

# East Channel association

## EASTERN ENGLISH CHANNEL MONITORING REPORT 2008

### Section 2. Benthic Communities and Habitats from Grabbing Surveys

Volume I (Report)

East Channel Association

Report No. 09/J1031333/0872 (Draft)

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Emu Ltd  
Head Office  
1 Mill Court  
The Sawmills  
Durley  
Southampton  
Hampshire, SO32 2EJ  
Tel: +44 (0) 1489 860050  
Fax: +44 (0) 1489 860051  
mail@emulimited.com  
www.emulimited.com



The East Channel Association (ECA) consists of companies developing marine aggregate extraction applications in the Eastern English Channel. This Regional Environmental Monitoring Report has been produced to fulfil the ECA's commitment to undertake regional environmental monitoring as outlined in the ECA Regional Monitoring Blueprint v0.3 (ECA and Emu Ltd., 2005).

## The Companies of the ECA



Britannia Aggregates Ltd  
Lower Road  
Northfleet  
Kent  
DA11 9BL



CEMEX UK Marine Ltd  
Baltic Wharf  
Elm Street  
Marine Parade  
Southampton  
Hants.  
SO14 5JF



Building Materials

Deme Building Materials Ltd  
Greenstede House  
Wood Street  
East Grinstead  
West Sussex  
RH19 1UZ



Hanson Aggregates Marine Ltd  
Burnley Wharf  
Marine Parade  
Southampton  
Hants  
SO14 5JF



United Marine Dredging Ltd  
United Marine Aggregates Ltd  
Francis House  
Shopwyke Road  
Chichester  
West Sussex  
PO20 6AD

**VDL**

Volker Dredging Ltd  
Robert Brett House  
Ashford Road  
Canterbury  
Kent  
CT4 7PP

**CONTENTS**

1.0	INTRODUCTION.....	6
1.1	Study Background.....	6
1.2	Report Objectives.....	6
1.3	Survey Array for 2008.....	6
1.4	Reporting of Biological Monitoring.....	6
<b>2.0</b>	<b>METHODS.....</b>	<b>8</b>
2.1	Field Methods and Operations Summary.....	8
2.1.1	Field Methods.....	10
2.1.2	Drop Down Video.....	10
2.1.3	Grabbing.....	10
2.2	Laboratory Analysis.....	10
2.2.1	Sample Processing.....	10
2.2.2	Identification of Infauna and Epifauna.....	10
2.3	Biomass.....	11
2.4	Data Analysis.....	11
2.4.1	Multivariate Analysis.....	11
2.4.2	Univariate Analysis.....	13
<b>3.0</b>	<b>RESULTS.....</b>	<b>14</b>
3.1	Regional Infaunal Component.....	14
3.1.1	Initial data treatment.....	14
3.1.2	Species composition.....	14
3.1.3	Multivariate Analysis.....	15
3.1.4	Distribution of Clusters.....	20
3.2	Infauna ANOSIM.....	21
3.3	Priority Sites - Combined Fauna.....	22
3.3.1	Cluster Analysis.....	22
3.4	Combined Fauna - ANOSIM.....	25
3.5	Summary Conclusion.....	26
<b>4.0</b>	<b>REFERENCES.....</b>	<b>27</b>
<b>5.0</b>	<b>AUDIT INFORMATION.....</b>	<b>28</b>

**FIGURES**

Figure 2. 1	MDS Cluster Separation for all Infaunal Sites, 2008 .....	16
Figure 2. 2	MDS Separation of Core Clusters, 2008 .....	16
Figure 2. 3	<i>Galathea intermedia</i> abundance.....	18
Figure 2. 4	<i>Ophiothrix fragilis</i> abundance.....	18
<b>Figure 2. 5</b>	<b><i>E. pusillus</i> abundance .....</b>	<b>18</b>
Figure 2. 6	<i>Syllis</i> spp abundance .....	18
Figure 2. 7	<i>G. lapidum</i> abundance.....	19
Figure 2. 8	<i>Branchiostoma lanceolatum</i> abundance.....	19
Figure 2. 9	<i>Polygordius</i> spp. abundance.....	19
Figure 2. 10	<i>Nephtys</i> spp. abundance .....	19
Figure 2. 11	Illustrating the Derived Clusters in relation to the Principal Environmental Variables, 2008 infauna.....	20
Figure 2. 12	Location of the ADZ Sites in Relation to PIZ and SIZ sites all sites.....	21
Figure 2.13	MDS Representation of Clusters based on all fauna in priority areas.....	22
Figure 2. 14	Impact zones within the MDS plot at 473e.....	26

**TABLES**

Table 2. 1	ECR Biological Monitoring Report Schedule .....	7
Table 2. 2	Vessel, Equipment and Navigation Information.....	8
Table 2. 3	Summary of Multivariate Routines used within PRIMER.....	12
Table 2. 4	Summary of Univariate Routines used within PRIMER .....	13
Table 2. 5	Most Frequently Present Infauna and Enumerated Species, 2008 .....	15
Table 2. 6	Mean and Maximum Abundance of Infaunal and Enumerated Species, 2008.....	15
Table 2. 7	Clusters derived from the infaunal analysis, all sites 2008. ....	17
Table 2. 8	ANOSIM Results for the Different Impact Zones.....	21
Table 2. 9	Clusters derived from analysis of the total fauna, 2008. ....	23
Table 2. 10.	Pair-wise Comparison of ANOSIM values between Impact Zones.....	25
Table 2. 11	Mean Abundance of Dominant species in Clusters HC7 and the sub-group HC7a.....	26

**CHARTS**

Chart No. 2.1	Hamon Grab Sampling Locations and Prospecting Areas
Chart No. 2.2	Total Number of Infaunal Species in Hamon Grab Samples across ECR Survey Area
Chart No. 2.3	Total Infaunal Abundance in Hamon Grab Samples across ECR Survey Area
Chart No. 2.4	Total Infaunal Biomass in Hamon Grab Samples across ECR Survey Area
Chart No. 2.5	Benthic Infaunal Clusters derived from Hamon Grab Samples
Chart No. 2.6	Benthic Infaunal and Epifaunal (Combined) Clusters Derived from Hamon Grab Samples

**APPENDICES (Volume II)**

Appendix Fig 2.1	Clustering of Infaunal Sites, Group Average
Appendix Fig 2.2	2005 Infaunal Clusters Superimposed on 2007 MDS Plots
Appendix Fig 2.3	Cluster Analysis of Combined Data for Area 473 East Indicating Clusters
Appendix Fig 2.4	Cluster Analysis of Combined Faunal Data for Area 461, 2007
Appendix A	Mini Hamon Grab Positions
Appendix B	Grab Survey and 2m Beam Trawling Operations Log
Appendix C	Grab Log and Inventory
Appendix D	Stills Images of Grab Samples Prior to Processing (CD)
Appendix E	Species List from 0.1m <sup>2</sup> Mini Hamon Grab Samples (CD)
Appendix F	Biomass from 0.1m <sup>2</sup> Mini Hamon Grab Samples
Appendix G	Primer Ready Infauna Corrected to 2005 (CD)
Appendix H	All Fauna Priority Sites (CD)
Appendix I	Primer Ready all Fauna Priority Sites (CD)

## **1.0 INTRODUCTION**

### **1.1 Study Background**

The six companies of the East Channel Association (ECA) have all made applications or have been awarded licences to extract marine aggregates (sand and gravel) from a region of the UK continental shelf known as the East Channel Region (ECR) (Chart 2.1).

During the application process for marine aggregate extraction and subsequent Regional Environmental Assessment (REA) the companies made a commitment to undertake assessment and monitoring of their activities using both licence specific and coordinated regional methods. As part of this approach the REA provided an assessment of the environmental conditions and sensitivities of the region and the likely cumulative and in-combination effects of extraction activities.

The recommendations of the REA included a requirement for the companies of the ECA to collaborate in undertaking a programme of regional monitoring. This monitoring programme was developed in consultation with the relevant regulatory bodies and technical specialists in order to provide data capable of identifying the impacts of extraction activities in the ECR.

The scope of monitoring was developed following extensive discussions with government scientific advisors and was progressively revised during development. The initial monitoring scope was presented in the ECA Regional Monitoring Blueprint v0.3 (ECA and Emu Ltd., 2005). The scope of analysis and reporting has been under continual review since the issue of the Blueprint v0.3 as issues have arisen during the monitoring activities.

### **1.2 Report Objectives**

This report has been produced on behalf of the ECA by Emu Limited to describe the monitoring activities with respect to the Benthic Communities and Habitats in the region for the year 2008. The report includes a description of the field methods used, the samples taken during the field work and analysis of the data. Infaunal and enumerated epifaunal data have been analysed for the whole of the EEC region, while selected areas (priority sites), where dredging has commenced, have been analysed using whole data sets, including enumerated infauna and epifauna in combination with presence/absence data for colonial epifauna.

### **1.3 Survey Array for 2008**

The 2008 survey array consisted of a total of 326 sites which included 32 replicate sites. At each of the selected sites, grab samples were attempted for the collection of both macrofauna and particle size analysis. A drop down camera system was also employed at each site to collect both video footage and stills of the seabed.

### **1.4 Reporting of Biological Monitoring**

This report is one of eight documents covering the biological monitoring undertaken within 2008. The full ECR biological monitoring report schedule is listed in Table 2.1.

<b>Report Title</b>	<b>Report Number</b>
1. Seabed Sediment Characteristics	09/J1031333/0871
2. Benthic Communities and Habitats from Grabbing Surveys	09/J1031333/0872
3. Regional Habitats and Biotopes Based on Static Image Analysis	09/J1031333/0873
4. Regional Epifaunal Communities Derived from 2m Beam Trawls	09/J1031333/0874
5. Regional Fish and Associated Epifaunal Communities Derived from 4m Beam Trawls	09/J1031333/0875
6. Regional Shellfish Populations derived from Scallop Dredge Surveys and Beam Trawl Surveys	09/J1031333/0876
7. Example Habitat and Biotope Monitoring site Employing Hydrographic and Video Monitoring Methods	09/J1031333/0877
8. Comparative Analysis Including Theoretical Frameworks	09/J1031333/0878

**Table 2.1 ECR Biological Monitoring Report Schedule**

## 2.0 METHODS

Seabed sediment samples were collected with the use of a 0.1m<sup>2</sup> Mini Hamon grab. The sampling operations were planned to target sites within the Eastern Channel Region that would be both directly (Primary Impact Zones) and indirectly (Secondary Impact Zones) influenced by extraction operations. Within the PIZ, sites were also targeted to take account of actively dredged areas, referred to as ADZ. In addition, reference areas and context sites were sampled to provide comparative sites that would allow natural variations in biological communities, similar too those in the PIZ and SIZ areas, to be investigated.

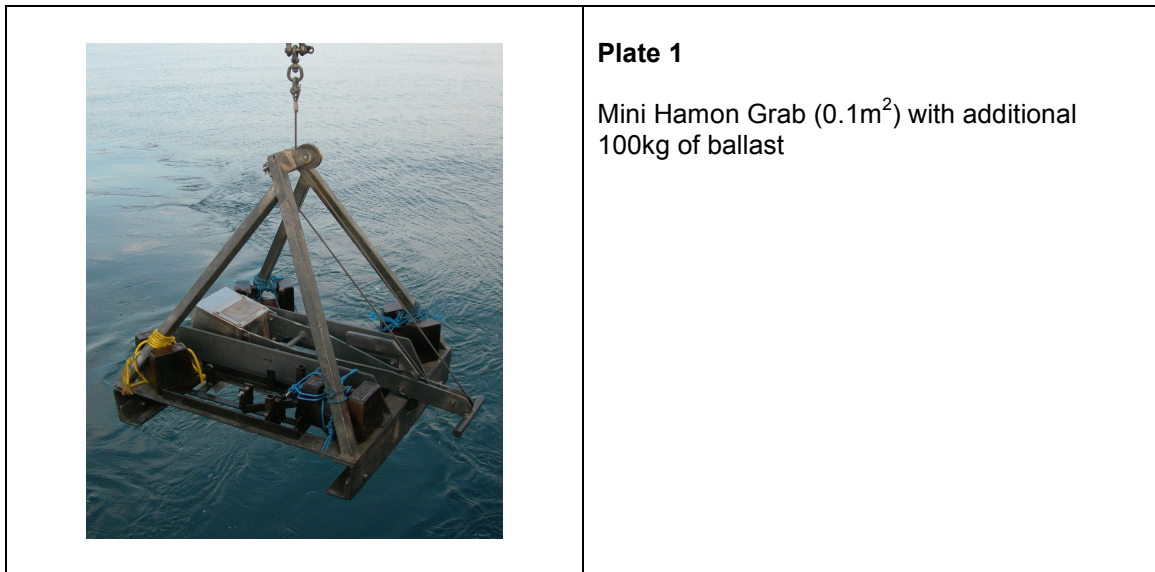
### 2.1 Field Methods and Operations Summary

This section includes a summary of the survey operations and field methods employed during the grabbing survey carried out between August and December 2008 to achieve selected objectives of the ECA Regional Monitoring Blueprint v0.3: Section 4 (ECA and Emu Ltd., 2005).

Details of vessels, equipment and navigation are detailed in Table 2.2. Detailed descriptions of the methods employed in the field are documented in full within Sections 3 and 4, and Annex 3 of the ECA Regional Monitoring Blueprint v0.3 (ECA and Emu Ltd., 2005). Key points from these are summarised in sections 2.1.1 to 2.1.3, together with details of any deviations from those proposed within the Blueprint v0.3.

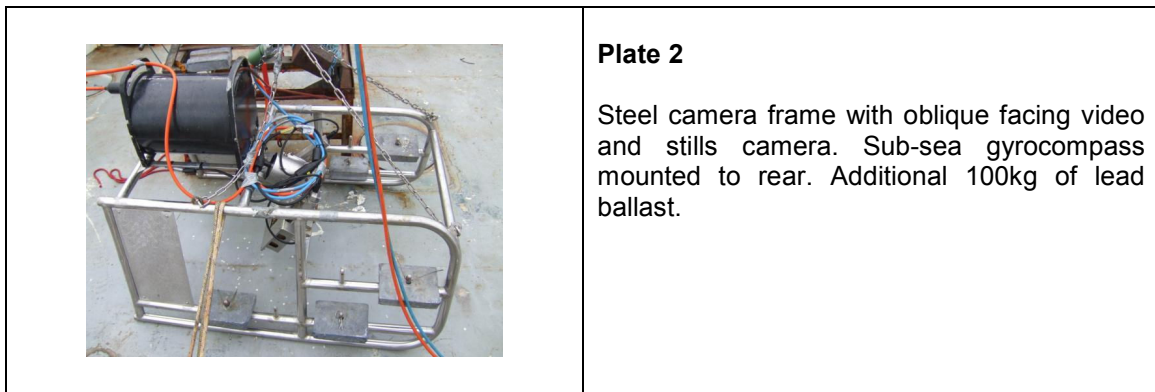
<b>Vessel, Equipment and Navigation Information</b>	
Vessel	FPV Clupea RV Discovery FPV Morven
Survey Dates	28 Days between 6/8/2008 to 16/12/2008 (Appendix A & B for full details)
Navigation Equipment	Liton LMX420 dGPS Lieca MX421B dGPS CSI Vector dGPS Mini-FOG Subsea Gyrocompass (Plate 2)
Sampling Equipment	Mini Hamon Grab (0.1m <sup>2</sup> ) with additional 100kg of ballast (Plate 1)
Digital Video and Stills Imaging	Chalco 12:1 digital zoom hyperdigital video camera. Konica Minolta Dimage X1 8MP Stills Camera. 3x LED units (90° beam, 120W). Camera umbilical (200m x 11mm diam). Sled-design frame with oblique-view video and stills mounting plate, additional 100kg of ballast. (Plate 2). Topside control unit (LCD monitor, Panasonic 400GB HDD (Plate 3). Sony GV-D1000E PAL MiniDV recorder.
Navigation Software	HYDROpro Navigation V2.30 Datum ETRS89 Spheroid WGS 1984 Projection UTM Zone 31
Position Accuracy	Samples within 10m radius of target position.

**Table 2.2 Vessel, Equipment and Navigation Information**



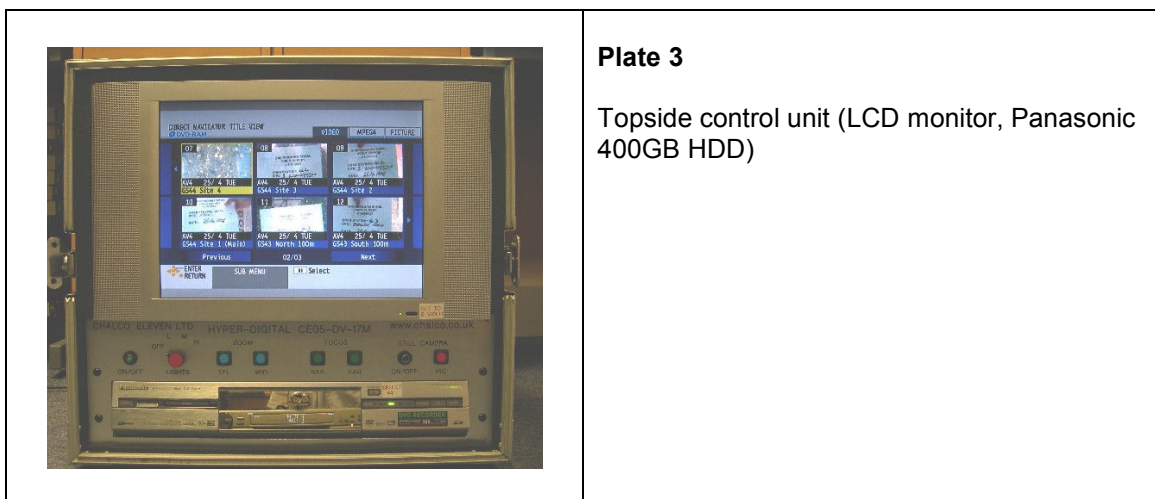
**Plate 1**

Mini Hamon Grab (0.1m<sup>2</sup>) with additional 100kg of ballast



**Plate 2**

Steel camera frame with oblique facing video and stills camera. Sub-sea gyrocompass mounted to rear. Additional 100kg of lead ballast.



**Plate 3**

Topside control unit (LCD monitor, Panasonic 400GB HDD)

### 2.1.1 Field Methods

A combined grab sampling and drop down video survey at 326 predetermined locations was completed within the Eastern English Channel in and around the prospecting and permission areas (Chart No. 2.1). Details of sample positions are included in Appendix A. Daily logs of events were recorded and are detailed in Appendix B. Full details of methods can be found in the ECA Regional Monitoring Blueprint v0.3: Section 4 (ECA and Emu Ltd., 2005).

### 2.1.2 Drop Down Video

To avoid damaging environmentally sensitive habitats prior to sampling, video images of the seabed were reviewed on site. The video system was deployed either via the stern 'A' frame on the vessels *RV Discovery*, and *FPV Clupea*, or from the stern HiAb on the *FPV Morven*. Position of the video system was recorded via the HYDROpro software package and displayed on the video image. Digital still images with an oblique view of the seabed covering an area of 0.1m<sup>2</sup> (min. of 4 Mega Pixel resolution) were also taken to enable review of seabed upon recovery. Direction of the field of view was achieved using a Mini-FOG Subsea Gyrocompass, which was overlaid onto the video image.

### 2.1.3 Grabbing

The 0.1m<sup>2</sup> Mini Hamon grab was deployed via the stern 'A' frame on the vessels *RV Discovery* and *FPV Clupea*. Position of samples was taken via a manual fix using the HYDROpro software package (Appendix A). Records of sample size, sediment characteristics and conspicuous fauna were recorded (Appendix C). A photographic record was taken of the sample once transferred from the grab bucket to a sample hopper (Appendix D). As standard a 300ml sample was taken for PSA analysis but was increased to 500ml if samples contained, what were considered to be, high gravel content.

## 2.2 Laboratory Analysis

The laboratory analysis of the macrobenthic samples collected by Mini Hamon grab was carried out by Emu Ltd. Macrobenthic analysis was completed using a laboratory Standard Operating Procedure (Emu, 2006), which is documented in full within Sections 3 and 4, and Annex 3 of the ECA Regional Monitoring Blueprint v0.3 (ECA and Emu Ltd., 2005).

### 2.2.1 Sample Processing

Macrofaunal grab samples were re-sieved over a 1mm sieve to remove all remaining fine sediment and preservative. Fauna were sorted from the sediment by elutriation, with the sediment then sorted by hand under a binocular microscope to ensure no fauna remained. A detailed method statement for the washing, sieving, elutriation and sub-sampling of grab samples for ECA Projects (Rev 1.0) is presented within Annex 3 of the ECA Regional Monitoring Blueprint v0.3 (ECA and Emu Ltd., 2005).

### 2.2.2 Identification of Infauna and Epifauna

Specimens collected from the grab samples were identified to species level (unless otherwise stated in the taxonomic discrimination protocol) and enumerated for non-colonial fauna (Appendix E). For colonial fauna, which were examined at the priority sites only, analysis was based on presence absence. In cases of doubtful identification, due to damage of the specimen or unresolved taxonomic problems, the best possible reliable taxonomic level was used.

## 2.3 Biomass

Biomass analysis of the Hamon grab samples was also undertaken by Emu Ltd following identification and enumeration. The infauna from each sample was sorted into 5 groups (Annelida (Polychaeta and Oligochaeta), Crustacea, Mollusca, Echinodermata, and Others), and biomass analysis conducted using the wet blot method. Subsequently, the appropriate, standard corrections were applied to this data to provide equivalent dry weight biomass data (Appendix F) (after Eleftheriou & Basford, 1989), as detailed in Emu Ltd's In-house Methods (MET/07, Emu Ltd 2006) and the ECA Regional Monitoring Blueprint v0.3 (ECA and Emu Ltd., 2005). The conversion factors applied are given below:

Annelida :	15.5%
Crustacea :	22.5%
Echinodermata :	8.0%
Mollusca :	8.5%
Others :	15.5%.

## 2.4 Data Analysis

The data set from the grab samples was investigated with the use of programs from the Plymouth Routine In Multivariate Ecological Research (PRIMER) suite (Clarke & Warwick, 2001 and Clarke & Gorley, 2006) using univariate and multivariate analyses.

### 2.4.1 Multivariate Analysis

For the purpose of multivariate analysis faunal data were imported into PRIMER, and were subject to transformation. Transformation is most commonly applied where the fauna is numerically dominated by a few species. This has the effect of masking the underlying community structures. Transformation reduces the influence of these more dominant species, with transformations ranging in severity from no transformation to the reduction of all the data to presence/absence only. In the case of the EEC macrofaunal data, a 4th Root (or Root-Root) transformation was applied. This transformation serves to down-weight the dominant species, taking a much greater account of the less abundant species, and allowing the underlying community structure to be assessed.

Details of each of the multivariate routines (e.g. Bray Curtis % similarity used in faunal data clustering) that have been applied are summarised in Table 2.3 below.

Various levels of data truncation were necessary to enable year to year comparisons to be made using a consistent data set. These modifications included combination of juveniles with adults, raising the level of taxonomic discrimination were necessary and standardizing species names where they have been subject to taxonomic revision.

Statistical Measure	Summary
<b>Multivariate</b>	
Hierarchical Clustering	This analysis divides sites into groupings based on a measure of similarity, in this case the Bray-Curtis index, which compares all samples with all other samples, producing a similarity matrix. The cluster analysis gradually combines sites into groups starting with the highest mutual similarities and then gradually lowering the similarity level at which groups are formed. The process ends with a single cluster containing all sites, and is best expressed as a dendrogram diagram, showing the sequential clustering of sites against relative similarity.
Multi-dimensional scaling (MDS) or ordination analysis	Best used together with cluster analysis and allows a check on the 'goodness of fit' of the clusters produced by both types of analyses. MDS analysis uses the same similarity matrix as that used by the cluster analysis to produce an ordination of sites which is multi-dimensional. This attempts to satisfy all of the between-sites relationships indicated by the similarity matrix, in terms of the multi-dimensional spatial relationships between sites. This multi-dimensional ordination is then reduced to a 2 dimensional representation that is a more accessible and useable representation. The 'goodness of fit' of this 2 dimensional version, in comparison to the multi-dimensional array, is indicated by a stress level. The closer this stress level is to zero, the better the fit. Following the MDS analysis, the groupings of sites produced by the cluster analysis may be overlaid on the MDS plot to assess their validity.
SIMPER (similarity percentages)	This can be applied to the data to gauge the faunal distinctiveness of each sample cluster, as identified by Bray-Curtis and MDS. The output is intended to identify a characteristic suite of macrofauna specific to a sample cluster. The taxa within each cluster are ranked with respect to the "within" sample cluster similarity contributed. Also, SIMPER provides a ranked list of taxa that contributes most to the dissimilarity between samples clusters on a pair-wise basis. This often leads to species which are indicative of more than one cluster, hence the data have been assessed further to identify species that are most characteristic of individual clusters, either through unique occurrence, which is rare, or through abundance difference. The outcome gives an indication of the faunal distinctiveness for each sample grouping.
1-way ANOSIM (analysis of similarities)	This routine is performed on the faunal data to assess whether the community composition at stations within each of the 'impact areas' were significantly different (null hypothesis is based on no difference rejected at $p < 0.05$ ). To carry out ANOSIM the grouping of samples/stations must be made <i>prior</i> to seeing the data. In this instance the <i>a priori</i> groupings relate to different impact zones. The resulting Global test statistic 'R' has a level of significance that indicates whether the null hypothesis may be rejected or not. Subsequent pair-wise comparison within the global data set are best assessed on the basis of R values with those closer to zero representing least difference and those closer to 1 representing most different.
BIOENV	BIOENV reveals those environmental variables which best match the observed grouping of faunal samples following the application of the Bray-Curtis similarity measure. Single and multiple combinations of variables can be input in order to assess those environmental factors which best fit the pattern of macrobenthic distribution. A ranked correlation using the Spearman method was applied.
PCA	The PCA plot enables the sites and groups of sites to be related to the physical variables on one plot. The physical variables are expressed as vectors so that their influence on the groups of sites may be visually expressed.

**Table 2.3 Summary of Multivariate Routines used within PRIMER**

### 2.4.2 Univariate Analysis

The features of each of the samples as well as the station groupings identified during the multivariate analysis may also be assessed using a variety of measures of community structure. Diversity measures that have been applied to the data were drawn from the DIVERSE program in the PRIMER suite. These summarise the raw species data by calculating a range of indices, including Margalef's index of Richness, Pielou's Evenness index, the Shannon-Wiener Diversity index, and Simpson's index of Dominance. Reference to the detailed calculation of these indices may be found in Clarke & Gorley (2006) and are summarised in Table 2.4 below. Such univariate indices are useful in reducing large faunal data sets to a single figure that may be used in comparison to other sites in assessing community structure and changes.

Statistical Measure	Summary
<b>Univariate</b>	
Shannon Wiener Diversity Index	<p>A very commonly employed diversity measure expressed as:</p> $H' = -\sum_i p_i \log(p_i)$ <p>Where <math>p_i</math> is the proportion of the total count arising from the <math>i</math> th species.</p>
Margalef's Species Richness Index	<p>A species richness index which also incorporates the number of individuals (N) and is a measure of the number of species (S) present for a given number of individuals. Expressed as:</p> $d = (S-1) / \log N$
Pielou's Evenness Index	<p>A measure of equitability or evenness – i.e. how evenly individuals are distributed between the various species. This is often expressed as:</p> $J' = H' / H'_{max} = H' / \log S$ <p>where <math>H'_{max}</math> is the maximum possible value of Shannon diversity, i.e. that which would be achieved if all species were equally abundant (namely, <math>\log S</math>).</p>
Simpson's Dominance Index	<p>A dominance index in which the largest values correspond to assemblages whose total abundance is dominated by one, or a very few, of the species present.</p> $\lambda = \sum p_i^2$ <p>Where <math>p_i</math> is the proportion of the total count arising from the <math>i</math> th species.</p>

**Table 2. 4 Summary of Univariate Routines used within PRIMER**

## 3.0 RESULTS

### 3.1 Regional Infaunal Component

#### 3.1.1 Initial data treatment

The source data set of infaunal species abundance (including some of the enumerated epifauna) was subjected to reconciliation with the 2005 and 2007 data sets to identify any sources of potential difference that might cause inconsistency within the PRIMER analysis. This was undertaken by initially comparing data sets using Excel spreadsheets to identify simple errors and separation of juveniles, etc. These data sets were then compared using the ANOSIM routine within PRIMER, which resulted in an R value of 0.207 at 0.1% significance based on an *a priori* separation into years. SIMPER output, using the years as groupings, were reviewed and further differences due to taxonomic or transcription errors were eliminated. Following this comparison the data were re-analysed, using PRIMER, and the ANOSIM value was found to be reduced to 0.129 at 0.1%. Hence differences were still evident, although these would appear to be due to faunal abundance differences between years with respect to some of the dominant species, which were considered to be acceptable. This will be discussed in more detail in the comparative study (Report Section 8).

The raw data prior to reconciliation are included in Appendix E. While the 2007 PRIMER ready data, which have been reconciled with the 2007 data, are included in Appendix G.

#### 3.1.2 Species composition

Sampling sites are indicated in Chart 2.1.

A total of 468 infaunal and other enumerated species were identified in the 2008 survey of the Eastern English Channel, following data reconciliation. This comprised primarily of Polychaeta, Crustacea and Mollusca, with significant numbers of Echinodermata.

The mean number of species per site was 45 with numbers ranging from 3 to 85 per grab sample (0.1m<sup>2</sup>). The distribution of the species number is presented in Chart 2.2, indicating no clear trend other than the reduced number of species to the north east of the region and a generally increased number of species to the south west.

The mean abundance of individuals per site was 136 per grab sample with a range of 4 to 411. Chart 2.3 illustrates that greatest abundances generally occurred in the south west of the area with relatively uniform abundances over the rest of the region, although reference area 6 was also found to support several sites in great abundance. Lowest abundances were noted in the context sites to the north east.

Biomass ranged from 0.0004 g(AFDW) per sample to 14.09g (AFDW), with a mean value of 1.63g (AFDW) per grab sample. The principal contributors to biomass were the Mollusca. The distribution of biomass is presented in Chart 2.4, which indicates that the bulk of the high biomass sites were in the southwest of the area, including sites within Reference area 4. Other raised values were noted in Reference area 7 and around areas 464-2 and 458. In general lower biomass was noted to the north and north-east of the region. Data are included in Appendix F.

The most frequently occurring species overall are summarised in Table 2.1. It is evident from this table that polychaetes in general were the most frequently present comprising 8 of the top 12 species. Of the other taxonomic groups, the mollusca, represented by *Glycymeris glycymeris* was the most frequently present along with representatives of the NEMERTEA.

Taxa	Percentage occurrence
<i>Aonides paucibranchiata</i>	93%
<i>Glycera lapidum</i> (agg)	86%
<i>Syllis</i> ( <i>Typosyllis</i> ) spp.	86%
<i>Glycymeris glycymeris</i>	84%
NEMERTEA	82%
<i>Pomatoceros triqueter</i>	77%
<i>Eulalia mustela</i>	77%
<i>Laonice</i> spp.	76%
Capitellidae indet	73%
<i>Echinocyamus pusillus</i>	73%
<i>Aphelochaeta</i> sp.	72%
<i>Galathea intermedia</i>	67%

**Table 2.5 Most Frequently Present Infauna and Enumerated Species, 2008**

In terms of abundance Table 2.6 indicates that the greatest mean abundance was noted for the echinoderm *Echinocyamus pusillus* and the polychaetes *Aonides paucibranchiata* and *Pomatoceros triqueter*, with the crustacean *Galathea intermedia* also present in large numbers. The greatest individual abundance at any site was noted for *Echinocyamus pusillus*, with *Galathea intermedia* also present in considerable numbers. It is also worth noting that several other species exhibited discrete distributions, hence they occurred at a low mean abundance but were found at large maximum abundances, including the polychaetes *Polygordius* spp. (120 per grab) and the brittlestar *Ophiothrix fragilis* (52 per grab).

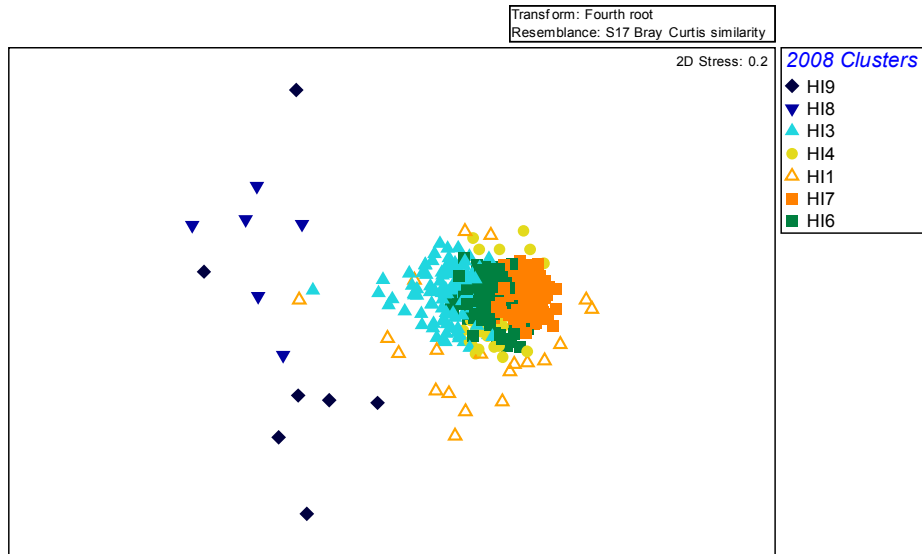
Taxa	Mean Abundance	Max Abundance
<i>Echinocyamus pusillus</i>	18.9	157
<i>Aonides paucibranchiata</i>	8.0	43
<i>Pomatoceros triqueter</i>	5.7	40
<i>Galathea intermedia</i>	5.0	68
<i>Syllis</i> ( <i>Typosyllis</i> ) spp.	4.9	27
<i>Glycymeris glycymeris</i>	4.8	37
NEMERTEA	3.4	15
<i>Glycera lapidum</i> (agg)	3.0	13
<i>Ampharete</i> ? <i>lindstroemi</i>	2.9	32
<i>Amphipholis squamata</i>	2.7	31
<i>Laonice</i> spp.	2.6	15
<i>Aphelochaeta</i> sp.	2.5	18

**Table 2.6 Mean and Maximum Abundance of Infaunal and Enumerated Species, 2008.**

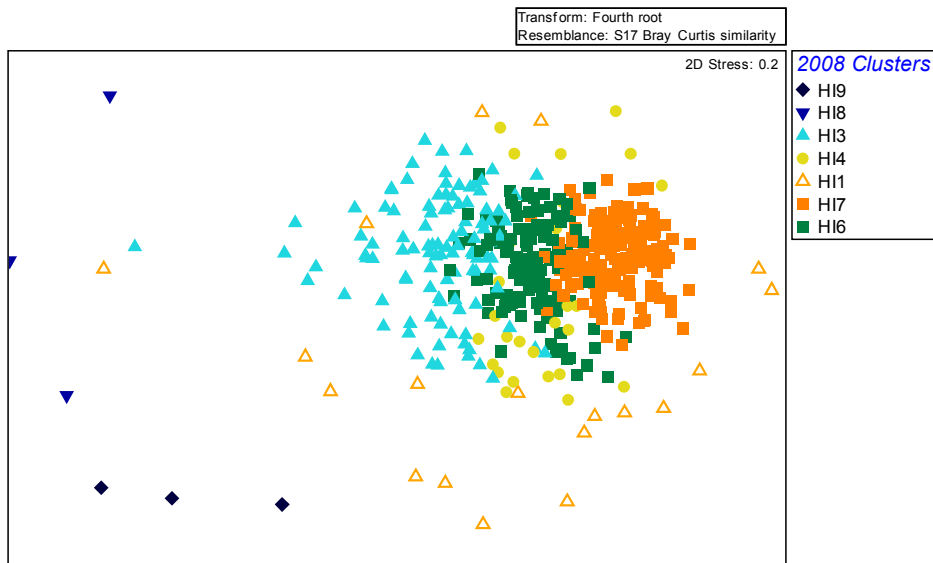
### 3.1.3 Multivariate Analysis

Following cluster analysis, 7 clusters were defined (Appendix Figure 2.1). These have been labelled following the same groupings employed for the 2007 data set by overlaying the 2007 clusters on the 2008 sites to look for consistency of grouping (Appendix Figure 2.2). These will be analysed more fully in the comparative report (Section 8), but in this section data are reported only with respect to the 2008 samples.

The clusters for the 2008 infaunal data are indicated in Figure 2.1 and 2.2. The separation of clusters on the MDS is relatively clear although for some of the data, based on the cluster analysis, it is evident that a continuum exists. The separations have, therefore, been imposed somewhat artificially, primarily to assist in description of the communities across the region.



**Figure 2. 1 MDS Cluster Separation for all Infaunal Sites, 2008**



**Figure 2. 2 MDS Separation of Core Clusters, 2008**

The dominant and characteristic species in each cluster are summarised in Table 2.7, along with information on community structure and physical conditions.

It is evident that several species were present across most of the groupings, including *Aonides paucibranchiata*, *Pomatoceros triqueter*, the Nemertea and *Echinocyamus pusillus*. The differences between clusters were in many cases related to abundance differences with respect to this key group of species, supporting the earlier description of the sites as forming part of a community continuum. Despite the evident overlap between some clusters the following descriptions may be provided. Illustration of the influence of some of the key species on the separation of these clusters is also provided in Figs. 2.3 to 2.10.



The two largest clusters, HI6 and HI7 supported several species that were common to both, although particular, key species, were indicative of each. The characteristic species were indicative of the physical conditions present with cluster HI7 comprising the cryptic crustacean species *Galathea intermedia* (Fig. 2.3) and the encrusting polychaete *Pomatoceros triqueter*, corresponding to the presence of the largest percentage gravel of any cluster (43%). Cluster HI7 also included the brittlestar *Ophiothrix fragilis* (Fig. 2.4) as a characteristic species, which was indicative of the coarsest substrata areas in 2005, although this species contributed less than 2% to the cluster similarity in 2008. Overall cluster HI7 supported the largest number of species and the highest mean abundance of any cluster.

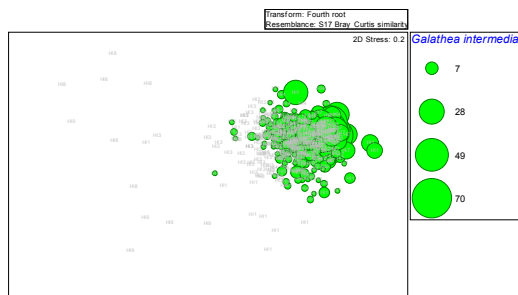


Figure 2.3 *Galathea intermedia* abundance

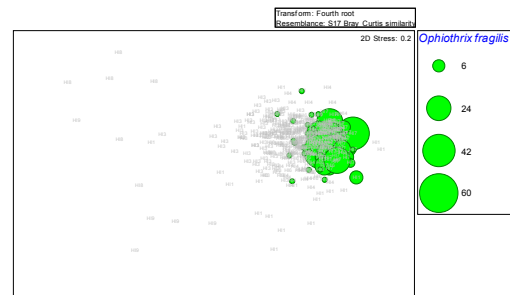


Figure 2.4 *Ophiothrix fragilis* abundance.

Cluster HI6 supported a slightly reduced number of species and abundance with a low evenness index, suggesting a large concentration of dominance within a few species. *Echinocyamus pusillus* was clearly the dominant and characteristic of this cluster, although it was present as the dominant in several other clusters (Fig. 2.5). This species has been encouraged by the sandier conditions evident in this cluster with an average of 66% sand. The remaining species, however, although more indicative of sandier sediments (e.g. *Syllis (Typosyllis) spp* Fig. 2.6), still included those favouring gravelly sediments such as *Pomatoceros triqueter*.

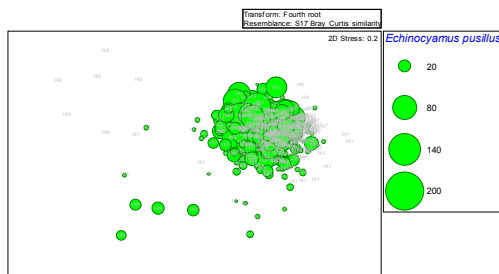


Figure 2.5 *E. pusillus* abundance

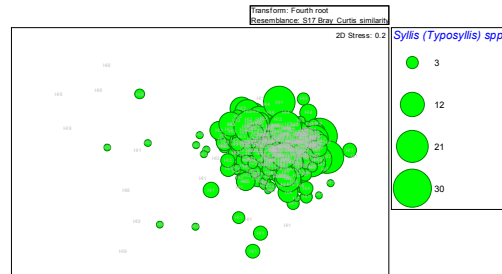
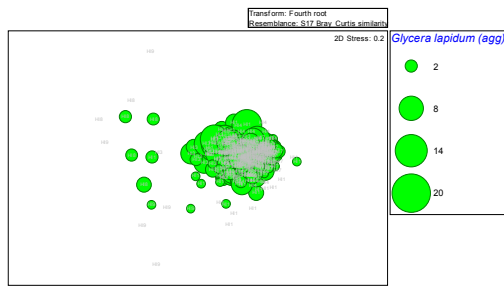
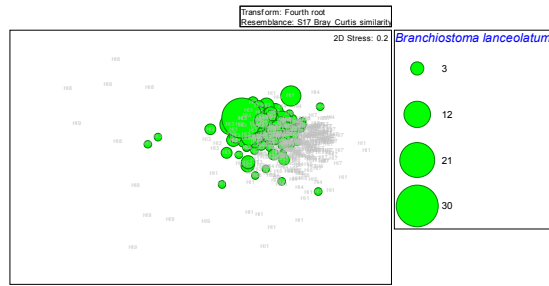


Figure 2.6 *Syllis spp* abundance

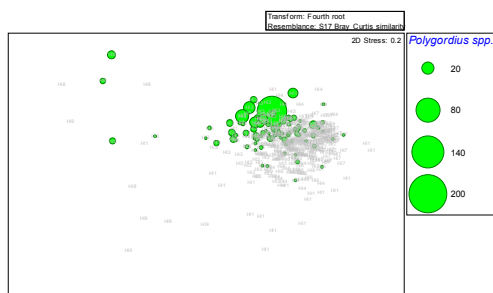
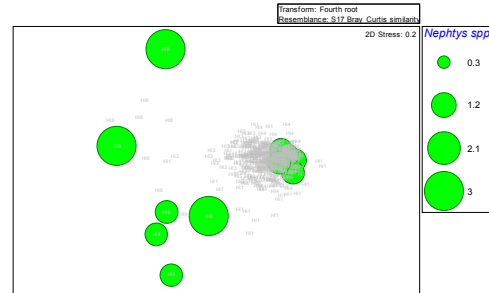
Cluster HI3, in contrast, supported fewer species and at a lower abundance. The fauna were indicative of sandy sediments with *Echinocyamus pusillus* occurring as dominant with a similar but reduced species composition compared to cluster HI6. Of the dominant species only *Glyceria lapidum* was characteristic (Fig. 2.7) although also widely present in other clusters. More characteristic of this cluster were some of the very low abundance species, which are typical of sandy gravel sediments, including *Atylus vedlomensis* and *Branchiostoma lanceolatum* (Fig. 2.8).

Figure 2.7 *G. lapidum* abundanceFigure 2.8 *Branchiostoma lanceolatum* abundance

HI4 supported an intermediate number of species but at relatively low abundances. Very few species dominated in large numbers and this cluster appears to be intermediate between the coarse sediments found in HI7 and HI6, and the finer sediments in HI3. Only the low abundance species were indicative of this cluster including *Polycirrus* spp. and *Spisula* spp., neither of which show a clear separation on the MDS plots.

HI1 is a further extension of what is effectively part of a continuum with a further reduced number of species and abundances. The lower abundances have, in general, resulted in the low level of internal cluster similarity of 24%. The cluster contains components of all the clusters described above, but with an impoverished fauna in all cases.

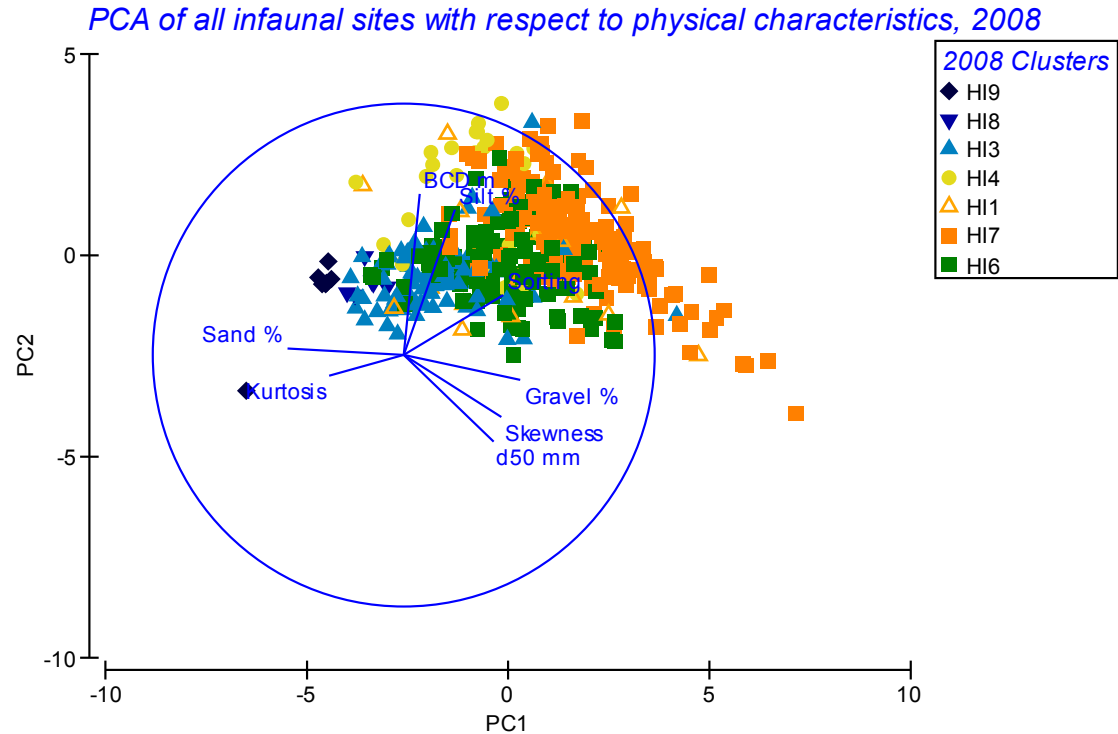
Cluster HI8 falls further along the gravel to sand continuum, with a mean of over 95% sand found in the sites comprising this cluster. The fauna were correspondingly more impoverished; a mean of 8 species was found, with all sites supporting a very low abundance fauna. The species indicative of this group of sites were restricted to two of the dominant species including, *Polygordius* spp. (Fig. 2.9) and *Protodorvilea kefersteini*. The former species clearly shows overlap with cluster HI3. Other indicative species include the sand eel *Ammodytes tobianus* and the polychaete *Spio filicornis*, but both in very low abundances.

Figure 2.9 *Polygordius* spp. abundanceFigure 2.10 *Nephtys* spp. abundance

The final cluster comprised of sites that were almost pure sand (average 98%) with a high degree of sorting. The species composition was limited with a mean of 11 species per site, all at a relatively low abundance. The characteristic species included one of the subdominants *Nephtys* spp. (Fig. 2.10).

The separation of the clusters in relation to the physical conditions is illustrated further in the PCA in Fig. 2.11. A clear trend in relation to the sand and gravel vectors is evident, with the influence of depth to seabed also corresponding to the separation of some of the clusters, including HI4 (in the deepest water) from HI3 (shallow waters). Sorting of sediment is also clearly relevant to the separation of the clusters from the most well sorted sites of clusters HI3, HI8 and HI9, to the poorly sorted clusters of HI6 and HI7.

The analysis of the overall physical conditions, using BEST, suggests that of the individual factors the most important were sorting (0.368), percentage sand (0.335) and gravel (0.298).



**Figure 2. 11 Illustrating the Derived Clusters in relation to the Principal Environmental Variables, 2008 infauna.**

**3.1.4 Distribution of Clusters**

Chart 2.5 illustrates the distribution of the derived clusters. It is evident that a continuum exists across the region with the, primarily, coarse sediment community found in the south west, progressively changing to the sandier sediment communities in the north east. The coarsest sediments found in cluster HI7 occurred in the south west of the region, including reference area 4, and extended up to the northern edge in the vicinity of area 473 West.

Cluster HI6 was found in the north and central areas of the region including licence blocks 473 East and West, as well as areas 464/2, 458, 474 Central and West and the eastern end of area 475. Sites from this cluster were also noted in reference areas 2, 5 and 7, the latter of which was dominated by this cluster.

Cluster HI4 appears to be interspersed within the HI7 and HI6 sites but occurs primarily on the periphery of these clusters, including reference area 1 and, to a lesser extent reference area 2.

Cluster HI3 was largely restricted to the east of the region, including most of the sites in reference area 6. There appears to be a relatively clear division between this cluster and that of HI7, although some overlap does occur in the southern reference site 5 and in licence blocks 473 East and 474 Central.

Cluster HI8 occurred at relatively few sites to the north east of the region and at a few sites in reference area 2. Cluster HI9 sites were located to the furthest north east of the area, only found in the context sites.

**3.2 Infauna ANOSIM**

ANOSIM has been employed to identify if differences between the types of impact zone may be detected. The R value for the global data set was 0.078, which is very low, although significant at 0.1%, suggesting a difference does occur within the whole data set. The pair-wise comparison of ANOSIM R values between impact types is indicated in Table 2.8.

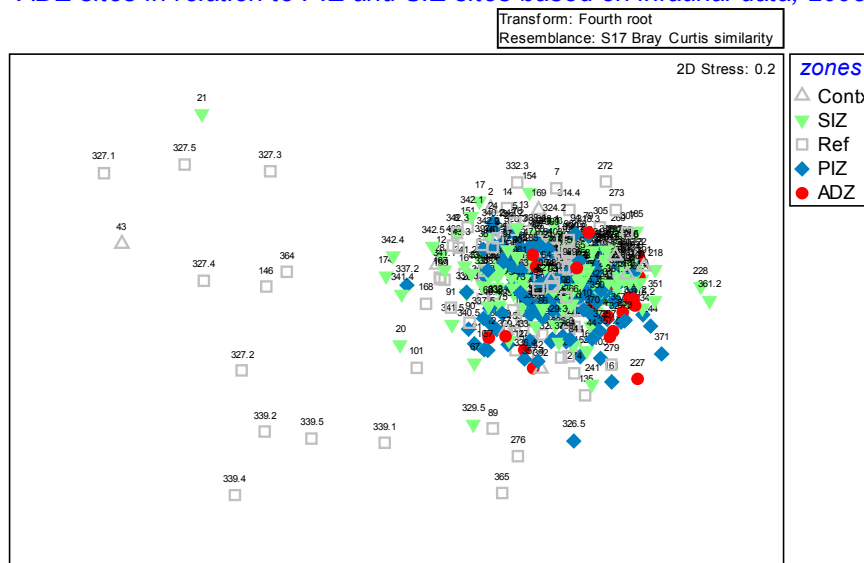
	SIZ	PIZ	ADZ	Ref
Contx	0.227	0.306	0.176	0.076
SIZ		0.010	0.097	0.084
PIZ			0.160	0.097
ADZ				-0.004

**Table 2. 8 ANOSIM Results for the Different Impact Zones.**

It is evident from Table 2.8 that the largest differences exist between the context sites and the PIZ and SIZ sites, with context site showing closer similarity to the ADZ and reference areas. Both the SIZ and PIZ can be seen to be little different from the reference areas and from each other. Of the impact zones the ADZ sites were the most similar to the reference areas, although all were very similar.

Consideration of the relationship of the ADZ sites to all others may be expressed using the MDS plot. Figure 2.12 illustrates the level of separation of these ADZ sites in relation to both the PIZ and SIZ sites. Most of the ADZ sites fall within the central core of sites, with only one site (227) separating from the main group.

*ADZ sites in relation to PIZ and SIZ sites based on infaunal data, 2008*



**Figure 2. 12 Location of the ADZ Sites in Relation to PIZ and SIZ sites all sites.**

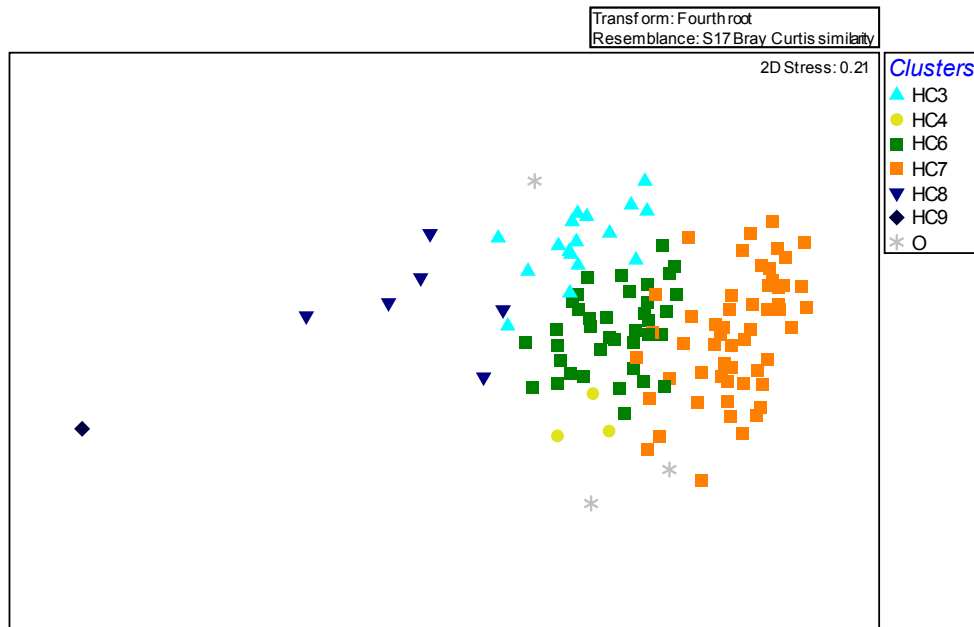
Site 227 is located in the Active Dredge zone of area 461, which is currently one of the more intensely dredged areas. The above analyses suggest that although some impacts are evident these are not evident on a regional scale, with similar variation, as demonstrated by the range of sites from other impact zones, 21, 241, 371, 326.5, and 329.5 also separate from the main core of sites. This observation will be investigated further in the following, high priority combined fauna analysis section and will be considered in the comparative assessment section 8, where the standardised data for 2005, 2007 and 2008 are considered together.

### 3.3 Priority Sites - Combined Fauna

A subset of high priority sites has been analysed which comprised the combined infaunal and epifaunal data. The data comprise a full data set of enumerated infauna, enumerated epifauna and colonial epifauna on the basis of presence absence. The sites were selected on the basis of areas of maximum dredging activity and to provide a representation of the range of faunal groups present. The areas covered included three licence areas, namely 473 East, 474 West and area 461, along with reference areas 2, 4, 5 and 6. For all data the fauna were reconciled against 2007 data, as described for the infauna. Appendix H contains all raw priority site data while Appendix I includes the Primer ready data.

#### 3.3.1 Cluster Analysis

It is apparent from the cluster analysis (Appendix Figure 2.3) that most separation occurs between 40 and 60% similarity. The same generic clusters that existed in previous years were identified by superimposing 2007 cluster names against each site. A high degree of consistency was identified and on this basis 5 clusters were defined and are illustrated on the MDS plot, Figure 2.13.



**Figure 2.13 MDS Representation of Clusters based on all fauna in priority areas.**

The figure is a relatively poor representation of the separation (2d stress = 0.21) with some overlap between clusters evident. The faunal composition and physical conditions apparent in each of these clusters is summarised in Table 2.9. This table confirms that the clusters adhere to a physical continuum with respect to sediment character, ranging from the coarsest sediment in Cluster HC7, through the mixed gravelly sands of HC6 to the three sandiest clusters HC4, HC3 and HC8. HC9 comprised one site only and was composed of 99% sand. A physical separation exists between HC3 and HC4 with respect to depth, with most sites in Cluster HC4 occurring in deeper water, while most in HC3 were in shallower water. The BEST analysis suggests that of the single physical variables, the most important in terms of explaining the faunal characteristics are percentage Sand (0.362), Sorting (0.2344) and percentage Gravel (0.189).



In general the number of species varied between 73, in the most diverse community (HC7), to 11 in the least (HC9). Cluster HC7 was clearly the most different from all other clusters, with *Echinocyamus pusillus* dominant in all clusters except HC7. Cluster HC7 was typified by a range of epifaunal species, including *Epizoanthus couchii*, *Galathea intermedia* and *Pomatoceros triqueter*, as well as a range of robust polychaetes and the bivalve *Glycymeris glycymeris*, all indicative of the gravelly sediments which predominate in these sites. None of the colonial bryozoa were indicative of this cluster, primarily because the colonial species found in this cluster tended to be widely present across the clusters, for example the Diastoporidae and *Rynchozoon bispinosus*. It is likely that this cluster may be subdivided, particularly with respect to the presence of *Ophiothrix fragilis* and *Gari tellinella* (Figs 2.14 and 2.15 respectively).

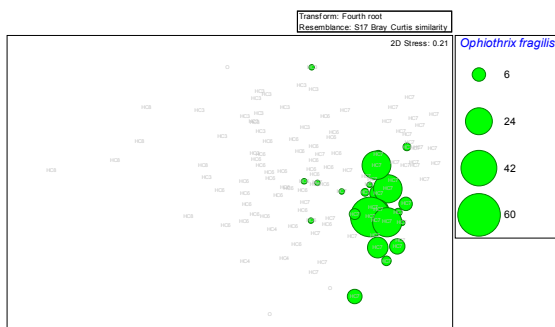


Figure 2.14 *Ophiothrix fragilis* abundance

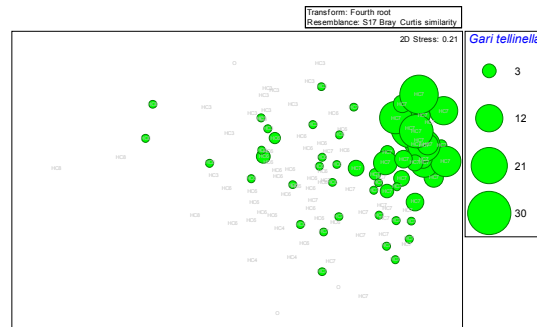


Figure 2.15 *Gari tellinella* abundance

Cluster HC3 was the most sandy of the major clusters, and supported a distinct and abundant fauna, with *Echinocyamus pusillus* clearly the dominant species supported by several characteristic

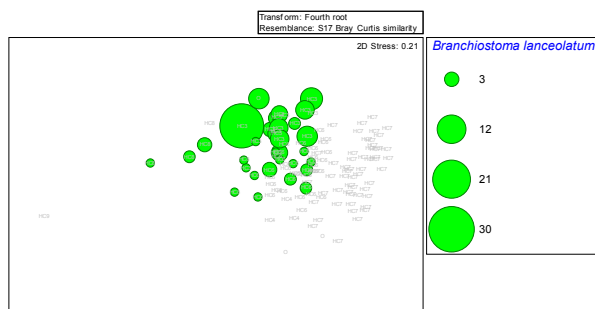


Figure 2.15 *Branchiostoma lanceolatum* abundance

infaunal polychaetes, including *Polygordius* spp., *Syllis* spp. and *Glycera lapidum*. Most of these were widely present across the other clusters, but were noted in characteristically high abundances in cluster HC3. Several other species were characteristic of this cluster including *Branchiostoma lanceolatum* (Fig. 2.15) and *Amphipholis squamata*. Cluster HC3 supported numerous colonial species including five colonial bryozoa.

Cluster HC6 comprised a similar mix of infauna and colonial epifauna as HC3, although with only one species characteristic of this group of sites (*Eulalia mustela*). The dominant was *Echinocyamus pusillus*, which along with several of the colonial species was moderately characteristic of this cluster. These species are probably responding to the mixed nature of the seabed with significant quantities of both sand and gravel present.

Cluster HC4 was comprised of a relatively small number of sites (3). The dominant species were similar to those found in both clusters HC7 and HC3, however, a range of characteristic species, generally not found in the other sites were present. Particularly species were noted which are indicative of instability, both in the form of irregular disturbance (*Capitellidae* and *Dendrodoa grossularia*) and regular, current induced instability (*Gastrosaccus normani* and *Eurydice* spp.). The sites were from the deepest areas and were primarily sandy in nature, with similar levels of sand to those found in HC3. The sites from this cluster appear to be transitional between clusters HC7 and HC3 but with a fauna apparently responding to raised levels of disturbance.

HC8 comprised the lowest number of species (36) of the major clusters, with a similarly reduced abundance. Few of the dominant species were characteristic, with only the polychaetes *Glycera*

*oxycephala* and *Pista cristata* highlighted. This cluster was also the only one which had a colonial bryozoan occurring as a characteristic species, *Puellina innominata*. The mixture of sand and gravel fauna, with relatively small amounts of gravel, suggests shell may be a significant component of the sediment.

In terms of spatial distribution of sites from each cluster (Chart 2.6) it is apparent that each of the licence blocks investigated supports an east to west trend, with 473 East ranging from HC7 in the west to HC6 in the east; 474 West ranging from HC7 in the west, through HC6 over the licence block, with HC3 occurring in the east. 461 was almost exclusively HC7 with only HC6 sites occurring at the eastern extent. The reference areas also fall into the same trend with the most western (Ref 4) supporting HC7, the central reference area (Ref 5) supporting HC6 and the most eastern reference area (Ref 6) supporting HC3.

### 3.4 Combined Fauna - ANOSIM

To identify the potential effect of dredging on the communities ANOSIM analysis was conducted on the different impact zones. The Global R value was 0.364 at 0.1% probability; hence a significant separation is likely to exist between the data sets. Examining the different impact zones on a pair-wise basis, albeit with only 5 ADZ sites included (Table 2.10) it is apparent that the ADZ sites are similar to the PIZ sites and that the PIZ and SIZ are also relatively similar. In contrast the impact zones are very different from the reference areas sites, with the exception of the ADZ with Ref area 2 and the PIZ and SIZ with reference area 5. It is evident, however, that differences between the reference areas are as great as or greater than the differences between the impact zones and reference areas.

	PIZ	SIZ	Ref 2	Ref 4	Ref 5	Ref 6
ADZ	0.034	0.117	0.183	0.867	0.340	0.878
PIZ		0.039	0.485	0.534	0.112	0.427
SIZ			0.530	0.243	0.159	0.470
Ref 2				0.715	0.253	0.444
Ref 4					0.851	0.985
Ref 5						0.454

**Table 2. 10. Pair-wise Comparison of ANOSIM values between Impact Zones.**

Considering the relationship of the ADZ sites to others in the area using the MDS analysis (Fig. 2.14), it is apparent that most of the impact sites form a coherent group, with small separations evident for several sites, including 227, 241 and 371, also verified through consideration of the 3D MDS output. All of these sites are in the vicinity of area 461, although only 227 falls within the ADZ. The reference areas appear as relatively dispersed groups on the MDS plot, with the exception of Reference area 4, which was well defined. Overlap between the sites which have separated and the reference areas is also evident.

Reconsidering the site classification and ordination, sites 227, 241 and 371 may be considered as a subset (HC7a) of HC7. The main separation, identified using Simper, between these groups is in relation to the dominant species in the subgroup, which were in much reduced abundances (Table 2.11). These sites also supported much reduced species diversity overall (42 cf. 73) and overall abundance (68 cf. 211). The combination of factors suggests that these sites are impacted, however, the fact that they are from a range of impact zones (SIZ, PIZ and ADZ) around area 461 and are similar to two of the reference sites (89 and 135 both classified as outliers) suggests that factors other than dredging may be involved. It is also of note that site 227, which falls within the ADZ has the highest proportion of gravel of all the sites in HC7 (70%).

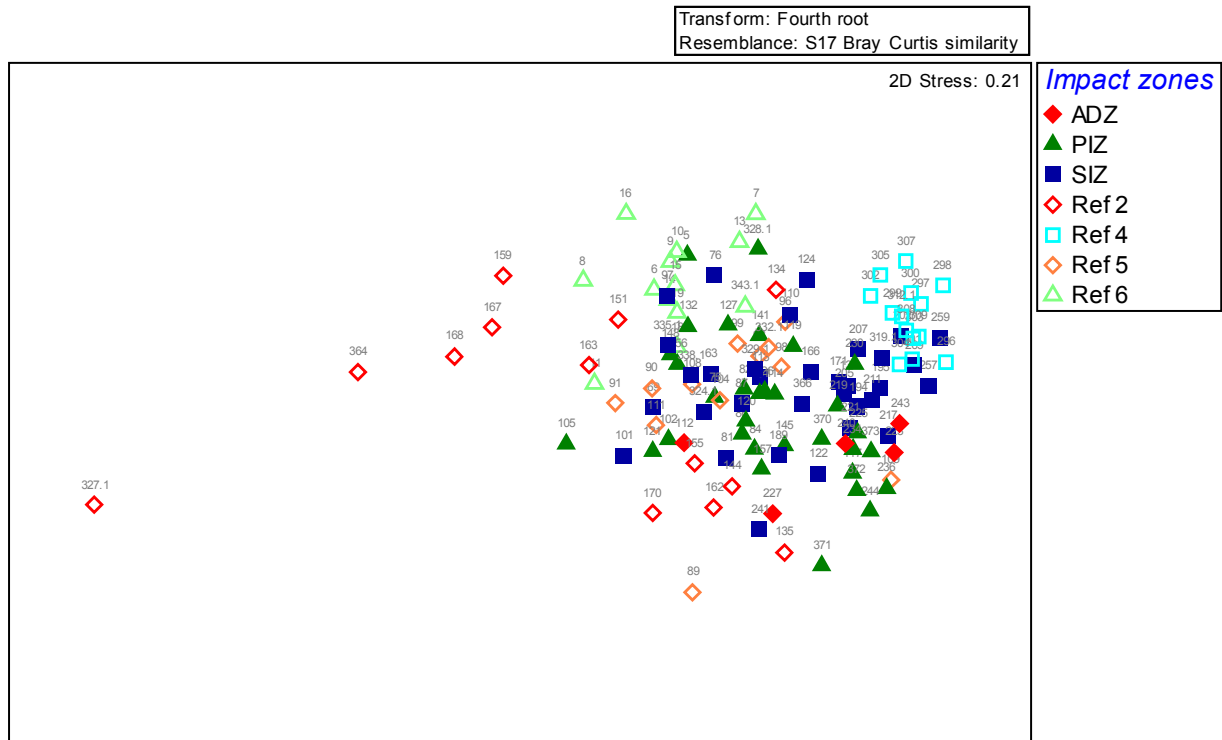


Figure 2. 14 Impact zones within the MDS plot at 473e.

Species	HC7	HC7a
Epizoanthus couchii	21.14	10.0
Galathea intermedia	13.53	2.33
Pomatoceros triqueter	11.98	2.67
Aonides paucibranchiata	11.31	3.00

Table 2. 11 Mean Abundance of Dominant species in Clusters HC7 and the sub-group HC7a.

### 3.5 Summary Conclusion

The analyses, considering both the infauna alone and the combined infauna, enumerated epifauna and colonial epifauna, suggests that impacts due to the dredging activity are becoming evident. However these tend to be on a licence specific scale and are not completely apparent due to the natural variation evident across all the impact zones and reference areas.

With respect to the infauna, only site 227, of the ADZ sites, has shown any difference from the remainder of sites. This separation has also been confirmed using the combined infauna and colonial epifauna data. However, several other sites have also separated on both analyses, which are not apparently in the immediate area of impact. These sites support similar, generally impoverished communities, versions of which are also found in the reference areas. It is apparent that some of these sites in the reference zones (particularly in Ref area 2), based on the faunal composition, are subject to a degree of disturbance (see Clusters HC4 and HI4), although the nature of this disturbance, natural or manmade, is not clear.

Over the rest of the ECR a high degree of regional consistency is evident, with communities following the natural variation in sediment character and depth to seabed.

## 4.0 REFERENCES

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**Clarke, K.R. and Warwick, R.M., (2001).** *Changes in marine communities: an approach to statistical analysis and interpretation, 2<sup>nd</sup> edition*. PRIMER-E: Plymouth.

**ECA and Emu Ltd, (2005).** *Regional Monitoring Blueprint Related to Marine Aggregate Extraction Operations in the Eastern English Channel v0.3*. Emu Ltd. Durley.

**Emu (2006).** *Methods for the Processing, Identification, Enumeration and Recording of Marine Benthic Macro-invertebrates*. Document Ref No: EMU MET 07. Emu Ltd, Hayling Island Laboratory.

**5.0 AUDIT INFORMATION**

<b>Title: EASTERN ENGLISH CHANNEL MONITORING REPORT 2008 Section 2. Benthic Communities and Habitats from Grabbing Surveys. (Volume I Report)</b>			
Report No : 08/J/1/03/1333/0872 - Draft			
Job No : J/1/03/1333			
Client Name : East Channel Association			
Client Contact : Graham Singleton			
<b>Project Manager</b>	Dr. Nigel Thomas		
<b>Field Manager</b>	Jo Weir		
<b>Fieldwork conducted by</b>	Jo Weir Adrian Cherry Leigh Marsh Alison Bessell Rayner Piper Ben Cross Garnet Hooper Jeremy Shottin Erin Pettifer John Peters Anthony Buckley James Cook		
<b>Data analysis and report written by</b>	Dr. Nigel Thomas		
		Signed	Date
<b>Report checked by</b>	Dr. Nigel Thomas		
<b>Report authorised by</b>	Simon Shaw		

## **CHARTS**

