified and recorded. The Phase I survey was used to determine the type and extent of biotopes present, and validate the selection of coring station locations for more detailed investigation.

Throughout the Phase I survey, descriptions of the habitats were recorded on JNCC Marine Nature Conservation Review (MNCR) forms. The information recorded incorporated general site conditions, including sediment type and topography. Sediment descriptions included:

- Sediment description – e.g. well sorted medium sand, muddy very fine sand, gravelly medium sand etc.);
- Sediment softness, scale 1 – 5, (1 = very hard, 5 = soft to ankle depth or more);
- Depth of redox layer;
- Interstitial salinity measured using a multi-parameter probe;
- Obvious fauna (e.g. *Arenicola marina* casts (number per unit area with 1 m^2 area explored where sparse or 0.25 m^2 area where dense); *Lanice* tubes (number per unit area, as per *A. marina*); *Scrobicularia plana* marks (number per unit area, as per above for *A. marina*));
- Any other conspicuous species e.g. macroalgal species such as *Ulva* sp. were to be recorded with estimates of abundance/cover (recorded separately from core-sample data) as are any other notable features.

The presence of any invasive and non-native species, particularly *Austrominius modestus* (Australasian barnacle), *Crassostrea gigas* (Pacific oyster), *Crepidula fornicata* (slipper limpet), and *Corella eumyota* (orange tipped sea-squirt), *Styela clava* (leathery sea squirt), *Ficopomatus enigmaticus* (trumpet tube worm) and *Didemnum vexillum* (carpet sea squirt), were recorded if present. Specific notes were made in relation to any potential anthropogenic pressure occurring at a given site at the time of sampling which could potentially influence intertidal ecology (e.g. pipelines, point source pollution, bait diggers) including their locations (marked with GPS where possible), the nature of the pressure, and whether it appeared to be continuous or intermittent.

2.1.3 Quantitative coring (Phase II) survey

Quantitative samples (for infauna and particle size analysis) were collected using a 0.01 m^2 hand held corer inserted into the sediment to a depth of 15 cm (Dalkin & Barnett, 2001). Three replicate cores were taken at each station for biological analysis and a further core collected for particle size analysis (PSA).

Following CSM guidance and the methods outlined in the Marine Monitoring Handbook (Davies *et al.,* 2001) all faunal samples were sieved through a BS410 standard 0.5 mm mesh sieve and subsequently fixed in 4-10% formaldehyde (with a borax buffer added). Samples were preserved at the end of each survey day.

Additionally, sediment characteristics, surface features and other notable species and features were recorded as indicated above for the Phase I survey.

2.2 Sampling site access and survey periods

The field work was conducted between 28th August and 2nd September 2015 during spring tides in order to optimise the length of time available for each survey and to ensure the lower reaches of the shores could be sampled. The lower shore was visited two hours either side of the predicted low water.

Access permissions from land owners for areas surveyed by hovercraft were primarily acquired by Natural England. This included site access within all units of the Langstone Harbour SSSI and Ryde Sands and Wootton Creek SSSI. All access permissions were granted for the duration of the survey with the exception of three locations within the Ryde Sands and Wootton Creek SSSI Unit 4 (in Wootton Creek) for which permission was not provided by the local landowners.

Permission was given by the National Trust and Newtown Harbourmaster to use their shallow draft boat for assisting with survey work within the Newtown Harbour SSSI. Permission was granted for use of a hovercraft within Langstone Harbour by the Harbour Authority and also by the Queen’s Harbourmaster for use of hovercraft and Ryde Sands and Wootton Creek SSSI.

2.3 Photographic evidence

Digital photographs were taken of each core sample to allow quality assurance of the data recorded. General photographs of the areas surveyed were also taken, which included views from each station towards the land and sea and further photos were taken at some stations including species and features of interest. Additional photographs were taken of specific taxa where required to inform identification.

2.4 Data compilation and biotope visualisation

On completion of the surveys, raw data were transferred to electronic spreadsheets and checked for errors and consistency. Potential errors such as transcription errors were cross-referenced with field notes and corrected. The wireframe maps were utilised to create detailed biotope mapping outputs (Appendix 1) and further refined following transcription of data from the field notes to electronic format (Appendices 2 and 3). All data were quality assured by a senior taxonomist.

Biotopes were assigned by experienced marine taxonomists according to EUNIS classification. Additionally to assist with interpretation APEM also provided classifications based on the JNCC's National Marine Habitat Classification for Britain and Ireland: Version 04.05 (Connor *et al.,* 2004). Both classifications utilised species information, relative abundances, exposure of the shore and substrate type to allocate biotopes. Biotopes were assigned based on field-based assessments during the Phase I survey and were further refined, as appropriate, utilising the data collected at the core sampling stations. The allocations were cross-validated by a second taxonomist for quality assurance (QA) purposes and once verified final biotope polygon layers were added to the original maps.

Biotope mapping of seagrass beds also took into consideration seagrass survey data held by the Hampshire and Isle of Wight Wildlife Trust (Marsden & Scott, 2015). Data were available for both Langstone Harbour SSSI and Ryde Sands and Wootton Creek SSSI, but no data were available for Newtown Harbour SSSI. Data provided on the extent and composition of the seagrass beds covered the period 2006 to 2014 and as such some change was anticipated due to natural variability over an almost 10 year period.

The drafting of all boundaries was informed by field notes and high resolution aerial imagery. A senior GIS operator provided QA of the final biotope maps.

All GIS outputs were generated in ArcGIS v9.2 and metadata were produced in accordance with MEDIN standards in the MESH Data Exchange Format.

2.5 Laboratory analysis

2.5.1 Macrobiota

Faunal samples were analysed at APEM's Marine Biolabs. To standardise the sizes of organisms recorded, and to separate preservative from the biota, all samples were washed over a 0.5 mm sieve in a fume cupboard. All biota retained in the sieve were then extracted, identified and enumerated, where applicable.

Taxa were identified to the lowest possible practicable taxonomic level using the appropriate taxonomic literature. For certain taxonomic groups (e.g. nemerteans, nematodes, and certain oligochaetes), higher taxonomic levels were used due to the widely acknowledged lack of appropriate identification tools for these groups. The National Marine Biological Analytical Quality Control (NMBAQC) Scheme has produced a Taxonomic Discrimination Protocol (TDP) (Worsfold & Hall 2010) which gives guidance on the most appropriate level to which different marine taxa should be identified, and this guidance was adhered to for the laboratory analysis. Where required, specimens were also compared with material maintained within the laboratory reference collection. Nomenclature followed the World Register of Marine Species (WoRMS), except where more recent revisions were known to supersede WoRMS.

All samples were subject to internal quality assurance procedures and, following analysis, were subject to formal Analytical Quality Control (AQC).

2.5.2 Particle Size Analysis

Sub-sampling and PSA was performed in accordance with NMBAQC Best Practice Guidance (Mason, 2011), with the modification that the wet separation was performed at 2 mm rather than 1 mm, to determine the 'gravel' to 'sand and mud' proportions by weight. A combination of dry sieving and laser diffraction was used depending upon the characteristics of the sediment.

Microsoft Excel 2010 was used for general data formatting and exploration. PRIMER v6 (Clarke & Gorley, 2006) was used for the multivariate statistical analyses.

2.5.3 Truncation and data consolidation

Truncation of the macrobiota data were undertaken before calculation of univariate and multivariate statistics. Juveniles were combined with adults of the same recorded taxon name for calculation of numbers of taxa and epitokes were also combined for the same taxon name. For analyses based on numbers of individuals, non-countable taxa and fragments of individuals were omitted.

Examination of the data supplied by the EA from 2014 required additional truncation to allow comparability with the 2015 data, due to the division of records of some species between several higher taxa and records of species that were atypical of the habitats sampled. The anomalies could have affected the summary statistics. These edits have been made for this report and the data truncated to allow comparability.The edits included the update of taxonomic names across the entire data set and revision of counts for the audited sample.

2.5.4 Univariate analysis

Univariate community analyses were undertaken using the PRIMER (version 6) software package. Biological diversity within a community was assessed based on taxon richness (total number of taxa present) and evenness (considers relative abundances of different taxa). The following metrics were calculated:

- **Shannon-Wiener Diversity Index (*H'*(log$_e$):** This is a widely used measure of diversity accounting for both the number of taxa present and the evenness of distribution of the taxa (Clarke & Warwick 2006).

- **Margalef's species richness (*d*):** This is a measure of the number of species present for a given number of individuals.

- **Pielou's Evenness Index (*J'*):** This represents the uniformity in distribution of individuals spread between species in a sample. High values indicate more evenness or more uniform distribution of individuals. The output range is from 0 to 1.

- **Simpson's Dominance Index (1-λ):** This is a dominance index derived from the probability of picking two individuals from a community at random that are from the same species. Simpson's dominance index ranges from 0 to 1 with lower values representing a more diverse community without dominant taxa.

Where mean values have been calculated per station, the standard deviation has been provided.

2.5.5 Multivariate analysis

Macrofaunal data were subjected to multivariate analysis using the PRIMER (version 6) software package (Clarke & Warwick 2006). Multivariate analyses were computed from resemblance or similarity matrices. The particle size data resemblance matrix was calculated using Euclidean Distance following normalisation. For the macrofaunal data set, the Bray-Curtis measure of similarity was used following a square root transformation of the data to reduce the influence of highly abundant or dominant species.

Cluster Analysis

Agglomerative hierarchical clustering (CLUSTER) analysis was utilised to provide a visual representation of sample similarity in the form of a dendrogram. CLUSTER analysis was conducted in conjunction with a SIMPROF (similarity profile) test to determine whether groups of samples were statistically indistinguishable at the 5% significance level, or whether any trends in groupings were apparent. Black lines on the dendrogram indicate statistical distinctions between sampling stations, whilst red lines indicate that the samples were statistically inseparable.

To facilitate interpretation of the data the CLUSTER analysis was run using mean values per station. Analysis was first run on station data for the entire survey comprising results from Langstone Harbour, Ryde Sands and Wootton Creek and Newtown Harbour. Following this a more detailed assessment was undertaken for the data specific to each SSSI.

Non-Metric Multidimensional Scaling

Non-metric multidimensional scaling (MDS) is a type of ordination method which creates a 2- or 3-dimensional 'map' or plot of the samples from a resemblance matrix. The plot generated is a representation of the dissimilarity of the samples (or replicates), with distances between the replicates indicating the extent of the dissimilarity. For example, replicates that are more dissimilar are further apart on the MDS plot. No axes are present on the MDS plots as the scales and orientations of the plots are arbitrary in nature.

Each MDS plot provides a stress value which is a broad scale indication of the usefulness of plots, with a general guide indicated below (Clarke & Warwick, 2006):

<0.05	Almost perfect representation of rank similarities;
0.05 to <0.1	Good representation;
0.1 to <0.2	Useful representation;
0.2 to <0.3	Caution should be exercised;
>0.3	Random distribution of points.

SIMPER

Where differences between groups of samples were found, SIMPER analysis (in Primer v6) was used to determine which taxa were principally responsible for differences between the statistically distinct groups of stations and describe assemblages to support biotope allocations.

2.6 Particle size analysis

The particle size data from all survey replicates were combined as consistent size fractions and entered into GRADISTAT (Blott & Pye 2001) to produce sediment classifications, following Folk (1954) (Figure 6). Summary statistics were also calculated including mean particle size and sorting. The full raw data set is presented in Appendix 2.

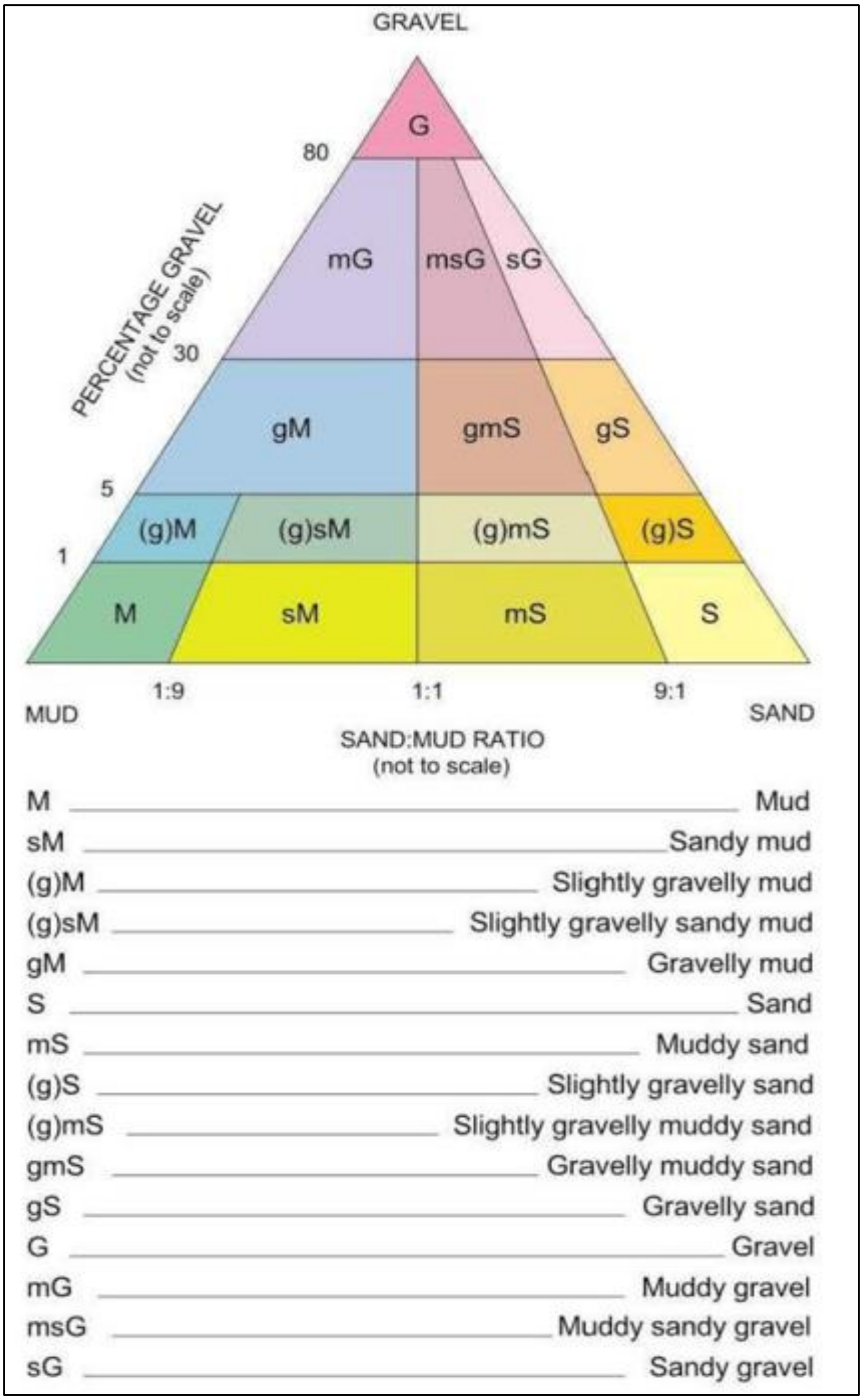


Figure 6: Folk sediment classification pyramid (Folk, 1954).

3. Results

3.1 Phase I survey

Mapping outputs visually representing the coverage and types of biotopes recorded during the Phase I survey are presented in Appendix 1.

3.1.1 Langstone Harbour

Fifteen different biotopes were identified within the Langstone Harbour SSSI during the Phase I survey, including a number of biotopes not currently described in the national classification (Connor *et al*., 2004). These biotopes including relevant codes, descriptions and extent are presented in Table 2, and biotope maps are in Appendix 1 (Figures A1.1 to A1.5). Example images acquired from the survey within the SSSI are provided in Figure 7a-f.

The predominant biotope across much of Langstone Harbour was A2.312 "*Hediste diversicolor* and *Macoma balthica* in littoral sandy mud" (LS.LMu.MEst.HedMac), which was found across the north east and western areas of the harbour inclusive of Units 3, 7, 10 and 13 (Figure 7b. Figures A1.1-A1.5). Within the centre of the harbour at Unit 14 and on the lower reaches of Unit 9 there was a significant area of A2.31 "polychaete/bivalve dominated mid estuarine mud shores", although all the described biotopes for this complex include *H. diversicolor* or *Nephtys hombergii*, *M. balthica* and *Streblospio. shrubsolii* and these were completely missing from the recorded biotope (LS.LMu.MEst variant) (Connor *et al.,* 2004) (Figure A1.4).

There were some sizeable areas of A2.5 "saltmarsh" biotope (LS.LMp.Sm) present within the northern central area of the harbour (Units 13 and 14 - Figure 7f, Figure A1.1-A1.4) with a large area of A2.6111 *Zostera noltii* beds in littoral muddy sand in the north west (Unit 3) and occasional patches to the south east near Unit 9 (LS.LMp.LSgr.Znol). Within Unit 9 and beyond there was a significant area of a variant biotope of A2.311 "*Nephtys hombergii, Macoma balthica* and *Streblospio shrubsolii* in littoral sandy mud" which contained low abundance of *Streblospio* and no *Macoma* compared to the national biotope description (LS.LMu.MEst.NhomMacStr variant, Connor *et al.* 2004) (Figures A1.1-A1.4).

At Unit 7 the biotope composition changed notably from A2.312 (LS.LMu.MEst.HedMac) at the boundary with Unit 6 to A1.3132 "patchy *Fucus vesiculosus* on muddy mixed sediment" (LR.LLR.F.Fves.X) and then into A2.3 "Littoral mud" (LS.LMu) at the very top of the shore (Figure 7c, Figures A1.1-A1.2). The upper shore of Unit 6 also showed marked variation from A2.312 (LS.LMu.MEst.HedMac), which transitioned into a variant of A2.421 "cirratulids and *Cerastoderma edule* in littoral mixed sediment", with this variant containing no *Cerastoderma* and a different faunal assemblage to the nationally described biotope (Connor *et al.,* 2004) (Figure A1.2 and A1.4). Unit 11 in the south west of the harbour contained a mixed sediment composition, although the faunal assemblage did not match any existing biotope description and was therefore classed as an A2.4 (LS.LMx) variant (Figure 7e, Figure A1.5). Moving north from Unit 11 to Unit 3 the lower shore mainly consisted of A2.821 "ephemeral green and red seaweeds on variable salinity and/or disturbed eulittoral mixed substrata" (LR.FLR.Eph.EphX) whilst the upper shore remained A2.312 (Figure 7a, Figures A1.3 and A1.5) as previously described above.

Table 2: Langstone Harbour SSSI 2015 biotope composition

EUNIS Code	Biotope Name	Biotope Code	Area (Ha)
A2.312	*H. diversicolor* and *M. balthica* in littoral sandy mud	LS.LMu.MEst.HedMac	373.08
A2.31#	Polychaete/bivalve dominated mid estuarine mud shores. All described biotopes for this complex includes *H. diversicolor* or *Nephtys hombergii*, *M. balthica* and *S. shrubsolii*. These are completely missing from the recorded biotope which is therefore undescribed	LS.LMu.MEst (variant)	266.63
A2.311#	*Nephtys hombergii, Macoma balthica* and *Streblospio shrubsolii* in littoral sandy mud. Variant with low abundance of *Streblospio* and no *Macoma*	LS.LMu.MEst.NhomMac Str (variant)	145.8
A2.6111	*Zostera noltii* beds in littoral muddy sand	LS.LMp.LSgr.Znol	102.76
A2.5	Saltmarsh	LS.LMp.Sm	74.32
A2.421	Cirratulids and *C. edule* in littoral mixed sediment. Variant with no *Cerastoderma* and different faunal assemblage to described type	LS.LMx.Mx.CirCer (variant)	63.31
A2.3	Littoral mud	LS.LMu	47.06
A2.821	Ephemeral green and red seaweeds on variable salinity and/or disturbed eulittoral mixed substrata	LR.FLR.Eph.EphX	45.14
A1.3132	*Fucus vesiculosus* on mid eulittoral mixed substrata	LR.LLR.F.Fves.X	39.47
A2.4#	Mixed sediment variant. The only described biotopes in LS.LMx are LS.LMx.GvMu (with *Hediste diversicolor*) or LS.LMx.Mx (with Cirratulidae and *Cerastoderma edule*). None of the communities belonging to the above selection match entirely the fauna assemblage but the physical characteristics are comparable.	LS.LMx (variant)	17.14
A2.321	*Nephtys hombergii* and *Streblospio shrubsolii* in littoral mud	LS.LMu.UEst.NhomStr	16.97
A2.111	Barren littoral shingle	LS.LCS.Sh. BarSh	9
A1.3142	*Ascophyllum nodosum* on full salinity mid eulittoral mixed substrata	LR.LLR.F.Asc.X	1.35
A5.432	*Sabella pavonina* with sponges and anemones on infralittoral mixed sediment. Exposed subtidal feature due to low spring tide *S. pavonina*	SS.SMx.IMx.SpavSpAn	0.68
A2.431	Barnacles and *Littorina* spp. on unstable eulittoral mixed substrata	LR.FLR.Eph.BLitX	0.66

a) Unit 3 view north west (A2.821)

b) Unit 3 view east (A2.312)

c) Unit 6 view south east (A2.312)

d) Unit 7 view north (A1.3132 and A2.3)

e) Unit 11 view south west (A2.3 variant)

f) Unit 14 south (A2.5)

Figure 7: Langstone Harbour SSSI 2015 example field images

3.1.2 Ryde Sands and Wootton Creek

Within the survey area 22 different biotopes were recorded (Table 3) and biotope maps are in Appendix 1 (Figures A1.6 to A1.10). Example images are presented in Figure 8a-f.

Within Wootton Creek there was little variation in biotopes with almost all units comprising entirely of A2.3223 "*H. diversicolor* and oligochaetes in littoral mud" (LS.LMu.UEst.Hed.Ol) (Figures A1.6-A1.7). The primary exception was in Unit 1 which was instead comprised of a mixed/disturbed substratum variant of A2.4/A2.821 "ephemeral green and red seaweeds on variable salinity and/or disturbed eulittoral mixed substrata" (LS.LMx/LR.FLR.Eph.EphX variant). Unit 6 was found to consist mainly of a variant biotope of A2.31 "polychaete/bivalve dominated mid estuarine mud shores." (LS.LMu.MEst variant). Small patches of A2.111 "barren littoral shingle" (LS.LCS.Sh.BarSh) were also noted in Units 1 and 6 near the mouth of Wootton Creek.

At Unit 7 the biotope composition changed, with large areas of A2.431 "barnacles and *Littorina* spp. on unstable eulittoral mixed substrata" (LR.FLR.EphBLitX), A1.15 variant "fucoids in tide-swept conditions" (LR.HLR.Ft variant) and A2.821 (LR.FLR.Eph.EphX) (Figure 8b, Figure A1.7). A further transition occurred between Units 7 and 11 with the presence of an A2 variant "littoral sediment" (LS) of clay with piddocks on the lower shore and clay along the mid-shore. A2.431 dominated the upper reaches of the beaches here. At Unit 12 A5.52 "Kelp and seaweed communities on sublittoral sediment" (SS.SMp.KSwSS) comprised the lower reaches of the intertidal area, whilst A2.821 "ephemeral green and red seaweeds on variable salinity and/or disturbed eulittoral mixed substrata" (LR.FLR.Eph.EphX) were found across the upper reaches. Throughout Units 7, 12 and 13 scattered patches of A1.3132 "*F. vesiculosus* on mid eulittoral mixed substrata" (LR.LLR.F.Fves.X) were found in the mid to upper intertidal zone.

From Unit 12 to Unit 13 the lower shore biotopes transitioned to A2.6111 *Z. noltii* beds (LS.LMp.LSgr.Znol) whilst the upper shore remained unchanged. Sandier sediments began to dominate the biotope assemblage from Unit 13 onwards (Figure 8c-d, Figure A1.8), however vertical zonation was apparent due to changes in the proportion in sediment characteristics. For example in Unit 13 barren littoral sand was present along with A2.2233 "*Pontocrates arenarius* in littoral mobile sand" (LS.LSa.MoSa.AmSco.Pon), A2.241 "*M. balthica* and *Arenicola marina* in littoral muddy sand" (LS.LSa.MuSa.MacAre) and an A2.23 (LS.LSa.FiSa) variant with *Arenicola* and amphipods forming distinct bands down the shore.

Unit 14 consisted mainly of A2.24 "polychaete/bivalve dominated muddy sand shores" (LS.LSa.Musa) as evident in Figure 8e and Figures A1.9-A1.10, with Units 16 and 17 consisting of A1.3132 (LR.LLR.F.Fves.X) (mainly in Unit 16). However, Unit 17 was mainly dominated by a variant of A2.244 "*Bathyporeia pilosa* and *Corophium arenarium* in littoral muddy sand." (LS.LSa.MuSa.BatCart), which was absent *Corophium* (Figure 8f, Figure A1.10).

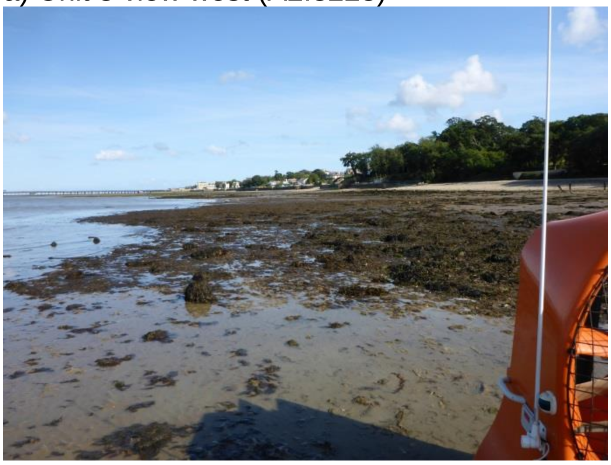
Table 3: Ryde Sands and Wootton Creek SSSI 2015 biotope composition

EUNIS Code	Name	Biotope	Area (Ha)
A2.2233	*Pontocrates arenarius* in littoral mobile sand	LS.LSa.MoSa.AmSco.Pon	97.34
A2.241	*M. balthica* and *Arenicola marina* in littoral muddy sand	LS.LSa.MuSa.MacAre	82.09
A2.6111	*Z. noltii* beds	LS.LMp.LSgr.Znol	53.47
A2.24#	Polychaete/bivalve dominated muddy sand shores. Variant with slightly more sand and none of the characterising species (e.g. *M. balthica* and *C. edule, H. diversicolor, C. arenarium, L. conchilega*) are present in this biotope and so it is undescribed	LS.LSa.MuSa (mid-shore variant)	33.01
A2.23#	Polychaete / amphipod dominated fine sand shores. Variant with *Arenicola* and amphipods	LS.LSa.FiSa (variant)	29.59
A2.821	Ephemeral green and red seaweeds on variable salinity and/or disturbed eulittoral mixed substrata	LR.FLR.Eph.EphX	21.11
A2.431	Barnacles and *Littorina* spp. on unstable eulittoral mixed substrata	LR.FLR.Eph.BLitX	19.41
A2.3223	*H. diversicolor* and oligochaetes in littoral mud	LS.LMu.UEst.Hed.Ol	19.17
A2#	Littoral sediment. Variant of this biotope consisting of clay with piddocks.	LS (clay with piddocks)	17.54
A2.221	Barren littoral coarse sand	LS.LSa.MoSa.BarSa	10
A2.24#	Polychaete/bivalve dominated muddy sand shores. Variant with much more sand and none of the characterising species (e.g. *M. balthica* and *C. edule, H. diversicolor, C. arenarium, L. conchilega*) are present in this biotope and so it is undescribed	LS.LSa.MuSa (upper shore variant)	8.61
A2#	Littoral sediment. Clay variant of this biotope	LS (clay variant)	8.25
A5.52	Kelp and seaweed communities on sublittoral sediment	SS.SMp.KSwSS	7.68
A1.3132	*F. vesiculosus* on mid eulittoral mixed substrata	LR.LLR.F.Fves.X	5.04
A2.4/A2.821	Ephemeral green and red seaweeds on variable salinity and/or disturbed eulittoral mixed substrata. Disturbed/mixed sediment variant	LS.LMx/LR.FLR.Eph.EphX (variant)	4.28
A2.31#	Polychaete/bivalve dominated mid estuarine mud shores. All described biotopes for this complex includes *H. diversicolor* or *Nephtys hombergii*, *M. balthica* and *S. shrubsolii*. These are completely missing from the recorded biotope which is therefore undescribed	LS.LMu.MEst (variant)	3.34

EUNIS Code	Name	Biotope	Area (Ha)
A2.244#	*Bathyporeia pilosa* and *Corophium arenarium in* littoral muddy sand. Variant of this biotope with no *Corophium*	LS.LSa.MuSa.BatCare (variant)	3.1
A2.421#	Fucoids in tide-swept conditions. Variant of biotope with no fucoids	LR.HLR.FT (variant)	2.49
A2.111	Barren littoral shingle	LS.LCS.Sh.BarSh	0.96
A1.3	Low energy littoral rock	LR.LLR	0.44
A2.5	Saltmarsh	LS.LMp.Sm	0.17
A1.451	*Enteromorpha* spp. on freshwater-influenced and/or unstable upper eulittoral rock	LR.FLR.Eph.Ent	0.05

a) Unit 3 view west (A2.3223)


b) Unit 7 view south west (A2.821)


c) Unit 12 view north east (A1.3132)


d) Unit 13 view south (A2.2233)


e) Unit 14 view north (A2.24)

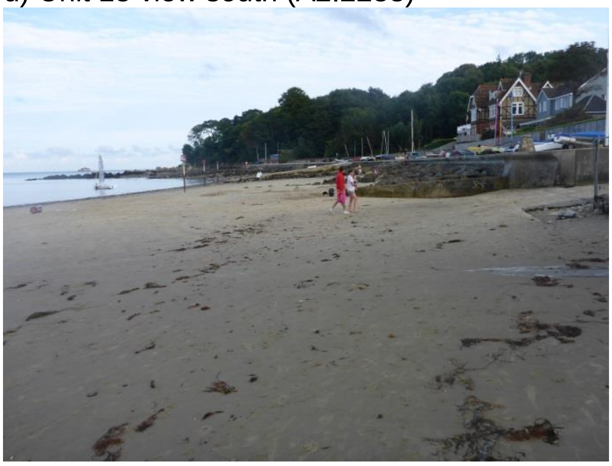

f) Unit 17 view south (A2.244)

Figure 8: Ryde Sands and Wootton Creek SSSI 2015 example field images

3.1.3 Newtown Harbour

A total of 23 different biotopes were identified, including variants from the JNCC national classification (Table 4) and biotope maps are in Appendix 1 (Figures A1.11 to A1.15). Example images acquired from the survey within the SSSI are presented in Figure 9a-f.

The coastline and beach areas leading to the harbour mouth were dominated by A2.231 “polychaetes in littoral fine sand” (LS.LSa.FiSa.Po) (Figures A1.12-A1.13). The biotope A2.11 “Shingle (pebble) and gravel shores” (LS.LCS.Sh) was present higher up the shore to the west of the harbour mouth and entrance (SSSI Unit 1, Figure 9a, Figure A1.12) and A1.2 “Moderate energy littoral rock” (LR.MLR) was recorded along the upper shore to the east (Unit 75, Figure 9b, Figure A1.13).

Within the main body of the SSSI beyond inside the harbour mouth a large proportion of the creeks and channels were found to comprise fine sediments representing the biotope A2.3 “Littoral mud” (LS.LMu, Figure 9e). Along the banks of the creeks and channels, habitats primarily consisted of a range different saltmarsh biotopes and these were most prevalent towards the south and east of the SSSI (Units 47 through 67, Figure A1.14). The saltmarsh was comprised of the following biotopes; A2.5429 “saltmarsh - *Limonium* grass community” (LS.LMp.Sm Limonium), A2.5513 “*Salicornia* spp. pioneer saltmarshes” (LS.LMp.Sm.SM8 *Salicornia* spp.) and A2.5543 “*Spartina maritima* pioneer saltmarshes” (LS.LMp.Sm.SM4).

There were also several large areas of A2.323 “*Tubificoides* and other oligochaetes in littoral mud” (LS.LMu.UEst.Tben) within the centre of the SSSI at Unit 41 and on the lower reaches of Unit 67. This biotope was also found towards the central and south sections of Units 25 and 29 (Figure A1.15). To the south west, SSSI units featured small areas of the aforementioned saltmarsh biotopes as well as several variant substrata biotopes (generally with macroalgae present), whilst the centre of the creeks was characterised by A2.3 (LS.LMu) (Figure A1.15).

Table 4: Newtown Harbour SSSI 2015 biotope composition

EUNIS Code	Name	Biotope	Area (Ha)
A2.3	Littoral mud	LS.LMu	88.54
A2.323	*Tubificoides benedii* and other oligochaetes in littoral mud	LS.LMu.UEst.Tben	73.58
A2.5543	*Spartina maritima* pioneer saltmarshes	LS.LMp.Sm.SM4	62.11
A2.231	Polychaetes in littoral fine sand	LS.LSa.FiSa.Po	22.19
A5.31	Sublittoral mud in low or reduced salinity (lagoons)	SS.SMu.SMuLS	8.09
A2.5513	*Salicornia* spp. pioneer saltmarshes	LS.LMp.Sm.SM8 (Salicornia spp.)	7.50
A2.5429	Saltmarsh (*Limonium* grass community)	LS.LMp.Sm (Limonium)	7.22
A1.323#	*F. vesiculosus* on variable salinity mid eulittoral boulders and stable mixed substrata variant	LR.LLR.FVS.FvesVS (variant)	4.41
A2.5	Saltmarsh	LS.LMp.Sm	4.41
A5.325	*Capitella capitata* and *Tubificoides* spp. in reduced salinity infralittoral muddy sediment. Surface water remained at low spring tide. *Ulva* spp. covering surface of sediment	SS.SMu.SMuVS.Cap Tubi	3.48
A2.4	Littoral mixed sediment	LS.LMx	2.89
A1.2	Moderate energy littoral rock	LR.MLR	2.73
A2.11	Shingle (pebble) and gravel shores	LS.LCS.Sh	2.73
A1.322#	*F. spiralis* on sheltered variable salinity upper eulittoral rock	LR.LLR.FVS.FspiVS (variant)	1.54
A2.221	Barren littoral coarse sand	LS.LSa.MoSa.BarSa	1.53
A2.431	Barnacles and *Littorina* spp. on unstable eulittoral mixed substrata	LR.FLR.Eph.BLitX	1.49
A1.2141	*F. serratus* and red seaweeds on moderately exposed lower eulittoral rock	LR.MLR.BF.Fser.R	1.33
A2.245	*Lanice conchilega* in littoral sand	LS.LSa.MuSa.Lan	1.12
B1.24	Sandy beach ridges with no or low vegetation	Dunes and grasses	0.52
A1.153	*F. serratus* with sponges, ascidians and red seaweeds on tide-swept lower eulittoral mixed substrata	LR.HLR.FT.FserTX	0.46
A2.4114	*H. diversicolor,* cirratulids and *Tubificoides* spp. in littoral gravelly sandy mud	LS.LMx.GvMu.HedM x.Cir	0.10
A2.2	Littoral sand	LS.LSa	0.03

a) Unit 1 view north west (A2.231 and A2.11)

b) Unit 75 view north east (A2.231)

c) Unit 8 view west (A2.245)

d) Unit 19 view west (A2.5543)

e) Unit 47.1 view south west (A2.3)

f) Unit 66N.2 view west (A2.5513)

Figure 9: Newtown Harbour SSSI 2015 example field images

3.2 Quantitative coring survey

Three infauna core samples and single PSA samples were successfully obtained and photographed at all sampling stations across the entire survey, providing 180 faunal replicate cores and 60 PSA cores. Additionally, one extra core was acquired in Langstone Harbour for further analysis in the laboratory due to a subtidal biotope being exposed at very low tide (this sample was excluded from survey analysis as it did not target intertidal biotopes or sediments and was not acquired in triplicate, however, it was discussed within the context of the Langstone Harbour biotope composition in Section 3.1.1).

3.2.1 Station naming convention

Sampling stations were assigned a range of prefixes and codes to assist with discussion and for production of figures and statistical analyses. The following conventions were used:

- Stations were prefixed with the starting letter of the relevant SSSI followed by the SSSI unit number e.g. L3 = sampling station in Langstone Harbour Unit 3
- Where stations were acquired along a transect at two heights on the shore the station name was followed by ".1" for a upper shore station and ".2" for an lower shore station. Thus N41.2 was a sampling station in Newtown Harbour Unit 41 on the lower shore
- Lastly, given that a select number of SSSI units had two sampling transects an "N" for North or "S" for South was added immediately after the SSSI unit number. So for example "N67N.2" = Station at Newtown Harbour SSSI Unit 67 from the Northern Transect but on the lower shore

3.2.2 Physicochemical composition

Salinity, temperature and depth of anoxic layer measurements were recorded at multiple stations across each of the three SSSI survey areas. Due to an equipment malfunction, however, no temperature measurements could be taken at either Ryde Sands and Wootton Creek SSSI or Langstone Harbour SSSI.

3.2.2.1 Langstone Harbour SSSI

Salinity varied from 31.15 to 35.82 across the SSSI units (Table 5). The salinity measurements reflect that the waters in Langstone Harbour are almost fully marine in nature.

The depth of the anoxic layer within the intertidal sediment was recorded at all stations. Anoxic depth varied from 3 cm to less than 1 cm indicating that the sediments in Langstone Harbour SSSI comprised mostly anoxic, rather than well oxygenated, sediments.

Table 5: Langstone Harbour SSSI 2015 physicochemical data

SSSI Unit	Salinity	Anoxic sediment depth (cm)
3	33.28	<1
6	31.98	1
7	35.71	3
9	35.01	1
10	35.56	1
11	35.82	<1
13	31.80	<1
14	31.15	1
Minimum	**31.15**	**<1**
Maximum	**35.82**	**3**

Analysis of both the current and EA (2014) particle size data indicated that mean particle size ranged from 15.0µm at Station EA_11 to 1129.1µm at Station LS7 (Table 6). A large mean particle size was also recorded at Station LS6 (757.6µm) along with EA_01 and EA_02. All other stations possessed ≤73.0µm mean particle diameter. Samples from both LS6 and LS7 were extremely poorly sorted and found to comprise 55.2% and 51.0% gravel respectively, with LS6 classified as muddy Gravel and LS7 as gravelly Mud, as were both EA_01 and EA_02 samples.

Samples from all other stations composed of ≤9.8% gravel (the majority composed of less than 1% gravel). The percentage contribution of both sand and mud varied across the remaining stations, with the percentage mud value typically greater than the proportion of sand. The raw particle size data is provided in Appendix 2.

Table 6: Langstone Harbour SSSI 2014/2015 particle size analysis data

Langstone	Mean (µm)	Gravel (%)	Sand (%)	Mud (%)	Folk*	Sorting
LS3	24.2	0.4	30.4	69.2	(g)sM	Very poor
LS6	757.6	55.2	15.0	29.9	mG	Extremely poor
LS7	1129.1	51.0	27.0	22.0	msG	Extremely poor
LS9	26.7	5.0	25.8	69.2	gM	Very poor
LS10	23.0	0.1	29.9	70.0	(g)sM	Very poor
LS11	26.6	0.1	32.9	67.0	(g)sM	Very poor
LS13	36.7	9.8	31.4	58.7	gM	Very poor
LS14	20.9	0.6	24.9	74.5	(g)sM	Very poor
EA_01	702.0	56.3	12.1	31.6	mG	Not available
EA_02	421.0	44.7	15.2	40.1	mG	Not available
EA_03	19.0	0.0	17.9	82.2	sM	Not available
EA_04	23.0	0.0	29.6	70.4	sM	Not available
EA_05	37.0	0.7	31.1	68.3	sM	Not available
EA_06	32.0	0.0	35.3	64.7	sM	Not available
EA_07	131.0	1.8	82	16.2	mS	Not available
EA_08	179.0	0.0	94.9	5.2	S	Not available
EA_09	37.0	0.0	29.9	70.1	sM	Not available
EA_10	64.0	0.0	51.1	49	mS	Not available
EA_11	15.0	2.7	14.4	82.9	sM	Not available
EA_12	73.0	0.8	43.1	56.1	sM	Not available
EA_13	33.0	3.6	35.4	61.1	sM	Not available
EA_14	21.0	5.0	19.5	75.5	gM	Not available
EA_15	34.0	5.6	29.7	64.6	gM	Not available
Min	**15.0**	**0.0**	**12.1**	**0.1**	**(g)sM to mG**	**Very poor to extremely poor**
Max	**1129.1**	**74.5**	**94.9**	**82.9**		
Mean	**168.1**	**25.3**	**33.0**	**41.7**		
SD	**296.9**	**30.1**	**19.9**	**30.2**		

* Folk (1954) classifications: M = Mud; (g)sM = Slightly gravelly sandy mud; sM = Sandy mud; gM = Gravelly mud; gmS = Gravelly muddy sand; mG = Muddy gravel

3.2.2.2 Ryde Sands and Wootton Creek SSSI

Salinity was found to be relatively consistent ranging from 28.29 to 35.94 (Table 7). The slightly lower salinities recorded at Units 3 to 5 corresponded to the most inland SSSI units in Wootton Creek which are likely subjected to greater potential freshwater inputs e.g. rainwater runoff. Typically salinity measurements were characteristic of fully marine waters as expected, with most SSSI units located on the coastline (including all Units at Ryde Sands).

Anoxic depth measurements were found to vary significantly between SSSI units with measurements taken in the more marine waters of Wootton Creek SSSI Unit 7 and all the Ryde Sands' Units being much greater (majority >10cm depth) than for Units 1 through 6 (majority at 1cm depth) within Wootton Creek.

Mean particle size ranged from 11.3 µm at Station R5 to 1374 µm at Station R14.1 (Table 7). Although not as high as Station R14.1, Stations R1, R7.1 and R9 had significantly greater mean particle size than the remaining stations. These remaining stations were broadly split into those in Wootton Creek and those on Ryde Sands, with the former typically comprising very poorly sorted sediments with much smaller mean particle diameter (majority <25µm whilst those in Ryde Sands tended to be >190µm diameter and were often well sorted. Percentage sands were often very high at Ryde with very little or no percentage muds and with stations classified as either Sandy gravel, Sand or Slightly gravelly sand. At the stations in Wootton Creek the percentage of mud in sediments was much higher than sand and stations were typically either classed as Gravelly mud, Slightly gravelly mud or Sandy mud.

Table 7: Ryde Sands and Wootton Creek SSSI 2015 physicochemical data

SSSI Unit	Salinity	Anoxic sediment depth (cm) range
1	34.62	3
2	32.5	1
3	28.29	1
4	29.4	<1
5	29.02	<1
6	33.95	1
7	34.85 – 35.20	1 - >10
11	35.70 – 35.85	<1 – 5
12	34.08 – 34.70	2.5 – 6
13	35.35 – 35.64	>10
14	35.65 – 35.94	>10
16	35.42	>10
17	35.24	>10
Min	**28.29**	**1**
Max	**35.94**	**>10**

Table 8: Ryde Sands and Wootton Creek SSSI 2015 particle size analysis data

Station	Mean (µm)	Gravel (%)	Sand (%)	Mud (%)	Folk*	Sorting
R1	2410.1	62.6	29.8	7.6	msG	Very poor
R2	17.9	7.2	14.0	78.8	gM	Very poor
R3	11.6	0.1	9.2	90.7	(g)M	Poor
R4	82.3	23.6	9.1	67.4	gM	Extremely poor
R5	11.3	1.4	9.7	88.9	(g)M	Very poor
R6	23.8	0.0	31.4	68.6	sM	Very poor
R7.1	1374.6	46.4	45.2	8.4	msG	Very poor
R7.2	92.1	7.1	54.0	38.8	gmS	Very poor
R11.1	36.0	14.4	33.0	52.6	gM	Extremely poor
R11.2	23.9	1.4	30.4	68.1	(g)sM	Very poor
R12.1	981.2	57.3	15.6	27.2	mG	Extremely poor
R12.2	12.8	1.3	20.0	78.7	(g)sM	Very poor
R13.1	214.9	0.0	100.0	0.0	S	Well
R13.2	217.8	0.0	100.0	0.0	(g)S	Well
R14.1	3326.0	66.2	33.8	0.0	sG	Very poor
R14.2	198.2	0.9	99.1	0.0	(g)S	Well
R16	247.1	0.4	99.6	0.0	(g)S	Moderate
R17	223.1	0.0	100.0	0.0	(g)S	Well
Min	**11.3**	**0.0**	**9.1**	**0.0**	**sM to sG**	**Well to extremely poor**
Max	**3326.0**	**66.2**	**100.0**	**90.7**		
Mean	**528.0**	**16.1**	**46.3**	**37.5**		
SD	**938.3**	**24.2**	**36.1**	**36.1**		

Folk (1954) classifications: (g)sM = Slightly gravelly sandy mud; sM = Sandy mud; (g)M = Slightly gravelly mud; gM = Gravelly mud; gmS = Gravelly muddy sand; (g)S = Slightly gravelly sand; S= Sand; mG = Muddy gravel; msG = Muddy sandy gravel; sG = Sandy gravel

3.2.2.3 Newtown Harbour

Temperature recorded was found to vary by several degrees across different SSSI units (Table 9). Minimum temperature (16.2°C) was recorded in Unit 67 compared to a peak temperature of 20.5°C in Unit 24. Typically, temperatures tended to be slightly higher in waters belonging to SSSI units located further inland, with cooler temperatures recorded towards the harbour entrance and along the coastline.

Salinity was found to be more variable than temperature ranging from 21.46 to a maximum of 36.62, with higher values at stations nearer the low water mark. There was notable variation, however, across some of the individual SSSI units and these were likely affected by localised fresh water inputs.

The depth of the anoxic layer was found to range from 1 to 10 cm depth, although variations were relatively small across a given SSSI unit. The anoxic depth was notably higher in SSSI Unit 1 than other units and was lowest in Units 8 and 32.

Table 9: Newtown Harbour SSSI 2015 physicochemical data

SSSI Unit	Temp (°C) range	Salinity	Anoxic sediment depth (cm) range
1	17.9 – 18.0	34.32 – 34.33	7 – 10
8	19.8 – 20.2	21.46 – 33.17	1 – 2
13	18.5	34.20	6
17	18.3	32.90	5
19	18.0	30.05	3
24	20.3 – 20.5	32.90 – 33.80	4 – 6
25	17.8 – 18.5	22.8 – 23.5	3
29	18.7 – 19.0	34.25 – 34.43	3 – 5
32	16.4	25.25	1
33	16.3	23.6	3
40	19.1	34.48	3
41	17.9 – 18.1	32.68 to 33.24	2 – 3
47	17.3 to 18.4	25.49 – 26.44	3
57	17.3 – 17.5	22.36 – 22.42	3
59	18.2 – 18.5	23.85 – 24.21	3
66	16.8 – 18.4	29.74 – 34.50	4 – 5
67	16.2 – 17.2	23.40 – 29.70	3 – 4
75	18.5	36.62	NA
80	16.5	22.08	5
Min	**16.2**	**21.46**	**1**
Max	**20.5**	**36.62**	**10**

Mean particle size ranged from 3.0 µm at Station N75.1 to 1505.7 µm at Station N13 (Table 10). For the vast majority of stations mean particle size was <100 µm although a high mean particle size of 1413.2 µm was recorded at Station N66N.2. Sediments were either very poorly or extremely poorly sorted and there was considerable variation in sediment composition across the SSSI sampling stations. Overall most stations possessed little gravel material with a general trend towards more muddy sediments with some sand. Small variations in the relative percentages of gravel, mud and sand resulted in a range of sediment classifications across stations within the SSSI (Table 10).

Table 10: Newtown Harbour SSSI 2015 particle size analysis data

Station	Mean (µm)	Gravel (%)	Sand (%)	Mud (%)	Folk*	Sorting
N1.1	246.3	8.6	73.9	17.6	gmS	Very poor
N1.2	311.1	36.9	26.3	36.8	mG	Extremely poor
N8.1	51.5	4.5	40.4	55.1	(g)sM	Very poor
N8.2	16.6	0.4	22.5	77.1	(g)sM	Very poor
N13	1505.7	66.1	16.0	17.9	mG	Extremely poor
N17	12.3	0.7	16.1	83.2	(g)sM	Very poor
N19	14.2	0.0	16.1	83.9	sM	Very poor
N24.1	21.9	0.2	28.0	71.8	(g)sM	Very poor
N24.2	40.4	0.5	41.3	58.2	(g)sM	Very poor
N25.1	195.0	26.5	21.8	51.8	gM	Extremely poor
N25.2	27.8	0.4	36.1	63.5	(g)sM	Very poor
N29N	105.4	9.3	46.7	44.0	gmS	Very poor
N29S	167.2	22.3	23.0	54.7	gM	Extremely poor
N32	18.6	4.9	16.6	78.5	(g)sM	Very poor
N33	36.0	2.6	38.2	59.2	(g)sM	Very poor
N40	28.3	1.2	33.4	65.4	(g)sM	Very poor
N41.1	80.0	5.7	52.5	41.8	gmS	Very poor
N41.2	42.4	0.9	43.2	55.8	(g)sM	Very poor
N47.1	36.3	8.8	29.1	62.2	gM	Very poor
N47.2	18.7	0.3	21.9	77.8	(g)sM	Very poor
N57.1	35.2	8.3	28.7	63.1	gM	Very poor
N57.2	18.6	0.5	25.0	74.5	(g)sM	Very poor
N59.1	19.5	1.0	26.0	73.0	(g)sM	Very poor
N59.2	24.1	2.2	25.9	71.9	(g)sM	Very poor
N66S	14.0	0.0	19.8	80.2	sM	Very poor
N66N.1	79.8	22.3	17.8	59.9	mG	Extremely poor
N66N.2	1416.2	62.1	9.8	28.1	mG	Extremely poor
N67N.1	63.4	15.8	20.0	64.3	mG	Extremely poor
N67S.1	63.3	7.0	52.2	40.8	gmS	Very poor
N67N.2	33.8	4.6	32.0	63.3	(g)sM	Very poor
N67S.2	15.7	0.7	18.3	81.0	(g)sM	Very poor
N75.1	3.0	0.0	2.8	97.2	M	Poor
N75.2	13.1	0.0	24.3	75.7	sM	Very poor
N80	31.9	4.8	34.8	60.4	(g)sM	Very poor
Min	**3.0**	**0.0**	**2.8**	**17.6**	**M to mG**	**Poor to extremely poor**
Max	**1505.7**	**66.1**	**73.9**	**97.2**		
Mean	**141.4**	**9.7**	**28.8**	**61.5**		
SD	**342.3**	**16.4**	**14.0**	**18.6**		

* Folk (1954) classifications: M = mud; (g)sM = slightly gravelly sandy mud; sM = sandy mud; gM = gravelly mud; gmS = gravelly muddy sand; mG = muddy gravel

3.2.3 Biota summary statistics from core samples

A total of 180 cores (each 0.01 m^2) were analysed with 283 taxa recorded. A brief summary of the most abundant taxa is presented below in Figure 10 followed by site-specific summaries. The full dataset is presented in Appendix 3.

The gastropod mollusc *Peringia ulvae* (previously *Hydrobia ulvae,* Neubauer & Gofas, 2015) was by far the most abundant species across the samples collected, contributing over 30% of total abundance. Nematode worms, several annelid polychaetes (*Tharyx* species A, *Capitella* and *Praxillella affinis*) and the oligochaete *Tubificoides benedii* comprised the majority of the remaining abundance and overall the six species present in Figure 10 contributed in excess of 85% of the entire invertebrate abundance across the survey.

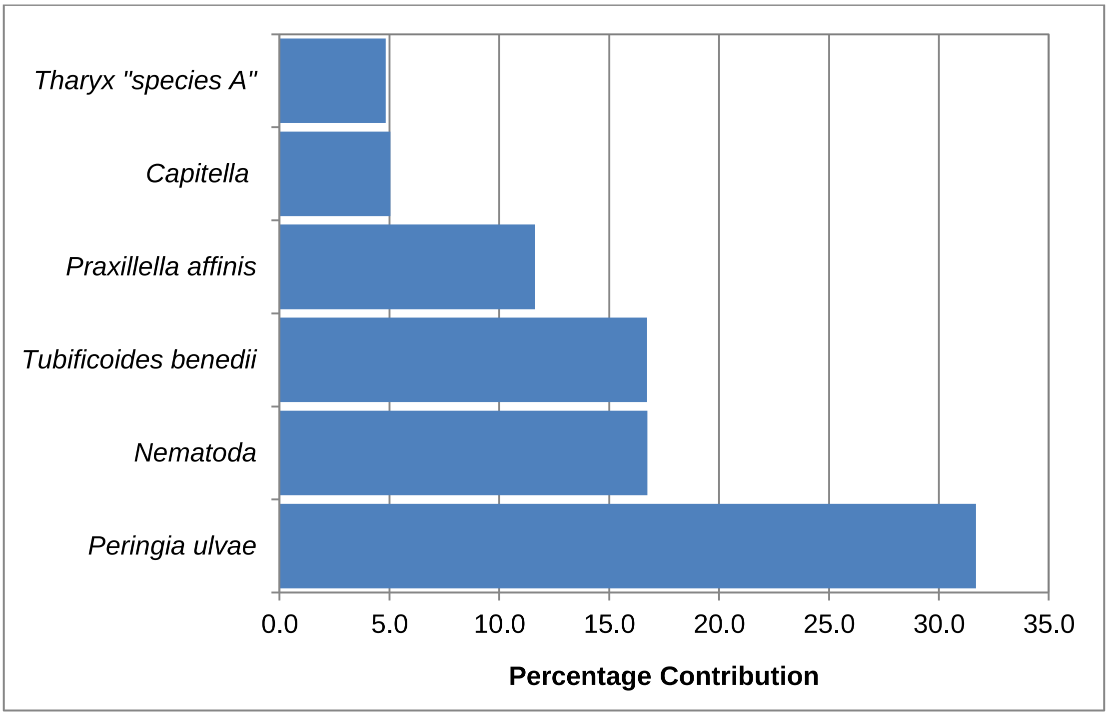


Figure 10: Ranked, percentage contribution of the predominant taxa (comprising 85% of the total biotic abundance) across the entire 2015 survey area.

3.2.3.1 Langstone Harbour

The mean number of taxa within the Langstone Harbour SSSI units ranged from 8.7 ± 2.1 (standard deviation) (LS11) to 29.0 ± 3.6 at Station LS7 with overall mean abundance per m^2 varying from 18,333 ± 5,263 at LS3 to 94,533 ± 76,937 at LS6 (Table 11). Pielou's evenness and Simpson's dominance indices values suggested that the communities found across the Langstone Harbour sampling stations were not particularly evenly distributed and that there was a tendency for several taxa to dominate communities within each station. This was indicative of the overall low biological diversity found within the core samples acquired within this SSSI which was also reflected in the Shannon-Weiner Diversity scores which ranged between 0.9 and 2.1, with lowest diversity recorded at Stations LS6 and LS14 (both 0.9 ± 0.3).

The EA (2014) core samples provide further information on the communities within the intertidal environment, but due to only acquiring single core samples (without any replicates) no mean or standard deviations could be determined. The results are integrated into Table 11 below. The results suggest a similar range of taxa to be found as with the 2015 samples; indicating increased confidence in the sampling results and further confirming that across the harbour communities were reasonably diverse. Highest diversity and abundance of individuals was recorded in EA_02 located in the north east of SSSI Unit 6 (35 taxa, 99,610 individuals per m^2). This was also the most abundant and diverse station across both 2014 and 2015 sampling locations and possessed some of the coarsest sediments recorded in the harbour. The diversity indices presented below also suggested similar trends the 2015 data regarding community diversity and structure with communities not being particularly evenly distributed and with increased dominance of some taxa. This was most prevalent at EA_05 located in SSSI Unit 9, although the values at this location did not appear to match as well with the current data.

The combined data sets (current survey and EA 2014) indicated that Nematoda were by far the most abundant species recorded across the harbour, although counts in the EA data were much higher, primarily due to counts of over 7000 individuals per m^2 in the sample at EA_02. Without additional replicate sit is however, difficult to confirm if such abundance in that location is truly representative. The combined data set also indicated that *T. benedii* and *P. ulvae* were also highly abundant across the harbour, with similar populations recorded in both sampling years.

Table 11: Langstone Harbour SSSI 2014/2015 population diversity statistics by station sampled. Values for 2015 data only indicate means ± SD. S.D. = Standard Deviation.

Station	Mean no. taxa	Mean abundance (m^2)	Mean Margalef's species richness (*d*)	Mean Pielou's Evenness (*J'*)	Mean Shannon Wiener Diversity (*H'*(log_e))	Mean Simpson's Dominance (1-λ)
LS3	9.7 ± 2.1	18,333 ± 5,263	1.7 ± 0.4	0.54 ± 0.11	1.2 ± 0.2	0.59 ± 0.11
LS6	19.0 ± 7.2	94,533 ± 76,937	2.7 ± 0.7	0.32 ± 0.12	0.9 ± 0.3	0.39 ± 0.14
LS7	29.0 ± 3.6	40,967 ± 23,312	4.8 ± 0.5	0.62 ± 0.12	2.1 ± 0.4	0.79 ± 0.08
LS9	11.3 ± 0.6	32,033 ± 20,937	1.9 ± 0.3	0.51 ± 0.06	1.2 ± 0.1	0.58 ± 0.04
LS10	13.7 ± 3.5	46, 033 ± 11,951	2.1 ± 0.5	0.46 ± 0.08	1.2 ± 0.3	0.58 ± 0.14
LS11	8.7 ± 2.1	55,100 ± 26,017	1.2 ± 0.3	0.55 ± 0.03	1.2 ± 0.1	0.62 ± 0.06
LS13	18.3± 3.1	39,167 ± 10,320	2.9 ± 0.5	0.53 ± 0.05	1.5 ± 0.2	0.68 ± 0.04
LS14	10.0 ± 4.4	19,133 ± 12,515	1.8 ± 0.6	0.43 ± 0.16	0.9 ± 0.3	0.40 ± 0.15
Station	**No. taxa**	**Abundance (m^2)**	**Margalef's species richness (*d*)**	**Pielou's Evenness (*J'*)**	**Shannon Wiener Diversity (*H'*(log_e))**	**Simpson's Dominance (1-λ)**
EA_01	25	33190	3.0	0.38	1.2	0.50
EA_02	35	99610	3.7	0.33	1.2	0.46
EA_03	22	6310	3.3	0.70	2.2	0.84
EA_04	22	8020	3.1	0.70	2.2	0.83
EA_05	14	9750	1.9	0.20	0.5	0.19
EA_06	19	5600	2.8	0.62	1.8	0.74
EA_07	15	1130	3.0	0.49	1.3	0.50
EA_08	19	3270	3.1	0.31	0.9	0.33
EA_09	16	8100	2.2	0.62	1.7	0.78
EA_10	13	7060	1.8	0.52	1.3	0.63
EA_11	17	20730	2.1	0.45	1.3	0.52
EA_12	14	5350	2.1	0.51	1.3	0.62
EA_13	23	15270	3.0	0.49	1.5	0.69
EA_14	23	22180	2.9	0.37	1.2	0.56
EA_15	28	48210	3.2	0.56	1.9	0.78
All Surveys Min	**8.7**	**18,333**	**1.2**	**0.32**	**0.9**	**0.39**
All Surveys Max	**29.0**	**94,533**	**4.8**	**0.62**	**2.1**	**0.79**

3.2.3.1 Ryde Sands and Wootton Creek

Within the stations sampled across Ryde Sands and Wootton Creek SSSI the mean number of taxa varied from 2.0 at Station RS17 to 44.7 ± 15.3 at R7.2. Mean abundance of individuals per m^2 was found to range from 567 ± 462 per m^2 for Station R17 to 372,033 ± 641,178 per m^2 at R12.2 (Table 12). The high standard deviation values are indicative of the variation observed in abundances across replicates within many of the Ryde Sands and Wootton Creek SSSI sampling stations.

Variation in mean values for both Pielou's evenness and Simpson's dominance across stations indicated considerable differences in assemblage composition across stations with several taxa dominating the faunal assemblages at a number of stations (indicated by a Pielou's evenness value of 0.32 ± 0.12 at Stations LS6 for example). Communities were more evenly distributed with less evidence of the presence of dominant taxa (i.e. values for both indices were nearer to 1) along Ryde Sands when compared with Wootton Creek. Diversity index values, such as Shannon-Weiner suggested that some stations such as R7.2 were notably diverse whilst others such as R17 (0.5 ± 0.2) were found to contain very impoverished communities. Overall the results suggest that whilst fauna were relatively abundant, several taxa were present in very high abundance with numerous other taxa present in very low abundances, leading to modest diversity but unevenly distributed communities.

Table 12: Ryde Sands and Wootton Creek SSSI 2015 population diversity statistics by station sampled. Values indicate means ± SD. S.D. = Standard Deviation

Station	Mean no. taxa (± SD)	Mean abundance (per m^2 ± SD)	Mean Margalef's species richness (*d*)	Mean Pielou's Evenness (*J'*)	Mean Shannon Wiener Diversity ($H'(\log_e)$)	Mean Simpson's Dominance (1-λ)
R1	21.7 ± 3.2	31,533 ± 3,967	3.6 ± 0.6	0.53 ± 0.07	1.6 ± 0.3	0.67 ± 0.10
R2	10.7 ± 2.1	30,000 ± 10,070	1.7 ±0.3	0.49 ± 0.07	1.2 ± 0.2	0.54 ± 0.15
R3	10.3 ± 2.9	27,967 ± 13,802	1.7 ±0.4	0.60 ± 0.05	1.4 ± 0.1	0.67 ± 0.05
R4	10.7 ± 1.4	38,467 ± 16,782	1.7 ± 0.3	0.44 ± 0.28	1.1 ± 0.7	0.49 ± 0.33
R5	6.0 ± 1.0	35,233 ± 7,419	0.9 ± 0.2	0.20 ± 0.14	0.4 ± 0.3	0.17 ± 0.16
R6	7.3 ± 2.1	2,833 ± 1,701	1.9 ± 0.2	0.68 ± 0.13	1.3 ± 0.1	0.59 ± 0.16
R7.1	16.0 ± 7.2	25,200 ± 26,817	2.8 ± 0.9	0.64 ± 0.01	1.7 ± 0.3	0.71 ± 0.07
R7.2	44.7 ± 15.3	14,233 ± 3,754	8.8 ± 2.8	0.77 ± 0.10	2.9 ± 0.6	0.87 ± 0.08
R11.1	8.3 ± 3.2	2,300 ± 819	2.3 ± 0.7	0.84 ± 0.03	1.7 ± 0.3	0.77 ± 0.08
R11.2	13.0 ± 3.5	8,167 ± 1,890	2.8 ± 0.9	0.53 ± 0.03	1.4 ± 0.2	0.53 ± 0.04
R12.1	15.0 ± 3.0	6,833 ± 5,727	3.5 ±0.1	0.74 ± 0.18	2.0 ± 0.4	0.76 ± 0.05
R12.2	11.7 ± 7.0	372,033 ± 641,178	2.8 ± 2.2	0.63 ± 0.54	1.4 ± 1.4	0.56 ± 0.14
R13.1	11.3 ± 3.2	19,233 ± 5,514	2.0 ±0.7	0.50 ± 0.07	1.2 ± 0.1	0.55 ± 0.49
R13.2	16.0 ± 3.6	16,867 ± 10,061	3.0 ± 0.4	0.55 ± 0.08	1.5 ± 0.3	0.58 ± 0.07
R14.1	16.0 ± 4.4	9,433 ± 7,778	3.4 ± 0.4	0.80 ± 0.06	2.2 ± 0.2	0.84 ± 0.10
R14.2	20.3 ± 1.5	9,100 ± 1,836	4.3 ±0.2	0.88 ± 0.02	2.6 ± 0.1	0.91 ± 0.03
R16	8.0 ± 2.0	2,933 ± 306	2.1 ± 0.7	0.68 ± 0.18	1.4 ± 0.2	0.62 ± 0.01
R17	2.0 ± 0.0	567 ± 462	0.7 ±0.3	0.76 ± 0.28	0.5 ± 0.2	0.35 ± 0.21
Min	**2.0**	**567**	**0.7**	**0.20**	**0.4**	**0.17**
Max	**44.7**	**372,033**	**8.8**	**0.88**	**2.9**	**0.91**

3.2.3.2 Newtown Harbour

Mean abundance per m^2 across the stations in Newtown Harbour ranged from a minimum of 100 ± 0 SD at N19 to a peak abundance of 306,500 ± 278,479 SD at Station N41.2. Pielou's evenness and Simpson's dominance indices suggested that stations that possessed less abundance were often more evenly distributed. At those stations with significantly greater abundance this likely derived from a few select taxa rather than proportional increases across the community. Both Margalef's and Shannon-Weiner's indices indicated that at some sampling stations, diversity of the communities was very high, but in other areas the communities appeared quite impoverished. For example on the upper shore of Unit 1 (N1.2) mean Margalef's was 9.3 ± 1.3 and Shannon's was 3.0 ± 0.1 whilst at Station N33 it was 0.8 ± 0.0 and 0.3 ± 0.3, respectively for both indices. Overall, it seemed that those sampling stations in SSSI units in the eastern areas of the harbour possessed a more abundant and rich intertidal community than those to the west. Those stations in SSSI units near the mouth of the estuary also had richer and more abundant faunal communities.

Table 13: Newtown Harbour SSSI 2015 population diversity statistics by station sampled. Values indicate means ± SD. S.D. = Standard Deviation

Station	Mean no. taxa (± SD)	Mean abundance (per m^2 ± SD)	Mean Margalef's species richness (*d*)	Mean Pielou's Evenness (*J'*)	Mean Shannon Wiener Diversity (*H'*(log_e))	Mean Simpson's Dominance (1-λ)
N1.1	18.3 ± 2.3	6,200 ± 1,572	4.2 ± 0.7	0.79 ± 0.09	2.3 ± 0.3	0.15 ± 0.05
N1.2	53.3 ± 14.0	32,733 ± 27,501	9.3 ± 1.3	0.77 ± 0.06	3.0 ± 0.1	0.09 ± 0.02
N8.1	5.7 ± 2.1	3,400 ± 1,400	1.4 ± 0.7	0.50 ± 0.27	0.9 ± 0.7	0.60 ± 0.30
N8.2	3.0 ± 1.7	1,400 ± 2,078	1.3 ± 0.2	0.78 ± 0.37	0.7 ± 0.1	0.59 ± 0.15
N13	4.0 ± 1.0	600 ± 100	1.7 ± 0.5	0.89 ± 0.07	1.2 ± 0.3	0.35 ± 0.11
N17	2.0 ± 1.0	267 ± 208	1.3 ± 0.1	0.93 ± 0.10	0.5 ± 0.5	0.65 ± 0.31
N19	1.0 ± 0.0	100 ± 0	NA	NA	NA	1.00 ± 0.0
N24.1	4.0 ± 2.0	5,867 ± 4,565	0.7 ± 0.3	0.51 ± 0.11	0.7 ± 0.3	0.64 ± 0.18
N24.2	1.7 ± 2.0	233 ± 231	1.2 ± NA	0.86 ± NA	0.3 ± 0.5	0.81 ± 0.32
N25.1	13.7 ± 2.5	69,967 ± 45,398	2.0 ± 0.2	0.50 ± 0.07	1.3 ± 0.2	0.41 ± 0.10
N25.2	12.3 ± 10.0	79,933 ± 72,616	1.6 ± 1.3	0.67 ± 0.19	1.3 ± 0.6	0.39 ± 0.16
N29N	2.7 ± 0.6	767 ± 379	0.8 ± 0.3	0.72 ± 0.20	0.7 ± 0.3	0.59 ± 0.18
N29S	1.7 ± 2.1	200 ± 265	1.9 ± NA	0.96 ± NA	0.4 ± 0.8	0.64 ± 0.51
N32	2.7 ± 1.5	2,433 ± 3,062	0.8 ± 0.0	0.34 ± 0.21	0.3 ± 0.3	0.88 ± 0.14
N33	2.0 ± 2.6	5,167 ± 8,862	0.8 ± NA	0.36 ± NA	0.2 ± 0.3	0.86 ± 0.20
N40	13.3 ± 10.0	85,367 ± 101,936	1.9 ± 1.1	0.56 ± 0.18	1.2 ± 0.3	0.41 ± 0.09
N41.1	14.0 ± 3.6	158,533 ± 51,895	1.8 ± 0.4	0.47 ± 0.16	1.2 ± 0.3	0.41 ± 0.13
N41.2	24.7 ± 4.7	306,500 ± 278,479	3.0 ± 0.2	0.50 ± 0.07	1.6 ± 0.2	0.31 ± 0.05
N47.1	13.7 ± 2.5	21,533 ± 9,377	2.4 ± 0.3	0.78 ± 0.06	2.0 ± 0.1	0.16 ± 0.02
N47.2	18.0 ± 2.6	238,300 ±119,690	2.2 ± 0.2	0.52 ± 0.04	1.5 ± 0.2	0.29 ± 0.05
N57.1	13.3 ± 2.1	146,400 ± 47,346	1.7 ±0.2	0.28 ± 0.03	0.7 ± 0.0	0.73 ± 0.01
N57.2	9.3 ± 2.5	28,367 ± 7,072	1.5 ± 0.4	0.43 ± 0.09	0.9 ± 0.1	0.56 ± 0.07
N59.1	7.0 ± 3.0	28,733 ± 14,365	1.1 ± 0.5	0.22 ± 0.08	0.4 ± 0.2	0.83 ± 0.09
N59.2	12.3 ± 1.5	132,167 ± 20,256	1.6 ± 0.2	0.48 ± 0.03	1.2 ± 0.1	0.38 ± 0.03
N66S	15.7 ± 2.3	66,400 ± 5,173	2.3 ± 0.4	0.30 ± 0.11	0.8 ± 0.3	0.67 ± 0.15
N66N.1	15.0 ± 3.6	92,933 ± 53,071	2.1 ± 0.4	0.39 ± 0.06	1.0 ± 0.3	0.52 ± 0.13
N66N.2	10.7 ± 2.9	143,933 ± 40,433	1.3 ± 0.3	0.22 ± 0.09	0.5 ± 0.2	0.74 ± 0.15
N67N.1	17.7 ± 6.1	197,167 ± 89,536	2.2 ± 0.7	0.51 ± 0.14	1.4 ± 0.2	0.31 ± 0.11
N67S.1	22.7 ± 5.1	65,500 ± 7,363	3.3 ± 0.7	0.54 ± 0.05	1.7 ± 0.2	0.30 ± 0.06
N67N.2	17.3 ± 5.5	53,567 ± 18,909	2.6 ± 0.8	0.29 ± 0.06	0.8 ± 0.2	0.67 ± 0.10
N67S.2	16.7 ± 0.6	182,167 ± 10,678	2.1 ± 0.1	0.58 ± 0.02	1.6 ± 0.1	0.26 ± 0.02
N75.1	13.3 ± 2.5	3,167 ± 808	3.6 ± 0.6	0.90 ± 0.04	2.3 ± 0.2	0.12 ± 0.03
N75.2	39.0 ± 9.5	23,133 ± 6,269	7.0 ± 1.4	0.78 ± 0.09	2.8 ± 0.5	0.11 ± 0.08
N80	1.7 ± 1.2	267 ± 289	1.1 ± NA	0.79 ± NA	0.3 ± 0.5	0.83 ± 0.29
Min	**1.0**	**100**	**0.7**	**0.22**	**0.2**	**0.09**
Max	**53.3**	**306,500**	**9.3**	**0.96**	**3.0**	**1.00**

3.3 Multivariate analysis of faunal composition

Due to differences in survey sampling years, number of replicates and sampling locations, and to prevent possible bias the EA (2014) core data for Langstone Harbour was not incorporated into the multivariate analysis of the faunal data. This was discussed with and agreed by Natural England.

CLUSTER analysis of data from all survey stations indicated that four stations were notably dissimilar to all others forming two pairs of closely associated stations (N19 and N60; R16 and R17) at <5% similarity to all other sampling stations (Figure 11). The remaining 59 stations all shared at least 18% similarity in faunal composition. Remaining stations were roughly grouped by SSSI although there were some exceptions. Typically, stations within SSSIs shared at least 40% similarity. Given the variation in location and site-specific features, interpretation then focused on trends within each SSSI (discussed below).

3.3.1 Langstone Harbour SSSI

CLUSTER analysis indicated the eight sample stations were separated into five different SIMPROF groups. Station L7 was least similar to all other stations, separated at 35% similarity (Figure 12). The closely associated pair of L6 and L11 were distinguished at 40% similarity whilst L13 and L14 were statistically isolated from all other stations and L3, L9 and L10 formed a true cluster (three or more stations), sharing 59% similarity in faunal community. The observed trends in similarity are represented through the associated MDS plot which, with a stress value of 0.09, can be considered as a good visual representation of the rank (dis)similarities between the faunal communities (Figure 13).

SIMPER analysis indicated that a wide range of subtle variations in the abundance and presence of numerous taxa contributed to the observed (dis)similarities and within these communities, populations of Nematoda and *A. modestus* had relatively higher abundances (Appendix 4). For example, *A. modestus* accounted for 7.5% of average dissimilarity between groups *d* and *e*, whilst Nematoda accounted for 9.47% of dissimilarity between groups *b* and *d*. In this latter example Stations L6 and L11 (group *b*) had extremely high abundances of nematodes compared to stations in group *e* (LS3, LS9 and LS10).

When reviewing trends that contributed to similarity within groups, SIMPER analysis indicated that for stations in group *e* populations of *P. ulvae, T. benedii* and *Tharyx* "species A" contributed to >50% of similarity. Overall 11 taxa contributed to >91% of similarity in this group. Within group *b* fewer taxa contributed to station similarity (90% from 8 taxa), with Nematoda responsible for >24% of similarity.

Note that SIMPER analysis could not be undertaken to assess trends in similarity within a group containing less than two sampling stations, so detailed analysis could not be undertaken for groups *a, c* or *e*. Full details of SIMPER analyses are presented in Appendix 4.

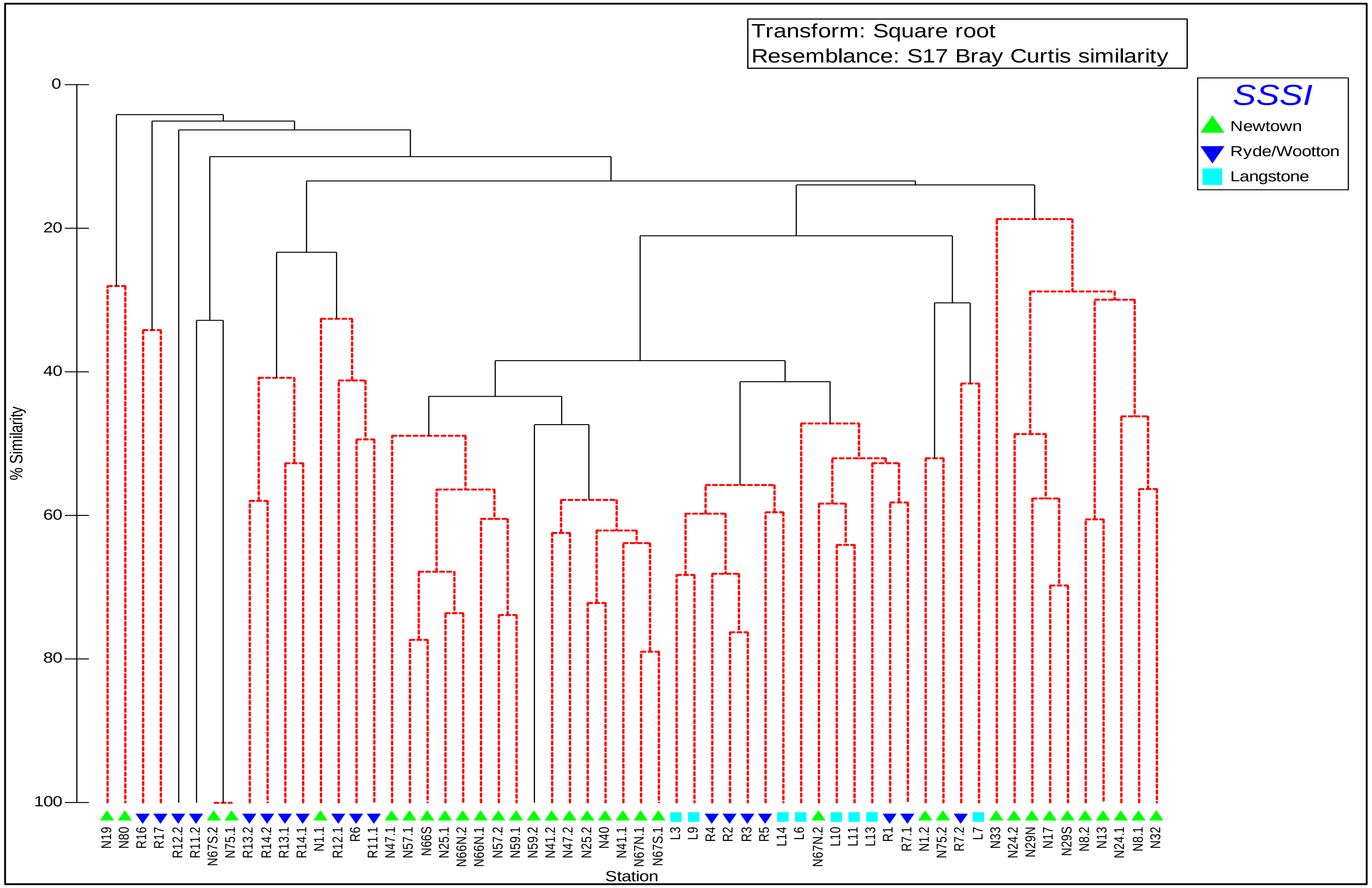


Figure 11: Solent Maritime SAC 2015 SIMPROF cluster dendrogram illustrating faunal similarities among all stations sampled within Langstone Harbour, Ryde Sands and Wootton Creek and Newtown SSSIs.

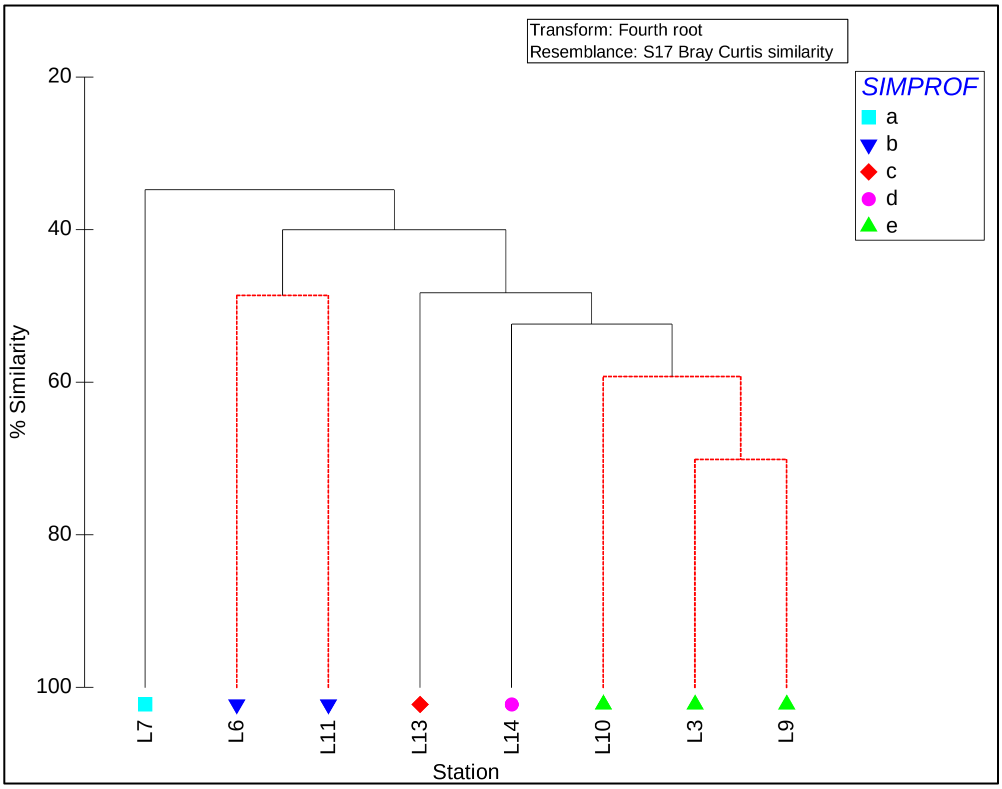


Figure 12: Langstone Harbour SSSI 2015 SIMPROF cluster dendrogram illustrating macrofaunal similarities by station

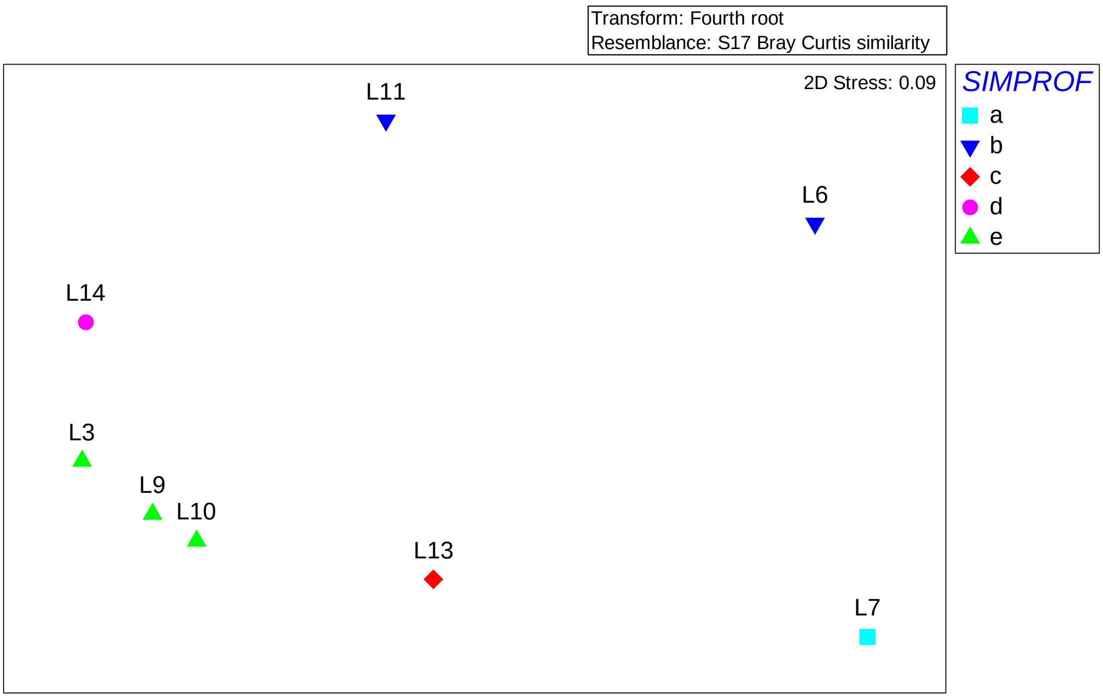


Figure 13: Langstone Harbour SSSI 2015 2D Multidimensional Scaling (MDS) ordination diagram. The labels indicate species groups (SIMPER)

3.3.1 Ryde Sands and Wootton Creek SSSI

Significant variation in faunal assemblage was found across the sampling stations using CLUSTER analysis (Figure 14). Stations R16 and R17 (SIMPROF group *a*; located at the eastern end of Ryde Sands) differed the most from the other stations. Stations R2 to R5, all within Wootton Creek formed a cluster of stations, indicating statistically inseparable faunal community assemblages (60% similarity) in this area of the SSSI. Upper and lower shore stations from R13 and R14 also formed a true cluster (group *h*) indicating similarity (41%) in the faunal community within this stretch of Ryde Sands. The dissimilarity amongst stations from R12, R1 and R7 likely reflects the higher gravel content at those locations, creating a more heterogenous habitat with associated variation in marine assemblages. These results are also apparent in the MDS plot which, with a stress value of 0.14, can be considered a useful representation of the trends in faunal assemblage (dissimilarity) between the sampling locations (Figure 15).

SIMPER analysis (Appendix 4) to determine the key taxa contributing to the (dis)similarity between groups of sampling stations found that numerous small variations in a wide range of species were typically responsible. However, several taxa were identified as commonly contributing to a greater extent to the dissimilarity across most groups and these were primarily the gastropod mollusc *P. ulvae*, along with nematode worms, and the polychaetes *Protocirrineris* and *Tharyx* “species A”*. P. ulvae* was the most abundant species across all of the SSSIs, whilst *Tharyx* was the sixth most abundant taxon (Section 3.2.3).

Within group *a* (R16 and R17)*,* trends in four taxa contributed to 100% of similarity - *Bathyporeia sarsi*, *Rissoa parva*, *Electra pilosa* and *Tricellaria inopinata.* Similarity within stations from group *d* was characterised by trends in the most abundant taxa across the surveys (*P. ulvae*, *Tharyx* "species A", *T. benedii*, *T. pseudogaster*, Nematoda and *Capitella*). In fact trends in *P. ulvae* contributed ~46% of total similarity. In groups *e* and *g,* a larger range of taxa contributed to the overall similarity of stations, indicating these stations were also more diverse, although trends in abundance of nematodes were significant factors.

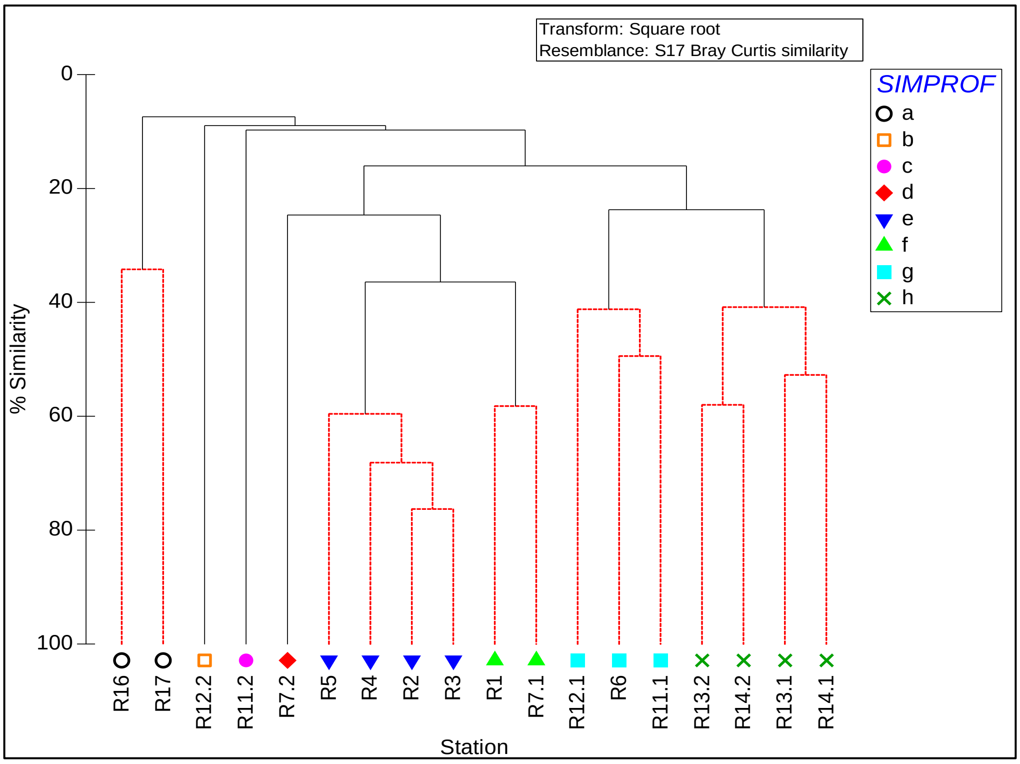


Figure 14: Ryde Sands and Wootton Creek SSSI 2015 SIMPROF cluster dendrogram illustrating macrofaunal similarities by station

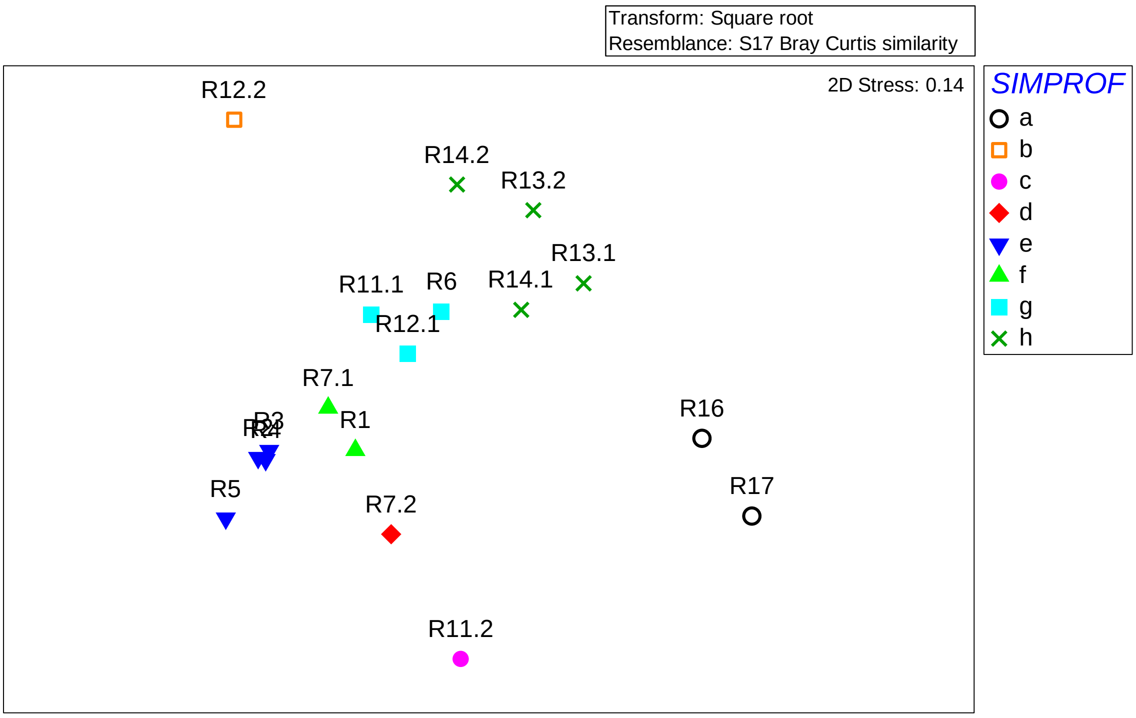


Figure 15: Ryde Sands and Wootton Creek SSSI 2015 2D Multidimensional Scaling (MDS) ordination diagram. The labels indicate species groups (SIMPER)

3.3.1 Newtown Harbour SSSI

Significant variation in faunal communities was apparent from the CLUSTER dendrogram, with eight SIMPROF groups (*a* to *h*) identified (Figure 16). Stations N19 and N80 (group *a*) were the most dissimilar stations within the SSSI with respect to faunal composition when compared to other sampling stations at just 5% similarity. Several other sampling stations (groups *b, c,* and *d*) also shared very little similarity with the majority of stations separated at ~10% similarity. Ten stations retained within group *h* were found to share approximately 12% similarity and could not be statistically separated any further. Two other statistically significant clusters (SIMPROF groups *e* and *g*) were also observed at 43% and 52% similarity, respectively. Further investigation based on sediment classification did not reveal any clear correlation with the faunal assemblages and SIMPROF groups. These results are also apparent in the MDS plot which, with a stress value of 0.12, can be considered a useful representation of the trends in faunal assemblage (dissimilarity) between the sampling stations (Figure 17).

SIMPER analysis (Appendix 4) identified a range of taxa contributing to station (dis)similarities. Notably for stations in group *h, P. ulvae* contributed to 50.03% station similarity, with almost 92% of similarity in the group deriving from this taxon combined with *T. benedii* and Nematoda. In group *e*, six taxa contributed to >90% of total similarity, with *P. ulvae* again the most dominant taxon and also including both *T. benedii* and Nematoda. Chironomidae was also a significant contributor. In other groups, e.g. group *b*, a much greater range of taxa contributed to the similarity amongst sampling stations with over 30 taxa identified as influencing the similarity.

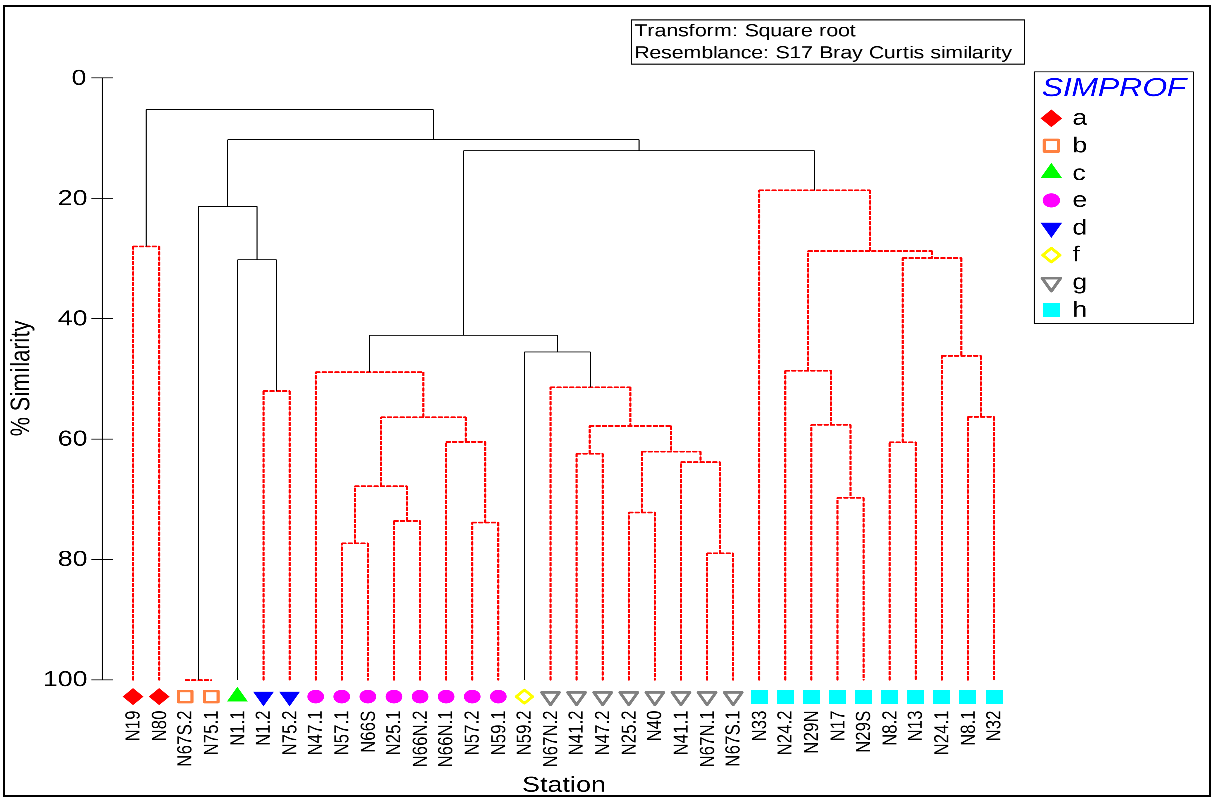


Figure 16: Newtown Harbour SSSI 2015 SIMPROF cluster dendrogram illustrating macrofaunal similarities by station

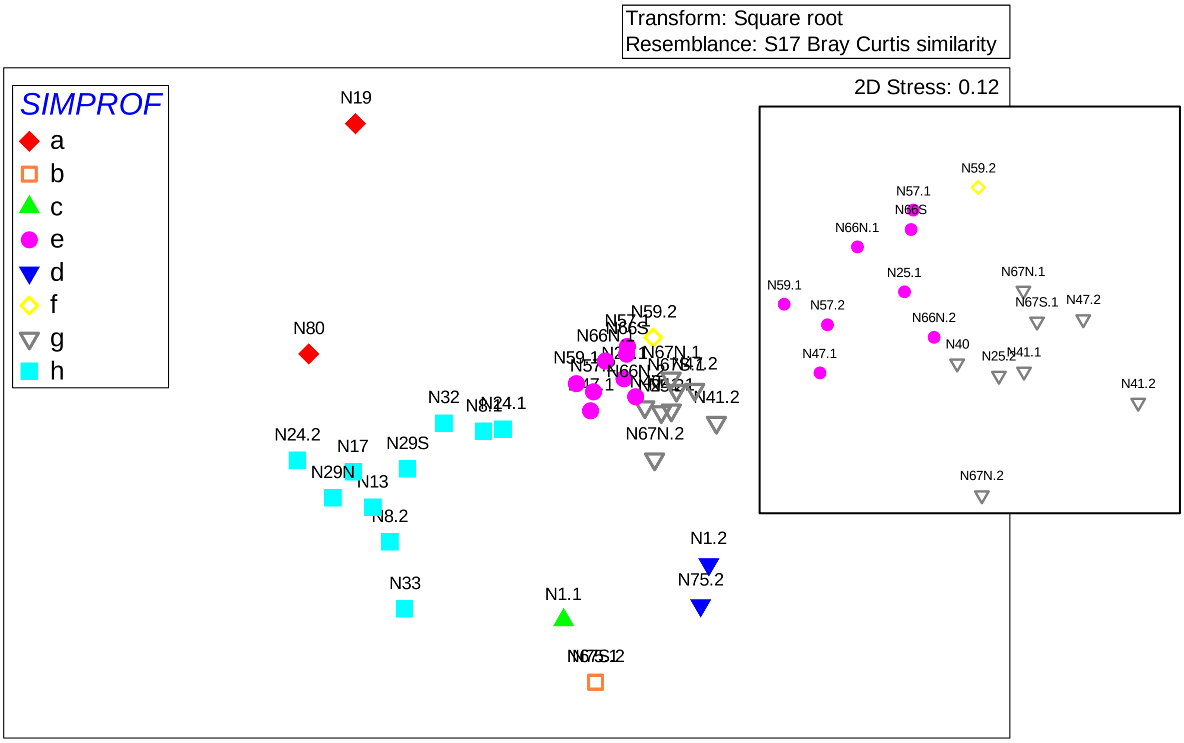


Figure 17: Newtown Harbour SSSI 2015 Multidimensional Scaling (MDS) ordination diagram. The labels indicate species groups (SIMPER)

3.4 Nationally and internationally important communities

The conservation value of many species is continually under review and more information on distribution and ecology is required for the majority. None of the taxa recorded have formal conservation designations but we consider *Psammodrilus balanoglossoide* and *Paragnathia formica* to be rarely recorded.

Also of interest were several taxa that may represent new species or new British records; the polychaetes *Sphaerosyllis aff. taylori*, *Lumbrineris coccinea*, *L. latreilli*, *Dipolydora coeca* agg, *Polydora ciliata* agg., *Spio filicornis* agg., *Protocirrineris* sp., *Caulleriella* sp., *Ampharete aff. acutifrons* and *Ampharete aff. baltica*, belong to groups that require taxonomic revision and may include new species.

The same is true for the oligochaetes *Tubificoides galiciensis* and *T. pseudogaster* agg., the amphipod crustacean *Pontocrates arcticus* 'Type A' and the parasitic copepod taxa (Copepoda parasite, Notodelphyidae, *Notodelphys* and *Sphaeronella*). The presence of the polychaete *Parapionosyllis macaronesiensis* and the oligochaete *Tubificoides nerthoides* in UK waters has not yet been formally published.

The brown shrimp *Crangon crangon*, the cockle *Cerastoderma edule* and Manila clam *Ruditapes philippinarum* are commercially valuable species.

3.5 Non-native species

New records of non-native species are made for British waters in most years and the native status of many known species requires further research (Katsanevakis *et al*., 2013). During the field survey of Langstone Harbour the presence of the invasive non-native species (INNS) Australasian barnacle *Austrominius modestus* was recorded in SSSI Units 3, 6, 7 and 10 with the INNS American slipper limpet *Crepidula fornicata* in Unit 3. *A. modestus* was also observed in the field at SSSI Units 1 and 75 at Newtown Harbour, which were situated on the coastline.

Both of these species were also found in the laboratory samples, along with several other non-native and cryptogenic species (i.e. possibly non-native but of uncertain origin). The clay-boring polychaetes *Boccardia proboscidea* and *Desdemona ornata* are fairly recent arrivals. The polychaete genus *Streblospio* includes a non-native species (*S. benedicti*) that is very similar to the native *S. shrubsolii* and external confirmation would be desirable. The sea spider *Ammothea hilgendorfi*, the ostracod crustacean *Eusarsiella zostericola*, the amphipod crustacean *Grandidierella japonica*, the bryozoan *Tricellaria inopinata* and the Manila clam *Ruditapes philippinarum* are also non-native.

The polychaetes *Polydora cornuta, Protocirrineris* sp., *Aphelochaeta marioni, Tharyx* 'sp. A' and *Cossura pygodactyla*, the amphipod crustacean *Monocorophium acherusicum*, the tanaid crustacean *Zeuxo holdichi* and the colonial ascidian *Botryllus schlosseri* are not known for certain to be non-native, but their pattern of distribution and habitat preference suggest that they may be, and they can be considered cryptogenic.

3.6 Anthropogenic pressures

3.6.1 Langstone Harbour SSSI

During the survey extensive bait-digging activity was noted within SSSI Units 6, 9, 10 and 13 within the Langstone Harbour SSSI. APEM staff noted the bait digging to be the predominant anthropogenic impact in the harbour.

As the entire area is a harbour there were a large number of recreation and fishing vessels beached on the muddy shores. To the north of the harbour in Unit 6 close to the border of Unit 13 the area was observed to be used for launching kayaks and personal water craft. A number of outfalls were noted across the harbour, although it was unclear whether these were industrial in nature or for runoff and rainwater overflow.

3.6.2 Ryde Sands and Wootton Creek SSSI

Within Wootton Creek significant boating activity was observed with also a large number of vessels moored up. These appeared to primarily be small recreational craft. Within Ryde Sands Units 7, 11 and 12 anthropogenic influences were limited, because the land is primarily private. Across Units 13 through 17 anthropogenic influences and activity were very high as these are the primary tourist beaches. Use of the beaches by the public was also increased during the surveys as they were undertaken across a bank holiday weekend. There were numerous beach users, dog walkers and people using metal detectors for archaeological purposes.

3.6.3 Newtown Harbour SSSI

A large number of moorings were observed between Unit 13/24 and Unit 41/67 and into Unit 25 and Unit 32. Several disused wooden jetties were found at Units 17 and 19, the latter with some small recreation boats temporarily moored there. At Unit 8 there was a disused pontoon, jetty for mooring, public footpath and surveyed bird breeding sites.

At Unit 25 there was boat mooring and also it was home to Shalfleet Quay. Scout camp water activities were also observed. Similarly Unit 40 was home to Newtown Quay and a range of water activities.

The only presence of any livestock in the SSSI was recorded in Unit 32. Flooded farmland was found at Unit 41 along with a seawall and also several bird hides.

A road and bridge was recorded at Units 32 to 33 and Units 80 and 19. Unit 57 housed a private mooring and derelict boat.

Units 59, 66, 67 and 75 are all within the Ministry of Defence (MOD) firing range. Unit 67 also possessed an oyster fishery and a disused wooden jetty whilst a bridge and footpath were noted in Unit 59.

4. Preliminary condition assessment

4.1 Comparison with historic data

Previous surveys have been conducted within the Solent over the last ten years to assess and monitor the intertidal marine habitats present. Surveys have encompassed Langstone Harbour SSSI and Newtown Harbour SSSI and these are discussed further below with respect to the relevant SSSIs (ERT, 2006; CMACS, 2012). No WFD benthic sample data were available for Newtown Harbour. No historic survey data were available for Ryde Sands and Wootton Creek SSSI.

4.1.1 Langstone Harbour SSSI

ERT Scotland Ltd (ERT, 2006) was commissioned to undertake Phase 1 and Phase 2 coring surveys of the intertidal sediments of Langstone Harbour as part of a wider survey of the Solent Maritime SAC. The sampled transects within Langstone Harbour ranged from predominantly sand at the entrance to mud in the innermost reaches, often including cobbles, pebbles and boulders. Sediments were generally muddier in the channels, with coarser sandier sediments towards the top of the shore. The main taxa identified included the lugworm *A. marina*, the mud snail *P. ulvae*, the cockle *C. edule*, *F. vesiculosus* and the green alga *Ulva* spp. (previously *Enteromorpha* spp.) (Table 14 and Table 15). Mobile fauna such as shore crabs and the winkle occurred frequently around the harbour. The estuarine mud biotope and the mixed sediment biotope were the most commonly recorded, and were present throughout the basin between the mid and lower shore levels.

The Centre for Marine and Coastal Studies Ltd (CMACS) carried out a repeat condition monitoring survey of the intertidal features within the Solent Maritime SAC in 2012 (Phase I and Phase II survey data), including Langstone Harbour but did not cover the area near Ryde on the Isle of Wight (as this is not within the SAC). Langstone Harbour was characterised by mud habitats throughout the majority of the area but with some areas of coarse mixed sediment on the upper shore which supported a wide variety of macroalgae and had signs of bait digging. Algal mats were prevalent in Langstone Harbour and seagrass was also extensive. The fauna of the samples from Langstone Harbour was dominated by cirratulids, oligochaetes and *P. ulvae*.

Details of the top ten taxa and their abundances recorded during the current survey and previous surveys are presented in Table 14 and Table 15, and these data suggest that the predominant faunal taxa within the communities have not changed significantly since the CMACS survey in 2011. CMACS (2012) indicated the faunal community was dominated by the annelid *T. killariensis*, the oligochaete *T. benedii* with abundant nematodes and *P. ulvae* (Table 14). These trends were consistent with the data from the current survey although there were some slight differences in the overall abundances. The results of the previous survey, however, suggest that there has been a slight reduction in diversity. In CMACS (2012), core samples were relatively rich ranging from 26 to 40 taxa at each station which was higher than observed in the current data set which had a mean number of taxa between 8.7 and 29. The most abundant taxa were found to be consistent across the CMACS (2012) data set and the current survey with *Tharyx*, *Aphelochaeta* and *Tubificoides* spp. all found in high abundances along with *P. ulvae* and nematode worms (Table 14 and Table 15).

Comparison with regards to the ERT (2006) report findings for taxon diversity and abundance (Tables 14-16) also indicated similar taxa to be present as for both the current and CMACS (2012) survey. There was some evidence of potential disturbance evidenced through the abundance of *Capitella capitata* in Units 6 and 14, for which there was no evidence within the current survey data, perhaps suggesting an improvement in the quality of the environment at those locations. CMACS (2012) also noted that *Capitella* often do well in hypoxic conditions often where algal mats may dominate habitats and limit oxygen exchange and bioturbation. Species abundances in the ERT data were also generally comparable to the current report findings and further compliment the CMACS report, which indicated little change between sampling in 2005 to 2011. Overall, comparison with the ERT historical data suggests relatively little change over the last 10 years in the intertidal communities of Langstone Harbours SSSI.

Biotope composition was also assessed as part of the CMACS (2012) report, although coverage was more limited (only four transects sampled) than the coverage of the current survey. On the eastern side of the harbour SSSI, CMACS (2012) recorded a mixed sediment habitat supporting dense growth of algae, mainly *Fucus serratus* and *Fucus vesiculosus* but with some *Chondrus crispus* and *Ulva* spp. (A1.3152 /LR.LLR.F.Fserr.X). The current survey found the sediments to be much finer in nature and with little algae present.

The biotope composition of the three remaining transects was more comparable with the findings of the current survey, with the littoral zone comprised of very fine sediment with *Arenicola marina, P. ulvae, L. saxatilis* and *C. edule* (A2.31/LS.LMu.MEst) and often with a thick covering of ephemeral green algae. On the eastern side of the harbour, extensive seagrass beds were recorded which is consistent with the current survey.

With regards to anthropogenic influences, bait digging was observed during the ERT (2006) and CMACS (2012) studies of the Langstone Harbour SSSI and during the current survey.

Table 14: Langstone Harbour SSSI 2015 top ten taxa for Units 6 and 9 historical data comparison. Abundance = mean no. individuals m^2

SSSI Unit 6					
APEM 2015		ERT 2006*		CMACS 2012	
Taxa	Abundance	Taxa	Abundance	Taxa	Abundance
Nematoda	76133	*Tubificoides benedii*	15500	Nematoda	131600
Tubificoides benedii	9933	*Abra tenuis*	4067	*Tharyx killariensis*	122200
Peringia ulvae	1933	*Capitella capitata (agg)*	3533	*Tubificoides benedii*	41400
Cirriformia tentaculata	1467	*Pygospio elegans*	2500	*ulvae*	12800
Melita palmata	1167	*Manayunkia aestuarina*	1400	*Elminius modestus*	8600
Aphelochaeta marioni	700	*Sabellidae spp juv*	700	*Ampharete acutifrons*	4900
Tubificoides galiciensis	700	*Streblospio shrubsolii*	667	*Aphelochaeta sp.*	1900
Capitella	567	*Tubificoides pseudogaster (agg)*	650	Copepoda	1500
Tharyx "species A"	267	*Anaitides mucosa*	500	*Chaetozone gibber*	1300
Aoridae	267	*Peringia ulvae*	333	*Galathowenia oculata*	1300
SSSI Unit 9					
APEM 2015		ERT 2006*		CMACS 2012	
Taxa	Abundance	Taxa	Abundance	Taxa	Abundance
Tubificoides benedii	19400	*Peringia ulvae*	19167	*Tubificoides benedii*	78700
Peringia ulvae	5867	*Tubificoides benedii*	7567	*Peringia ulvae*	23700
Tharyx "species A"	3200	*Pygospio elegans*	1533	*Pygospio elegans*	12900
Pygospio elegans	667	*Tubificoides pseudogaster (agg)*	1167	Nematoda	8900
Ampharete aff. acutifrons	667	*Corophium arenarium*	233	Copepoda	8700
Streblospio	567	*Streblospio shrubsolii*	200	*Tharyx killariensis*	4700
Hediste diversicolor	433	*Anthozoa*	150	*Capitella capitata complex*	1900
Eteone longa	400	*Glycera tridactyla*	150	*Eteone longa/flava (agg.)*	1600
Nephtys hombergii	267	*Cerastoderma* spp. *juv*	133	*Abra tenuis*	500
Nematoda	233	*Cerebratulus* spp	100	*Diptera larvae*	400

*based on nearest location to APEM 2015 sampling. Core used for comparison was a mid-shore sample, as per shore height for APEM sample acquisition

Table 15: Langstone Harbour SSSI 2015 top ten taxa for Units 3 and 13 historical data comparison. Abundance = mean no. individuals m^2

SSSI Unit 3			
APEM 2015		**ERT 2006**	
Taxa	**Abundance**	**Taxa**	**Abundance**
Peringia ulvae	10767	*Peringia ulvae*	15500
Tubificoides benedii	3133	*Tubificoides benedii*	2667
Tharyx "species A"	3000	*Streblospio shrubsolii*	900
Ampharete aff. acutifrons	667	*Ampharete grubei*	400
Nematoda	167	*Cerastoderma edule*	400
Phyllodoce mucosa	133	*Tharyx sp*	333
Glycera tridactyla	67	*Pygospio elegans*	167
Hediste diversicolor	67	*Melinna palmata*	150
Nephtys hombergii	67	*Nereididae spp juv*	100
Melinna palmata	67	*Nephtys hombergii*	100
SSSI Unit 14			
APEM 2015		**ERT 2006**	
Taxa	**Abundance**	**Taxa**	**Abundance**
Peringia ulvae	15167	*Tubificoides benedii*	51167
Tharyx "species A"	900	*Peringia ulvae*	3067
Austrominius modestus	800	*Tharyx* sp	2567
Tubificoides benedii	667	*Pygospio elegans*	1767
Hediste diversicolor	400	*Streblospio shrubsolii*	367
Ampharete aff. acutifrons	267	*Tubificoides pseudogaster*	367
Littorina littorea	267	*Melinna palmata*	300
Nematoda	200	*Ampharete grubei*	167
Nephtys hombergii	67	*Manayunkia aestuarina*	167
Ulva spp.	67	*Capitella capitata*	133

*based on nearest location to APEM 2015 sampling. Core used for comparison was a mid-shore sample, as per shore height for APEM sample acquisition

4.1.2 Newtown Harbour SSSI

As part of the survey of the Solent Maritime SAC, ERT Scotland Ltd undertook Phase 1 and Phase 2 surveys across one transect within Newtown Harbour (in Causeway Lake) (ERT, 2006). This transect was characterised by an intertidal muddy sand biotope with the upper shore characterised by stony substratum dominated by a narrow band of *F. ceranoides*. A second transect was surveyed on the open coast area of the Newtown Harbour SSSI, which was characterised by mixed sediments and large boulders with a dense canopy of *F. vesiculosus*.

During the CMACS survey of the Solent Maritime SAC in 2011, one transect was surveyed inside Newtown Harbour and this was characterised by an estuarine mud biotope with *C. edule* and *P. ulvae* visible in the sediment and an algal mat covering most of the muddy part of the shore (CMACS, 2012). On the upper shore, just below the saltmarsh was an area of muddy sand with numerous *A. marina*, *P. ulvae* and gammarid amphipods. On the eastern spit separating the harbour from the open sea there was a low-lying area of muddy gravel and pebble with growth of *F. spiralis, F. serratus* and *F. vesiculosus* as well as filamentous green algae in standing water along with *P. ulvae* and *L. saxatilis*. On the open coastline of Newtown Harbour SSSI in Unit 75 a second transect was surveyed, which was characterised by large coarse particles on the upper shore supporting growth of brown and green algae and paddock-bored clay platforms overlain with sediment on the mid- low shore.

CMACS (2012) found that the few cores taken inside Newtown Harbour (i.e. not beyond the harbour mouth to the sea)were from a soft mud habitat and cirratulid polychaetes dominated the fauna. The taxa *Aphelochaeta* sp., *T. killariensis* and the oweniid *Galathowenia oculata* were present in relatively large numbers; however, nematodes and *P. ulvae* were present in low numbers compared to samples from Langstone Harbour SSSI. The top ten taxa and their abundances recorded in Newtown Harbour during the current survey and previous surveys are provided in Table 16. These data indicate some variation from the current findings in terms of overall abundance of individual taxa, likely reflecting natural variability but overall similar taxa are present. Taxon abundance varied across surveys with up to 35 taxa per core recorded during the previous survey (CMACS, 2012), however, far fewer stations were targeted compared to the current survey which had much greater coverage across SSSI units. A direct comparison between samples acquired from the same locations in the current survey (SSSI Units 67 and 75) indicates that total taxa per core ranged from 11 to 48 taxa. Overall, the data suggests that there is considerable natural variability within the communities in Newtown Harbour and that in some areas biodiversity is higher than previously recorded. This is supported by the findings of EA WFD IQU assessment for Newtown Harbour which also recorded biological variability between SSSI units (EA, 2015).

Previous survey data relating to biotope extent and distribution are limited with biotope information available for two transects sampled in 2005 (ERT 2006) and 2011 (CMACS 2012). Comparison with the CMACS transects from 2011 indicates that along the open coastline the biotopes recorded during the current survey comprised of finer sediments and had less algal coverage. Inside the Harbour the remaining CMACS transect found sediments to be primarily muddy and supporting a range of polychaetes, which was a similar habitat to that recorded during the present survey.

The ERT (2006) survey undertook a transect near Causeway Lake, which was characterised by an intertidal muddy sand biotope with the upper shore characterised by stony substratum dominated by a narrow band of *Fucus ceranoides*. Comparison with the current survey suggests a similar lower shore biotope but during the current survey the upper shore was dominated by saltmarsh biotopes, possibly indicating some encroachment into the intertidal zone. The second transect on the open coast area of the Newtown Harbour SSSI (Unit 75), was characterised by mixed sediments and large boulders with a dense canopy of the wrack *F. vesiculosus*. This transect was located towards the eastern most edge of the SSSI and comparable habitats were observed during the current survey.

Table 16: Newtown Harbour SSSI 2015 top ten taxa historical data comparison. Abundance = mean individuals m^2 ± Standard Deviation (where applicable).

SSSI Unit 40			
APEM 2015*		**ERT 2006**	
Taxa	**Abundance**	**Taxa**	**Abundance**
Peringia ulvae	34167 ± 2381	*Peringia ulvae*	55700
Tubificoides benedii	33167 ± 2121	*Aphelochaeta spp*	10000
Capitella	7833 ± 731	*Tubificoides benedii*	9000
Nematoda	3333 ± 1014	*Mediomastus fragilis*	5300
Chironomidae	1867 ± 896	*Aoridae spp indet (female)*	3800
Abra tenuis	1667 ±684	*Melinna palmata*	3200
Malacoceros tetracerus	967 ±778	*Scoloplos armiger*	3000
Turbellaria	600 ±613	*Microdeutopus gryllotalpa*	1200
Scoloplos armiger	400 ± 660	*Anaitides mucosa*	700
Tubificoides pseudogaster	333± 118	*Abra tenuis*	600
SSSI Unit 75			
APEM 2015		**CMACS 2012**	
Taxa	**Abundance**	**Taxa**	**Abundance**
Protocirrineris	1683	*Aphelochaeta sp. Agg.*	106500
Nematoda	1500	*Tharyx killariensis*	21700
Dipolydora coeca	950	*Galathowenia oculata*	16700
Grandidierella japonica	817	*Tubificoides benedii*	6300
Galathowenia oculata	633	*Tubificoides swirencoides*	6300
Mediomastus fragilis	617	*Nematoda spp.*	3900
Parexogone hebes	550	*Mediomastus fragilis*	3900
Scoloplos armiger	467	*Oligochaeta spp.*	2300
Aricidea minuta	467	*Capitella capitata complex*	1300
Perinereis cultrifera	450	*Ampharete acutifrons*	1000

*mean values based on multiple survey stations

4.2 Condition recommendation tables

Overleaf, APEM provides a preliminary condition assessments for the three SSSIs based on the attribute targets for the relevant sub-features detailed for the Solent Maritime SAC. The condition recommendation incorporates a comparison of the new data with the historic findings (Table). Where suitable historic data was available APEM has detailed whether the Conservation Objective (CO) target for a given attribute is judged to have been met. Where insufficient data were available to make such an assessment, this has also been noted and PAEM has highlighted that the current survey findings provide detailed baseline data upon which future surveys can compare findings.

It should be noted that Ryde Sands & Wootton Creek is not part of the Solent SAC but updated Feature Condition Tables for the SSSI and updated conservation advice (SATs) for the Solent & Southampton Water SPA are not yet available so the SAC Reg 33 attributes and targets have been used to assess the SSSI feature / SPA supporting habitat condition.

Table 17: Site-specific standards defining favourable condition for attributes of Intertidal mudflats and sandflats habitats/sub-features within the Solent Maritime SAC (inclusive of all surveyed SSSIs). Only attributes for which new evidence was obtained in the 2014/2015 field investigations have been included in the pre-assessment exercise.

Attribute (Measures)	Site Specific Target	Condition and Recommendation
Extent Area (ha) of intertidal mudflats, measured periodically during the reporting cycle (frequency to be determined).	No decrease in extent from an established baseline, subject to natural change.	**Langstone Harbour:** The Harbour was found to be dominated by large areas of mudflats with numerous soft sediment biotopes mapped. The general distribution of broad habitat was comparable to the evidence found by the CMACS (2012) survey, although CMACS survey coverage was very limited. However, it is not possible to provide conclusive determination of change in biotope extent due to different areas sampled and survey effort between previous surveys and the current work. Although the data may not allow for a precise comparison, it is highly likely that the character and extent of the mudflat sub-features have remained within the range of natural variability. Consequently the **CO target for this attribute is judged to have been met**. However, without previous data enabling a robust comparison the confidence on this assessment is low. **Ryde Sands and Wootton Creek:** No historical data available to make an assessment of change. The current findings therefore establish a new **baseline for future assessments.** **Newtown Harbour:** The Harbour was found to be dominated by large areas of mudflats with numerous areas of soft sediment biotopes. However, on the outer areas of the harbour along the open coastline, sandier sediments were more prevalent. The general distribution of broad habitat was comparable to the results of the CMACS (2012) survey, although CMACS survey coverage was very limited. Although it is not possible to provide conclusive determination of change in extent, it is highly likely that the character and extent of the mudflat sub-features have remained within the range of natural variability. Consequently the **CO target for this attribute is judged to have been met**. However, without previous data enabling a robust comparison the confidence on this assessment is low.
Intertidal mud Communities Range and distribution of characteristic mud biotopes e.g. LMu biotopes.	Range and distribution of biotopes measured during reporting cycle should not deviate from an established baseline, subject to natural change.	**Langstone Harbour:** Intertidal mud biotopes were found to dominate across almost all of Langstone Harbour. A2.312 (LS.LMu.MEst.HedMac), A2.31 (LS.LMu.MEst) variant and A2.311 (LS.LMu.MEst.NhomMacStr) variant dominated the muddy biotope communities. The general distribution of broad habitat was comparable to the evidence found by the CMACS (2012) survey, although the CMACS survey coverage was very limited. Consequently the **CO target for this attribute is judged to have been met**. However, without previous data enabling a robust comparison the confidence on this assessment is low. **Ryde Sands and Wootton Creek:** Muddy biotopes were present throughout Wootton Creek, but largely absent from Ryde Sands. Within Wootton Creek mud biotopes covered almost 100% of Units 1 to 6 (A2.3223/LS.LMu.UEst.Hed.Ol). No historical data available to make an assessment of change. The current findings therefore establish a **new baseline for future assessments.** **Newtown Harbour:** The general distribution of broad habitats was comparable to the evidence found by the CMACS (2012) survey, although CMACS survey coverage was very limited. Consequently the **CO target for this attribute is judged to have been met**. However, without previous data enabling a robust comparison the confidence on this assessment is low.
Intertidal mixed sediment communities Range and distribution of characteristic mixed sediment biotopes e.g. LMx biotopes.	Range and distribution of biotopes measured during reporting cycle should not deviate from an established baseline, subject to natural change.	**Langstone Harbour:** Mixed sediment biotopes were recorded in Units 6 (A2.421 /LS.LMx.Mx.CirCer variant) and 11 (A2.4/LS.LMx variant). In Unit 6 this indicated an apparent change from A1.3152 (LR.LLR.F.Fserr.X) in the previous survey (CMACS, 2012). Consequently the **CO target for this attribute is judged to have been met**. However, without previous data enabling a robust comparison the confidence on this assessment is low. **Ryde Sands and Wootton Creek:** Mixed sediment biotope only recorded in Unit 1. No historical data available to make an assessment of change. The current findings therefore establish a **new baseline for future assessments.** **Newtown Harbour:** Mixed sediment biotopes comprised only a small proportion of the biotope coverage across Newtown Harbour and was present in Units 8, 19, 29 and 75, typically as LS.LMX. Historical data found little presence of mixed sediments at the two targeted sampling

Attribute (Measures)	Site Specific Target	Condition and Recommendation
		locations. Current survey findings at the same locations also indicated little in the way of mixed sediment communities. Consequently the **CO target for this attribute is judged to have been met**. However, without previous data enabling a robust comparison the confidence on this assessment is low.
Intertidal muddy sand Communities Range and distribution of characteristic sand and gravel biotopes e.g. LMs biotopes.	Range and distribution of biotopes measured during reporting cycle should not deviate from an established baseline, subject to natural change.	**Langstone Harbour:** Sediments were found to almost be exclusively muddy in nature with gravel and sand virtually absent. An occasional area of barren shingle was observed. Previous data supports that the harbour primarily consisted of fine, rather than coarse sediments. Consequently the **CO target for this attribute is judged to have been met**. However, without previous data enabling a robust comparison the confidence on this assessment is low. **Ryde Sands and Wootton Creek:** Sand biotopes were found extensively within Ryde Sands, between Units 7 and 17. No historical data available to make an assessment of change. The current findings therefore establish a new **baseline for future assessments.** **Newtown Harbour:** There was little in the way of gravel biotopes or supported faunal assemblages in Newtown Harbour. Sandy sediment biotopes were present beyond the harbour mouth (Units 1 and 75). Limited historical data prevents detailed comparison but intertidal sand communities were present along the coastline in previous surveys suggesting any change is probably just natural variation. Consequently the **CO target for this attribute is judged to have been met**. However, without previous data enabling a robust comparison the confidence on this assessment is low.
Extent (m^2) of *Zostera* beds.	No decrease in extent from an established baseline subject to natural change.	**Langstone Harbour:** Extensive *Zostera* beds recorded in current survey in south east and central north of harbour (102.8 Ha total coverage). The general distribution of *Zostera* beds was comparable to the evidence found by the CMACS (2012) survey, although CMACS survey coverage was limited. Comparison of coverage with data held by Marsden & Scott, 2015) suggested a slight reduction in coverage but this was within the levels anticipated for natural change, given that the data provided covered the period 2006-2014. There appears to therefore have been no change and consequently the **CO target for this attribute is judged to have been met.** Historical data enables a medium confidence on this assessment. **Ryde Sands and Wootton Creek:** Extensive *Zostera* bed recorded in current survey across Unit 12 and 13 (53.5 Ha). Comparison of coverage with that from Marsden & Scott, 2015) indicates that has been little of any change in coverage and consequently the **CO target for this attribute is judged to have been met.** Historical data enables a medium confidence on this assessment. **Newtown Harbour:** No *Zostera* beds recorded during current survey. No presence of *Zostera* beds in historical data. There appears to therefore have been no change and consequently the **CO target for this attribute is judged to have been met.** However, without previous data enabling a robust comparison the confidence on this assessment is low.
Nutrient enrichment - macroalgal mats	Extent and cover of macroalgal mats, measured in the summer during the reporting cycle (frequency to be determined). Average abundance of macroalgal mats should not increase from an established baseline, subject to natural change.	**Langstone Harbour:** Algal mats were observed across areas of finer sediment within the harbour, but extent was difficult to assess accurately in the field. Previous reports note significant areas of algal mats within very specific sampling locations. Therefore it is not possible to provide conclusive assessment of change. Therefore, the preliminary assessment for this attribute is unknown. **Ryde Sands and Wootton Creek:** No historical data available to make an assessment of change. Therefore, the preliminary assessment for this attribute is unknown. **Newtown Harbour:** Algal mats were observed in previous reports at specific sampling locations, but there was inconclusive data for the majority of the harbour. Therefore it is not possible to provide conclusive assessment of change. Therefore, the preliminary assessment for this attribute is unknown.
Sediment character 1. Particle size analysis (PSA). Parameters include percentage sand/silt/gravel, mean and median grain size, and sorting coefficient, used to characterise	Average PSA parameters should not deviate significantly from the baseline, subject to natural change.	**Langstone Harbour:** Sediments within the harbour were found to primarily comprise of a high percentage of mud with some sand content, although stations L6 and L7 were found to be more gravelly in nature. This was broadly comparable with the findings of the CMACS (2012) survey which identified sediments as sandy mud, although sampling was much less extensive in the CMACS survey. Consequently the **CO target for this attribute is judged to have been met**. However, without previous data enabling a robust comparison the confidence on this assessment is low. **Ryde Sands and Wootton Creek:** Sand content was very high at Ryde with very little or no mud or fine sediments. At the stations in Wootton Creek the percentage muds was much higher than sand and stations were typically either classed as Gravelly mud, Slightly gravelly mud or

Attribute (Measures)	Site Specific Target	Condition and Recommendation
sediment type. Measured in summer, once during the reporting cycle.		Sandy mud. No historical data available to make an assessment of change. Therefore, the preliminary assessment for this attribute is unknown. The current findings therefore establish a new **baseline for future assessments.** **Newtown Harbour:** PSA parameters indicated sediment composition to generally be sandy mud at the majority of sampling locations and especially across the creek and channel areas. Select locations displayed increased sand and gravel content e.g. Unit 66, typically on the upper shore. Historical data is limited, but where such data were available they indicated sediments were also fine and muddy in nature. Consequently the **CO target for this attribute is judged to have been met.** However, without previous data enabling a robust comparison the confidence on this assessment is low.
4. Oxidation – reduction potential. Depth of black anoxic layer. Measured periodically during the reporting cycle (frequency to be determined).	Average black layer depth should not deviate significantly from an established baseline, subject to natural change.	No previous findings were available regarding depth of the anoxic layer (CMACS, 2012). Therefore, the preliminary assessment for this attribute is unknown. The current findings therefore provide a **baseline for all future assessments.** **Langstone Harbour:** Phase I evidence supports the view of a very shallow redox potential discontinuity (RPD) layer, for all the sampled SSSI units. The evidence suggests anoxic muds are present across much of the SSSI. **Ryde Sands and Wootton Creek:** There was a notable variation in anoxic depth between those SSSI units in Wootton Creek and those at Ryde Sands. Within the creek, the RPD was very shallow, indicating potential anoxic muds. However, from Unit 11 eastwards the anoxic depth was shown to be very deep, often >10cm, suggesting well oxygenated sediments. **Newtown Harbour:** Phase I survey evidence established that anoxic depth was generally <5cm across the SSSI. Occasionally the depth was found to be very shallow (<2cm) and on occasion much deeper (up to 10cm).

5. Discussion

For Langstone Harbour SSSI, sampling stations were found to primarily comprise of a high percentage of mud with some sand content, although stations L6 and L7 were found to be more gravelly in nature. Sand content was very high at Ryde with very little or no mud of fine sediments. At the stations in Wootton Creek the percentage muds was much higher than sand and stations were typically either classed as Gravelly mud, Slightly gravelly mud or Sandy mud. In Newtown Harbour most sampling stations possessed little gravel material with a general trend towards more muddy sediments with some sand.

The gastropod mollusc *Peringia ulvae* was found to be by far the most abundant species across the samples collected, contributing over 30% of total invertebrate abundance. Nematode worms, several annelid polychaetes (*Tharyx "*species A", *Capitella* and *Praxillella affinis*) and the oligochaete *Tubificoides benedii* comprised the majority of the remaining invertebrate abundance across the whole survey.

P. ulvae and *T. benedii* are typical characterising species of intertidal mud habitats (Connor *et al.,* 2004). The distribution of oligochaetes is strongly influenced by salinity and substratum and *T. benedii* is often dominant in variable salinity mud habitats (Birtwell & Arthur, 1980). Similarly, *P. ulvae* often dominates estuarine mud habitats and may have patchy abundance due to its movement up and down the shore (Fretter & Graham, 1978). Nematoda also have patchy distributions and different species dominate in different habitats but many nematode species are typically abundant on estuarine mud. *Capitella* is known to be an indicator of organic enrichment, mainly on lower shore and subtidal mud (Borja *et al.,* 2000), although no significant organic enrichment was observed by field staff. APEM scientists have previously observed *Tharyx* "species A" to be abundant in variable salinity mud on the lower shore and subtidal (Worsfold, 2006) although it may be the same taxon as the recently described *T. robustus* (Blake & Goransson, 2015). *Praxillella affinis* is mainly subtidal but APEM's marine taxonomists and field staff have witnessed it dominate on some extreme lower shore muds (pers. obs.).

Overall, given the varying nature of sediment composition, the intertidal areas within the SSSIs were found to be reasonably diverse, but with some slightly impoverished areas. Abundance of individuals was relatively high, but abundance was generally dominated by specific taxa, with other taxa present in low abundance. Benthic invertebrate communities were therefore relatively rich, but not evenly distributed across sampling stations.

No protected or nationally rare taxa were recorded during the survey, although several species of interest were found to be present including *P. balanoglossoide and P. formica.* Several commercially valuable taxa were also noted, including brown shrimp and cockles.During the field survey of Langstone Harbour the presence of the invasive, non-native species *A. modestus* was recorded in SSSI Units 3, 6, 7 and 10 with *C. fornicata* in Unit 3. *A. modestus* was also observed in the field at SSSI Units 1 and 75 at Newtown Harbour.

Significant anthropogenic disturbance was noted to occur through units along the eastern side of Langstone Harbour SSSI, in the form of bait digging. A range of recreational activities such as personal water craft were present across all SSSIs. There was significant human impact at Ryde Sands across the intertidal areas in Units 13 through 17 which are key tourist beaches.

Comparison of historical data and the current survey findings within Langstone Harbour indicated that the composition of much of the harbour has remained similar. The faunal data indicated that the same dominant taxa found previously were prevalent during the current survey. It was difficult to extensively compare the biotope composition, given the limited biotope mapping available from previous surveys. However, much of the harbour continues to consist of fine sediment supporting a variety of polychaete assemblages. Saltmarsh and *Z. noltii* biotopes were recorded during the CMACS (2012) and current surveys. Overall, much of the harbour has seen relatively little change, although it is considered that variation in environmental conditions and natural change over time has resulted in some changes at finer scales with shifts in some community assemblages.

Within Ryde Sands and Wootton Creek SSSI a total of 22 different biotopes (including variants) were recorded. Within Wootton Creek there was little biotope variation, being predominantly A2.3223 (LS.LMu.UEst.Hed.Ol). Along the coastline of Ryde Sands, biotope variation was considerable, with a range of sandy sediments supporting differing benthic invertebrate communities e.g. A2.241 (LS.LSa.MuSa.MacAre). There were also patches of coarse substratum supporting algal species, typically A1.3132 (LR.LLR.F.Fves.X) and *Z. noltii* beds were present at Unit 13.

Within Newtown Harbour SSSI a total of 23 biotopes were identified. The Newtown Harbour coastline and beach areas to the harbour mouth (Units 1 and 75) were dominated by A2.231 (LS.LSa.FiSa.Po), A large proportion of the creeks and channels within the harbour consisted of A2.3 (LS.LMu) with saltmarsh biotopes dominating the upper shores, especially in the east. There were also several large areas of A2.323 "*Tubificoides* and other oligochaetes in littoral mud" (LS.LMu.UEst.Tben) within the centre of the SSSI. Other soft and hard sediment biotopes were found in patches, with increased macroalgae in some of the south western SSSI units.

No previous historical data were available for Ryde Sands and Wootton Creek SSSI. Historical data were also limited for Newtown Harbour SSSI, with only two locations sampled in 2005 and 2011 (ERT, 2006; CMACS, 2012). A broad comparison found that sediments and faunal communities appear to have remained broadly similar, although some variation has occurred over time. Consequently, at higher levels, biotope composition was found to be similar, although at a finer scale biotope variation was evident when comparing current and previous survey findings.

The overall initial condition assessment found that the condition of the SSSIs has remained similar to that recorded in previous surveys; however, confidence in the assessment is limited due to a lack of suitable historic data, with particularly limited coverage and a low number of sampling stations within both Langstone Harbour SSSI and Newtown Harbour SSSI. As no historic data were available for Ryde Sands and Wootton Creek SSSI it was not possible to assess change within this SSSI. Consequently, the current assessment enables a broad indication of condition based on previous data currently available, but going forward it provides more detailed quantitative data and biotope mapping baseline for each SSSI for future condition assessments.

It is recommended that future surveys continue to apply the same or similar sampling array and methods across these SSSIs as the extra coverage compared to previous surveys yielded greater detail and reliability of results and was also able to highlight subtle spatial variations in both physico-chemical and faunal characteristics. The sampling strategy applied during the current survey provides a fully repeatable method for future survey of the SSSIs to enable direct comparison of both qualitative and quantitative data, and this design will facilitate the application of robust statistical techniques for future assessments.

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Appendix 1 – Biotope mapping outputs

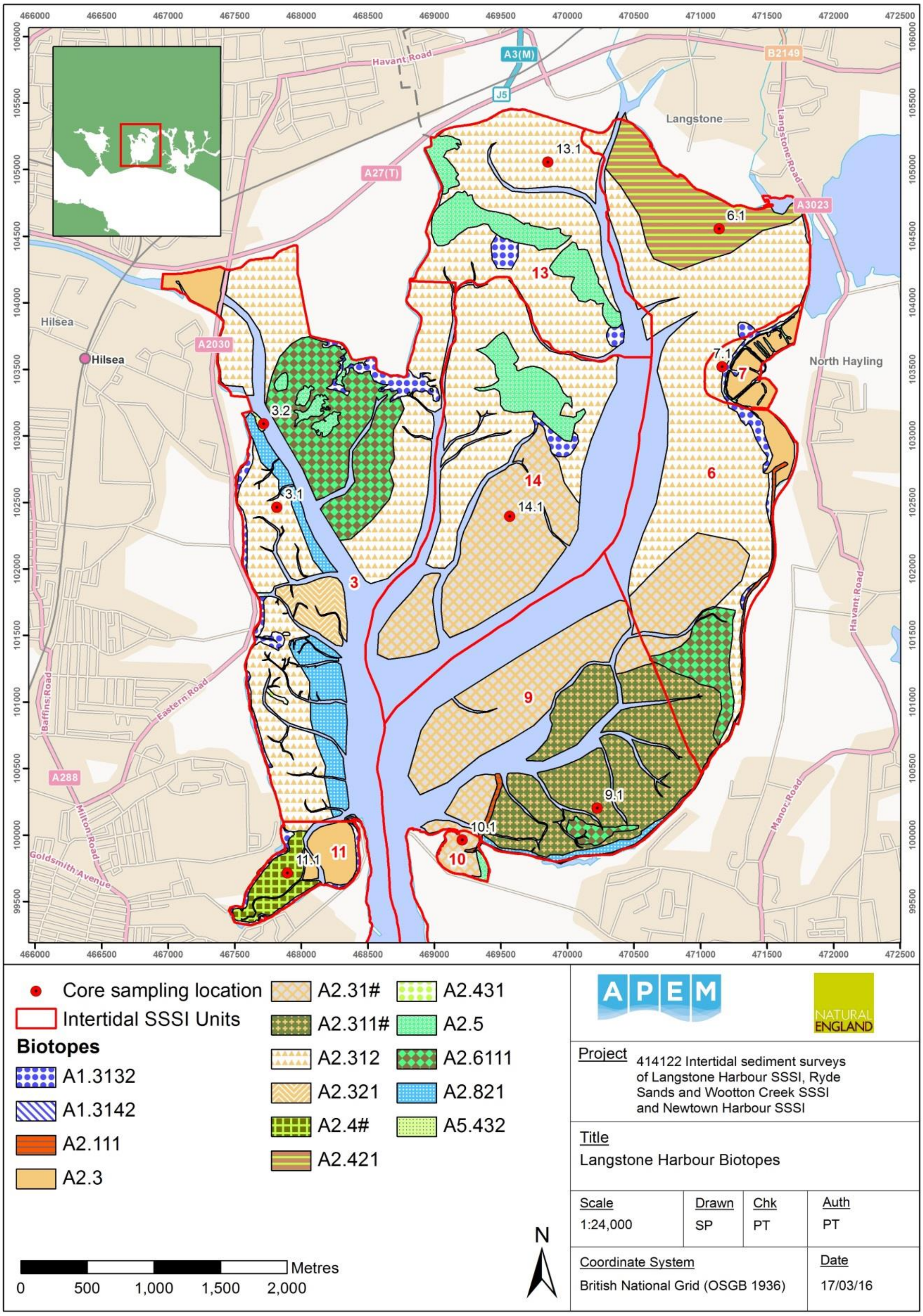

Figure A1.1: Distribution of biotopes across Langstone Harbour SSSI

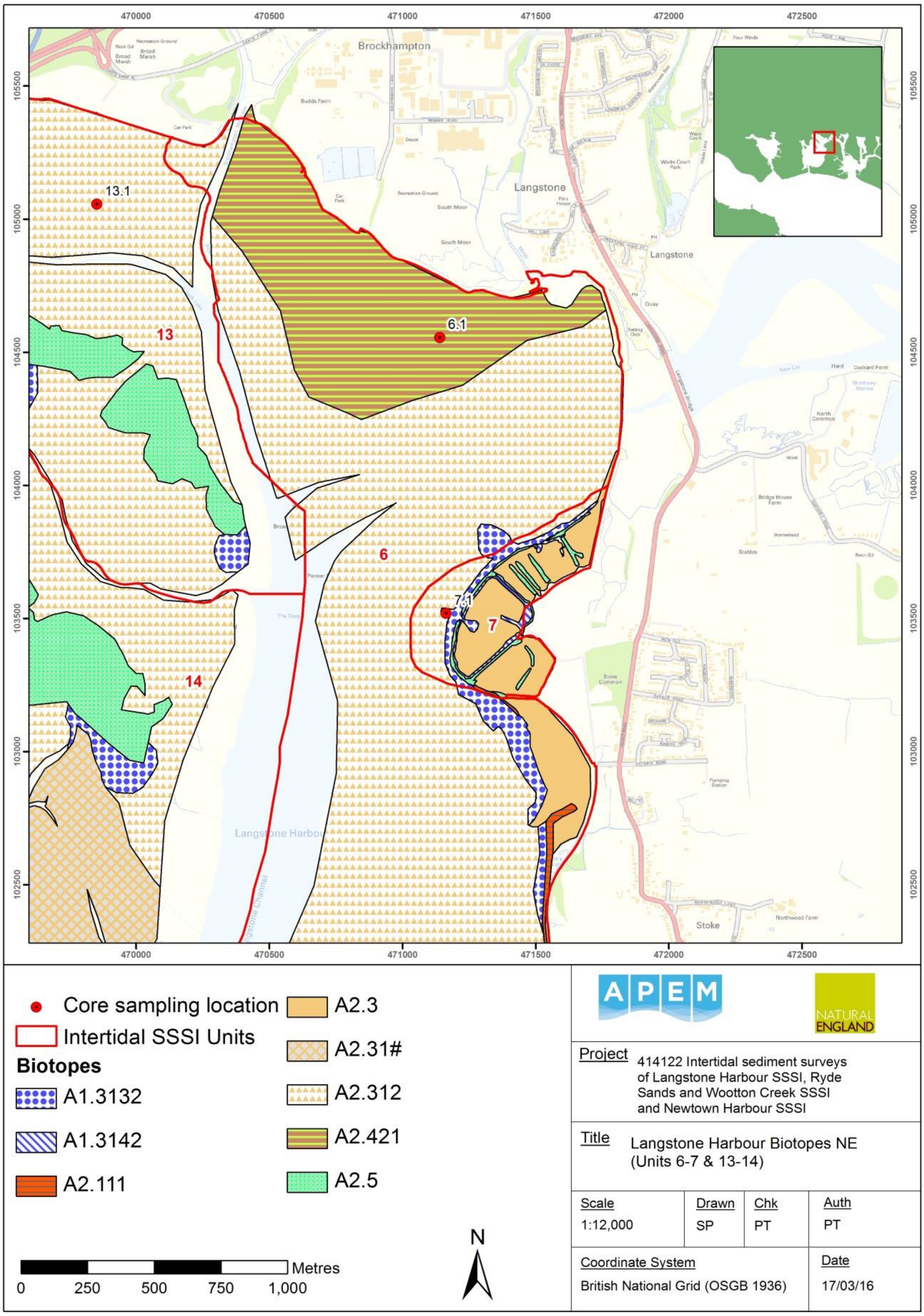

Figure A1.2: Distribution of biotopes across Langstone Harbour SSSI Units 6-7 and 13-14

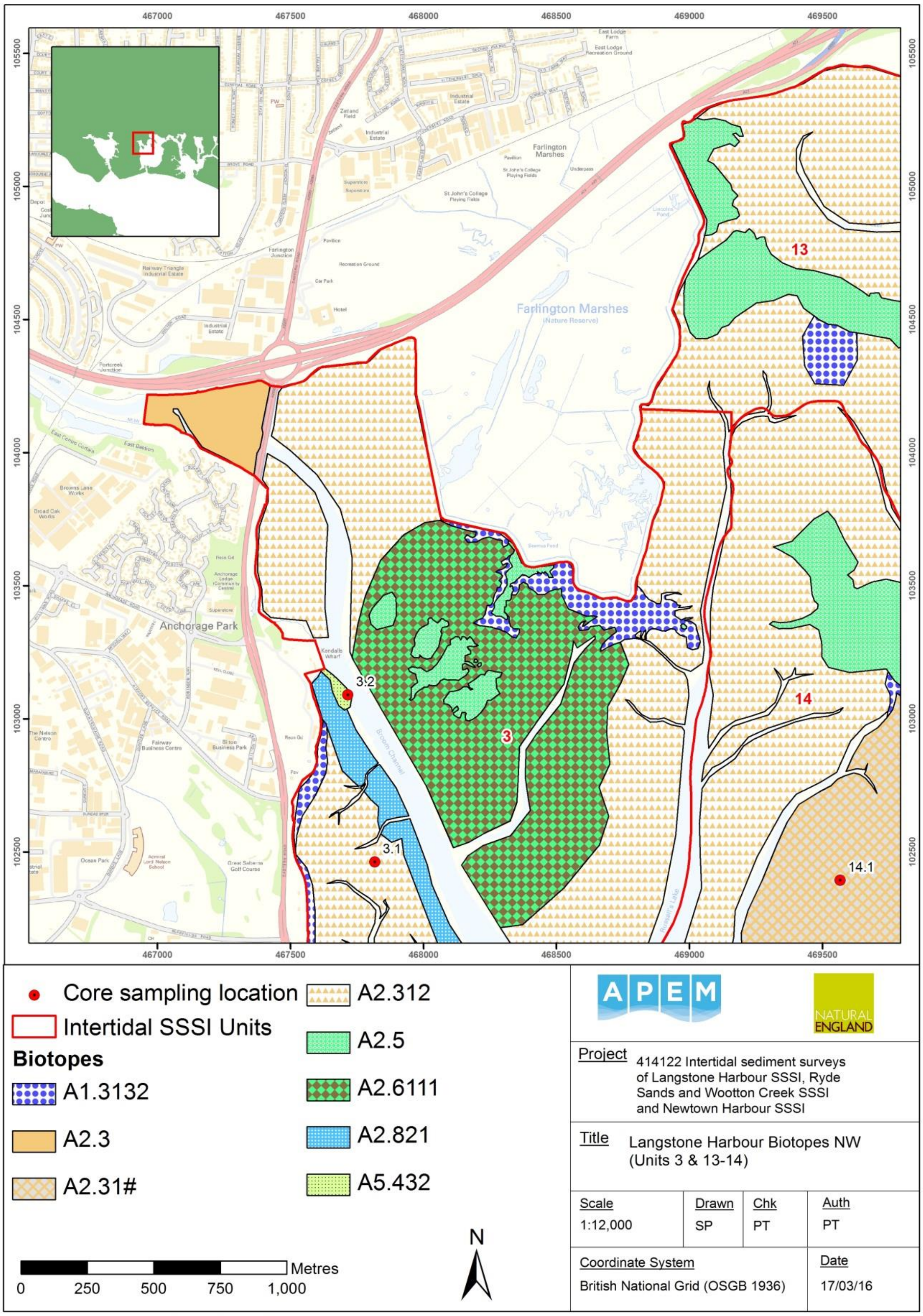

Figure A1.3: Distribution of biotopes across Langstone Harbour SSSI Units 3 and 13-14

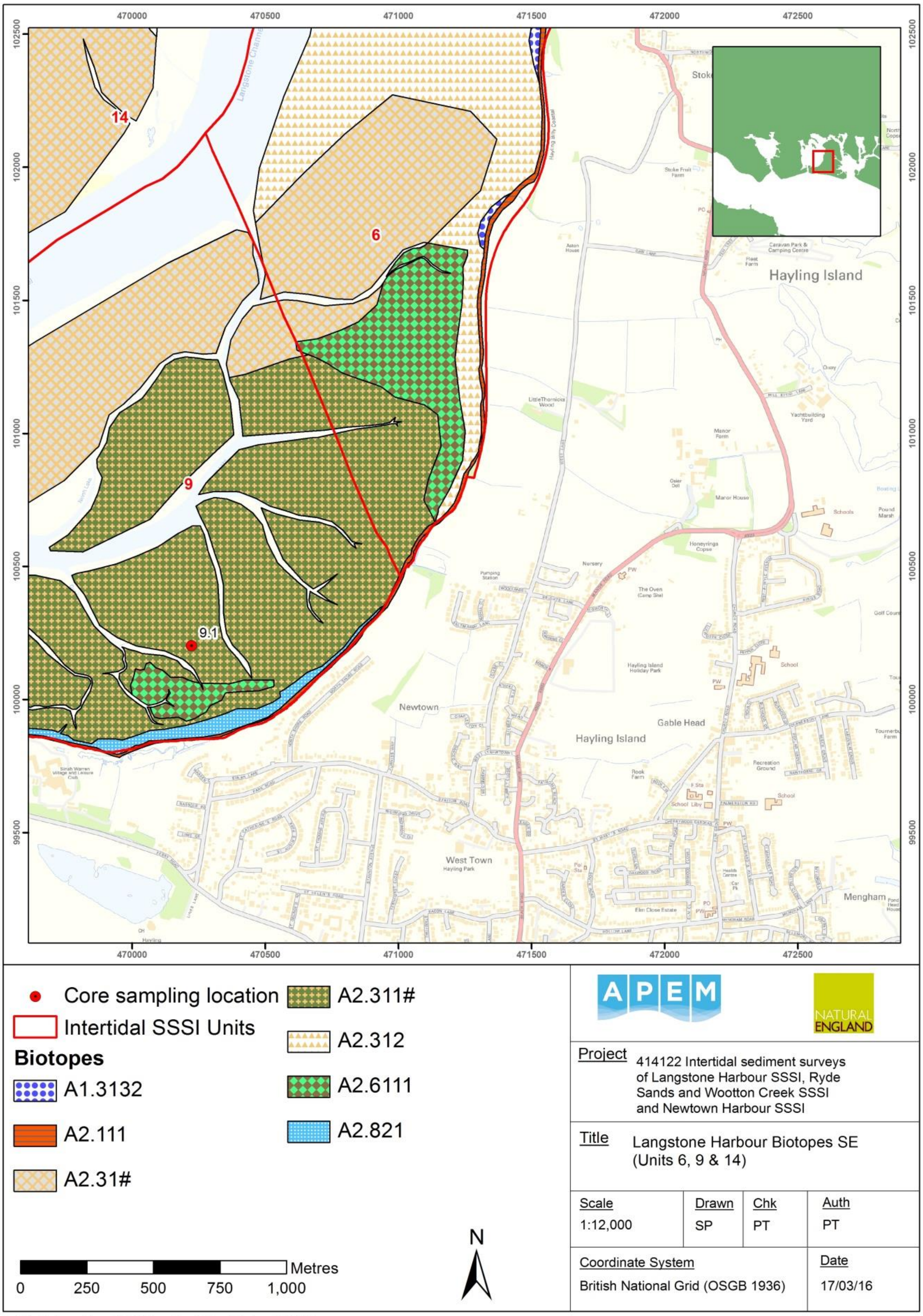

Figure A1.4: Distribution of biotopes across Langstone Harbour SSSI Units 6, 9 and 14

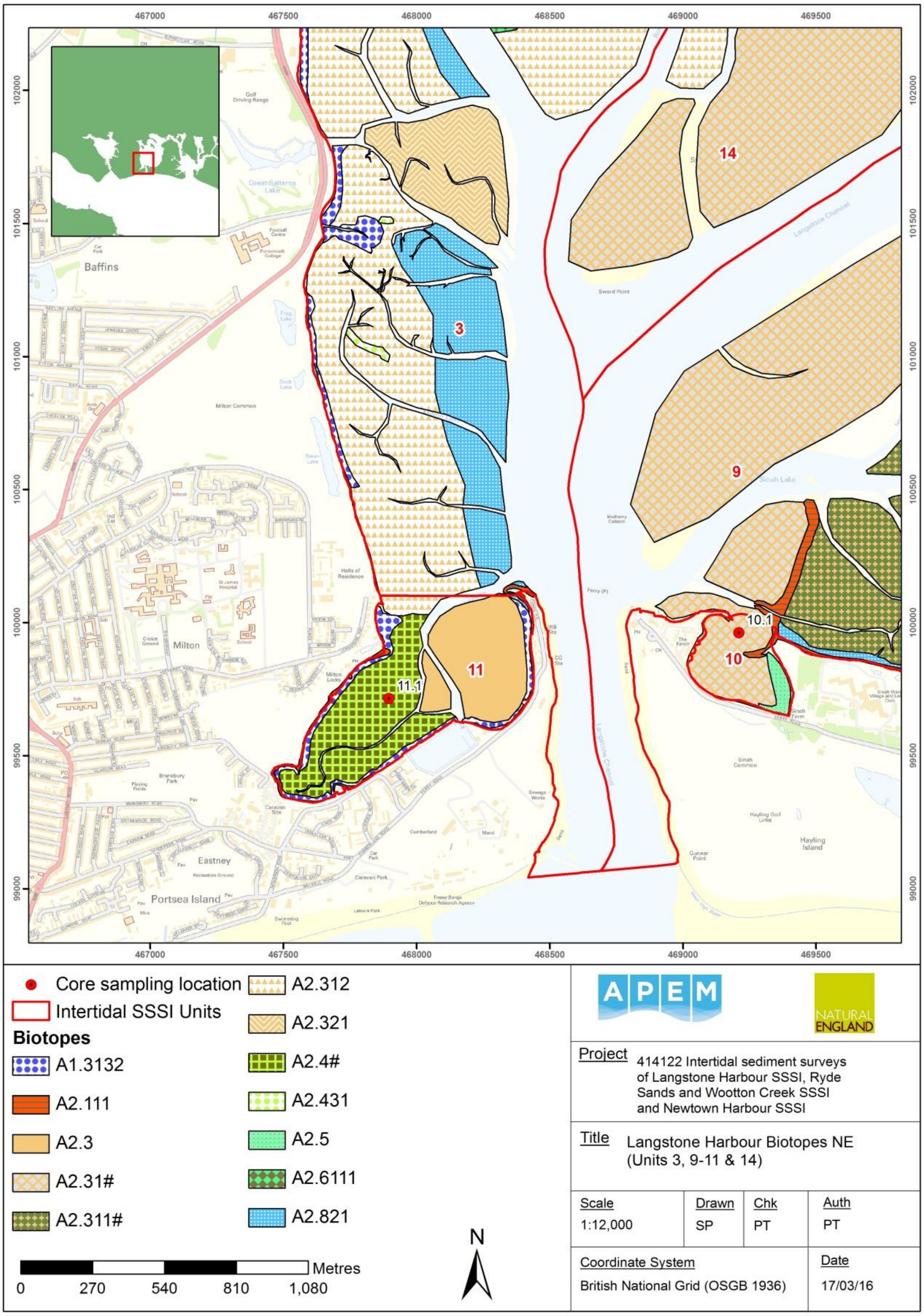

Figure A1.5: Distribution of biotopes across Langstone Harbour SSSI Units 3, 9-11 and 14

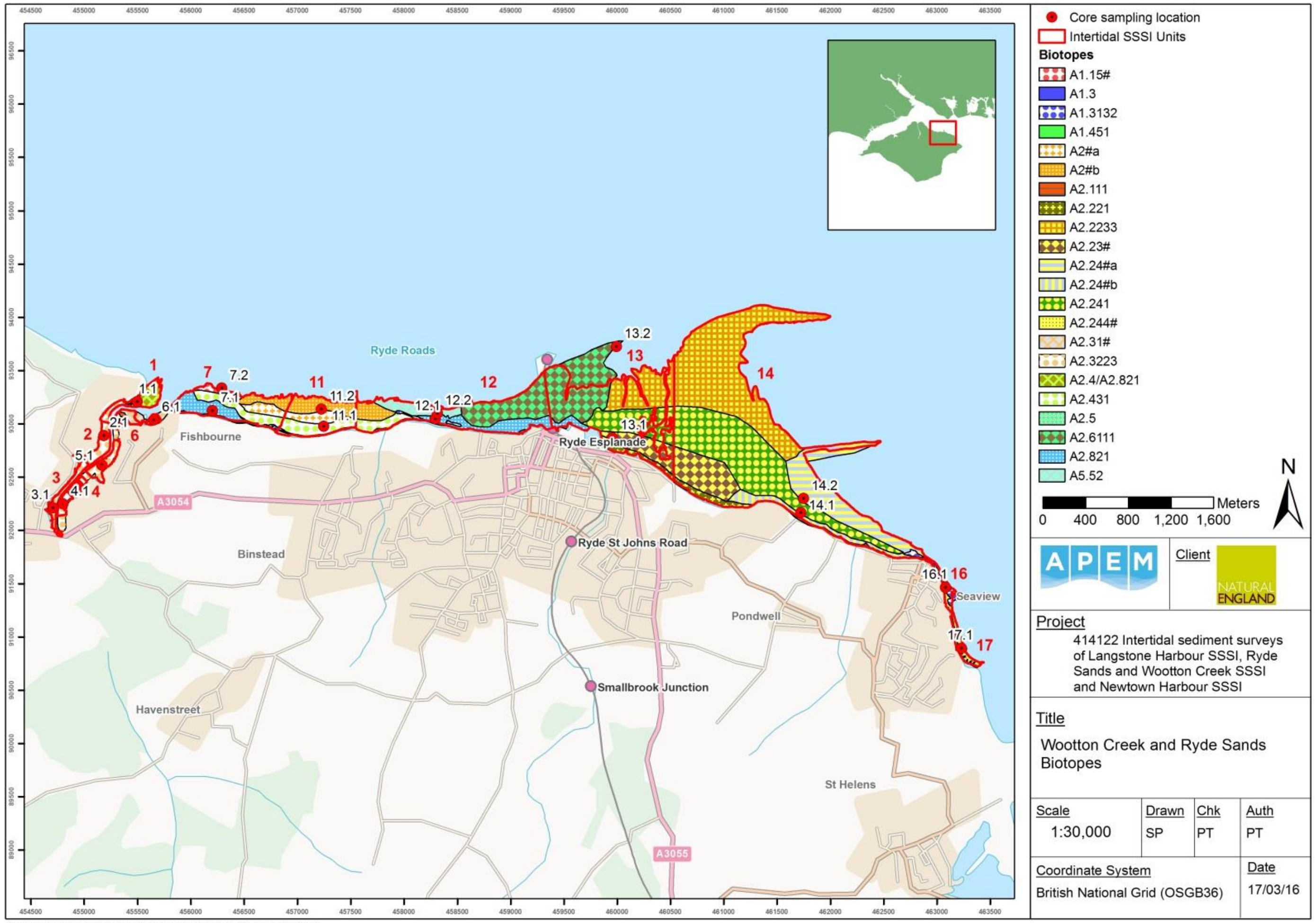

Figure A1.6: Distribution of biotopes across Ryde Sands and Wootton Creek SSSI

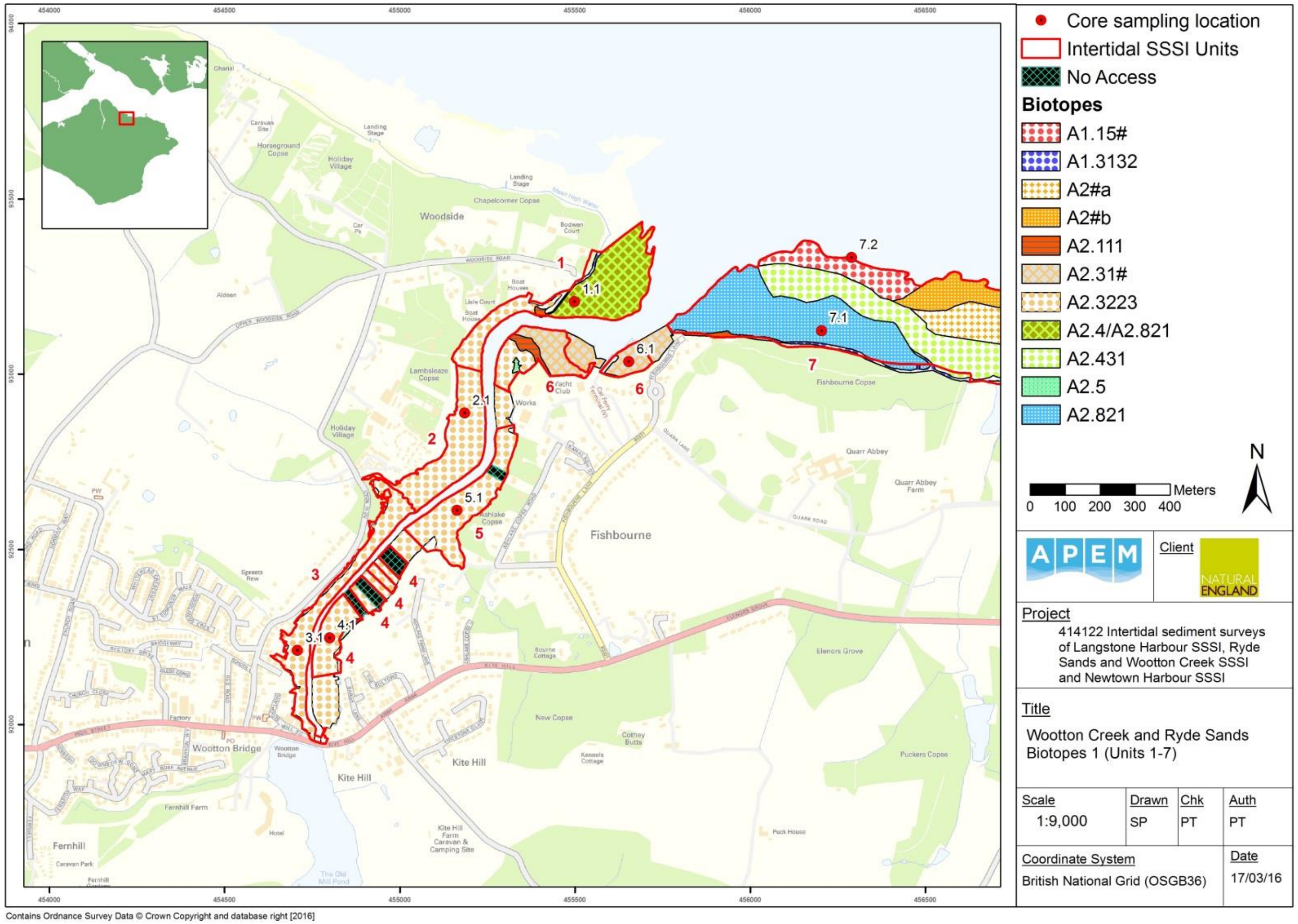

Figure A1.7: Distribution of biotopes across Ryde Sands and Wootton Creek SSSI Units 1-7

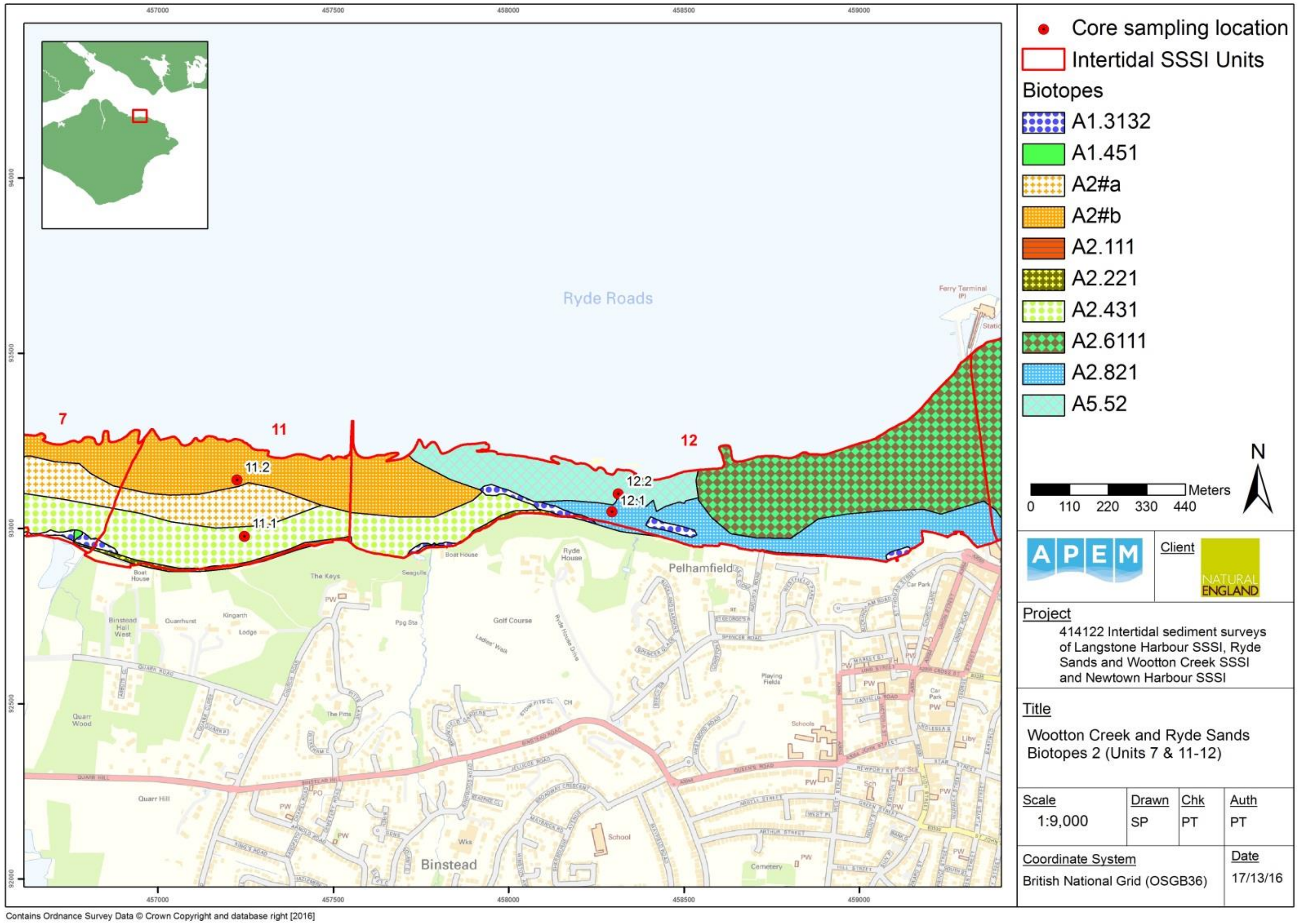

Figure A1.8: Distribution of biotopes across Ryde Sands and Wootton Creek SSSI Units 7 and 11-12

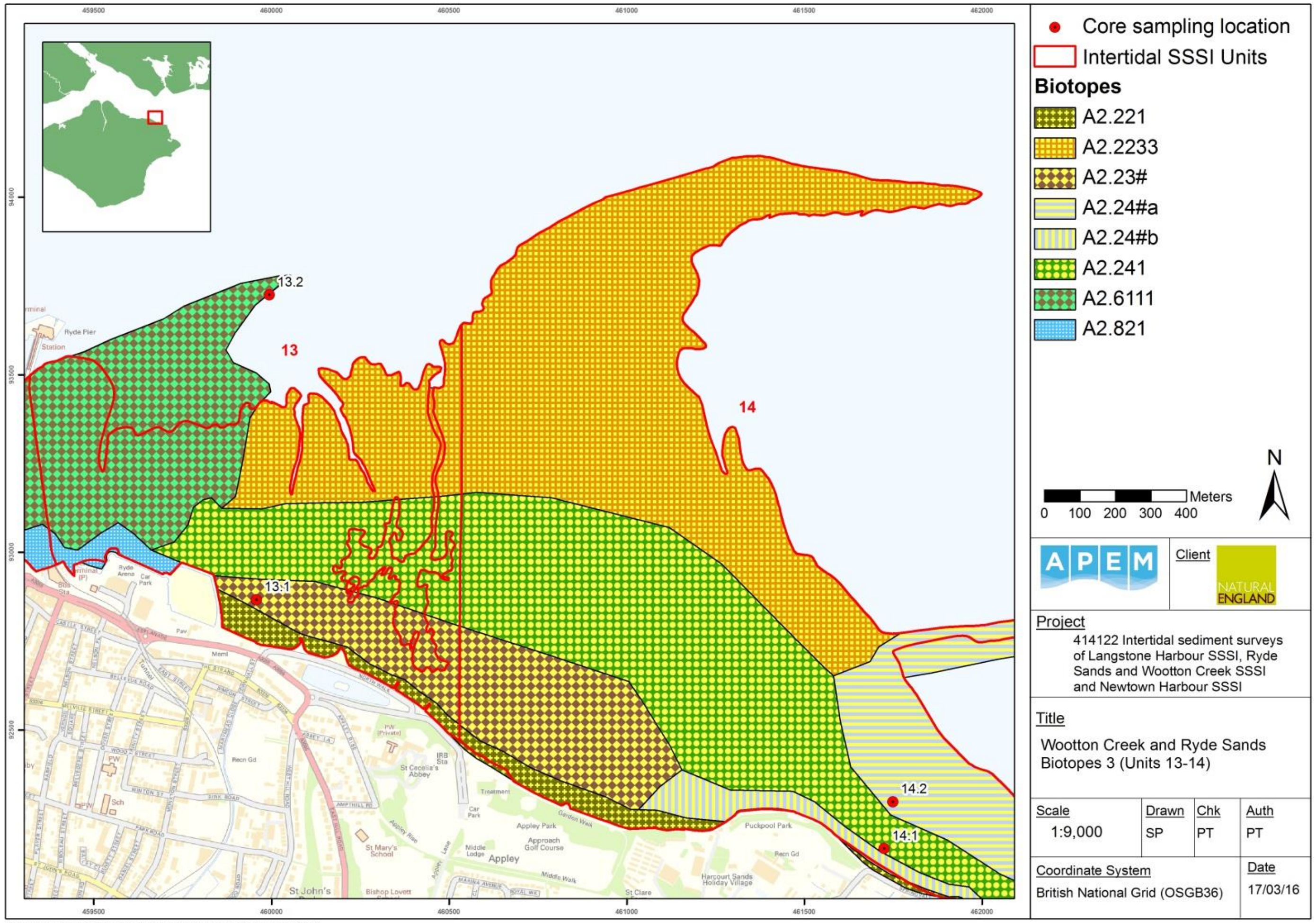

Figure A1.9: Distribution of biotopes across Ryde Sands and Wootton Creek SSSI Units 13 and 14

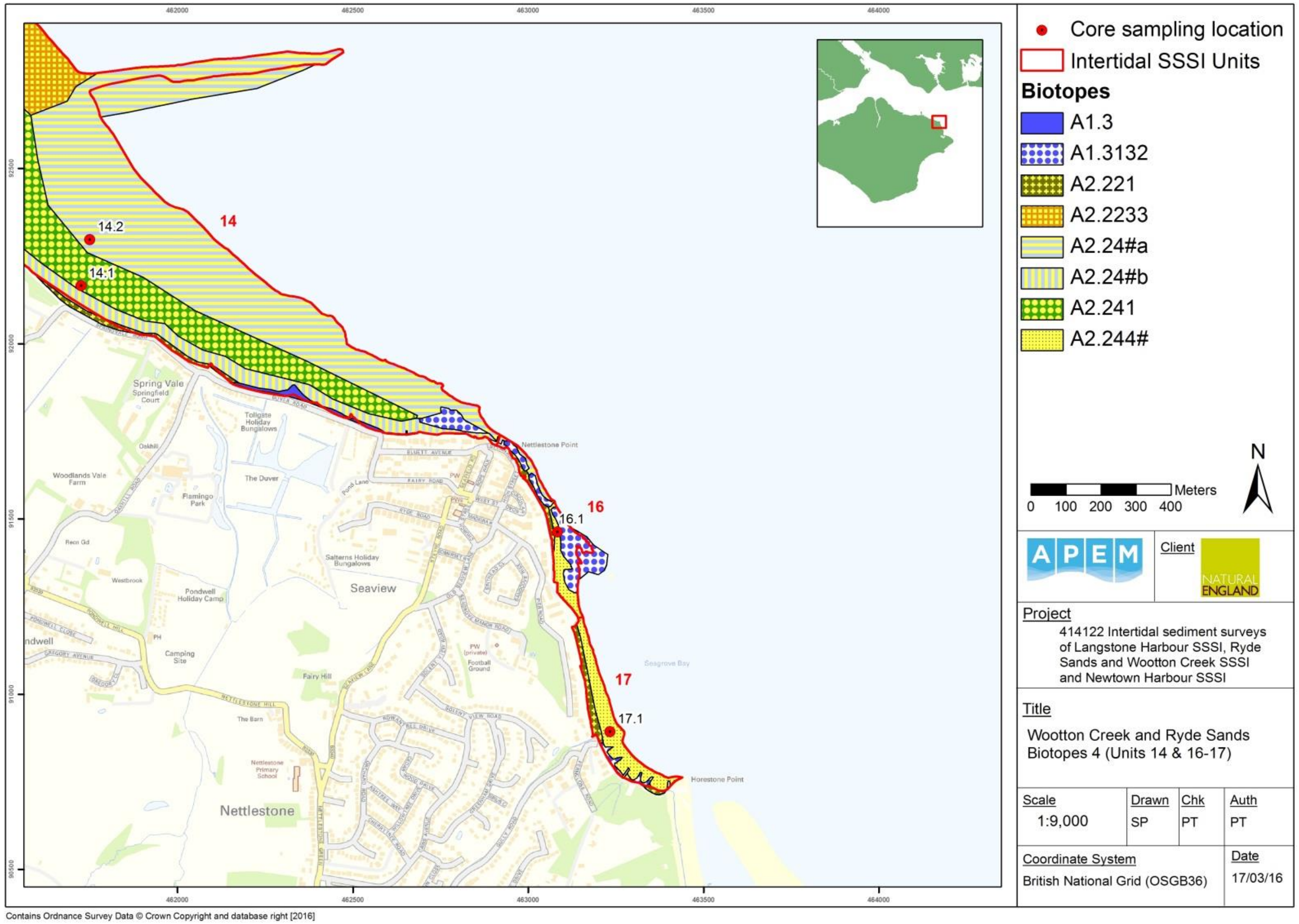

Figure A1.10: Distribution of biotopes across Ryde Sands and Wootton Creek SSSI Units 14 and 16-17

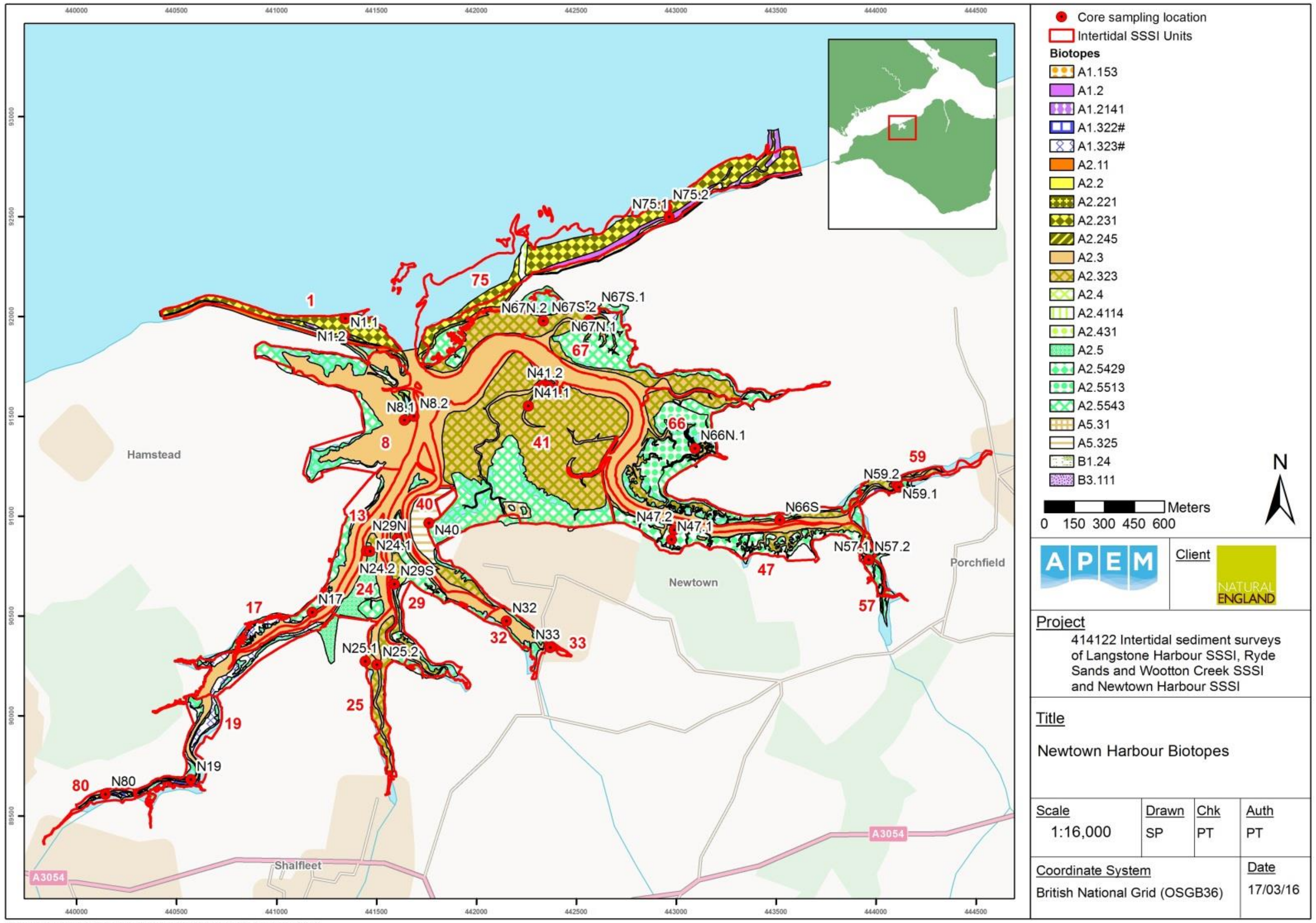

Figure A1.11: Distribution of biotopes across Newtown Harbour SSSI

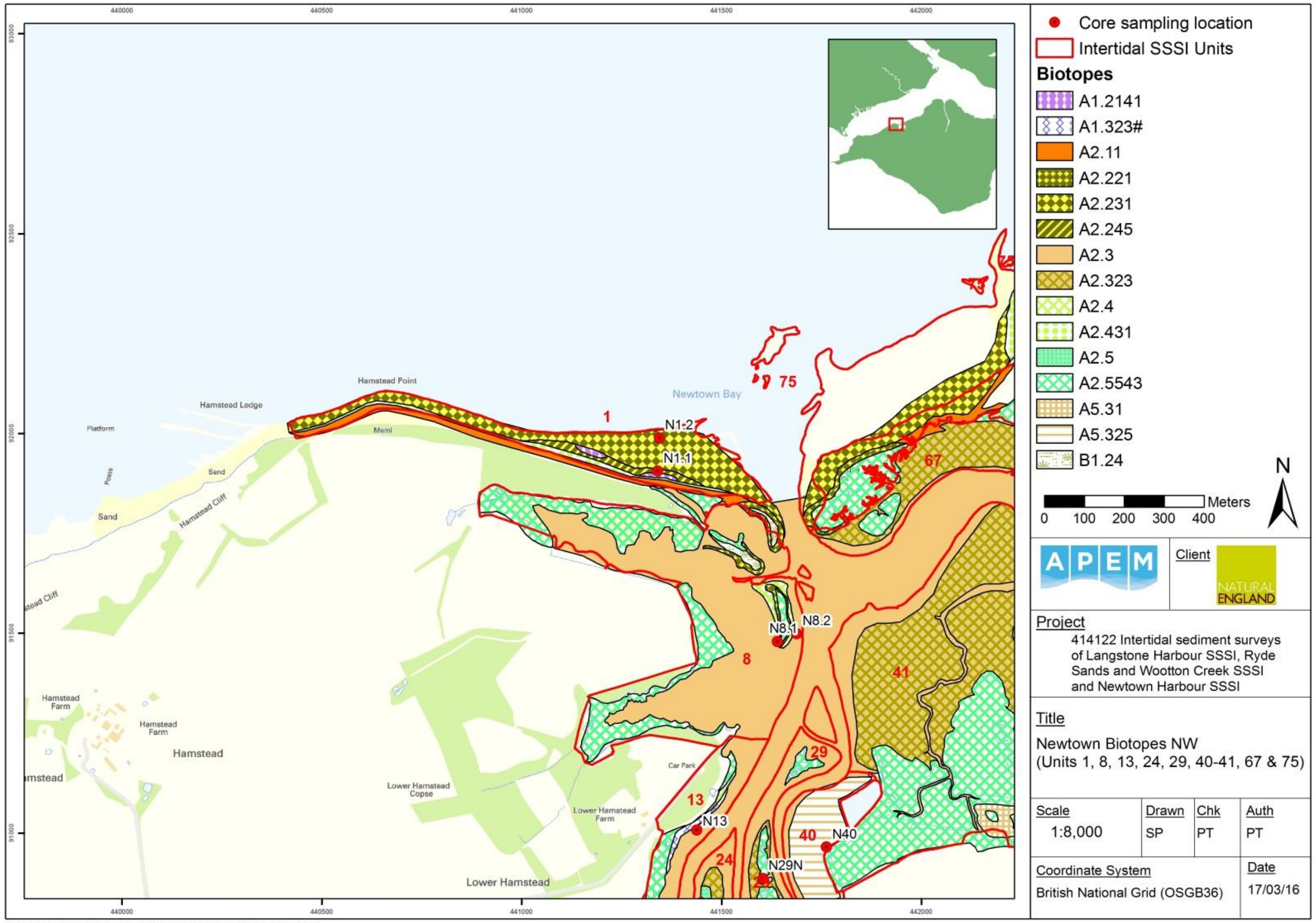

Figure A1.12: Distribution of biotopes across Newtown Harbour SSSI Units 1,8, 13, 24, 29. 40-41, 67 and 75

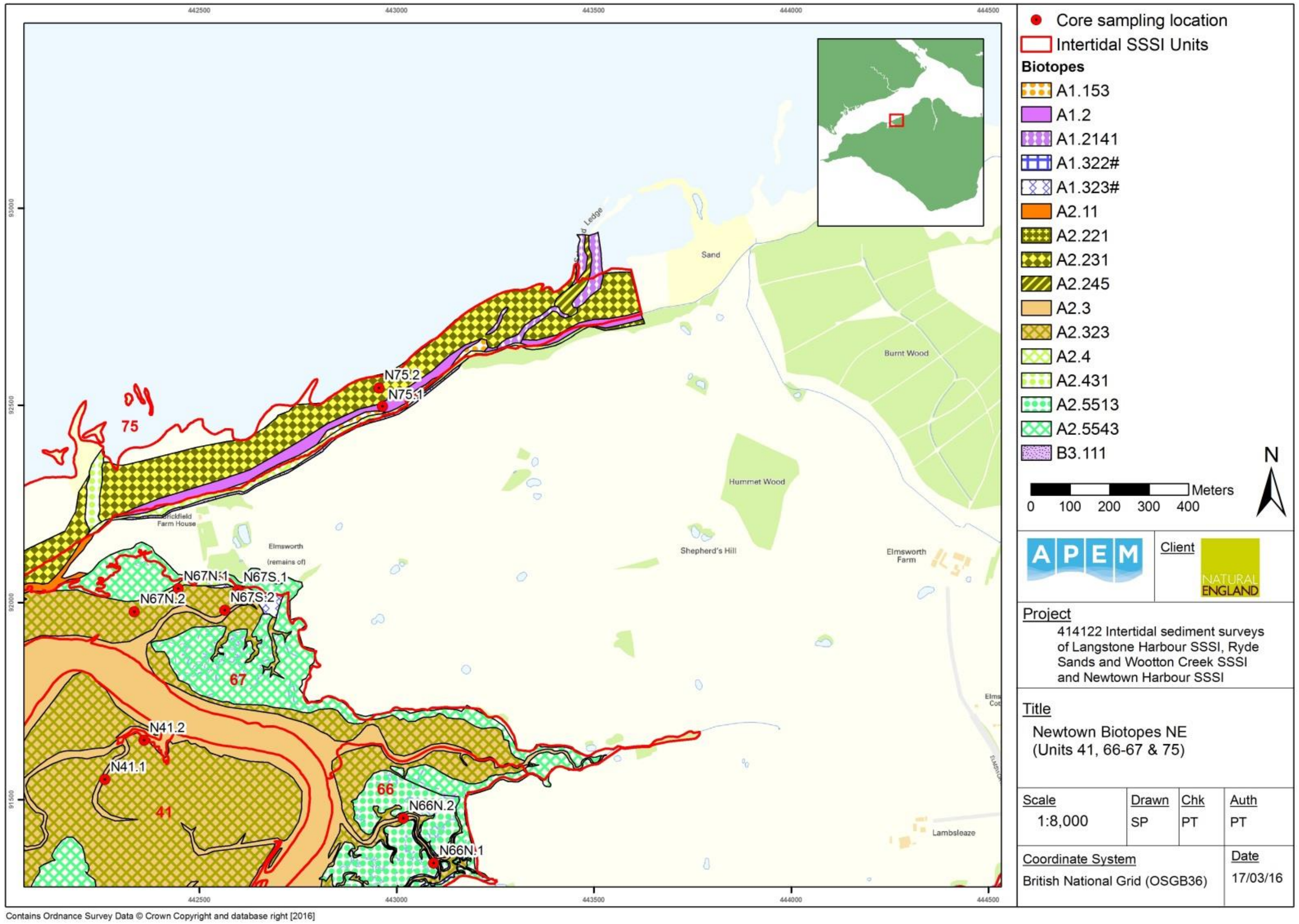

Figure A1.13: Distribution of biotopes across Newtown Harbour SSSI Unit 41, 66-67 and 75

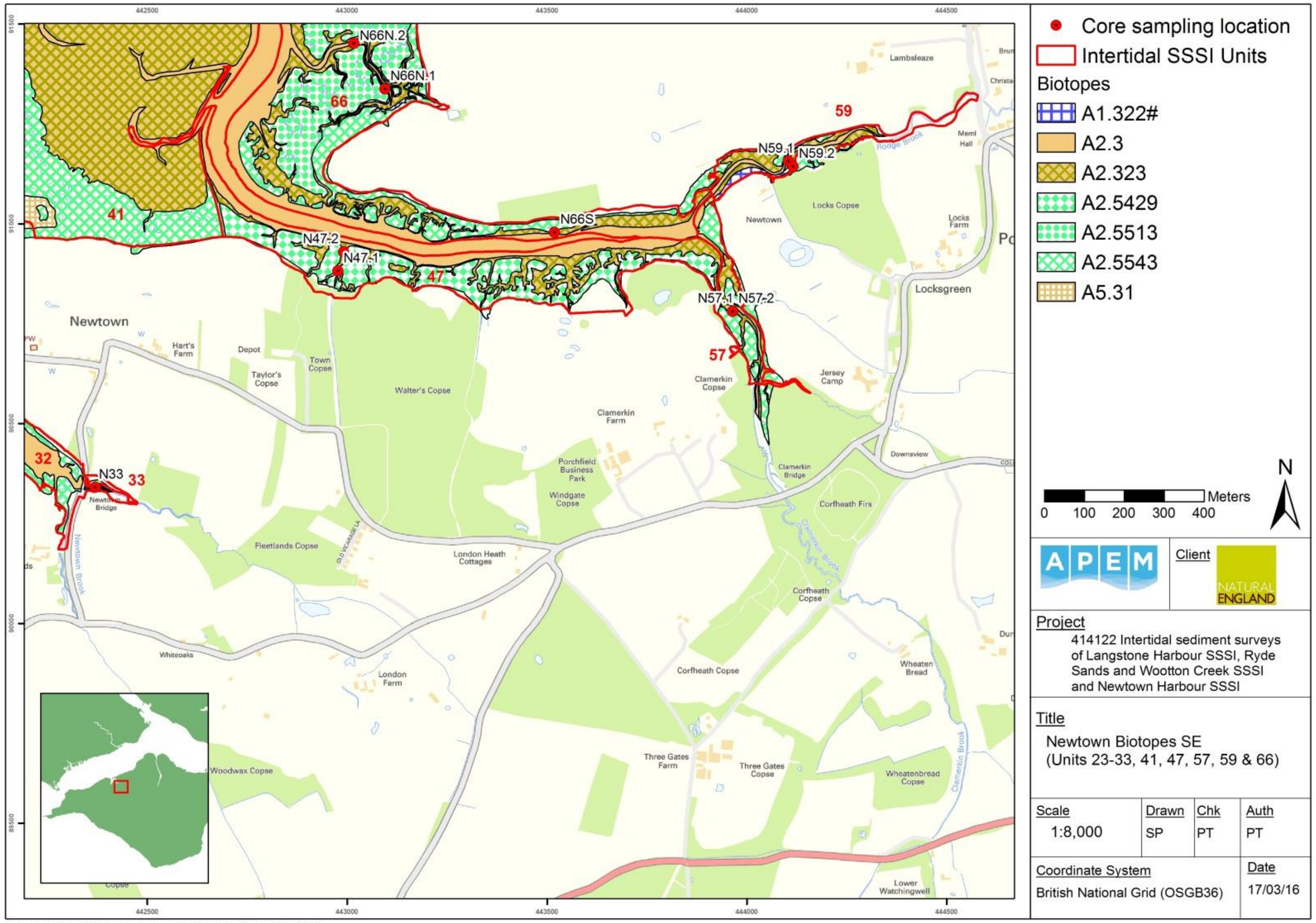

Figure A1.14: Distribution of biotopes across Newtown Harbour SSSI Unit 23-33. 41, 47, 57, 59 and 66

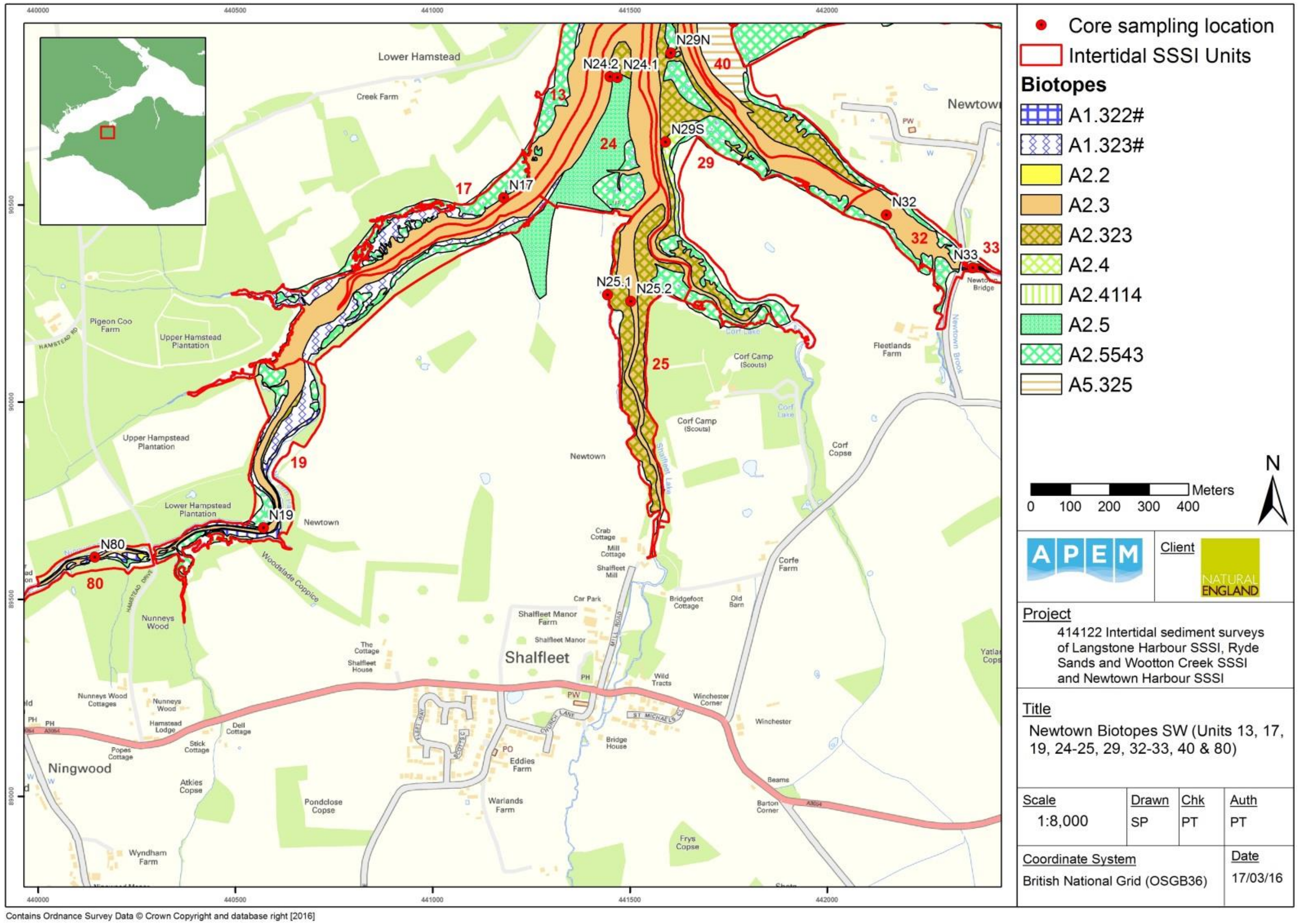

Figure A1.15: Distribution of biotopes across Newtown Harbour SSSI Unit 13, 17, 19, 24-25, 29, 32-33, 40 and 60

Appendix 2 – Raw data from Particle Size Analysis samples

Provided as electronic file.

Appendix 3 – Raw data from core samples

Provided as electronic file.

Appendix 4 – SIMPER analysis outputs

Langstone Harbour SSSI

Factor Groups

Sample	SIMPROF
L3	e
L9	e
L10	e
L6	b
L11	b
L7	a
L13	c
L14	d

Group e
Average similarity: 62.82

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Peringia ulvae	3.28	11.68	7.25	18.59	18.59
Tubificoides benedii	3.16	10.66	8.04	16.97	35.55
Tharyx "species A"	2.35	9.36	7.93	14.89	50.44
Ampharete aff. *acutifrons*	1.65	6.43	8.03	10.24	60.69
Nematoda	1.71	4.67	11.03	7.43	68.12
Hediste diversicolor	1.08	3.62	8.03	5.76	73.87
Nephtys hombergii	0.98	3.26	4.40	5.19	79.06
Carcinus maenas	0.91	3.23	6.92	5.14	84.21
Pygospio elegans	1.00	1.64	0.58	2.60	86.81
Phyllodoce mucosa	0.69	1.51	0.58	2.41	89.22
Melinna palmata	0.60	1.37	0.58	2.17	91.39

Group b
Average similarity: 48.57

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Nematoda	4.49	11.72	-	24.12	24.12
Tubificoides benedii	3.20	9.91	-	20.40	44.53
Peringia ulvae	2.94	6.58	-	13.55	58.08
Capitella	2.00	4.84	-	9.97	68.05
Hediste diversicolor	1.12	3.14	-	6.46	74.52
Chironomidae	1.07	2.84	-	5.84	80.36
Glycera tridactyla	0.76	2.39	-	4.91	85.27
Tharyx "species A"	1.02	2.39	-	4.91	90.18

Group a
Less than 2 samples in group

Group c
Less than 2 samples in group

Group d
Less than 2 samples in group

Ryde Sands and Wootton Creek SSSI

Factor Groups

Sample	SIMPROF
R1	e
R7.1	e
R2	d
R3	d
R4	d
R5	d
R6	g
R11.1	g
R12.1	g
R12.2	g
R7.2	c
R11.2	b
R13.1	f
R13.2	f
R14.1	f
R14.2	f
R16	a
R17	a

Group e
Average similarity: 58.15

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Nematoda	11.28	16.41	-	28.22	28.22
Tubificoides benedii	6.95	9.14	-	15.72	43.94
Capitella	3.22	4.60	-	7.90	51.84
Pygospio elegans	2.64	3.98	-	6.84	58.68
Peringia ulvae	4.43	3.87	-	6.65	65.33
Actiniaria	3.94	3.75	-	6.45	71.78
Notomastus	2.36	3.38	-	5.82	77.60
Tharyx "species A"	1.72	2.48	-	4.27	81.87
Chironomidae	1.28	1.88	-	3.23	85.09
Phyllodoce mucosa	0.91	1.33	-	2.28	87.37
Galathowenia oculata	1.60	1.33	-	2.28	89.65
Carcinus maenas	1.05	1.33	-	2.28	91.94

Group d
Average similarity: 65.16

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Peringia ulvae	14.25	30.03	4.35	46.08	46.08
Tharyx "species A"	7.55	14.98	5.98	22.98	69.07
Tubificoides benedii	5.45	9.14	2.19	14.02	83.09
Tubificoides pseudogaster	1.59	2.09	0.91	3.21	86.30
Nematoda	1.56	1.87	0.90	2.87	89.18
Capitella	1.41	1.63	3.59	2.50	91.67

Group g
Average similarity: 37.98

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Scoloplos armiger	2.17	8.02	1.64	21.12	21.12
Nematoda	2.77	7.18	1.78	18.91	40.03
Tubificoides benedii	1.54	4.41	2.27	11.62	51.64
Phyllodoce mucosa	0.80	3.40	4.45	8.96	60.60
Pygospio elegans	0.72	2.85	4.86	7.51	68.11
Capitella	0.73	1.93	0.88	5.09	73.20
Actiniaria	1.09	1.88	0.80	4.96	78.16
Spio martinensis	0.64	1.73	0.76	4.56	82.73
Cladophora	0.43	1.32	0.88	3.47	86.20
Notomastus	0.82	1.07	0.41	2.81	89.01
Peringia ulvae	0.43	0.58	0.41	1.54	90.55

Group c
Less than 2 samples in group

Group b
Less than 2 samples in group

Group f
Average similarity: 45.63

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Cumopsis goodsir	5.32	7.61	2.42	16.69	16.69
Tanaissus lilljeborgi	3.16	6.04	13.29	13.25	29.93
Scoloplos armiger	2.42	4.31	1.73	9.45	39.38
Urothoe poseidonis	2.03	3.20	1.55	7.01	46.39
Psammodrilus balanoglossoides	2.01	2.68	1.25	5.87	52.27
Capitella	2.02	2.47	1.17	5.42	57.68
Bathyporeia sarsi	3.73	2.36	0.90	5.17	62.85
Paraonis fulgens	1.52	2.17	2.50	4.76	67.61
Pygospio elegans	1.18	2.13	2.31	4.68	72.29
Streptosyllis websteri	1.82	2.10	0.81	4.61	76.90
Nematoda	1.03	1.76	4.56	3.85	80.75
Peringia ulvae	1.08	1.64	2.84	3.59	84.34
Spio martinensis	1.15	1.13	0.73	2.47	86.81
Copepoda	0.85	1.06	0.78	2.33	89.14
Bathyporeia guilliamsoniana	1.31	0.98	0.41	2.14	91.28

Group a
Average similarity: 34.14

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Bathyporeia sarsi	3.02	18.29	-	53.59	53.59
Rissoa parva	0.79	5.28	-	15.47	69.06
Electra pilosa	0.70	5.28	-	15.47	84.53
Tricellaria inopinata	0.58	5.28	-	15.47	100.00

Newtown Harbour SSSI

Factor Groups

Sample	SIMPROF
N1.1	c
N1.2	d
N75.2	d
N8.1	h
N8.2	h
N13	h
N17	h
N24.1	h
N24.2	h
N29S	h
N29N	h
N32	h
N33	h
N19	a
N80	a
N25.1	e
N47.1	e
N57.1	e
N57.2	e
N59.1	e
N66N.1	e
N66N.2	e
N66S	e
N25.2	g
N40	g
N41.1	g
N41.2	g
N47.2	g
N67N.1	g
N67N.2	g
N67S.1	g
N59.2	f
N67S.2	b
N75.1	b

Group c
Less than 2 samples in group

Group f
Less than 2 samples in group

Group d
Average similarity: 51.99

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Nematoda	6.96	4.90	-	9.42	9.42
Galathowenia oculata	5.34	3.18	-	6.12	15.54
Parexogone hebes	3.51	2.97	-	5.70	21.24
Aricidea minuta	4.53	2.73	-	5.25	26.50
Dipolydora coeca	3.11	2.13	-	4.09	30.59
Lumbrineris coccinea	2.38	2.06	-	3.97	34.56
Microprotopus maculatus	3.03	2.00	-	3.85	38.41
Pariambus typicus	2.62	2.00	-	3.85	42.25
Mediomastus fragilis	2.62	1.71	-	3.29	45.54
Notomastus	2.37	1.71	-	3.29	48.84
Monocorophium acherusicum	1.91	1.63	-	3.14	51.98
Scoloplos armiger	2.32	1.46	-	2.81	54.78
Pygospio elegans	2.23	1.46	-	2.81	57.59
Capitella	1.73	1.15	-	2.22	59.81
Aoridae	1.51	1.15	-	2.22	62.03
Perinereis cultrifera	1.73	1.03	-	1.99	64.02
Phyllodoce mucosa	1.26	0.89	-	1.72	65.74
Exogone naidina	2.16	0.89	-	1.72	67.46
Grandidierella japonica	2.46	0.89	-	1.72	69.18
Bodotria scorpioides	1.21	0.89	-	1.72	70.90
Nemertea	1.67	0.73	-	1.40	72.30
Sphaerosyllis aff. *taylori*	1.60	0.73	-	1.40	73.70
Marphysa sanguinea	0.91	0.73	-	1.40	75.11
Lanice conchilega	1.27	0.73	-	1.40	76.51
Tubificoides benedii	0.82	0.73	-	1.40	77.92
Ampelisca tenuicornis	1.27	0.73	-	1.40	79.32
Retusa obtusa	1.12	0.73	-	1.40	80.73
Polysiphonia	0.82	0.73	-	1.40	82.13
Actiniaria	1.20	0.52	-	0.99	83.12
Eteone longa	0.58	0.52	-	0.99	84.11
Glycera tridactyla	0.58	0.52	-	0.99	85.11
Lumbrineris latreilli	1.00	0.52	-	0.99	86.10
Tharyx "species A"	0.70	0.52	-	0.99	87.09
Praxillella affinis	0.70	0.52	-	0.99	88.09
Melinna palmata	0.70	0.52	-	0.99	89.08

Group h
Average similarity: 32.50

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Peringia ulvae	2.24	16.26	1.97	50.03	50.03
Tubificoides benedii	1.33	9.20	1.21	28.31	78.34
Nematoda	0.87	4.57	0.60	14.05	92.39

Group a
Average similarity: 27.99

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Ulva	0.79	27.99	#######	100.00	100.00

Group e
Average similarity: 58.40

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Peringia ulvae	21.78	26.02	2.54	44.56	44.56
Nematoda	8.04	9.80	3.45	16.78	61.34
Chironomidae	5.27	6.04	2.81	10.34	71.68
Dolichopodidae	3.47	4.97	3.30	8.51	80.18
Tubificoides benedii	3.82	3.74	1.39	6.40	86.58
Abra tenuis	2.09	2.00	1.54	3.42	90.00

Group g
Average similarity: 58.97

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Tubificoides benedii	21.42	15.38	3.76	26.09	26.09
Peringia ulvae	18.04	12.67	3.10	21.49	47.58
Nematoda	17.00	10.25	2.93	17.39	64.96
Capitella	9.21	5.87	2.64	9.95	74.91
Abra tenuis	3.39	2.22	2.79	3.77	78.68
Chironomidae	3.80	2.09	1.51	3.54	82.21
Tharyx "species A"	6.17	1.21	1.03	2.06	84.27
Copepoda	3.32	1.10	0.79	1.86	86.13
Nemertea	2.06	0.90	1.30	1.52	87.65
Scoloplos armiger	3.29	0.77	0.70	1.30	88.95
Pygospio elegans	1.71	0.74	0.99	1.25	90.20

Group b
Average similarity: 100.00

Species	Av.Abund	Av.Sim	Sim/SD	Contrib%	Cum.%
Corophium volutator	2.24	9.14	-	9.14	9.14
Dipolydora coeca	2.08	8.51	-	8.51	17.65
Perinereis cultrifera	1.91	7.83	-	7.83	25.48
Pygospio elegans	1.73	7.08	-	7.08	32.56
Phyllodoce mucosa	1.63	6.68	-	6.68	39.24
Boccardia proboscidea	1.41	5.78	-	5.78	45.02
Marphysa sanguinea	1.15	4.72	-	4.72	49.74
Dipolydora quadrilobata	1.15	4.72	-	4.72	54.46
Mediomastus fragilis	1.15	4.72	-	4.72	59.18
Tubificoides benedii	1.00	4.09	-	4.09	63.27
Grandidierella japonica	1.00	4.09	-	4.09	67.36
Cerebratulus	0.82	3.34	-	3.34	70.70
Polydora cornuta	0.82	3.34	-	3.34	74.04
Actiniaria	0.58	2.36	-	2.36	76.40
Fecampia erythrocephala	0.58	2.36	-	2.36	78.76
Nemertea	0.58	2.36	-	2.36	81.12
Hediste diversicolor	0.58	2.36	-	2.36	83.48
Lumbrineris coccinea	0.58	2.36	-	2.36	85.84
Scoloplos armiger	0.58	2.36	-	2.36	88.20
Polydora ciliata	0.58	2.36	-	2.36	90.56

Further information

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

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