APPENDIX 9A

The species macro-invertebrate community structure and sediment distributions were investigated by employing a number of univariate and multivariate statistical measures drawn from the PRIMER v6 suite of programs (Clarke and Gorley, 2006; Clarke and Warwick, 2001). Prior to analyses, the faunal grab datasets were rationalised by removing species for which quantitative sampling by grab techniques is not appropriate such as nematodes and zooplankton, and allocating entries denoted by sp. or juv. into the higher taxonomic level. Rationalisation and further reconciliation were also necessary to account for any taxonomic inconsistencies resulting from using different laboratories to analyse the SCREA and SCREC grab samples. Where more detailed speciation was encountered in one dataset, the other was taken up to a matching taxonomic level. This was performed by expert taxonomists with full understanding of current taxonomic nomenclature. This technique reduces the problem of statistical bias driven purely by laboratory differences.

The rationalised data were imported into PRIMER and 4th root transformed to down-weight the dominant species taking a much greater account of the less frequently occurring species and allowing the underlying community structure to be assessed.

The transformed data were subjected to hierarchical clustering during which the relative similarities between every pair of samples were calculated. Macrofaunal data were compared using the Bray-Curtis similarity measure whilst physical data were compared using the Euclidean distance measure of similarity. Cluster analysis combined with a permutation test (SIMPROF) was used to identify the presence of significant clusters within the dataset which are revealed on a 2 D dendrogram. Calculated pair-wise similarities were then used to group the faunal and sediment samples using a Multi Dimensional Scaling (MDS) plot to highlight the association of significant SIMPROF clusters.

The results of PRIMER were used initially to check if the SCREA and SCREC data were comparable post-rationalisation and that no bias between surveys existed that could not be explained ecologically. This could be seen from the amount of overlap between sites sampled from the two different surveys (shown in the cluster dendrogram in Figure 9A.1 and the corresponding MDS plot in Figure 9A.2). From these analyses it was then decided that the species datasets were suitable to be viewed as one in any further analyses.

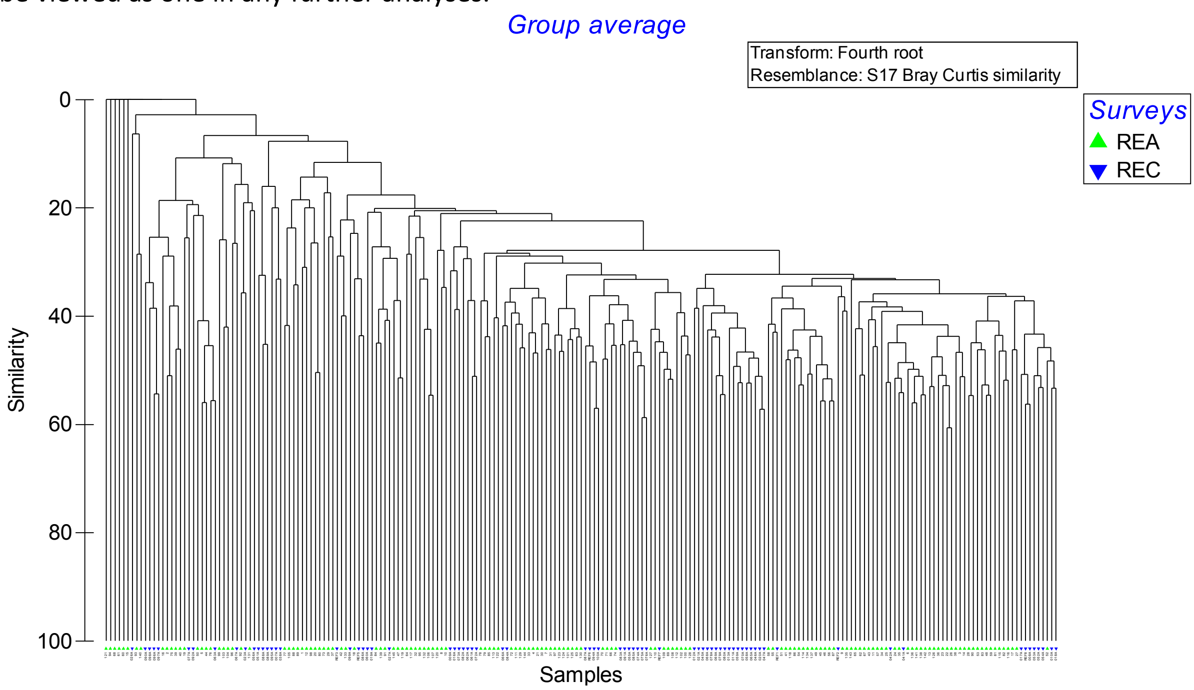


Figure 9A.1: Cluster dendrogram of combined rationalised SCREA and SCREC data.

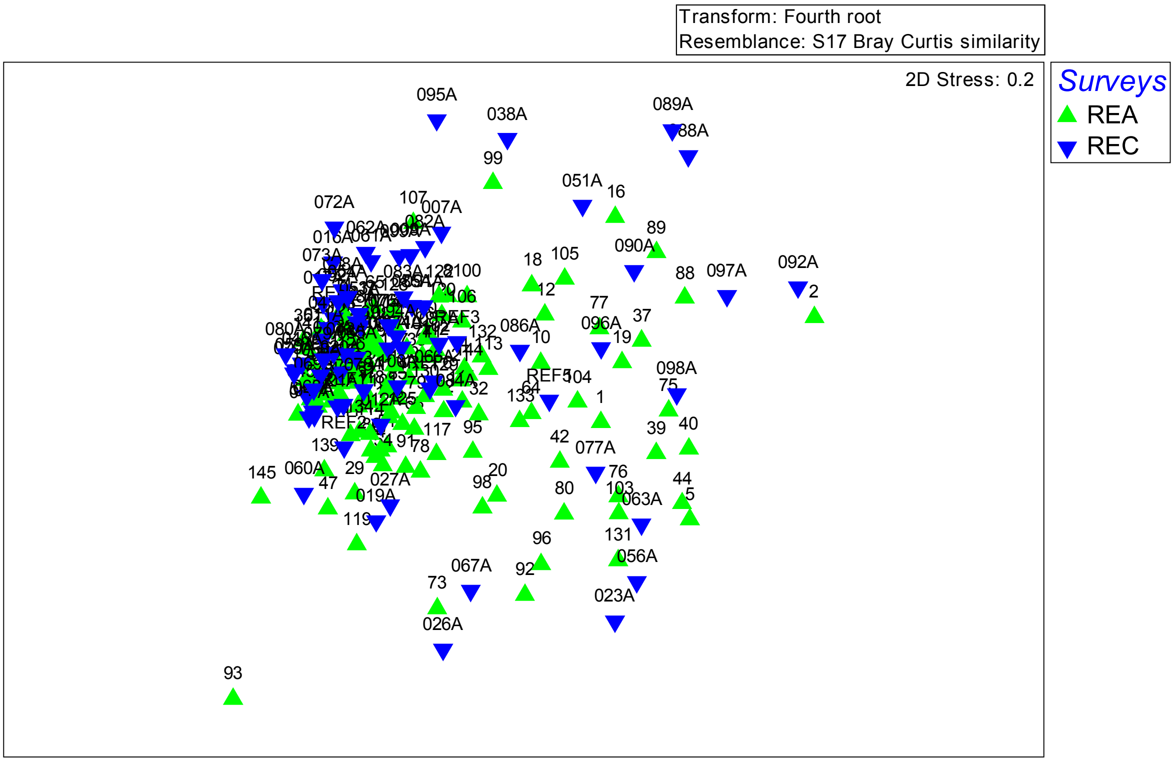


Figure 9A.2: MDS plot of combined rationalised SCREA and SCREC data.

The idea of the PRIMER analyses is to identify statistically similar groupings that can be related to actual communities and then classified as to biotope accordingly. However, because of the geographical spread of the samples across the south coast MAREA region and the natural heterogeneity of the sediments across the south coast, the clustering of groups was not deemed adequate for biotoping purposes. To this end, the PRIMER route of allocating biotopes to SIMPER groups was attempted, however the samples were also reviewed independently of each other and using video and sediment data to gain more confidence in biotope allocation. This means that some samples that grouped together were allocated very different biotopes when all environmental information was reviewed. This approach should be considered when using data from a geographically large area covering an extensive number of habitats containing a high degree of local heterogeneity.

In terms of detection of potential impacts, direct comparison between previous and current REA survey data is not considered entirely appropriate because of the different scales over which the respective surveys have been undertaken. Whilst sufficient to gain a broad understanding of the benthic ecology and likely gradients of dredging impacts at regional level, the intensity of the sampling undertaken during the current REA was inadequate to provide further insight of dredging related trends at any one particular aggregate licence area. In general, impacts associated with aggregate extraction on benthos have been well documented and assessed over many years both through site specific monitoring and as a result of experimental dredging studies in the south coast region. There are also considerable amounts of information on the expected responses of biotopes to a range of physical effects that can be attributed to dredging. As a result, the consequences of future dredging scenarios can be predicted with a degree of confidence as presented within the current study.

It is also important to note that the historic data presented in Appendix B is collated from a large number of disparate datasets. This introduces considerable spatial, temporal and methodological variation so that precise interpretations at the broad scale are generally not possible. Appendix B spells this out and states that with regard to historic species abundance data, these span 10 years and so to provide a clear and uncomplicated overview of abundance over the total survey period of the dataset, faunal abundances were presented without indicating trends over time. The value of the REA, together with the REC, is that it avoids the temporal and methodological variations inherent within previous sub-regional and regional investigations providing a reliable baseline picture of the physical and biological trends over the south coast region upon which subsequent regional monitoring programmes can be based.

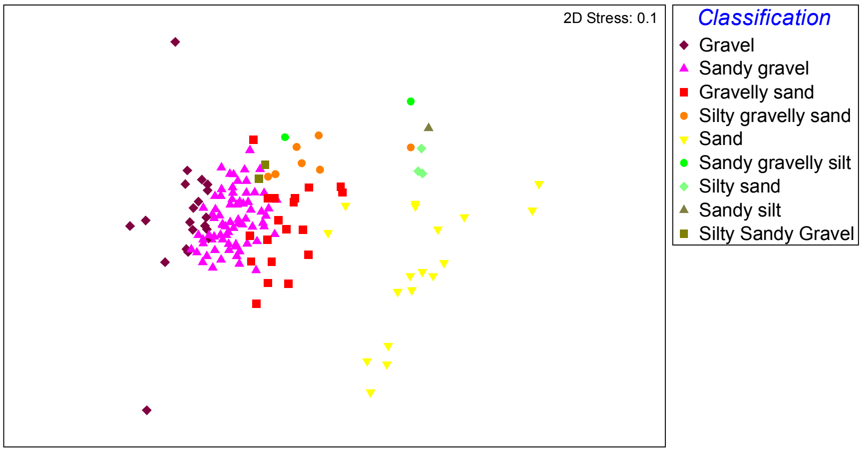
On a site by site or species by species basis, some comparison between historic and current data can be made although the value of this is questionable given the different spatial scales used and the inherent temporal and methodological variations which will caveat firm conclusions. Figure 9.1 of the REA shows that the most intensive sampling has historically occurred within and around Areas 395, 372/1, 372/2, 407, 351, 396, 435 and the complex of sites associated with Area 122 although some limited sampling has taken place in other areas such as application areas 488 and 453, 451 and the 122, 123 & 124 complex of aggregate licences. No historic survey data were available for aggregate sites to the west of the Isle of Wight.

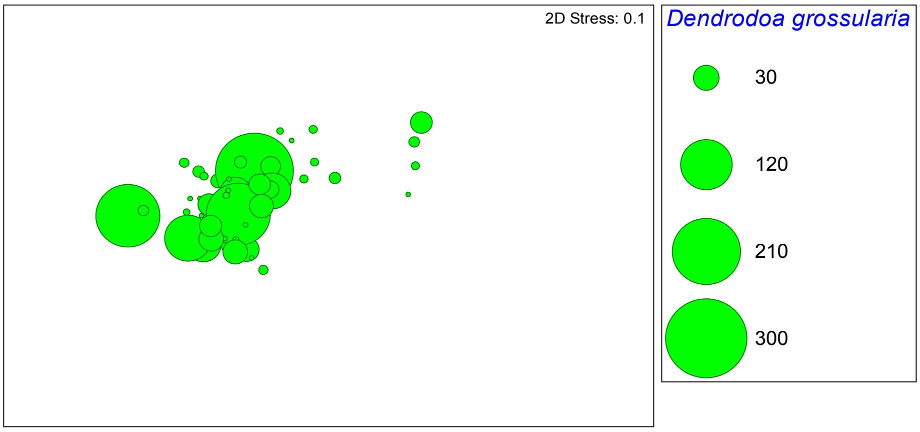
Historically, the seabed sediment within the east of the Isle of Wight sub-region has been described as predominantly comprising gravel although these were often bordered by gravelly sands. This highlighted the local variability and gradation of sediment types possibly relating to the mobility of sediments in the gravel dominated central region compared to the sandier sediments further east and in the Owes sub-region. The REA generally confirmed this picture of coarse sediments within the eastern Isle of Wight region and particularly within and around Areas 351, 340 and 122/3 from which the greatest number of REA grab samples were collected. Gravelly sand sediments observed outside the boundaries of licence areas and within the potential cumulative effects of sediment plume movement between 340, 341 and 351 may be consistent with a fining of previously coarser substrates, as a result the re-mobilisation and deposition of fine sediments arising from active dredge areas, although this may equally be an artefact of the current survey design. A programme of regional monitoring against the current baseline is expected to elucidate cumulative effects between aggregate extraction sites. The REA also confirmed the presence of comparatively sandy sediments to the south of Hayling Island, aligning with previous observations.

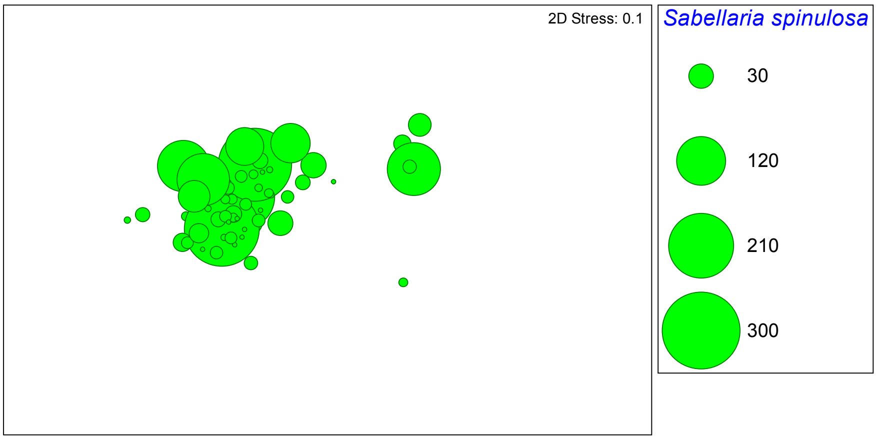
The general eastward movement of mobile sands from Selsey Bill, which would result in sandier sediments in the eastern region and more gravelly sediments to the south of Selsey Bill, was discussed in the review and appears to have been confirmed by the current study. In general, sediments collected from the east of the sample array and in the Owers sub-region comprised more sand than those further west Licence areas 122/1G, 123G & 124/1G, 396, 122/1 and 122/1A were found to comprise sandy and gravelly sand substrates matching previous descriptions of sediment conditions for these areas. Some stations within the Owers sub-region, however also comprised coarser sandy gravel substrates presenting a picture of local heterogeneity. Whilst a coarsening of sediments within active dredge zones is well documented, no dredging related effect can be confirmed in these instances.

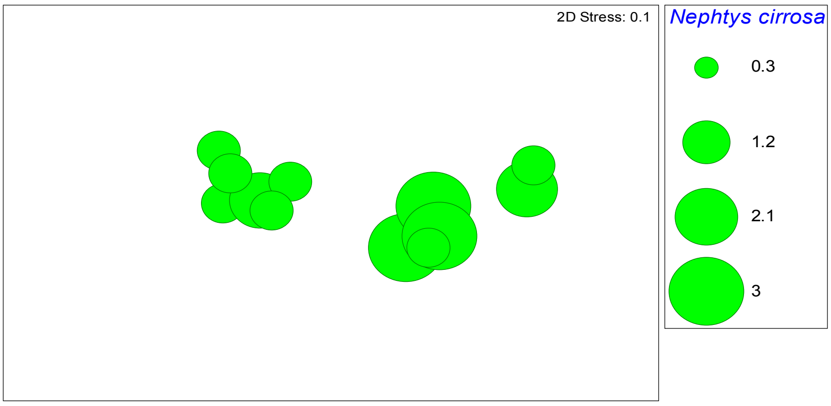
No evidence of adverse impacts on fauna were detected from comparison of current and historic review data. In response to Cefas' first comment concerning the benthic environment, a series of multivariate (clustering & MDS) analyses have been performed to detect trends in psd and faunal data that might be indicative of potential dredging effects. Results were inconclusive and no distinct sample groupings relating to dredging treatments were found.

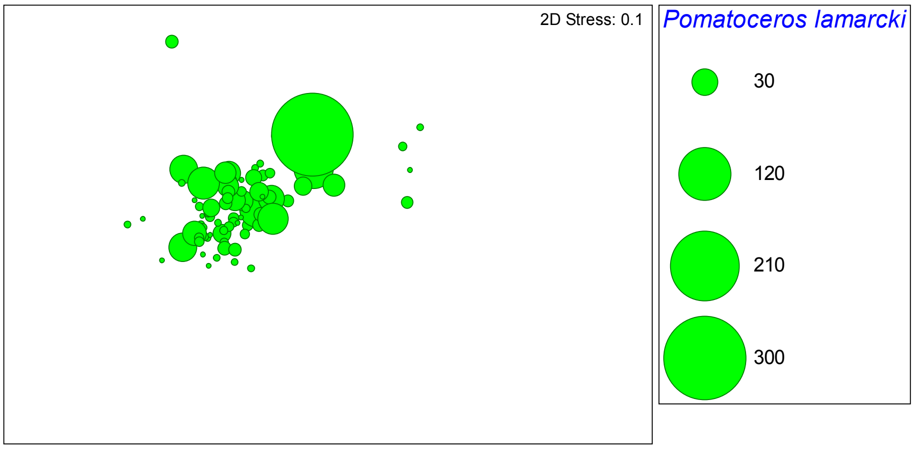
The distribution of macrofauna appeared to be related to sediment types although correlations (BIOENV & RELATE) were poor suggesting other factors may be attributable in this respect. Sediment/faunal relationships were further explored through the overlay of abundances of key taxa onto the ordination of sediment data (Figure 9A.3). This suggested that *Dendrodoa grossularia*, *Sabellaria spinulosa* and *Pomatoceros lamarcki* appear to have a close association with gravel and mixed sand and gravel sediment but were infrequently found in finer grained sand and silty sands.








2D Stress: 0.1
Nephtys cirrosa
0.3
1.2
2.1
3


2D Stress: 0.1
Pomatoceros lamarcki
30
120
210
300


2D Stress: 0.1
Lumbrineris gracilis
3
12
21
30


2D Stress: 0.1
Goodalia triangularis
2
8
14
20

Figure 9A.3. Non-transformed species abundances overlaid onto the PC ordination of sediment grab sample data. The plots highlight species preference and avoidance of certain sediment habitat types.

The bivalves *Goodalia triangularis*, *Spisula elliptica* and the cat worm *Nepthys cirrosa* on the other hand showed an apparent avoidance of the coarsest gravel sediments and a preference for gravelly sand and sand sediments. The polychaete *Lumbrineris gracilis* was more cosmopolitan and did not exhibit any sediment preference other than avoidance of the coarse clean sands found west of the Isle of Wight.

Current data showed a zonation of macrofauna across the MAREA study area suggesting the presence of distinct sub-regional communities of infauna. Group G, for example was the dominant community type towards the east of the region around the Owers group of licences and appeared to be exclusive to this general area. It was associated with mixed sand and gravel substrates and was characterised by a comparatively diverse macrofauna including the polychaetes *L. gracilis*, *Pomatoceros* spp., *Notomastus* spp. and *Caulleriella alata* together with the barnacle *Balanus crenatus* and the sea urchin, *Echinocyamus pusillus*. Group H, on the other hand was the dominant infaunal community type to the west of the region and was only represented by a few sample stations east of the Isle of Wight. It was not present at the Owers group of licences. Group H comprised predominantly coarser sandy gravel substrates supporting the baked bean sea squirt *Dendrodoa grossularia*, and the polychaetes *Notomastus* spp., *Aonides paucibranchiata* and *Glycera lapidum*.

Group D, was another relatively large group of samples and comprised mixed sand and gravel sediments with some small amounts of silt/clay. The macrofauna was the richest and most diverse of any infaunal group and included the polychaetes *Sabellaria spinulosa*, *L. gracilis*, *P. lamarcki*, the sea squirt *D. grossularia* and the nut shell *Nucula nucleus*. This grouping was notably well represented to the east and west of the Isle of Wight but only occurred infrequently at the Owers group of aggregate licences. Group D was differentiated from the principal Owers macrofaunal grouping (Group G) as a result of greater abundances of *S. spinulosa*, barnacles *Balanus crenatus* and *Verruca stroemia*, *D. grossularia, N. nucleus* and *P. lamarcki* in Group D. These species are typical of coarse gravel substrates and so match the general picture of the distribution of sediment types across the region.

The review of historic data showed that the slipper limpet *Crepidula fornicata* was well distributed throughout the survey area and that it had spread well outside of the Solent area, and was now prevalent in this region, out towards the 12-mile limit in places (i.e. to the south of Area 407). REA data generally confirmed the widespread nature of this species as shown in Figure 9A.4 below which plots abundance of slipper limpet against longitude (eastings) and revealed comparable numbers in grab samples from all sub regions.

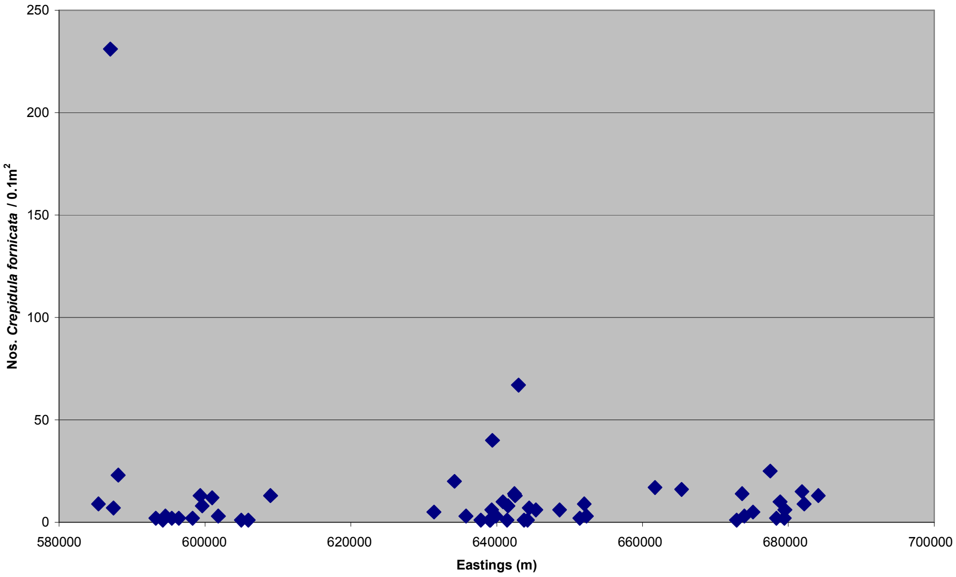


Figure 9A.4: Distribution of *Crepidula fornicata* abundance in grab samples within the south coast REA region.

The REA also generally confirmed earlier observations concerning the distribution of barnacles suggesting that greatest abundances were recorded to the east of the REA area (Figure 9A.5). Overall, these barnacles were associated with gravelly sands or sandy gravels. Note that whilst eastern areas comprised generally less gravel, this distribution does partially relates to (but is not limited to) the distribution of *Aequipecten opercularis*, whose shell is a platform for attachment for barnacles. Whilst current sampling methods were not adequate for accurate determination of the distribution of scallop abundance historical records suggested that greatest abundances (no. individuals / m^2) were recorded around License Areas 122/1A and B, 123A and B, and 124/1A and B.

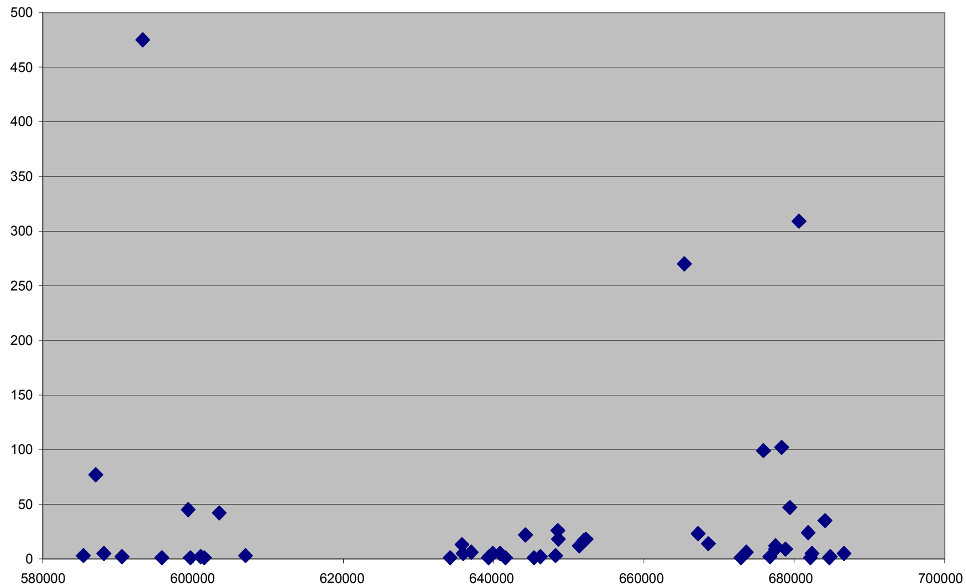


Figure 9A.5: Distribution of *Balanus crenatus* abundance in grab samples within the south coast REA region.

Interestingly, the REA did reveal a strong distributional trend for the polychaete *S. spinulosa*. (Figure 9A.6) not apparent from the historical data. Highest numbers were found within the eastern Isle of Wight and Owers sub regions within and around dredging licences. In contrast only low numbers were found within the west IoW sub region. The eastern distribution pattern of *S. spinulosa* corresponded to the occurrence of Group F at the Owers and east of the Isle of Wight. This faunal grouping was not represented to the west of the Isle of Wight where abundance of *S. spin*ulosa is comparatively low.

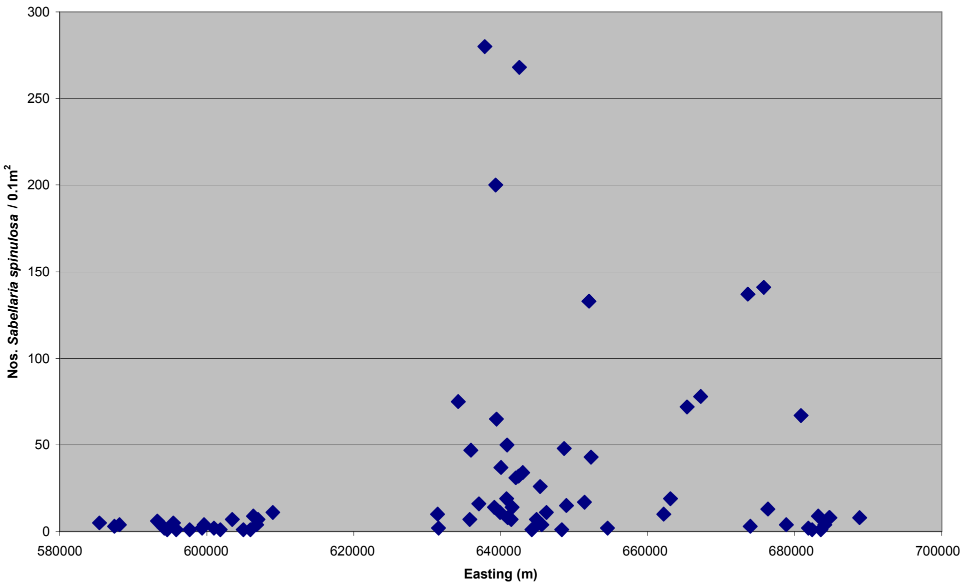


Figure 9A.6: Distribution of *Sabellaria spinulosa* abundance in grab samples within the south coast REA region.

Current data showed that *D. grossularia* was also distributed unevenly and appeared to exhibit the reciprocal zonation pattern to that of *S. spinulosa*, i.e. densities of this species decreased with increasing distance eastwards. Factors influencing the distribution of this species across the South Coast MAREA study area were unclear it was postulated this may be related to the substrate type available for colonisation, in many cases this sea squirt species was found to be attached to *Crepidula* shell so respective distributions may be correlated. The animal may also reproduce by cloning thus producing localised concentrations which will affect the numbers recorded. Limited larval dispersion and low potential for colonisation of new areas may be a contributing factor.

The REA has improved knowledge of the distribution of the brittlestar *Ophiothrix* spp. which was previously described as exhibiting a patchy distribution over the survey area with greatest abundances occurring to the west of License Area 122/1 A, 123 A and 124/1 A. Current data showed that high densities occurred within and around Area 407 to the south of the study area in numbers indicative of the presence of brittlestar bed habitat.

Further comparison of species abundance data is possible but in light of the spatial, temporal and methodological variations, is unlikely to provide further insight on changes in macrobenthos at a regional scale attributable to dredging. Instead, future monitoring against this baseline and following the same methods and design would allow assessment in this respect. Future monitoring could also provide opportunity to develop further additional measure to detect changes in communities. For instance the ratio of the relative proportions of filter /deposit feeders to predator scavenging species at sampled sites over time might prove a useful index for the measurement of change attributable to dredging relating disturbances.