The extent of Annex I Sandbanks in North Norfolk Sandbanks and Saturn Reef cSAC/SCI

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The extent of Annex I sandbanks in North Norfolk Sandbanks and Saturn Reef cSAC/SCI

In 2010, JNCC published The North Norfolk Sandbanks and Saturn Reef SAC Site Assessment Document[1] (SAD) to support the nomination of the site under the EC Habitats & Species Directive. The SAD noted:

> *The* [SAC] *boundary presented includes both 'sandy sediments in less than 20m water depth' and the flanks and troughs of these banks which are also part of the sandbank feature but extend into deeper waters.*
>
> *The boundary of the site has been defined to enable conservation of the structure and functions of the sandbanks and to include representation of both more disturbed (inshore) and more stable (offshore) sandbank biological communities. The sandbank structures are maintained through offshore sediment transport, with each bank acting as a stepping stone, and the development of new sandbanks between existing banks. Therefore, the proposed boundary encompasses the whole linear sandbank system rather than attempting to separate out individual banks.*

In 2013, JNCC produced a map showing the UK resource of the Annex I feature '*Sandbanks which are slightly covered by sea water all the time,*' that was developed using a spatial modelling approach which applied a series of criteria to physical environmental data. In trying to separate banks according to the broad definition of the feature provided by the European Commission[2], these criteria considered both the slope and depth of the seabed. The final map showed a series of individual 'sandbanks' within the North Norfolk Sandbanks and Saturn Reef cSAC/SCI, somewhat contradicting the conclusion in the Site Assessment Document.

Reflecting that the EC Habitats & Species Directive aims to conserve biodiversity, the EC guidance notes:

> *Sandbanks can, however, extend beneath 20 m below chart datum. It can, therefore, be appropriate to include in designations such areas where they are part of the feature and host its biological assemblages*.
>
> *They consist mainly of sandy sediments, but larger grain sizes, including boulders and cobbles, or smaller grain sizes including mud may also be present on a sandbank.*

JNCC had used this guidance when defining the boundary of the North Norfolk Sandbanks and Saturn Reef cSAC/SCI; a similar approach had previously been adopted for the Dogger Bank cSAC/SCI.

Additional data were collected from the North Norfolk Sandbanks and Saturn Reef cSAC/SCI as part of a JNCC/Cefas survey of the site in 2013[3]. The survey targeted both the

[1] http://jncc.defra.gov.uk/PDF/NNSandbanksAndSaturnReef_SACSAD_5.0.pdf
[2] http://ec.europa.eu/environment/nature/legislation/habitatsdirective/docs/Int_Manual_EU28.pdf
[3] http://jncc.defra.gov.uk/page-7139

'sandbanks' mapped by the modelling approach described above, together with deeper areas of the site away from the mapped 'banks' that were surveyed for *Sabellaria spinulosa* reef.

JNCC have undertaken statistical analysis of the biological communities present within the cSAC/SCI using the data from grab and video samples from the 2013 survey. To complement previous analysis undertaken by Cefas[4], JNCC's analysis combines data from multiple datasets collected from the 2013 survey, to consider the biological communities across the MPA. The report summarising this analysis is provided in Annex A.

The headline results of our analyses are:

- Initial analysis suggested that there was considerable overlap in the species composition of the biological communities present on the modelled 'sandbank' crests, flanks and troughs, and the deeper areas of the site away from the mapped 'banks'.
- Further testing confirmed that sediment type had the greatest influence on the composition of biological communities present rather than the predicted topography (crest, trough, etc).
- The sand fraction dominated the particle size composition of all stations, with those located on 'crests' consistently comprising >80% sand, whilst stations in the troughs/areas between 'banks' had a slightly wider range of sediment grades, but still typically contained 70-80% sand.
- Four community groups were identified from the biological data, based on the characterising species and sediment composition. Two of the groups are associated with coarser sediments, one associated with mixed sediments, and the most widespread community group is associated with sandy sediment. The coarse and mixed sediment community groups share many of the same species as the sand group, although the abundance attributed to individual taxa was generally higher in the coarser sediment. The coarse and mixed sediment groups were mostly recorded in the troughs adjacent to the modelled banks and the deeper areas between the banks.
- A significant difference ($p<0.001$) was found between the community assemblages present within different topographic categories, although further analysis suggests that the topography only accounted for ~10% of the difference in community composition.
- Guidance from the EC notes that Annex I sandbank may extend into areas beyond 20m where they are part of the feature and where the biological communities are contiguous with shallow areas. The community grouping associated with sandy sediment within the North Norfolk Sandbank and Saturn Reef cSAC/SCI clearly extends into water deeper than 20m, with an average depth of 30m, and the deepest record at 57m. Consequently, applying a depth criterion of 20m is not an appropriate factor to delineate the extent of any individual Annex I sandbank feature within the cSAC/SCI.

- Considering the EC guidance that larger grain sizes may also be associated with the sandbank feature, along with the analysis that suggests only slight differences in the species present in the community groupings, the coarse and mixed sediment biotopes are considered to be part of the biological components of the sandbank feature, and integral to the functioning of the feature across the site.

In summary, JNCC conclude that the biological communities associated with the individual modelled shallow sandbanks occur across the MPA, including adjacent areas where the seabed is much deeper than 20m. Sand is the dominant sediment type across the MPA, with patches of coarser and mixed sediment, which may then also be associated in places with *Sabellaria spinulosa* reef. These results confirm JNCC's earlier view set out in the SAC Selection Assessment Document, that the whole MPA should be considered as a representative functioning example of the Annex I feature *Sandbanks which are slightly covered by sea water all the time*.

Annex A: Comparing community assemblages associated with the sandbank feature in the North Norfolk Sandbanks and Saturn Reef (NNSSR) cSAC/SCI

1. Introduction and overview

North Norfolk Sandbanks and Saturn Reef candidate Special Area of Conservation (cSAC) is located in the southern North Sea, extending from approximately 40km (22 nautical miles) off the north east coast of Norfolk out to approximately 110km (60 nautical miles) (see Figure 1). The cSAC/SCI was designated for two Annex I features: 'Sandbanks which are slightly covered by seawater all of the time' and '*Sabellaria spinulosa'* Reef.

To support ongoing discussions about management within the cSAC/SCI, JNCC has undertaken further analysis to confirm the extent of the features within the site. The Annex I Sandbank map (Figure 2) published by JNCC shows a series of isolated features within the site, but the model used to create the map applied a series of rules to physical data only, without considering the biological communities present within the sediment. Since the Annex I sandbank layer was produced, we have further biological data from within the site. Showing individual banks as areas of Annex I feature contradicts the original site assessment document for the site and has created some confusion over the agreed extent of the sandbank feature in the site. To address this, the present analysis uses biological data from a recent survey to examine whether the sandbank communities present within the areas between the banks (i.e. the troughs) are different to those communities found on the flanks and crests.

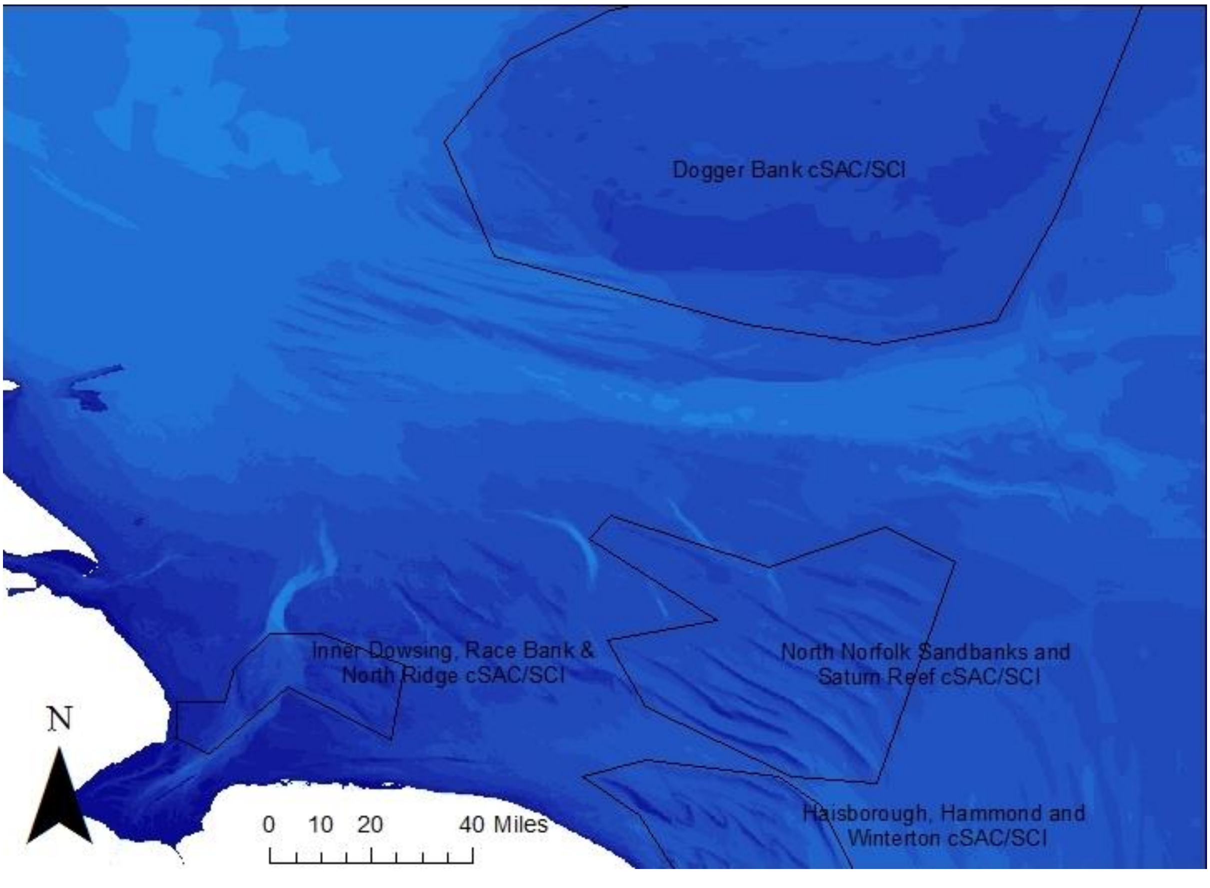


Figure 1: Map showing location of North Norfolk Sandbanks and Saturn Reef cSAC/SCI and the bathymetry of the wider Southern North Sea

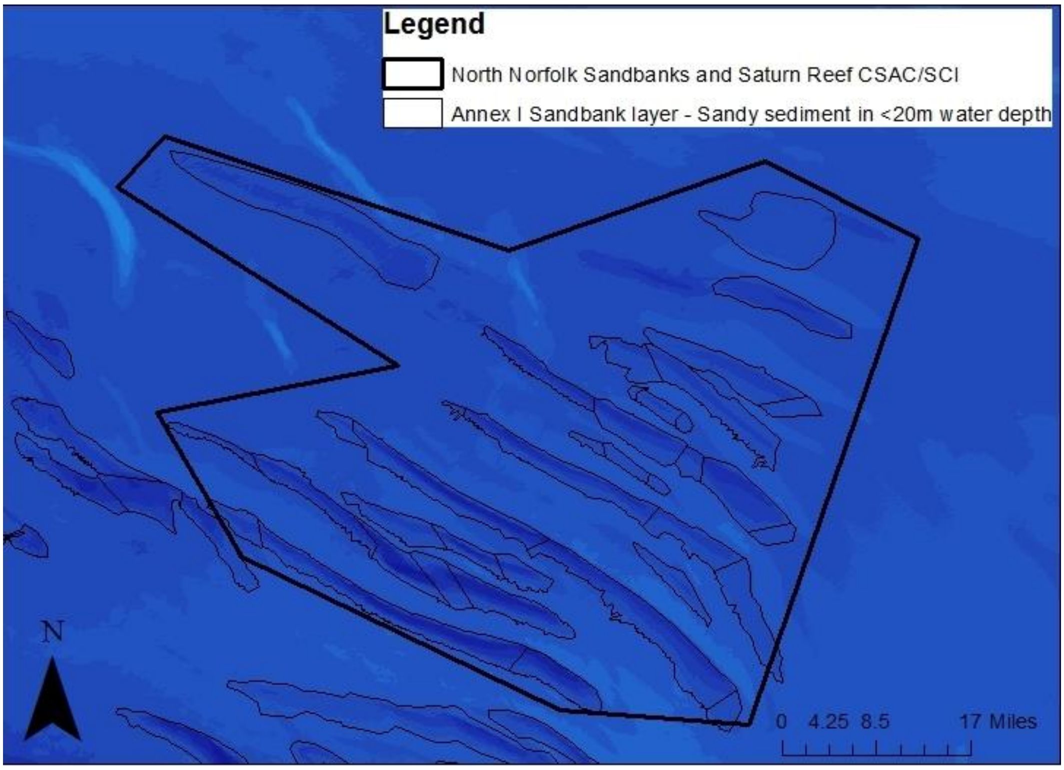
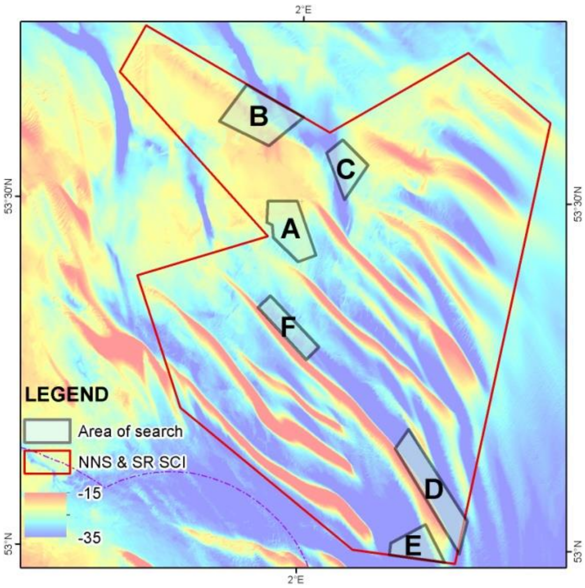


Figure 2: Map showing the ribbons of the Annex I sandbank layer

Additional data were collected from the North Norfolk Sandbanks and Saturn Reef cSAC/SCI as part of a JNCC/Cefas survey of the site in 2013 (Vanstaen and Whomersley, 2015). The 2013 survey collected biological and acoustic data from 6 blocks within the MPA to look at *Sabellaria* reef (Figure 3a). Biological data including grab samples, video and still images were also collected from 17 transects across apparent individual sandbanks within the site (Figure 3b.).

Community analysis of data from the 2013 survey was undertaken by Cefas, the results of which are available in Jenkins *et al.* 2015. The additional analysis described in this report complements the Cefas analysis by combining the data collected from the sandbank and non-sandbank areas (areas selected for Annex I reef) to compare the biological communities present across the site.



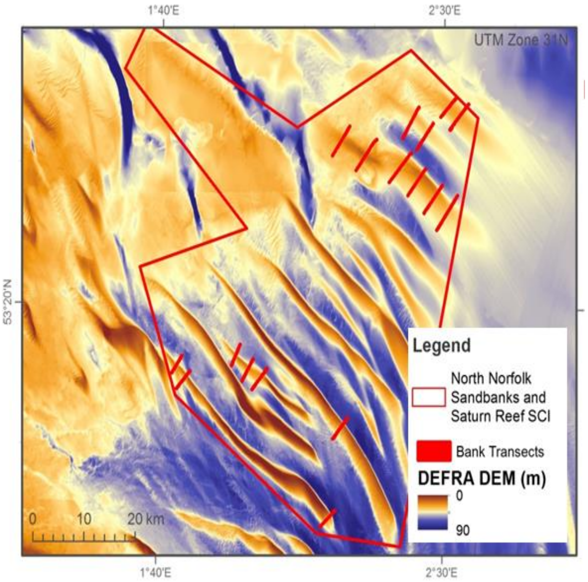


Figure 3a (left): Areas surveyed for Annex I reef on the 2013 JNCC/Cefas survey within the North Norfolk Sandbanks and Saturn Reef cSAC/SCI. **Figure 3b (right):** Location of sandbank transects surveyed in 2013 by JNCC/Cefas within the North Norfolk Sandbanks and Saturn Reef cSAC/SCI. (Figures taken from Jenkins *et al.* 2015)

2. Method

2.1. Data preparation

Faunal and sediment samples were processed and results checked following the recommendations of the NMBAQC Scheme (Jenkins *et al*, 2015). These data were prepared for analysis by undertaking the steps outlined below.

- Juveniles and larval stages were removed, as these often appear in blooms and are not representative of the usual community structure and may bias results.
- Highly mobile species (fish) were removed as they are not a permanent part of the benthic community.
- The data were examined to find any taxa that may, in fact, be the same species. This occurs where some individuals could be identified to species level and others to a higher parent taxon, but it is not clear that the 'parent' is a different species. Where this occurred, the parent was deleted if fewer were recorded than at species level, or the species was merged up to the parent level if more of the parent were recorded.
- The species names were check against WORMS.
- Details of taxa removed or merged were saved in a worksheet with the taxa matrices.

Most taxa were recorded as counts, but some colonial species, such as hydroids, could only be recorded as present. Two taxa matrices were produced from the original – one which included only count data, and the other containing all data transformed to presence/absence. The count data set will be more effective at showing patterns in community as it takes into account differences in the relative abundance of taxa; however, colonial species will not be considered. The presence/absence data set includes all taxa but has less power to detect differences in community as each taxon is treated as having the same abundance. Consequently, count data were used in the analysis, but additional colonial taxa checked to identify any patterns.

Records of taxa from video tow samples were prepared in a similar way. Abundance from video was recorded as SACFOR for all taxa in one matrix, and counts or % cover in another. SACFOR data was converted to a 1 to 6 scale, with 1 being 'rare'. Some species were recorded as actual counts, or percentage cover, but only SACFOR data has been analysed for this work as it provides a standard unit, and count data would not provide much more information on relative abundance once it had been transformed.

Sabellaria reef habitats were not of interest for this work, as they are already known to be associated with a different community. In the grab data set, those stations with a high abundance of Sabellaria spinulosa (>100 individuals in grabs) were removed. In the video data set, those stations labelled 'biogenic reef' in the metadata were removed.

A physical data set was prepared for grab samples, listing sample references that could be linked to species data, and associated information about substrate type, depth and topography. Substrate type was recorded as EUNIS substrate category based on the results of particle size analysis. Depth was taken from the metadata spreadsheet which recorded depth from fixes taken during the survey. In order to compare communities on different positions on the sandbanks, the sample locations were overlain onto modelled Defra Astrium bathymetry data and a sandbank topography category assigned (top, flank, trough, outside sandbank). The categories assigned are indicative; the position of sandbanks may have changed since the modelled data layer was produced and the recorded coordinates have associated positioning error. It is noted that bathymetry data were collected on the 2013 survey for transects across the sandbanks but these data were not available at the time of analysis. It is recommended that these data are used for any future analysis associated with the sandbank transects.

A similar physical dataset was produced for video, but EUNIS substrate type was taken from the metadata spreadsheet. This was estimated by contractors based on the proportion of different sediment types evident in the video footage.

2.2. Data analysis

Grab count data were opened in PRIMER and a square root transformation performed to ensure highly abundant species did not have a disproportionate effect on the results of analysis. A Bray-Curtis resemblance matrix was created, and a cluster analysis performed. The SIMPROF test was used to show which clusters were considered significant. An MDS ordination was also performed, as this shows spatially how clusters relate to each other. Any outliers that were skewing the results were then removed (these were stations with no, or very few, taxa recorded), and the analysis run again. SIMPER analysis was performed to find the characterising species for each cluster from the cluster analysis, and discriminating taxa between them. Substrate type and sandbank topography was included as a factor and displayed as symbols over cluster analysis dendrograms and MDS plots to assess whether differences in community were linked to changes in the physical environment. Cluster analysis and MDS results were reviewed and clusters aggregated to represent real differences in community, based on expert judgement and results of the SIMPER analysis. SIMPER analysis was then run again to compare between these refined clusters. The communities present in the refined clusters were matched to biotope descriptions in the EUNIS habitat classification and equivalents on the JNCC Marine Habitat Classification for Britain and Ireland. Video SACFOR data were analysed in a similar way, but no transformation was necessary as data were already reduced to a 1 to 6 scale.

3. Results

3.1. Grab samples

The result of the initial cluster analysis of grab samples is displayed in the dendrogram in Figure 4. The symbols show significant clusters.

A large number of significant clusters were identified (31); as the site is fairly homogenous it is unlikely that all these clusters represent recognisable differences in community. Cluster analysis can differentiate samples due to very subtle differences in community where all samples analysed are similar. The MDS plot displayed in Figure 5 shows some grouping of clusters, but all are close together indicating the community recorded in all samples is relatively similar. Therefore, the clusters should be aggregated up to higher branches in the dendrogram to form groups that are considered to represent true differences in community.

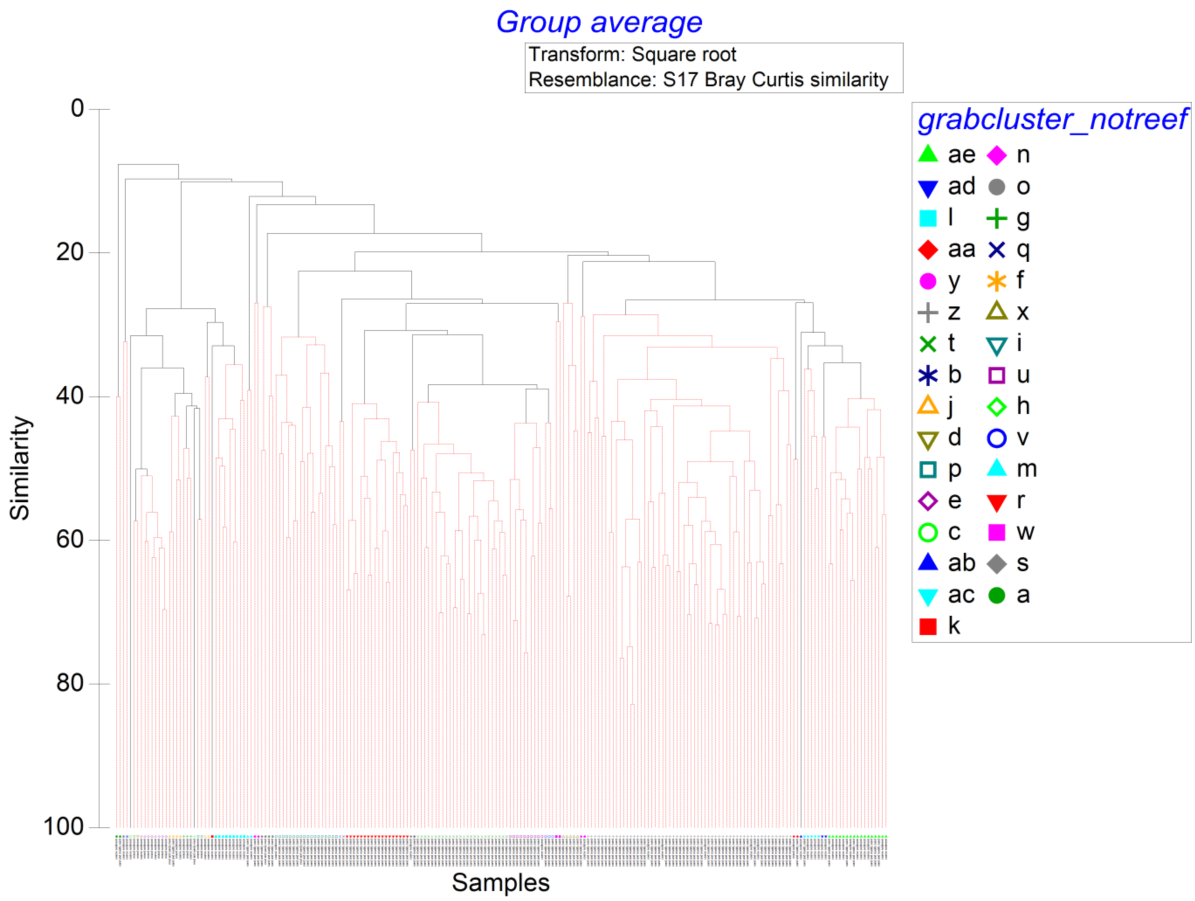


Figure 4: Dendrogram of cluster analysis of grab samples.

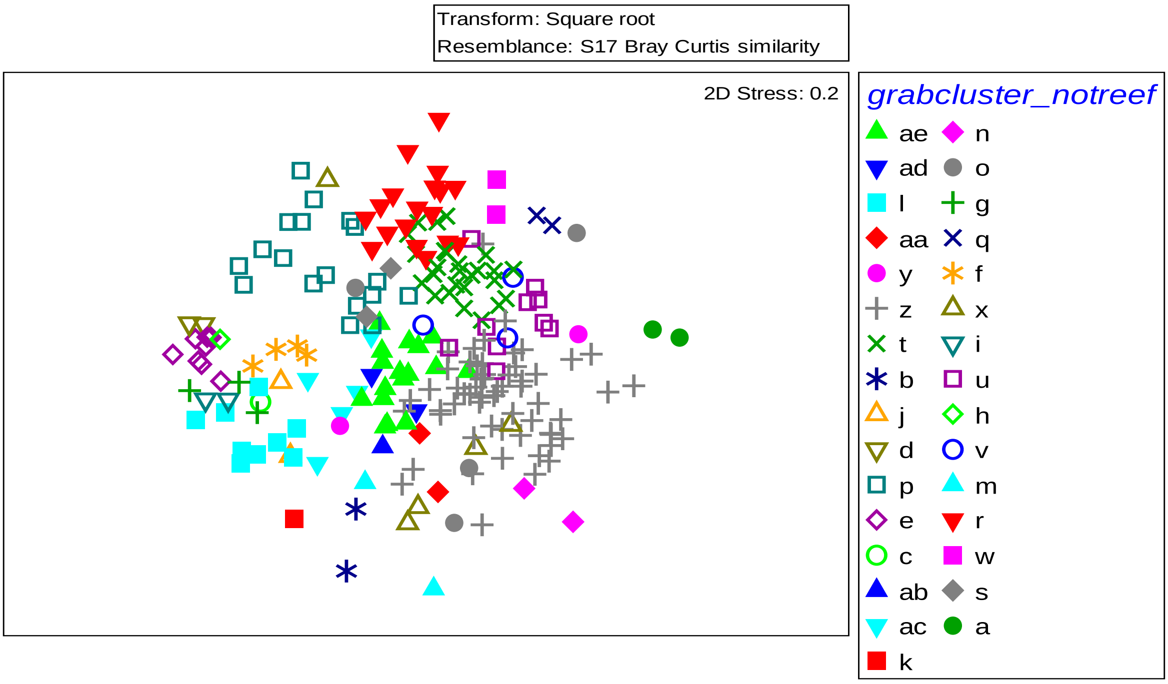


Figure 5: MDS ordination results for all grab samples (excluding *Sabellaria* reef)

EUNIS broad substrate type and sandbank topography were added as factors and displayed over the dendrogram and MDS plot to assess whether physical variables were driving changes in community. The MDS plot in Figure 6 shows EUNIS substrate type overlain on the same MDS ordination shown in Figure 5. Results indicate substrate type is driving changes in community as samples with the same substrate group near each other in the MDS plot. Substrate type could, therefore, be used as a guide to grouping clusters.

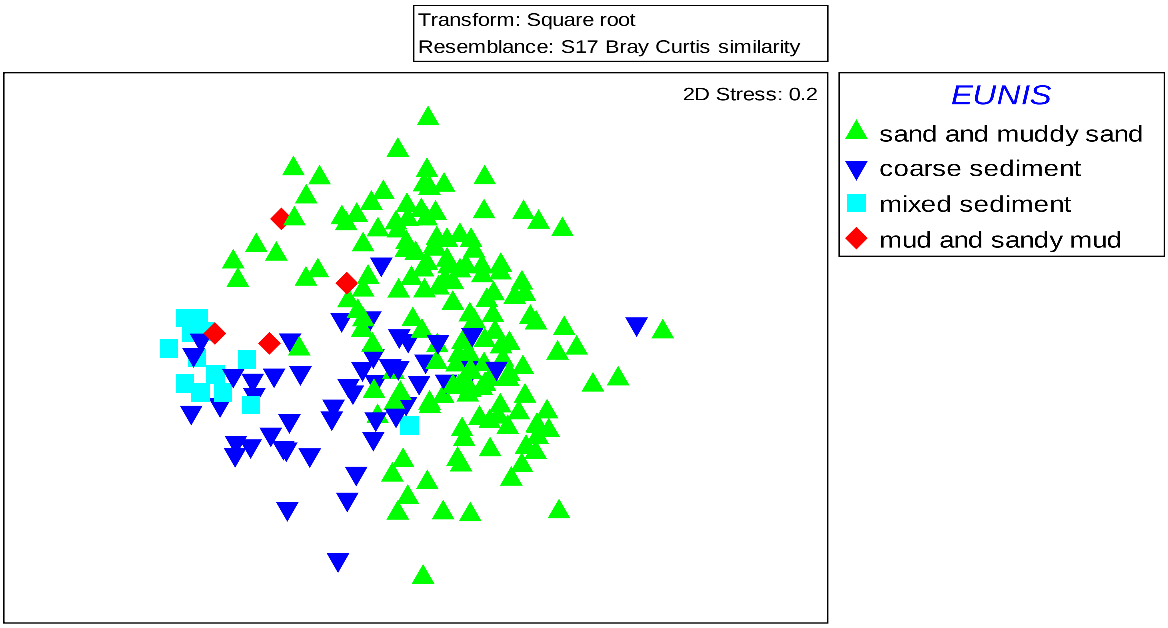


Figure 6: MDS ordination of grab samples labelled by EUNIS broad substrate type

The MDS plot was also overlain with the sandbank topography factor to assess whether this could be driving changes in community (see figure 7). There is some grouping of samples from the same part of a sandbank, but substantial overlap.

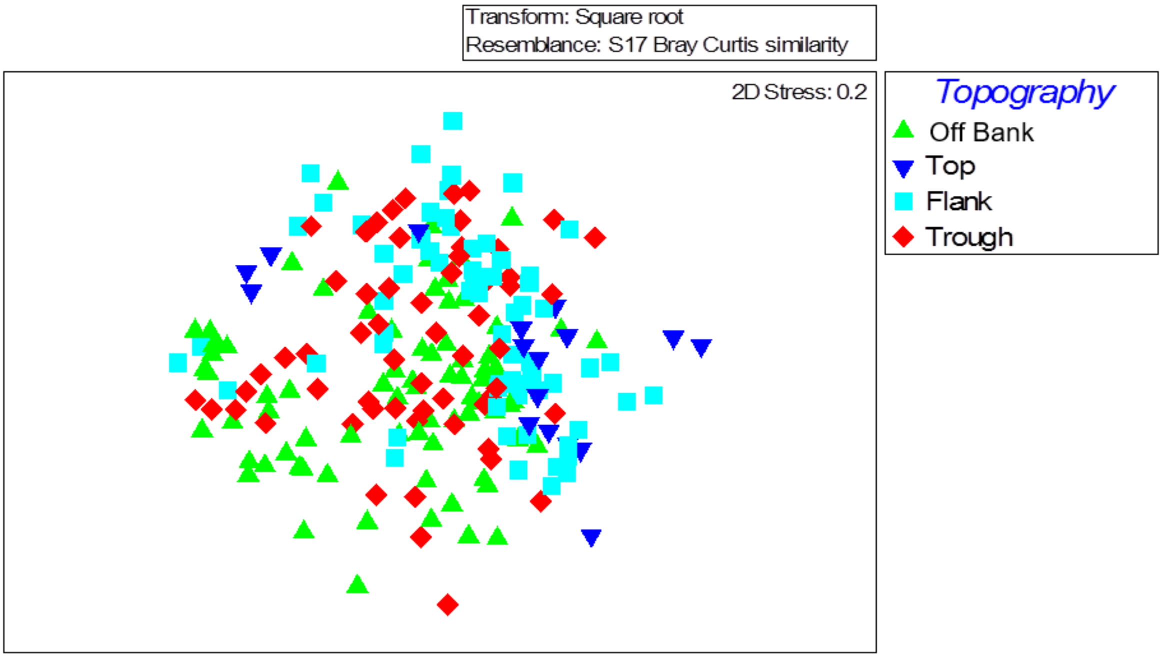


Figure 7: MDS ordination of grab samples labelled by sandbank topography category

An Analysis of Similarities (ANOSIM) was performed to test whether samples with different topographic categories had significantly different communities. Results found a significant difference ($p<0.001$), but the Global R statistic was very low (0.092), which indicates the differences in community were very slight. An ANOSIM was also performed to test between samples of different substrate type, results found a significant difference ($p<0.001$) with a Global R statistic of 0.354. This shows that substrate type does not have a very strong effect on differences in community, but does have a stronger effect than sandbank topography.

The results of SIMPER analysis were used to help aggregate groups of clusters that have a similar community, along with patterns in associated physical variables. SIMPER analysis identifies the characterising taxa for each cluster, and the discriminating taxa which separate each cluster. The percentage contribution of each taxon to similarity shows whether a small number of taxa dominate the community, or if a large number of taxa each contribute a small amount. All clusters seemed to have some of the same characterising species (e.g. ribbon worms Nemertea, polychaete *Ophelia borealis*), but those clusters with the different substrate types had more distinct communities.

Looking at those clusters with > 3 samples, cluster E with ‘mixed sediment’ has much higher average abundances of taxa than other clusters, and some different characterising species (notably *Anobothrus gracilis* and *Ampharete lindstroemi*). Coarse sediment clusters (L and AC) have some of the same characterising species as Cluster E (e.g. *Mediomastus fragilis*, *Sabellaria spinulosa*, *Scalibregma inflatum*, *Notomastus*), but in lower abundances. The key difference between cluster L and AC, is that AC has a higher abundance of *Sabellaria spinulosa* and, as such, is likely to be found at the edge of reefs. All those clusters with sand substrate (AE, Z, T, P, O, X, U, R), have generally lower abundances of species, but are sometimes dominated by a small number of species known to prefer sand (*Abra alba*, *Nephtys cirrosa*, *Bathyporeia guilliamsoniana*). The majority of all sand clusters list the amphipod *Bathyporeia guilliamsoniana* as a characterising species. This is known to be tolerant of disturbed sand, as is present of mobile sand waves.

Based on these SIMPER results and PSA results, cluster E was labelled ‘Circalittoral mixed sediment biotope’. Cluster AC was merged with other small clusters with coarse sediment substrates and labelled ‘Circalittoral coarse sediment biotope A’. Cluster L was kept separate and labelled ‘Circalittoral coarse sediment biotope B’. All sand clusters (AE, Z, T, P, O, X, U, R plus small clusters with sand present) were merged and labelled ‘Circalittoral sand biotope’, although it should be noted that in some areas this biotope may cross into the infralittoral. The MDS plot was labelled with these new ‘refined clusters’ (see figure 8), and the samples group well into these categories.

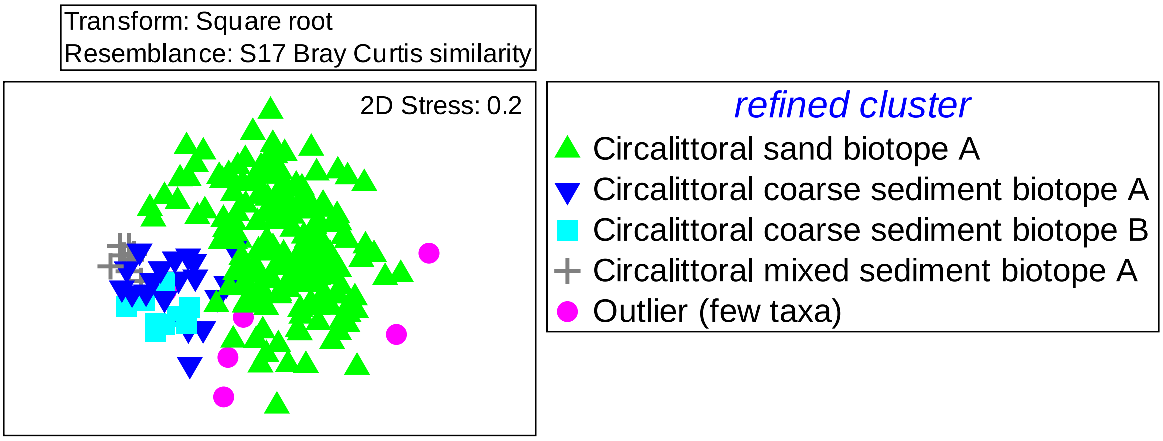


Figure 8: MDS ordination of grab samples labelled by refined cluster

The SIMPER analysis was run again on the refined clusters to summarise the characterising species for each biotope. The discriminating taxa tables show that a key difference between Circalittoral sand biotope A and Circalittoral coarse sediment biotope A was the abundance *Bathyporeia guilliamsoniana* which was higher in sand. Circalittoral sand biotope A recorded many of the same species as the Circalittoral mixed sediment biotope, but in lower abundances. Circalittoral mixed sediment biotope differed from all other biotopes due to the presence of *Anobothrus gracilis* and *Ampharete lindstroemi*, and other taxa occurring in much higher abundances. Circalittoral coarse biotope B differed from A, only notably in having a higher abundance of *Sabellaria* (other taxa were present in slightly different abundances in both A and B).

Each biotope was matched to the EUNIS classification. Both of the circalittoral coarse sediment biotopes, and the mixed sediment biotope, were most similar to A5.142 - *Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel (SS.SCS.CCS.MedLumVen in the JNCC classification) and A5.443 *Mysella bidentata* and *Thyasira* spp. in circalittoral muddy mixed sediment (SS.SMx.CMx.MysThyMx in the JNCC classification). However, a number of the top characterising species (e.g. *Polycirrus*, *Pholoe baltica*, *Anobothrus gracilis*) do not match any of the level 5 biotopes. As no good level 5 match could be found, these groups had to been assigned at a higher level. They all have some characterising species which are known to occur in coarse sediment, as well as some which occur in mixed sediments so it was hard to select a level 4 habitat based on biology alone. Consequently, these groups were assigned to either A5.14 Circalittoral coarse sediment or A5.44 Circalittoral mixed sediment based on the PSA results.

The circalittoral sand biotope was a good match with A5.233 - *Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand (SS.SSa.IFiSa.NcirBat). This biotope is found on ‘medium to fine sandy sediment in shallow water, often formed into dunes, on exposed or tide-swept coasts' which fits the North Norfolk Sandbanks site, and 'often contains very little infauna due to the mobility of the substratum' which also matches results. Sand eels (*Ammodytes* sp.) are known to occur with this biotope, and they were recorded at a number of sand stations from the 2013 survey (although sand eels were removed from the analysis as they are mobile). It should be noted that in some places this biotope may continue into the circalittoral zone.

The sand biotope A5.233 tends to occur in shallower water, and can be found on the top and flanks of sandbanks as well as in troughs and outside sandbanks. The coarse and mixed sediment biotopes tend to occur outside sandbanks and in the troughs, but sometimes on sandbank flanks.

3.2. Video samples

Video results were reviewed in the same way as grab samples. The initial cluster analysis found many significant clusters (see figure 9). The MDS ordination (Figure 10) showed some smaller clusters separated out, but there was a central group of stations that were close together.

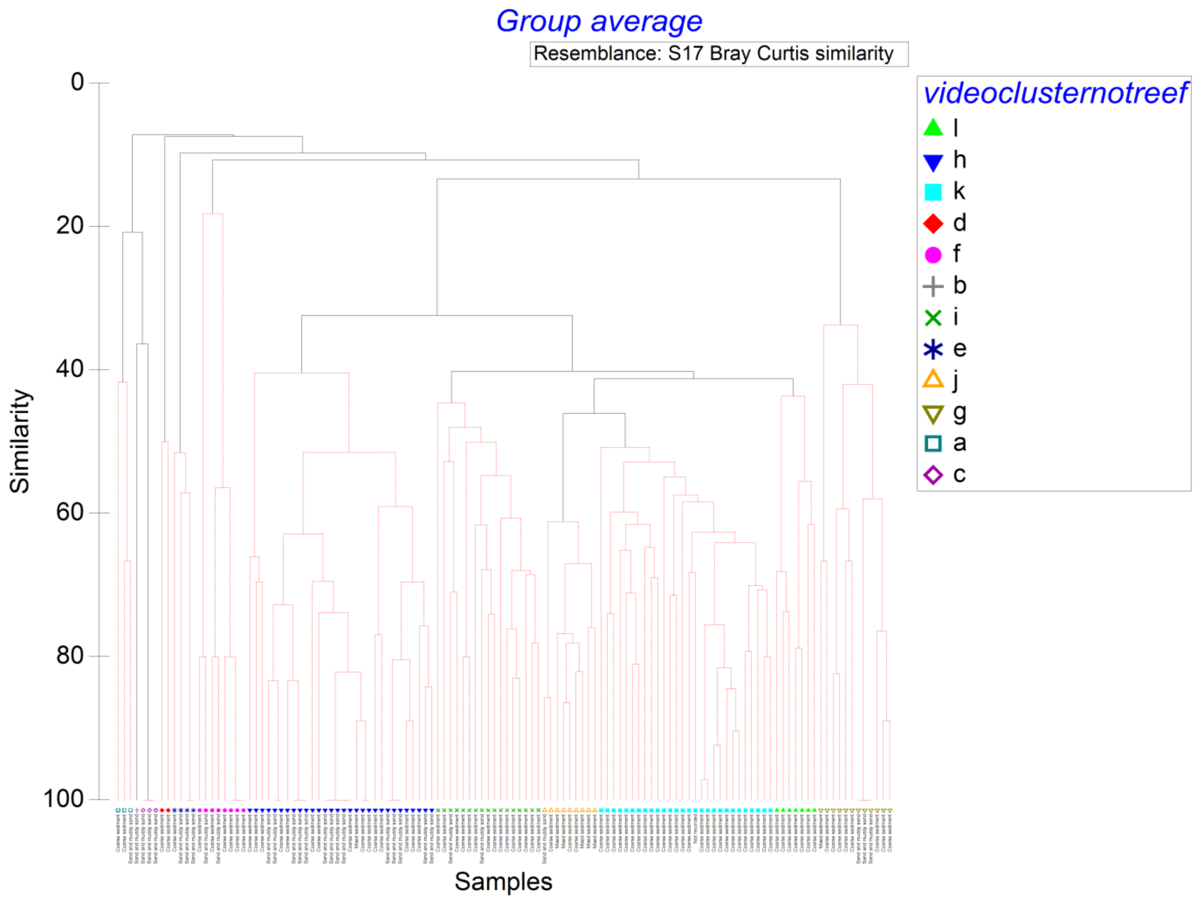


Figure 9: Dendrogram of cluster analysis of SACFOR video samples

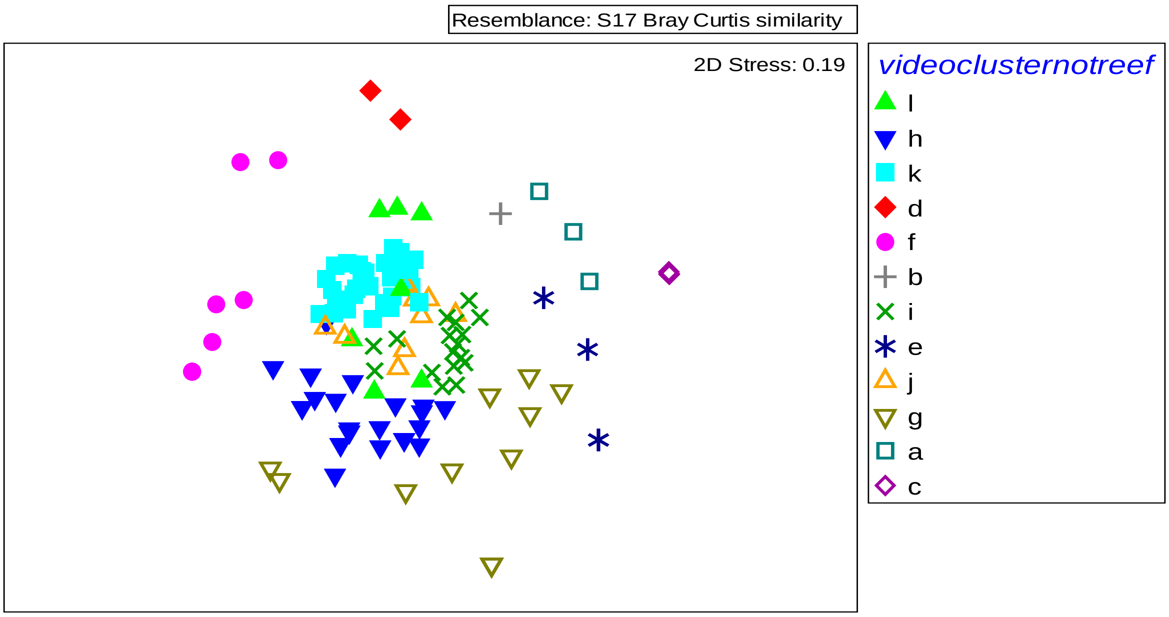


Figure 10: MDS ordination of video SACFOR samples labelled by cluster

SIMPER analysis revealed many clusters had the same characterising species in slightly different relative abundances, including attached epifauna such as soft coral *Alcyonium digitatum*, Bryozoa including *Alcyonium diaphanum* and *Flustra foliacea*, and hydroid *Nemertesia antennina* as well as the anemone *Urticina felina*. Other clusters (e.g. H, I) had fewer characterising species with less attached epifauna, but were dominated by seastar *Asterias rubens*. Clusters were grouped into two 'refined clusters'; one with attached epifauna, and one with sparse mobile epifauna (see Figure 11). SIMPER analysis was performed on the refined clusters to summarise characterising species.

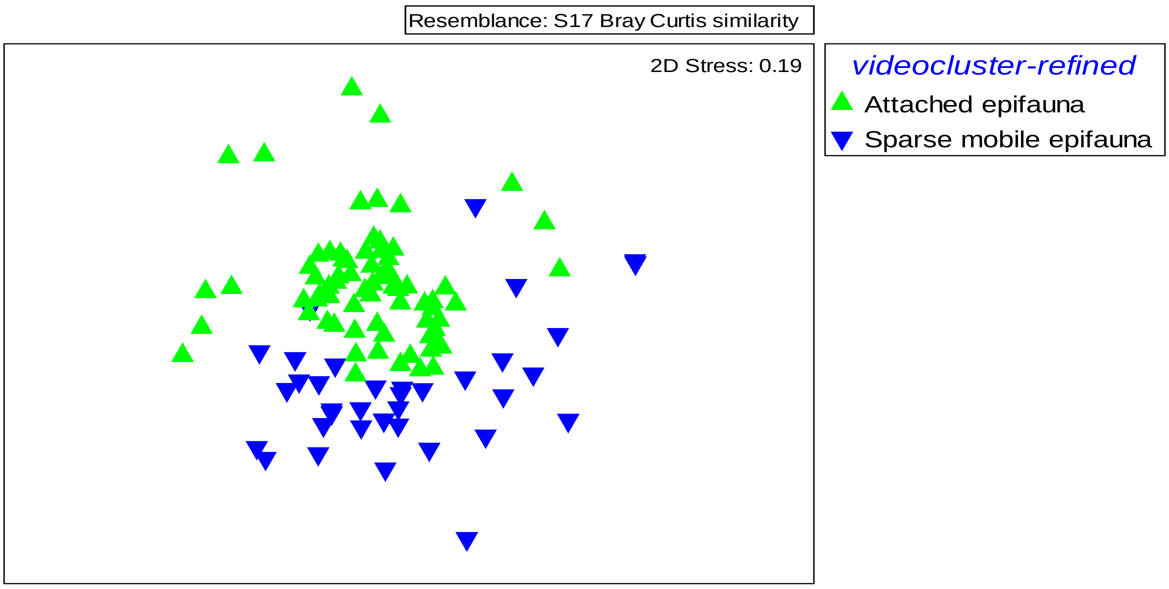


Figure 11: MDS ordination of video SACFOR samples labelled by refined cluster

The substrate type was added as a factor to assess whether epifaunal community was driven by substrate type. The attached epifauna occurred mostly on coarse sediment as expected, but also on sand. It should be noted that it is hard to identify how much mud is present in the sediment from video footage, so it is possible that some samples labelled as coarse sediment could be mixed sediment. A review of the raw stills found that attached epifauna could occur on areas of sand where a small number of pebbles and cobbles were present, as well as on coarse sediment.

The two refined biotopes were matched with the EUNIS Classification. The 'attached epifauna' biotope was matched to A5.444 '*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment' (SS.SMx.CMx.FluHyd), although it should be noted that this refers to the pebbles and cobbles present in a video tow only. The underlying substrate will not necessarily be mixed sediment; consequently, each sample was also assigned a higher level habitat (A5.14 Circalittoral coarse sediment or A5.25 Circalittoral fine sand) depending on the substrate recorded in the video logs. The mobile epifaunal biotope had too few characterising taxa to be matched to a level 5 biotope.

4. Conclusion

The distribution of biotopes assigned to grab samples and video samples is displayed side by side in Figure 11. Both show similar patterns, with sand biotopes occurring both on the bank topographic features and in deeper areas, and coarse and mixed sediment biotopes being found mostly in troughs and deeper areas. Results indicate that areas off the topographic bank features where mobile sand is present have the same community, and as such, could be considered to be important to sandbanks.

Coarse and mixed sediment biotopes in the troughs and outside sandbank areas have many of the same species as sandbanks, in higher abundances. Samples to the north of the site with higher mud content (coarse sediment biotope A) had a particularly high abundance of taxa. This could be due to the proximity with Sabellaria reefs, or perhaps a result of the increased stability of sediment.

5. References

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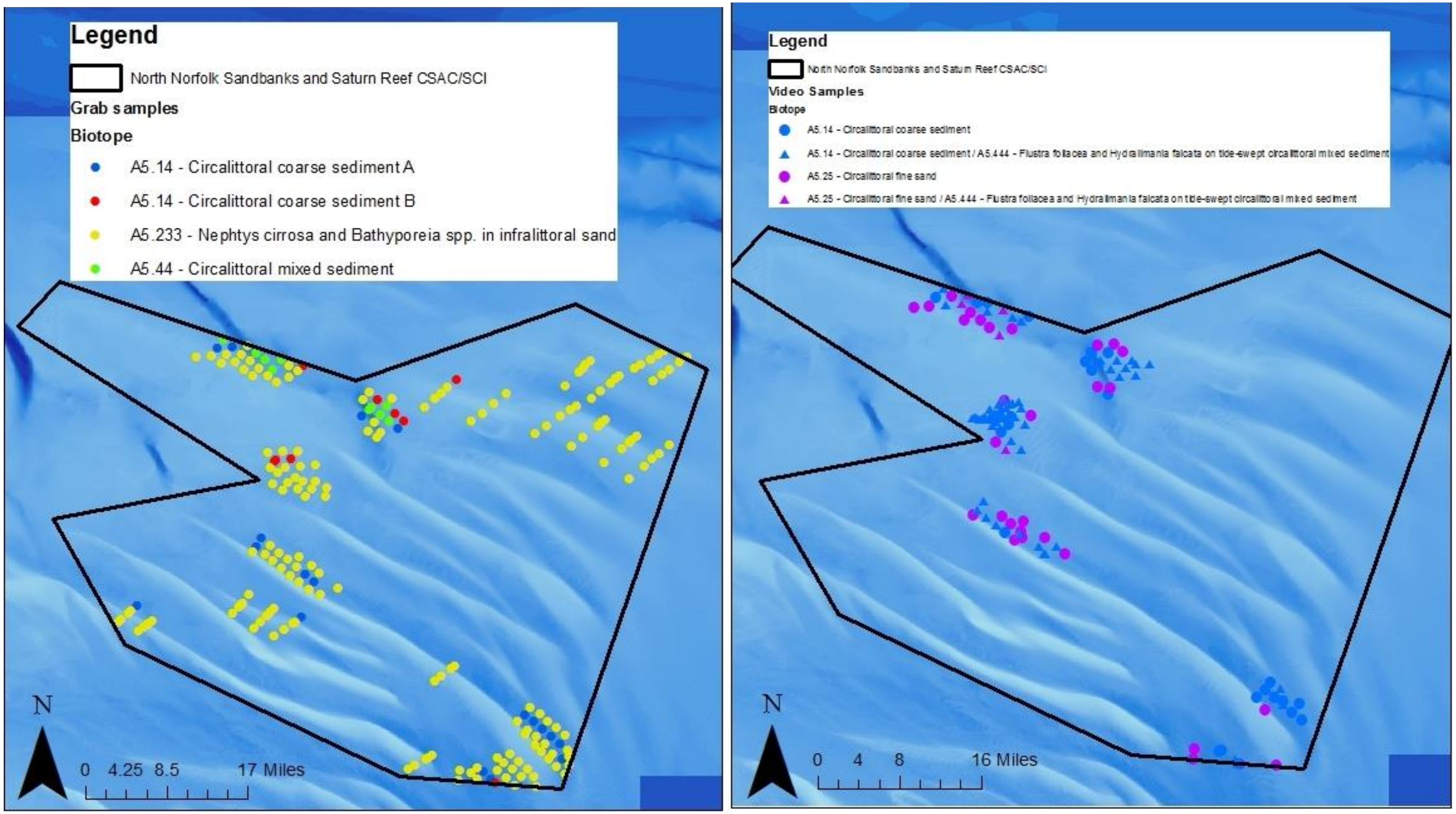

Figure 11: Map showing the distribution of biotopes assigned to grab samples (left) and video samples (right) in the North Norfolk Sandbanks cSAC using data from the 2013 JNCC/Cefas survey