5 BENTHIC ORGANISMS

The results of the benthic organism and sediment monitoring described below will be related in annual reports to the parallel monitoring of birds, particularly common scoter. For this reason, CCW have been consulted on sampling locations and timing.

5.1 SUBTIDAL

5.1.1 Introduction

Benthic surveys of the North Hoyle site and its surrounding area were undertaken by the Centre for Marine and Coastal Studies (University of Liverpool) during August 2001 and involved sampling at 55 sites across the area using a combination of Day and Anchor grabs. These provided data on the baseline conditions based upon information regarding the benthic infaunal community and superficial sediments for the general area. This baseline information was then used to select 17 sites to be used for monitoring purposes as agreed for the FEPA license. Pre-construction surveys were then carried out during September 2002 at these monitoring sites and then during October 2003 the Centre for Marine and Coastal Studies (CMACS Ltd) undertook surveys at the same 17 monitoring sites to obtain data to identify any changes which may have occurred in either the sediment or benthic community characteristics during the construction period. At this stage all the piles had been installed, the majority of the turbines were completed, the main cables to Rhyl were installed, and a proportion of the inter-array cables were in place. The sites used for the pre-construction and construction surveys (2002 and 2003) are displayed in Figure 5.1. Sites 1 to 17 were sampled during the pre-construction surveys (2002) and sites 18, 19 and 20 are additional sites for the 2003 construction survey taken in close proximity on the westward side of turbine number 18 in order to investigate possible effects of scour on benthos. Figure 4.1 also includes the position of the wind turbines in relation to the grab sites, the route of the main cable and the array cables, as they were when the survey was undertaken.

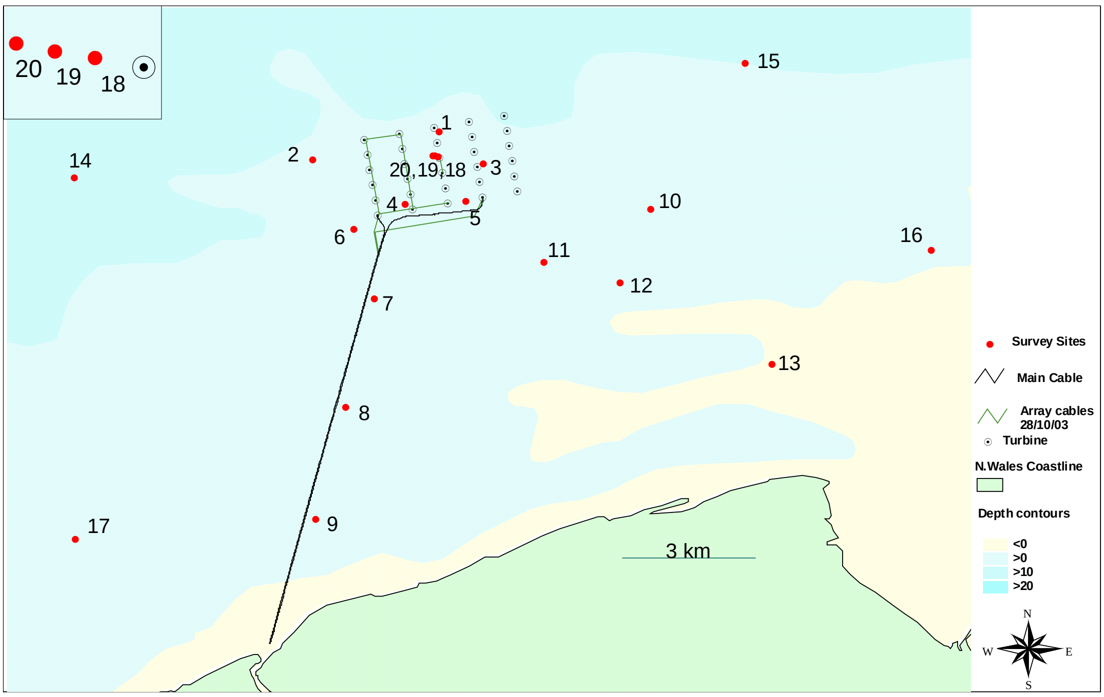


Figure 5.1 Location of Grab sampling sites

During August 2001 twenty-two beam trawls were undertaken to provide baseline information on the epifaunal communities, of the North Hoyle site and its surrounding area (see Figure 5.2), which also provided some information on smaller demersal fishes. CMACS Ltd was commissioned to repeat these 2001 beam trawls to provide some preliminary information on fish distribution in and around the development area immediately after the main construction period, but prior to completion of all installation works (undertaken in October 2003). Under the terms of the FEPA license awarded to NWP, proposals for a post development fish survey must be prepared within three months of completion of the development works. The work reported here was, therefore, not intended to contribute directly to those requirements, but rather to obtain some preliminary additional information concerning benthic epifauna and fish at a time much closer to the actual time of the main installation works than will be possible under the surveys required under the FEPA license. Small beam trawls are not ideal for fish surveys as they only provide semi-quantitative data, but their use allowed a useful comparison with existing data from 2001, whilst the use of larger commercial type gear would have been far less practical given the presence of so many structures and cables as well as ongoing construction activities in the area at the time of the survey. For safety reasons, some of the 2003 survey site locations were required by the Construction Works Vessel Co-ordinator to be moved slightly in order to reduce risk of entanglement of the beam trawl with wind farm infrastructure, particularly cables (see Figure 5.2).

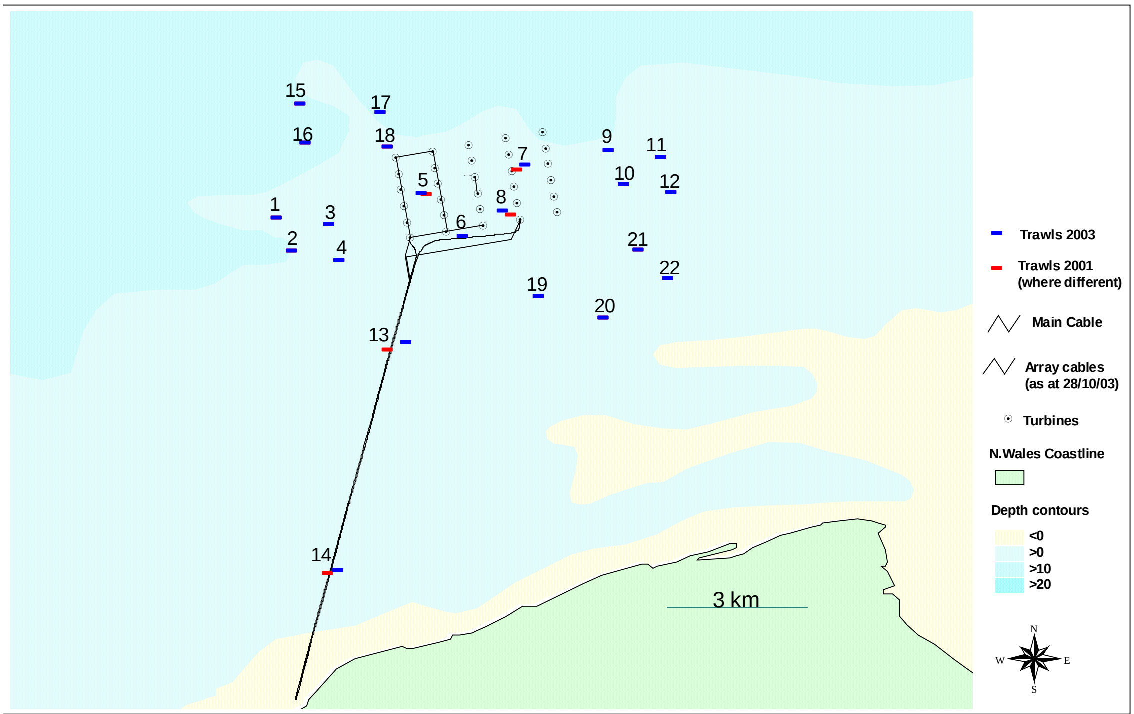


Figure 5.2 Beam Trawl locations 2001 and 2003. Where sites were moved (for safety reasons) the original (i.e. 2001) positions are shown in red and the 2003 positions in blue.

The following section presents the findings of the benthic grab surveys undertaken during the construction phase of the wind farm (March 2003 to March 2004) and discusses any obvious differences between this and the pre-installation surveys of 2002, the results of which were presented in the FEPA monitoring report 2003. The results from the 2003 beam trawl survey are also presented within this section.

5.1.2 Methods

The methods used for the 2003 construction survey were agreed with CCW/CEFAS and are the same as those in the pre- construction survey of 2002 and the initial baseline survey of 2001. This was to allow direct comparisons to be undertaken from results of all three surveys. The methods for the 2003 beam trawl survey were also identical to those of the 2001 survey, again to allow a direct comparison.

5.1.2.1 Field Survey

5.1.2.1.1 Grab sampling

The field survey was planned for September 2003 with the aim to replicate as far as possible the date of sampling in 2002 to maximise the comparability of data between years (as is the intent of the previous monitoring statement). Although there were delays (due to a combination of poor weather and boat availability sampling was delayed until October 26th and 27th 2003) these were relatively short and it is considered that the data collected are useful for the purpose of detecting any significant changes in benthos associated with the North Hoyle development. All sediment and biota samples were obtained from the survey vessel “Freja” (OSIRIS Projects) using a 0.1m^2 Day Grab. The seventeen sites sampled in 2002 were repeated in 2003 with the addition of three extra survey sites (numbers 18, 19 and 20). These were taken due west of turbine number 18 (Site 18 -57m from the installation, 19 - 100m and 20 -150m). Site 18 was not as close to the turbine installation as desired, but this was as close as could be achieved on the day of survey.

Three replicate faunal samples and one sediment sample were taken at each of the twenty sites over the two-day survey period. If any obstruction to the closing of the grab jaws was encountered (e.g. stones, shells etc) the sample was retaken. For the faunal replicates the sample was photographed before being gently washed through a 1mm sieve using a seawater hose. The sample was then back-washed into a labelled container and a solution of 3.5% w/v magnesium chloride ($MgCl_2$) and 0.02% w/v rose bengal was added to the containers in sufficient volume as to just cover the samples. The samples were then left for a minimum period of two hours, following which they were preserved by addition of sufficient 10% solution of formalin to achieve a final concentration of approximately 4-5%. Field notes including the estimated volume of each grab (Litres), time and date of sample and the visual appearance of the sediment were also taken at all sites.

5.1.2.1.2 Beam Trawl Survey

Surveys on both occasions (August 6th – 18th 2001 and Nov 10th - 11th 2003) were carried out using 2m beam trawls equipped with a chain matrix and 4mm square mesh cod-end. Tows were carried out into the current for a distance of 300m at a speed of 2 knots over the ground, with a warp length of a minimum of 2.5 times the water depth. All organisms were identified in the field where possible, although a few invertebrates were retained for confirmation of identification. All elasmobranchs, and the main commercial fish species, were also measured in 2003 although this was not the case in 2001. Most colonial organisms (the soft coral *Alcyonium digitatum* and colonial hydroids and bryozoans) were either recorded as present, where only trivial amounts were found, or weighed. In November 2003 all beam trawl contents were photographed.

Subsampling was required where extremely large numbers of brittle stars were encountered (once only in the 2003 surveys). In this case the catch was first searched thoroughly for all large organisms and as many fish as possible. The remainder of the sample was then subsampled to an appropriate fraction, and the brittle stars, and any other smaller organisms, identified and counted. These numbers were then multiplied by the appropriate factor to get an estimate of the true number in the sample remainder, and these estimates added to those found during the initial search.

5.1.2.2 Faunal Samples

5.1.2.3 Sample Analysis

Sample information such as site, sorter ID, time and date of processing were firstly logged onto the laboratory sorting sheet. Excess formalin was then removed by gently washing samples using filtered seawater over a 1mm mesh. Sediments were methodically searched using forceps and a white enamel tray by the same processor for each sample. Quality control was exerted by the chief taxonomist randomly checking one in every ten sorted samples. If sorting efficiency was found to be less than 95% then all ten of the samples were re-sorted by the original sorter. All organisms found were separated into major taxonomic groups (e.g. molluscs; worms; crustaceans; echinoderms; others) and preserved in 70% alcohol for later identification.

All the archived organisms from each sample were identified to species level where possible, but in some cases only to genus (mainly juvenile and damaged specimens) or to higher taxa. All organisms were recorded quantitatively where possible but colonial forms (bryozoans, hydroids and sponges) were recorded on a presence/absence basis. Nomenclature followed the Ulster Museum and Marine Conservation Society species directory (Howson and Picton, 1997).

Once the raw data had been obtained from the sorted samples and organised into a database (Microsoft Access) analysis was then undertaken, mainly using PRIMER Version 5 (see Clark and Warwick, 1994, for an introduction to PRIMER). A variety of univariate, multivariate and graphical techniques were also used to provide information concerning species richness, universal features of community structure and diversity indices.

Multivariate analysis, (dendrograms, MDS plots and SIMPER Analysis) was based on the mean root-root transformed abundance of species found, which provides a sensible balance between rare and common species, and using the Bray-Curtis similarity coefficient (Bray and Curtis, 1957). The dendrograms were plotted using hierarchical clustering with group average linking.

Multi-Dimension Scaling (MDS) ordination was also based on the Bray-Curtis similarity coefficient. Stress values are provided for each MDS plot; a stress value of <0.05 indicates that there is an excellent representation of the relationship between the various samples, 0.1 indicates good ordination and 0.2 indicates a potentially useful 2-dimensional picture (Clarke and Warwick, 1994). In order to investigate the effect of the environmental data on the stations, sample clustering determined from the above analysis was repeated with mean sediment particle size and total organic carbon superimposed.

SIMPER (Similarity Percentages – species contributions) analysis was also performed to identify the contribution of individual species to any dissimilarity between faunal communities.

5.1.3 Benthic Grab Results

The following presents the results from the 2003 survey and includes comparisons with the data from the monitoring sites taken during the 2002 survey and, where appropriate, data from the baseline survey of 2001.

5.1.3.1 Abundance of Major Taxonomic Groups

A list of all the taxa found at the twenty sites in the 2003 post-installation survey is presented in Appendix 5.1 with the number of organisms found at each station in Appendix 5.2. Overall, 160 taxa were found, of which 138 were identified to species level, all being known from Liverpool Bay. The majority of these were found in the baseline survey of 2001 and the pre-installation survey of 2002, and of those that were not, none were found in large numbers or are indicative of any unusual or important communities, or of significant changes to the population.

The mean number of taxa and individuals (per m^2) based on pooled data for the 51 grab samples is displayed in Figure 5.3. Annelid worms (mainly polychaetes were the most abundant group in terms of both the number of taxa and individuals, as in the pre-construction survey. Molluscs were the second highest group in terms of the number of taxa and individuals, while, echinoderms were marginally more important than crustacea in terms of the number of taxa but not in terms of the number of individuals. In contrast, in 2002 crustacea were the second most numerous in terms of both taxa and individuals.

Figure 5.3 Numbers of taxa and individuals per m^2 by Phylum for the 2003 survey

5.1.3.2 Univariate Analysis

Appendix 5.3 displays the data for the number of species, the number of individuals and the Shannon Wiener diversity index for each grab at North Hoyle 2003. The number of taxa and individuals found at each site during the 2002 and the 2003 surveys have been mapped and graphically displayed and are based upon pooled data from three replicates (Figures 5.4 & 5.5). From Figure 5.4 it can be seen that there is an overall reduction in the number of taxa found at all sites with the exception of site 13, where there was an increase from 18 to 23 different taxa. In 2003 the highest number of taxa were found at sites 18, 19 and 20 which all had similar taxa numbers (55, 50 and 52 respectively). These sites were new to the post-installation survey of 2003 therefore direct comparisons with 2002 data cannot be made. The sites with the greatest and most obvious reductions in number of taxa were 11 (reduced from 63 in 2002 to 5 in 2003) and 4 (reduced from 84 in 2002 to 33 in 2003). The number of individuals found at sites 4 (2270 to 173 individuals) and 11(11,23 to 6) were also greatly reduced when compared to the 2002 survey (Figure 5.5). Overall, most sites did show a drop in the number of individuals present with the exception of sites 5, 13 and 16 where numbers increased. The highest numbers of individuals were found at sites 16, 19 and 18 respectively. However it should be noted that the high number of individuals at site 16 could all be attributed to one species (the bivalve *Donax vittatus* - see map Figure 5.8) causing this site to have a low number of taxa when compared to other sites.

Figure 5.6 graphically displays the mean number of taxa, individuals and Shannon Wiener per m^2 (Appendix 5.3) for 2003 alongside the results from the 2001 & 2002 surveys. From these graphs it is clear that there has been a reduction in both the number of species and individuals for 2003 when compared to the 2002 and 2001 surveys. There also a reduction in the Shannon Wiener diversity index, which was low for all but at it's highest during 2002. Figure 5.7 displays the diversity profile for both the 2002 and 2003 data in the form of a cumulative dominance curve that confirms the general decrease in species diversity in 2003.

Although changes have been observed in the number of species and individuals with reductions noted at most sites. There appears to be no uniform pattern for this reduction in taxa and individuals, rather this has occurred at sites across the entire area including those within the wind farm and at distant control sites. Reasons for this alteration and for the large changes in taxa and individuals at certain sites are postulated and discussed further in the multivariate analysis (section 5.3.2.6).

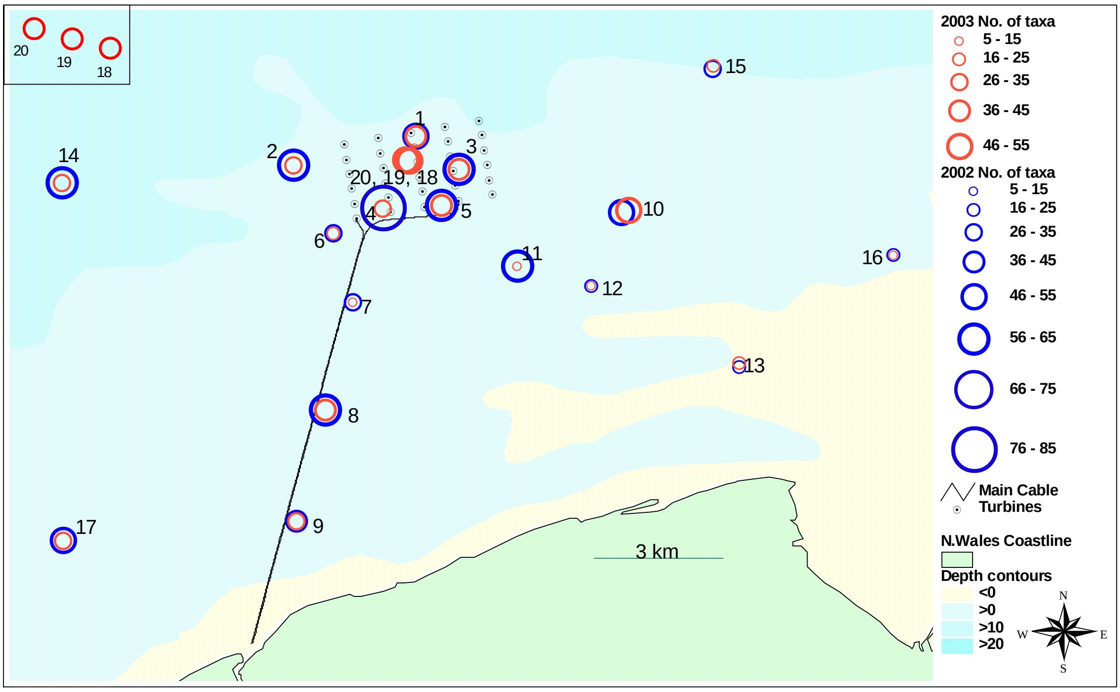


Figure 5.4a Number of Taxa per site for 2003 (red) and 2002 (blue)

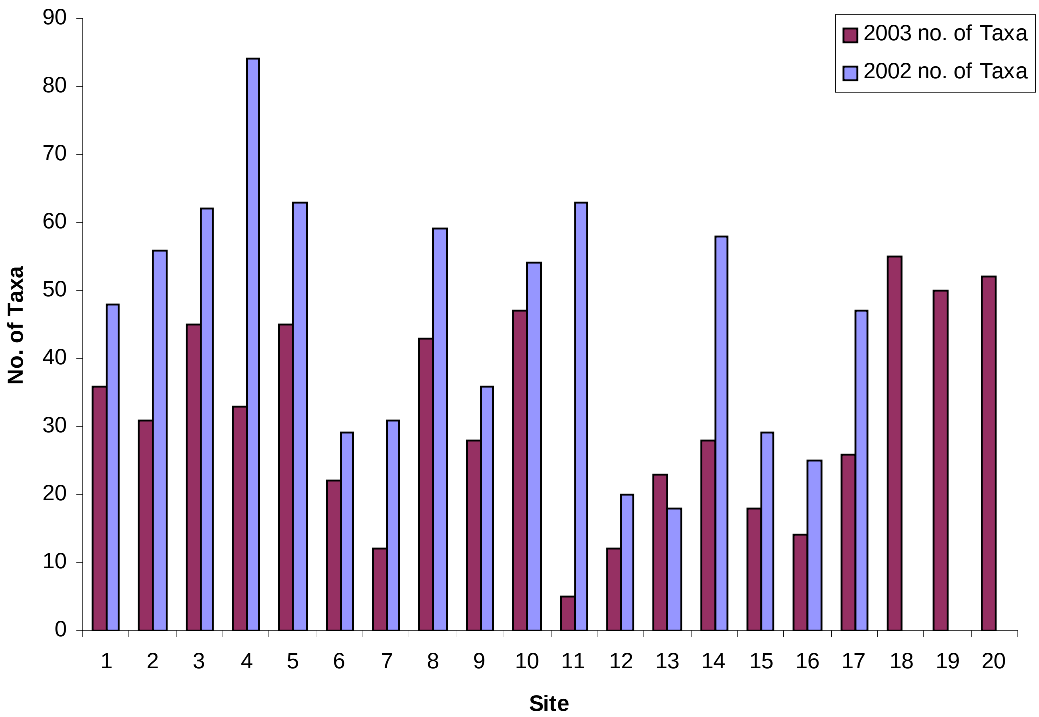


Figure 5.4b Number of taxa per site displayed graphically for 2003 (red) and 2002 (blue)

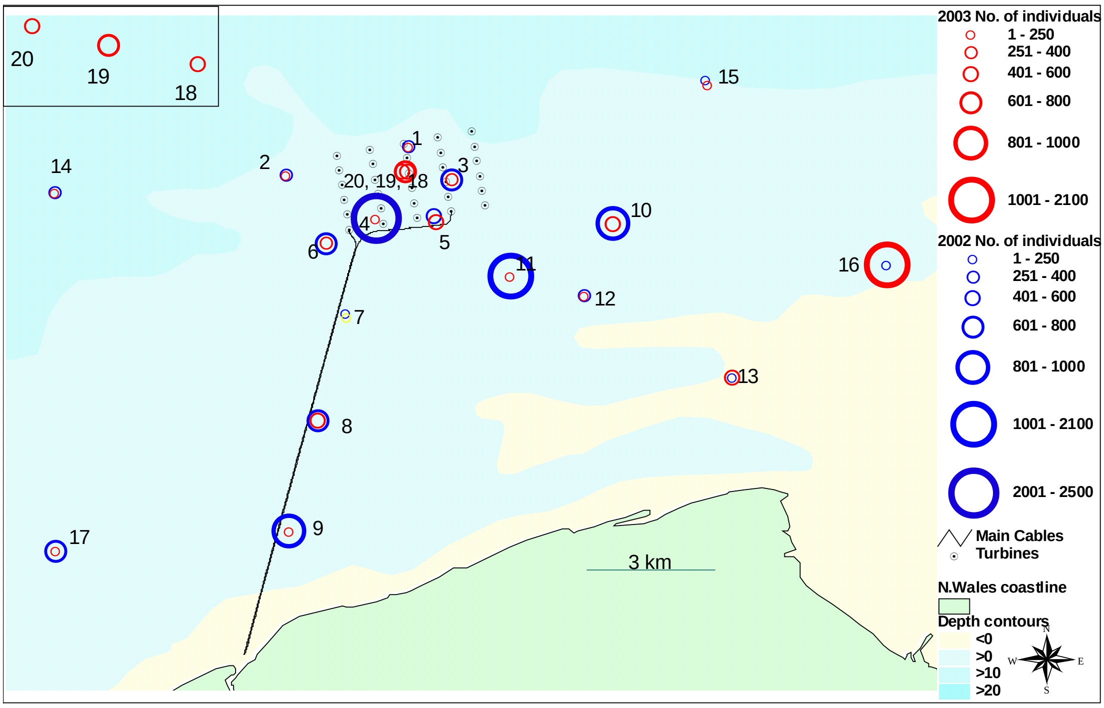


Figure 5.5a Number of individuals per site for 2003 (red) and 2002 (blue)

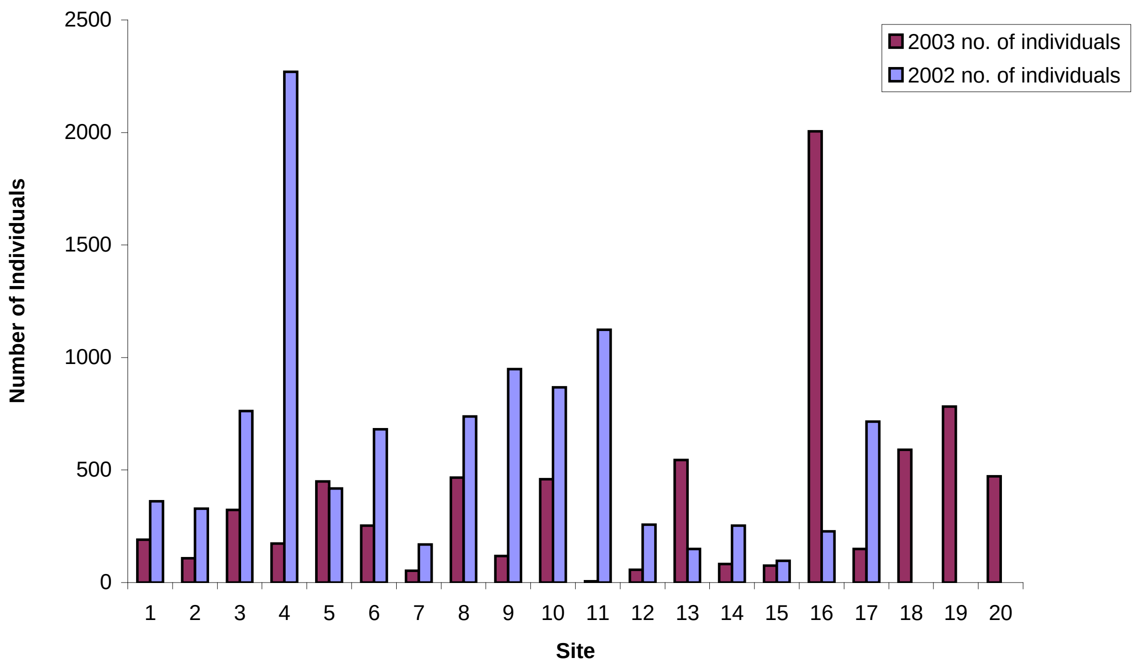


Figure 5.5b Number of individuals per site displayed graphically for 2003 (red) and 2002 (blue)

Figure 5.6 displays the mean number of taxa, individuals and Shannon Wiener per m^2 (Appendix 5.3) for 2003 alongside the results from the 2001 & 2002 surveys. The reduction in the number of species and individuals for 2003 is obvious compared with the baseline surveys of 2001 & 2002. The Shannon Wiener diversity index was low for all years but at it's highest during 2002. There was a noticeable reduction in 2003 compared to previous years.

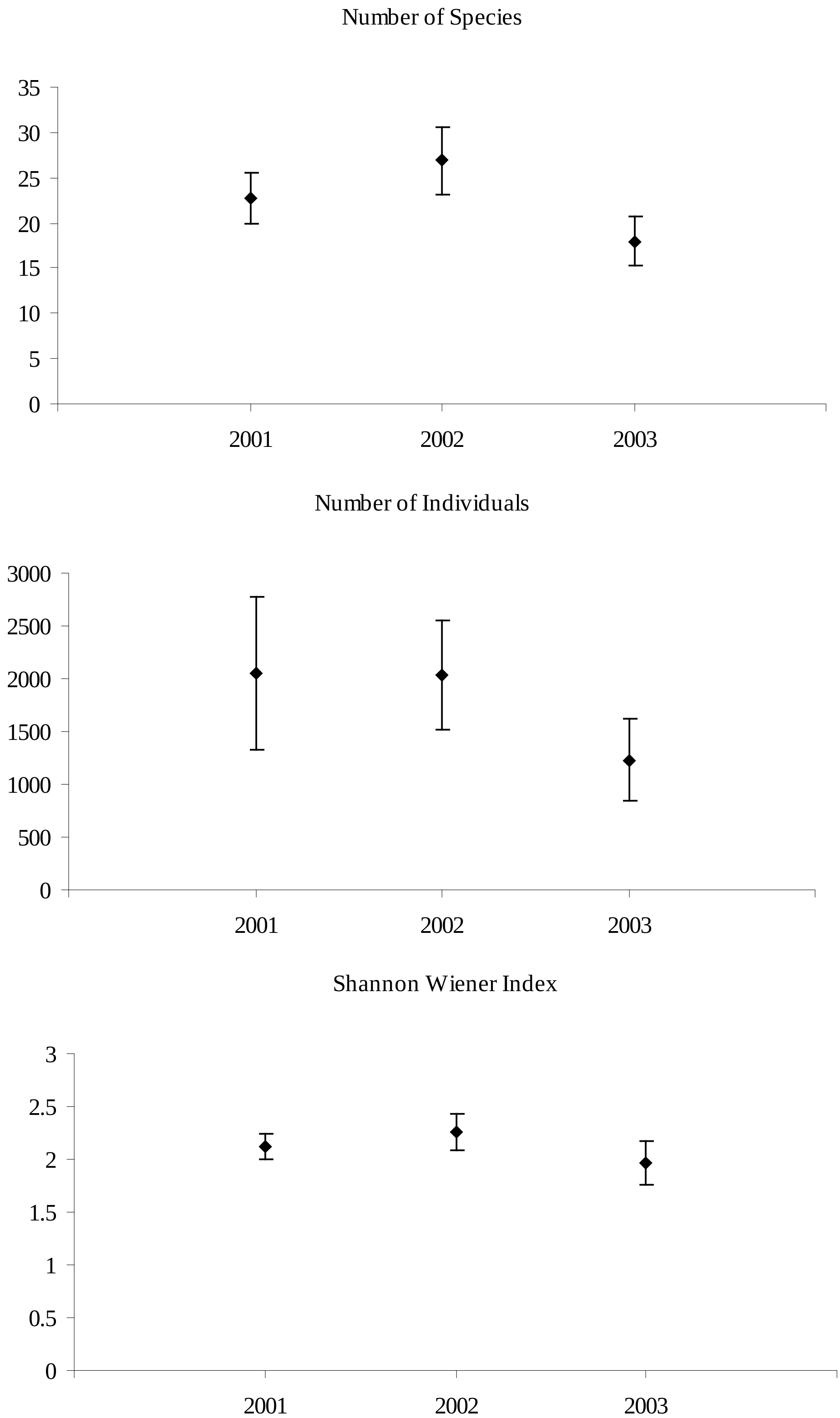


Figure 5.6 Comparisons between baseline data of 2001 & 2002 with construction surveys of 2003 showing species number, taxa and Shannon Wiener diversity indices (based on pooled data).

5.1.3.3 Graphical Analysis

The diversity profile for both the 2002 and 2003 data has been plotted in the form of a cumulative dominance curve in Figure 5.7. This confirms the general decrease in species diversity in 2003.

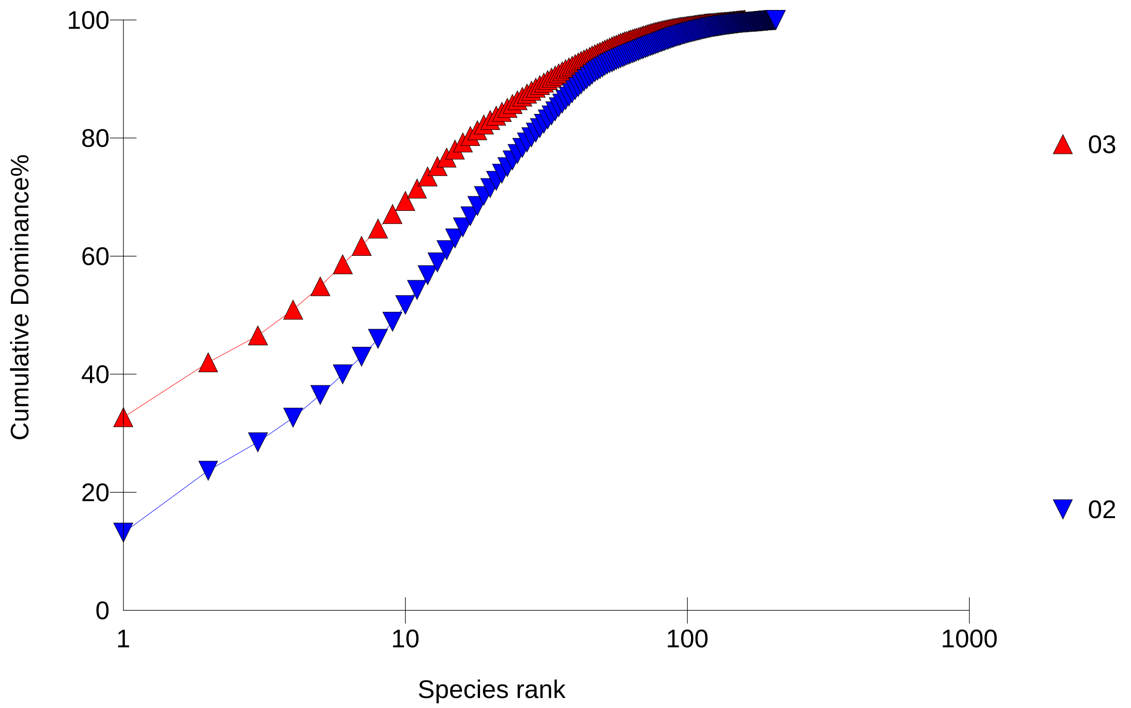


Figure 5.7 Cumulative dominance curves based on pooled data for pre-installation surveys (2002 Blue) and post-installation surveys (2003 Red).

5.1.3.4 Most Numerous Species from the 2003 Survey

The three most numerous species in 2003 were the mollusc *Donax vittatus* and the Annelid worms *Aonides paucibranchiata* and *Protodorvillea kefersteini.* These species have been mapped in Figures 5.8 to 5.10 with the results for the same species from the 2002 survey plotted onto the same map to allow a comparison. It should be noted that on the graphs where the numbers of individuals were the same for both years, one of the markers has been moved slightly to allow it to be seen and this does not signify the exact location the grab was taken. Also sites 18, 19 and 20 were new to the post-installation survey of 2003 therefore direct comparisons with 2002 data cannot be made

The banded wedge shell *Donax vittatus* was the most numerous species in the 2003 survey with 2406 individuals being found at 5 sites (8, 9 13, 16 and 17) (See Figure 5.8). The highest numbers were from sites 13 and 16 (413 and 1971 individuals respectively). In 2002, *Donax vittatus* was the fourth most numerous species with 431 individuals found at eight sites (2,5,8,9,10,12, 16 and 17). The largest number was found at site 17 (209 individuals) and only 13 individuals were found at site 16. *Donax vittatus* was absent from sites 2,5,12 and 10 in the 2003 survey but was present in high numbers at site 13 where it had been absent in the previous 2002 survey. *Donax vittatus* is a filter feeder preferring to live in well-sorted sediment. All the sites in 2003 where *Donax vittatus* was present are described as being well sorted either medium or fine sands, the only exception was at site 8 in 2003, which was poorly sorted gravelly sand.

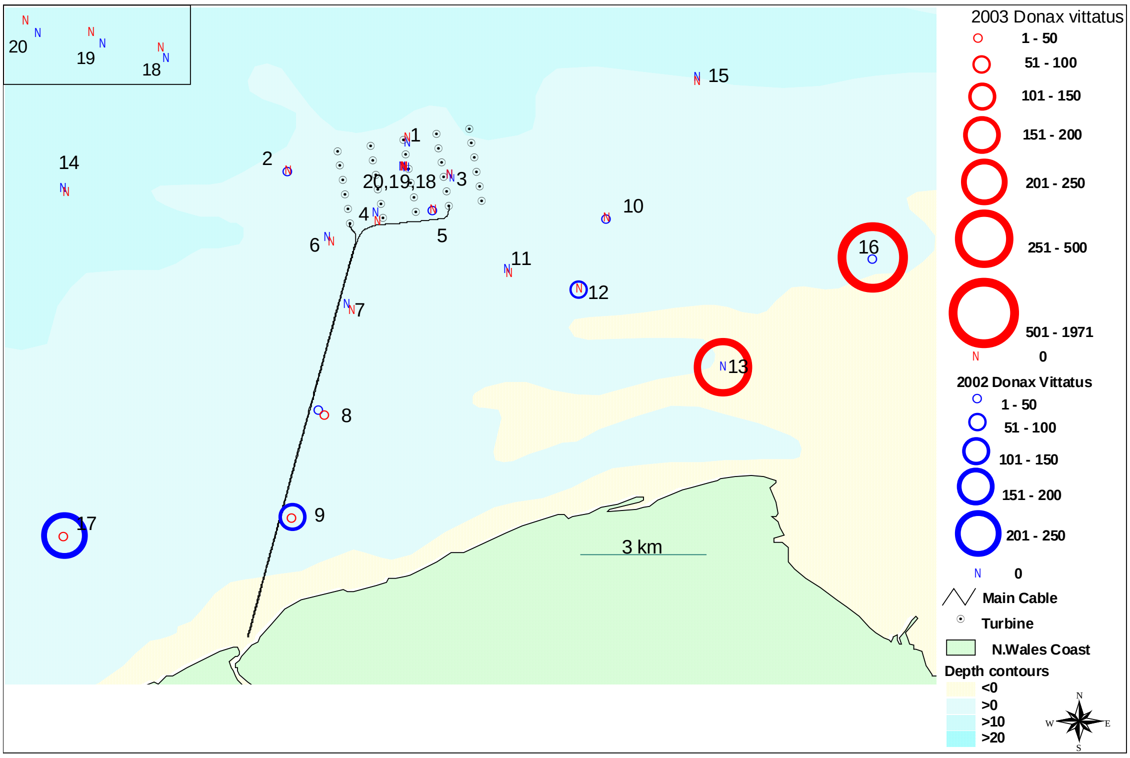


Figure 5.8 Distribution map for *Donax vittatus* from the 2002 (Blue) and 2003 (Red) surveys.

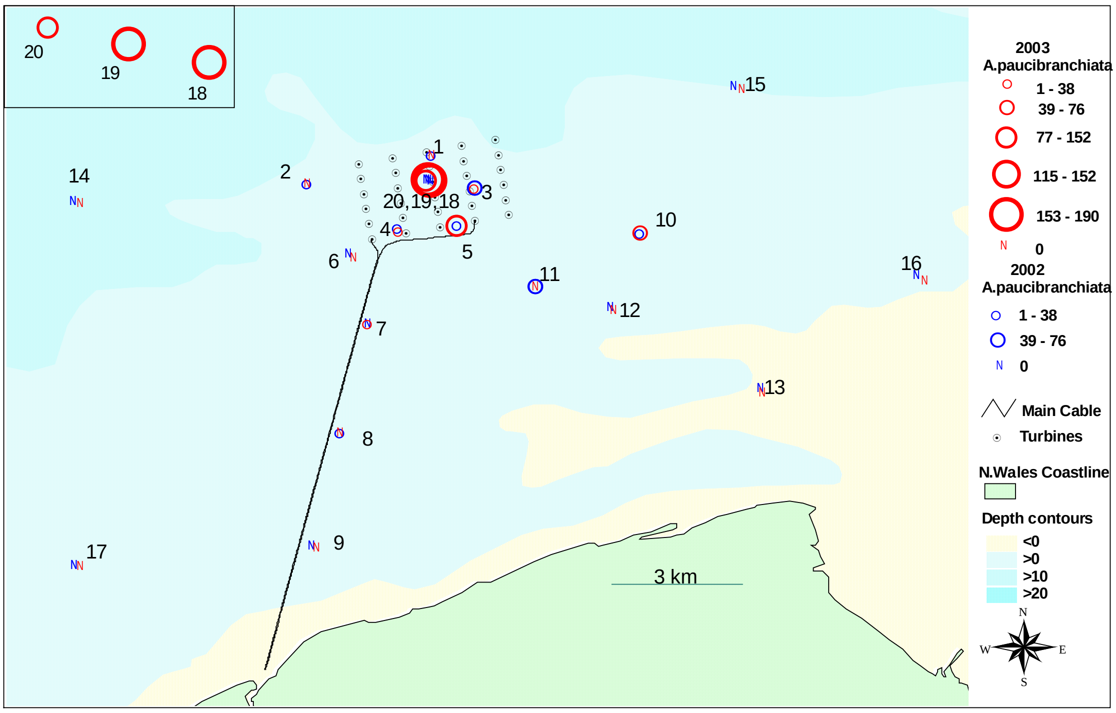


Figure 5.9 Distribution map for *Aonides paucibranchiata* from the 2002 (Blue) and 2003 (Red) surveys.

The Annelid worm *Aonides paucibranchiata* (Figure 5.9) was the second most numerous species with 684 species found in 2003 (203 individuals and 15th most numerous in 2002). In the 2003 surveys it was found at sites mostly in or around the wind farm or on the main cable route. The highest numbers were recorded at sites 5,18,19 and 20. Compared with its distribution from the 2002 surveys *A. paucibranchiata* was absent from sites 1,3 and 8 but now present at site 7.

Protodorvillea kefersteini (Annelid worm) was the third most numerous species with 334 individuals recorded from seven sites (Figure 5.10). This species was present at the same sites as in 2002 with the exception of sites 1 and 11 where it was absent in 2003 and was recorded in the highest numbers at sites 18, 19 and 20. Again, this species was found at sites located in or around the wind farm.

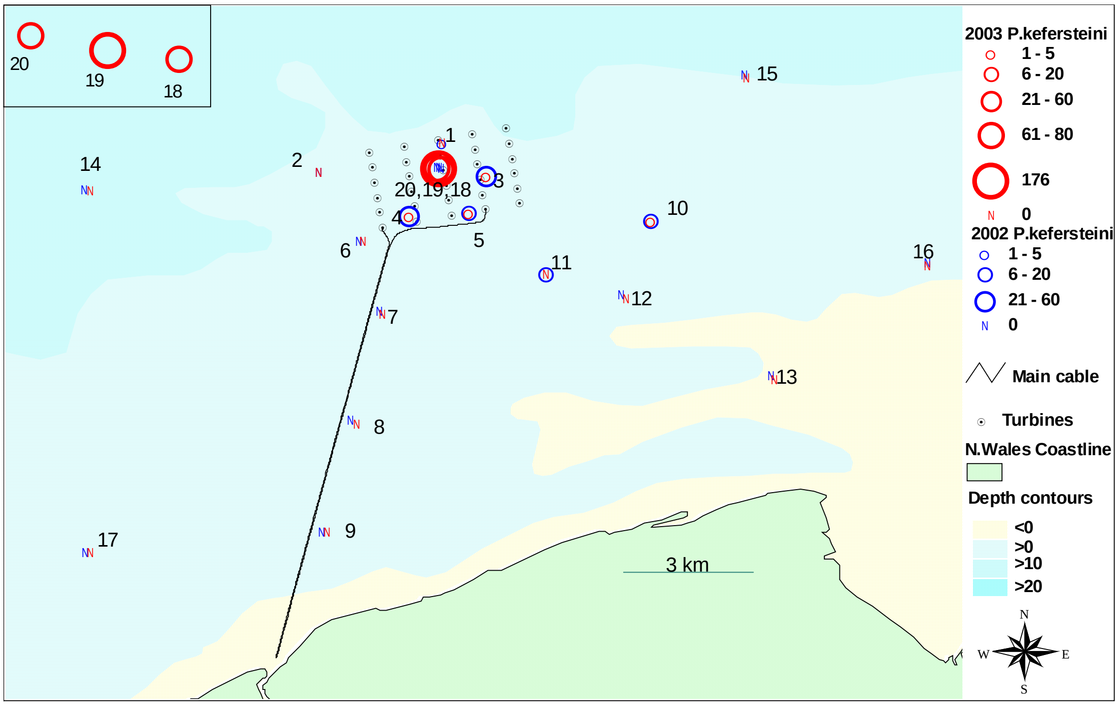


Figure 5.10 Distribution map for *Protodorvillea kefersteini* from the 2002 (Blue) and 2003(Red) surveys.

5.1.3.5 Most Numerous Species from the 2002 Survey

The top three taxa found in 2002 were the anemone *Sagartiidae* sp, the polychaete *Cirratulus* sp and the amphipod *Bathyporeia guilliamsoniana*. These have been mapped in Figures 5.11 to 5.13 alongside the results for the same species from the 2003 surveys.

In 2002 *Sagartiidae* sp was the most numerous taxon with a total of 1364 being found from 7 sites (see Figure 5.11). In 2003 *Sagartiidae* was the 27th most numerous species with 39 individuals found at 10 sites. In 2003 *Sagartiidae* was absent from site 11 but present at sites 13 and 9. Site 4 showed the most noticeable decrease in numbers, while sites 5 and 8 (sited within the wind farm or cable route area) had similar numbers to those in 2002.

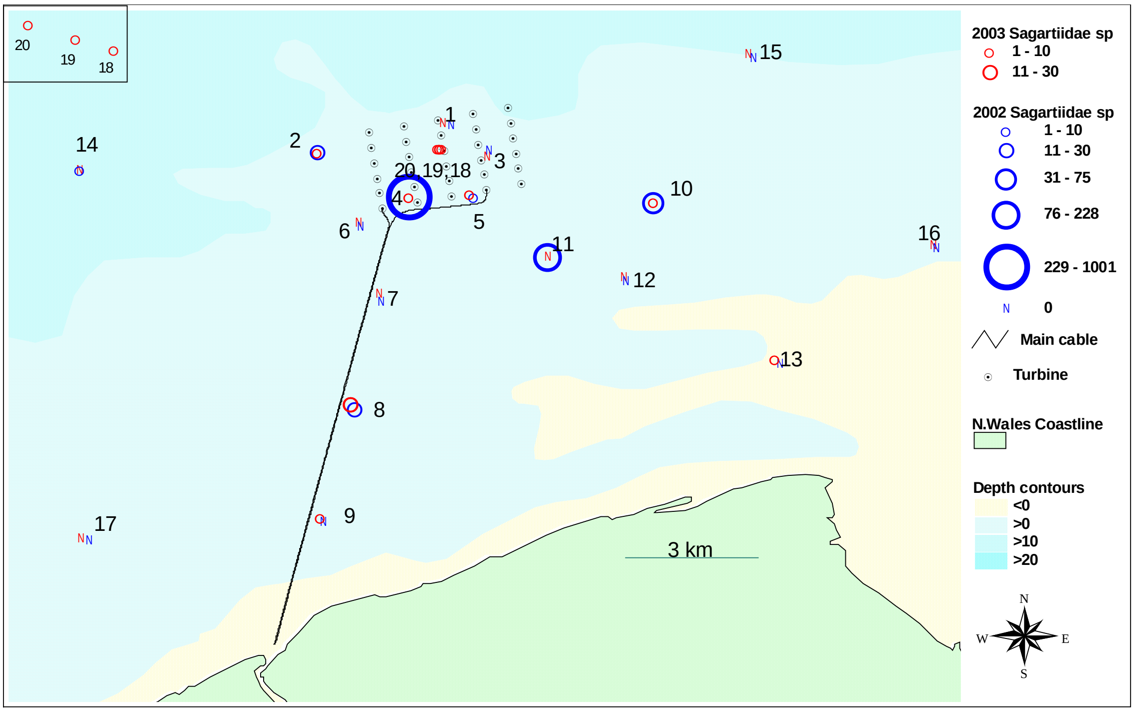


Figure 5.11 Distribution map for Sagartiidae sp from the 2002 (Blue) and 2003 (Red) surveys.

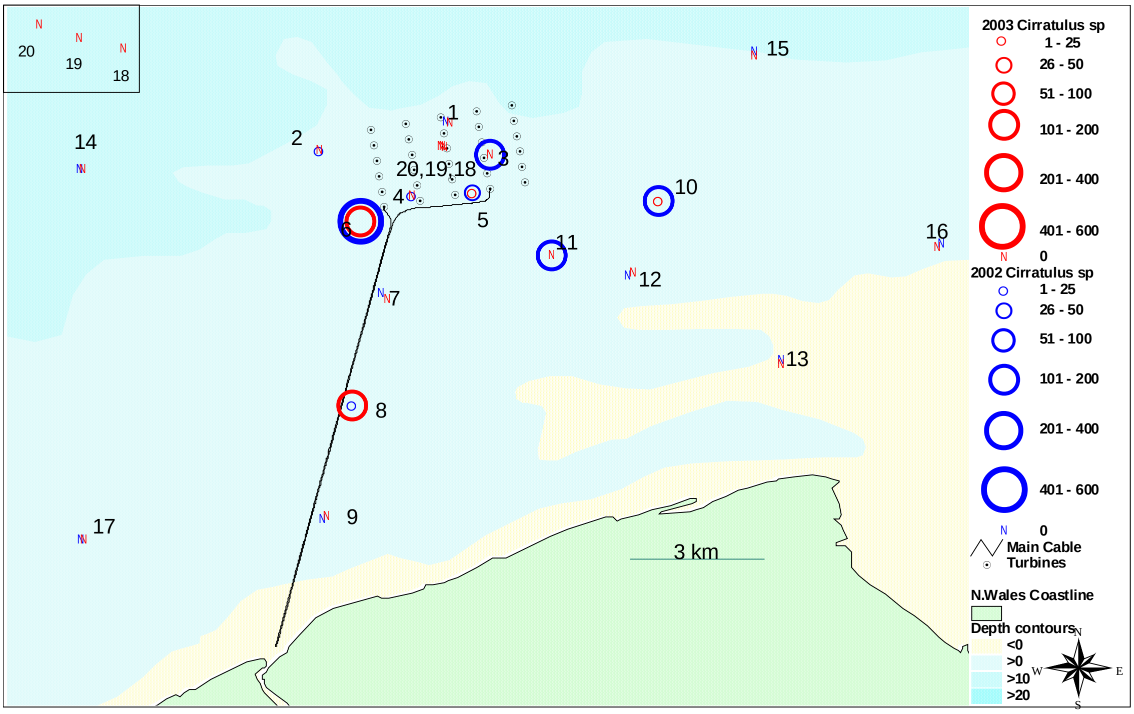


Figure 5.12 Distribution map for *Cirratulus* sp from the 2002 (Blue) and 2003 (Red) surveys

In 2002, 1088 *Cirratulus* sp. worms were found compared to 291 individuals in 2003 (see figure 5.12). This species was absent from sites 2, 11 and 3 in 2003 but were present at site 8, and were again found in their highest numbers at site number 6 as in the 2002 survey. Cirratulidae worms are generally found living in mud, which allows their filaments to protrude (Hayward & Ryland, 1990).

The amphipod *Bathyporeia guilliamsoniana,* which is generally associated with fine and medium sands and was the 7th most common taxon in 2003 with 230 individuals compared to the 500 individuals found in 2002. *B. guilliamsoniana* was absent from sites 5, 10, 16 and 17 in 2003 but at other sites such as 7,8,13, 14 and 2 was found in similar levels as in 2002 (see Figure 5.13). In 2003 this species was also found to be present at sites 3 and 4 where it was absent in 2002 and was also present in higher numbers at site 6 than in 2002.

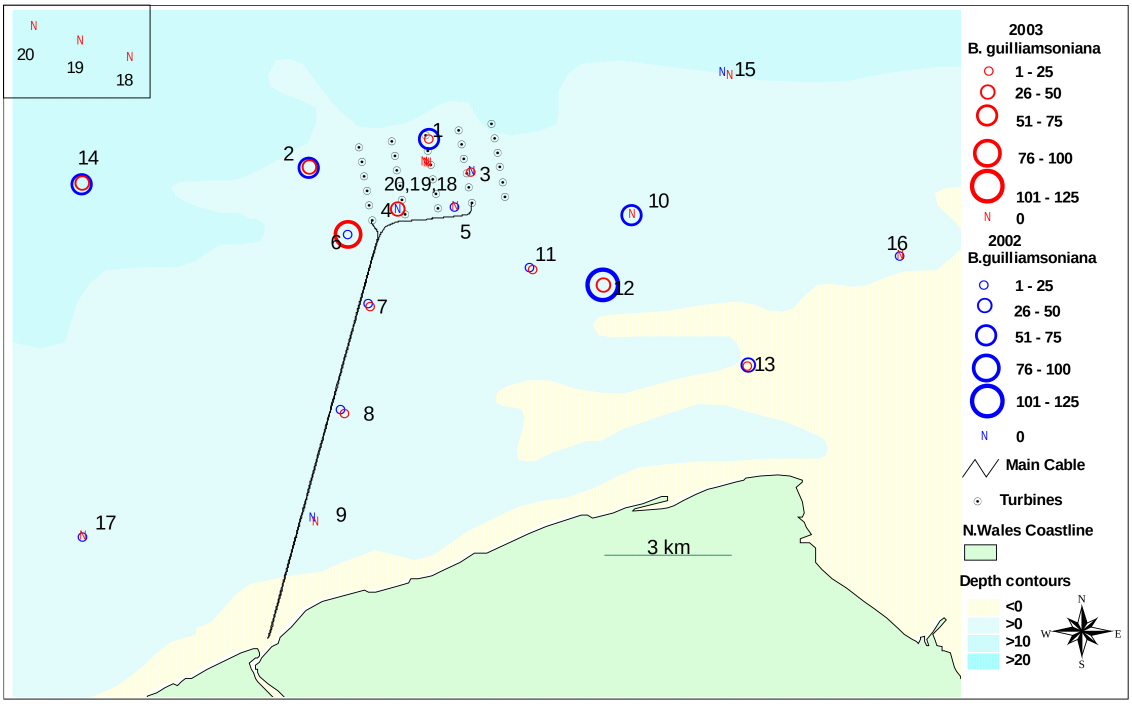


Figure 5.13 Distribution map for *Bathyporeia guilliamsoniana* from the 2002 (Blue) and 2003(Red) surveys

5.1.3.6 Multivariate Analysis

Figures 5.14 and 5.15 display a multidimensional scaling plot (MDS) and a cluster dendrogram for benthic fauna from the 2003 survey. The MDS stress level of 0.16 indicates a fair representation of relationships between the sites. Replicates tend to cluster very well together indicating the similarity of community structure between grabs at each site. The only exceptions were the two control sites, 11 and 14, which did not cluster so well together but were not completely disparate. From this MDS plot it can therefore be determined that there would have been little value in taking more than three replicates at each site.

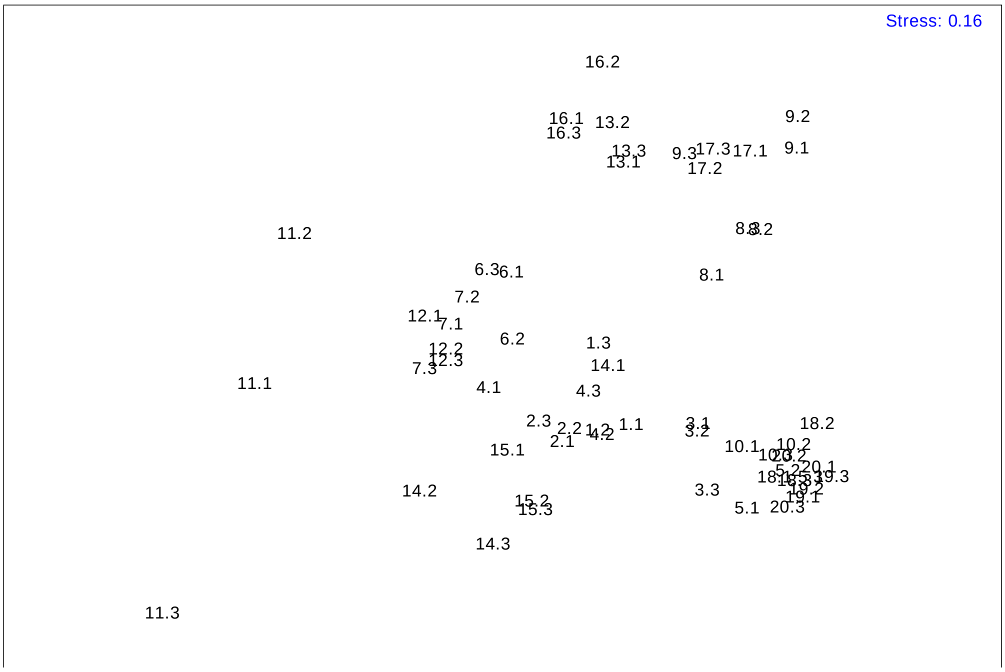


Figure 5.14 Multidimensional scaling plot showing the relationship between the communities found in each grab (2003)

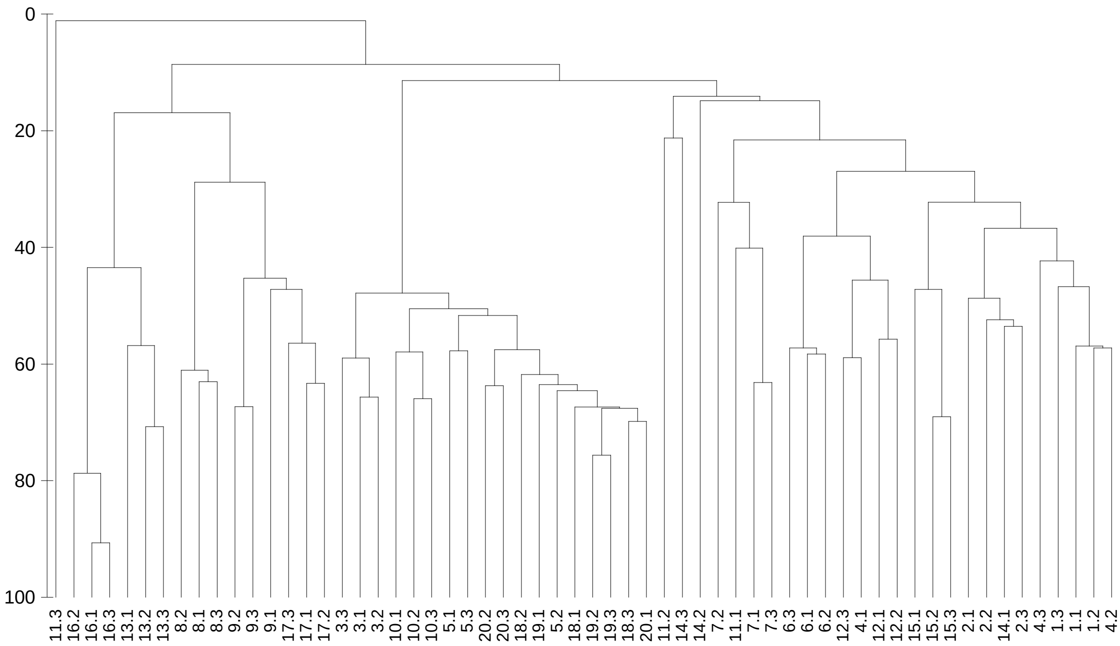


Figure 5.15 Cluster diagram of replicate samples from post-installation 2003 survey

Figure 5.16 shows the MDS and dendrogram of the data pooled from three replicates for 2002 and 2003. In 2003, four groups of sites clustered according to their faunal similarity. Sites 16, 13, 9, 17 and 8 cluster well together at around the 25% similarity level. These sites are all located within the inshore areas and include both control sites and those along the cable route. Site 17 is located approximately 150m offshore from the discharge point of Kinmel Bay sewage outfall pipe. As the community composition at site 17 was so similar to inshore sites located at greater distances such as the control sites 13 and 16, which are located towards the Dee estuary, it can be concluded that site 17 is not impacted by the outflow. Sites within the wind farm such as 3, 5, 18, 19, and 20 also grouped well together along with site 10 suggesting that they have very similar species composition. Similarities are also apparent between sites 1,2 and 4, which, again, are all relatively close to each other. The control sites 14 and 15 were fairly similar in community composition. Site 11 was very dissimilar to the other groups. To identify the main species contributing to the group dissimilarities in Figure 5.16, SIMPER analysis was carried out. Appendix 4.4 shows the main contributing species to the four groups of sites in Figure 4.16 and the dissimilarity between each group.

Figures 5.17 and 5.18 display the combined MDS and dendrogram plots for 2002 and 2003 (based upon pooled data). Overall the 2003 results appear to be very similar for most sites, including those within the wind farm construction area, to the results from 2002. Exceptions to this include sites 11, 4,13 and 16. Reasons for this may be that at site 4 and 11 there has been an alteration in sediment characteristics (see section 5.3.1 and Figure 5.19). At site 4 large numbers of the anemone Sagartidae, often found attached to stones and shell, were found in 2002 but were absent from 2003 when the substrate was much sandier. In 2002 the sediment from site 11 was gravel but in the 2003 surveys it was fine sand substratum, which does not support large numbers of taxa. Site 11 is situated well outside the wind farm boundary and it is therefore unlikely that construction has influenced the sediment distribution at this site. It is more likely that either natural sediment flux has occurred or a small area of sand within a surrounding area of gravel at this location was sampled by the grab. Site 4 in 2003 was composed of medium sand with some gravel whereas in 2002 it was predominantly gravel. This site is located within the wind farm boundary. At sites 13 and 16 large numbers of *Donax vittatus* were found in 2003 surveys, which were absent from the 2002 results. As the sediment at these two sites appear unaltered and these sites are located within control areas and are thus not affected by wind farm construction it appears that this may be attributed to either chance or, as it occurred at two sites rather than one, as a result of inter-annual variation. *Donax*, like many infauna, can experience huge variations in numbers from one year to the next. The SIMPER analysis in Appendix 5.5 identifies the main species contributing to the dissimilarities between the 2002 and the 2003 surveys.

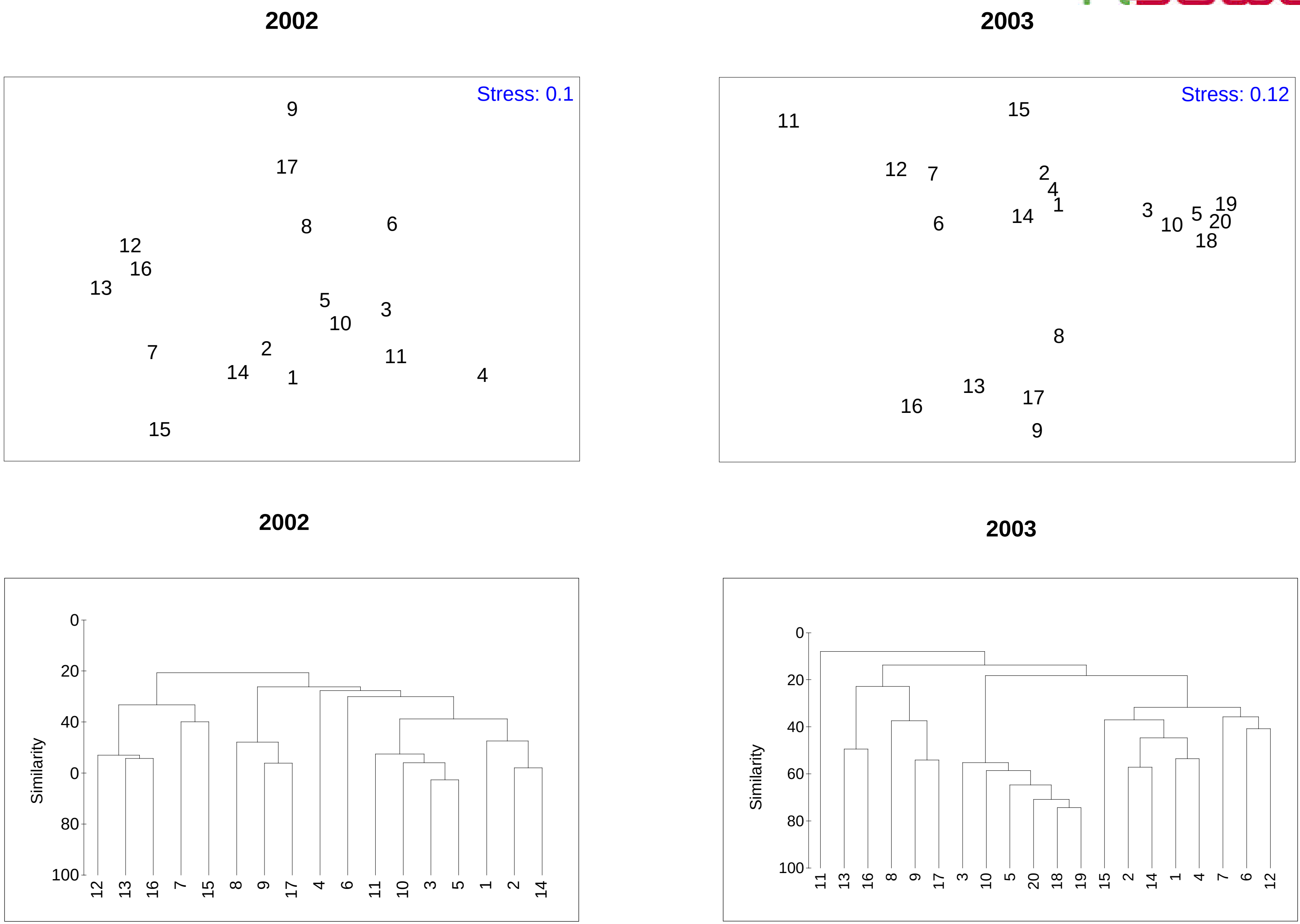


Figure 5.16 MDS plots and cluster dendrograms for 2002 and 2003 based upon pooled data

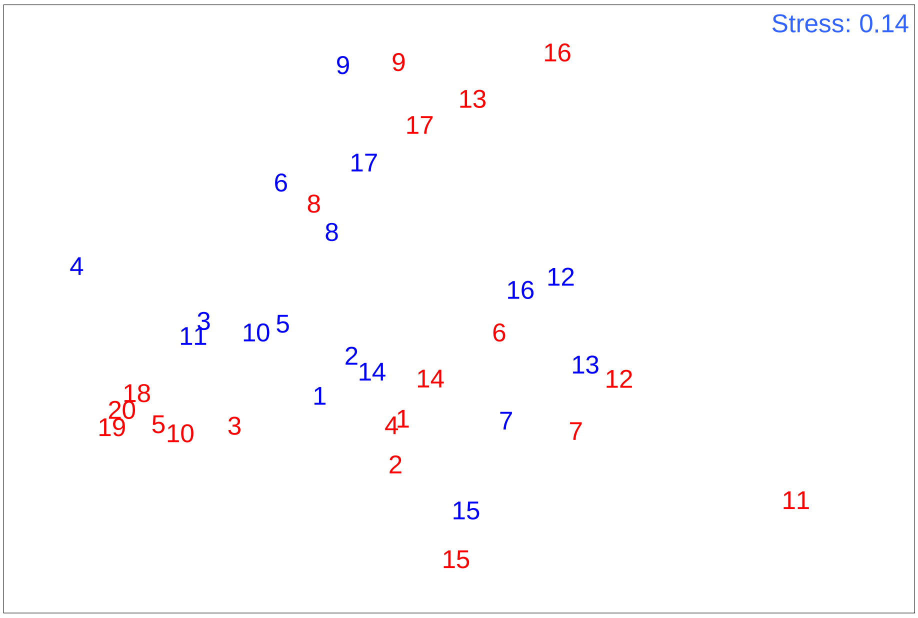


Figure 5.17 Combined multidimensional scaling plot for communities 2003 (Red) and 2002 (Blue) communities based on pooled data

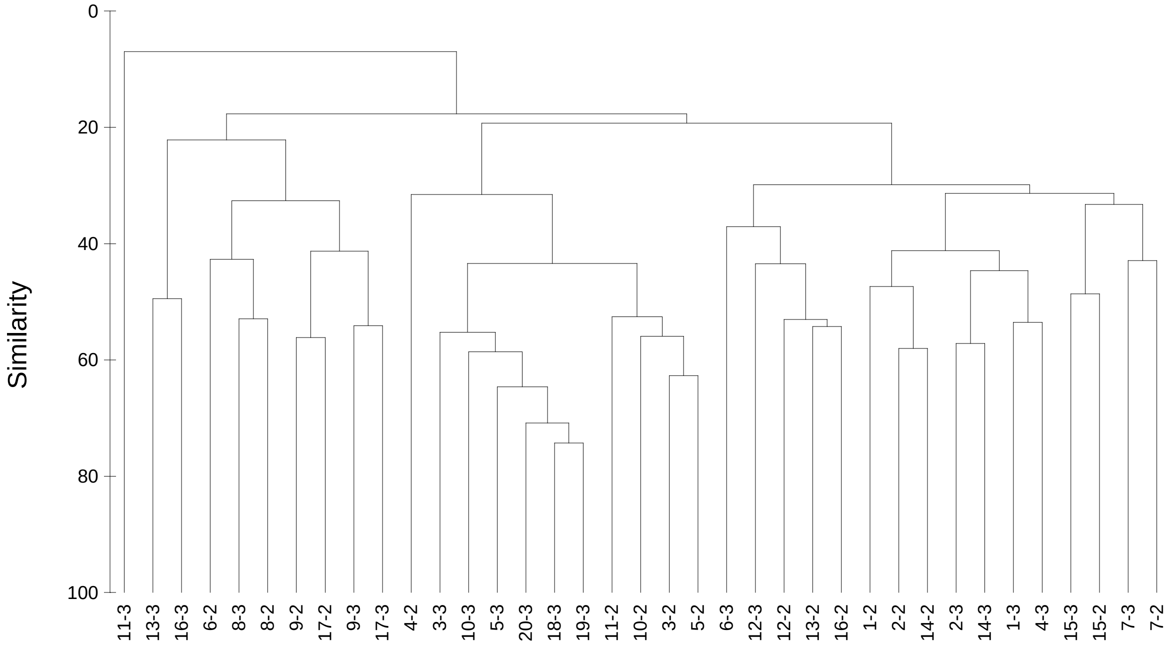


Figure 5.18 Species abundance (based on pooled data) for 2002 and 2003 dendrogram similarities (the post-fix number e.g. 2 or 3 indicates the year.

Figures 5.19 and 5.20 show the benthic community MDS data for both 2002 and 2003 superimposed with the mean particle size (mm) and the total organic carbon data for both years. From figure 5.19 it can be seen that mean particle size seems to have a considerable influence on the communities, but this is by no means universal, one exception is site 14 where the results from 2002 and 2003 group well together indicating a similar community composition despite having a much smaller particle size in 2003 than 2002. Site 14 was described as being poorly sorted pebble in 2002 with a mean particle size of 7.64mm (see Table 5.5). In 2003 the sediment at this site was described as very poorly sorted cobble with some sand, with a mean particle size of 3.55mm. Although there has been a reduction in mean sediment particle size, the sediment type can be considered similar enough in both years to support a comparable benthic community.

Sites 5 and 10 grouped very closely together in both 2002 and 2003, and both appeared to have somewhat coarser sediment in 2003. However, the changes were not very dramatic in nature and the sites would therefore be expected to support a very similar benthic community in 2002 and 2003, which would appear from the MDS in Figure 5.19 to be the case. As site 5 is within the wind farm construction area and site 10 is considered to be one of the control sites and is sited well away from construction activities it can be postulated that the wind farms construction has not had a direct effect at this stage upon their benthic populations. Figure 5.19 also shows the obvious change within the benthic community at site 11, as it was no longer similar to sites 3, 5 and 10 as it was in 2002. Instead it was now dissimilar to most sites. Again this is attributable to sediment alteration at this site as discussed previously. Overall, site 4 has had the largest change in taxa and individuals. Sediment at this site has altered from poorly sorted gravel to well sorted medium sand Medium sand will generally support a less diverse benthic community than poorly sorted gravel thus giving the large decrease in the number of taxa and individuals found at this site when compared to the 2002 data.

Figure 5.20 displays the benthic community similarity data for both 2002 and 2003 superimposed with the total organic carbon data for both years. There is little obvious pattern, which is not surprising since levels are generally low.

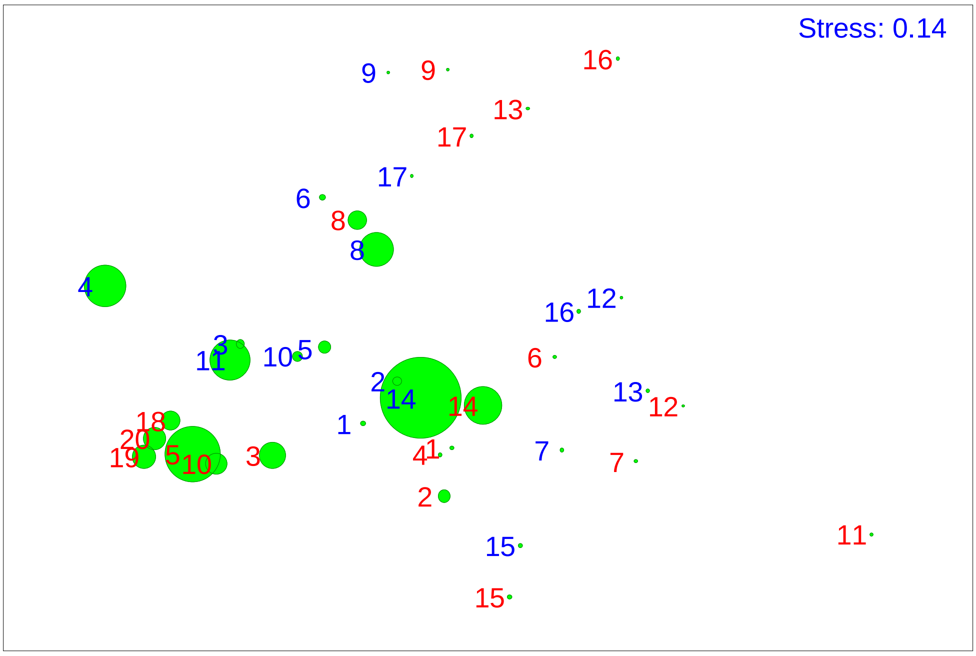


Figure 5.19 Species abundance data for 2002 (blue) and 2003 (red) superimposed with mean particle size (green)

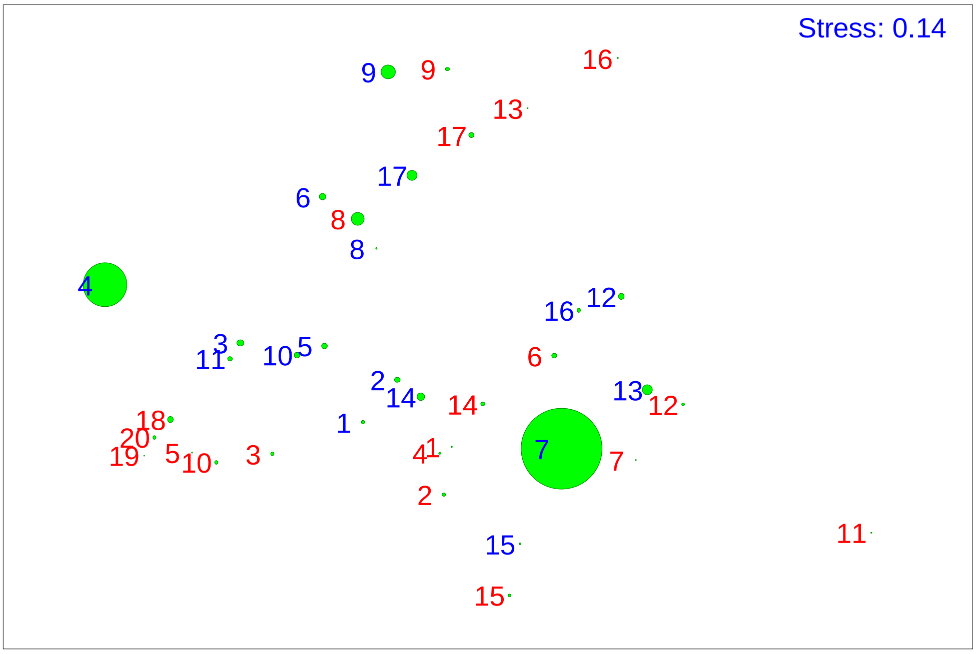


Figure 5.20 Species abundance data for 2002 (blue) and 2003 (red) superimposed with total organic carbon (green)

5.1.3.7 Community Description

The North Hoyle baseline survey of 2001 identified and classified the benthic community distributions according to the MNCR biotope classifications (Connor *et al*, 1997). This classification revealed the benthic community at North Hoyle to fit reasonably well to that of Mackie's shallow Venus community. This community is common throughout the coastal areas of the Irish Sea including that of Liverpool bay. Mackie further describes two sub communities of this shallow Venus community as being the *Spisula* sub-community (found in medium to coarse sands), and the *Fabulina* sub-community, in fine stable sands. Within MNCR classifications these equate to IGS.Sell (*Spisula elliptica* and venerid bivalves in infralittoral clean sand or shell gravel) and IGS.Fab/Mag (*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves in infralittoral compacted fine sand). Large numbers of the bivalves *Spisula elliptica, Spisula subtruncata* and *Spisula solida*, and large numbers of the polychaetes *Spiophanes bombyx* and *Nephtys cirrosa* were found in 2001 giving rise to the conclusion that the North Hoyle benthos, overall, seems to equate better with the *Spisula* or IGS.Sell sub-community. Inshore sites from the baseline surveys revealed the presence of the IMS.EcorEns (*Echinocardium cordatum* and *Ensis* spp. in lower shore or shallow sublittoral muddy fine sand. The North and West of the area showed similarity to IGS.ScupHyd (*Sertularia cupressina* and *Hydrallmania falcat*a on tide-swept sublittoral cobbles or pebbles in coarse sand) that often contains the '*Venus'* associations within the infauna. The biotope was better described as IGS.Sell with variable amounts of overlying stones and associated hard fauna. To the south and east of the site a very sparse fauna dominated by the worm *Nephtys cirrosa* and the amphipod *Bathyporeia* spp, was described by the biotope description MNCRs IGS.NcirBat (*Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand). This biotope occurs on well-sorted sands and is to some degree intermediate between IGS.Sell and even sparser communities in mobile coarse sands (Connor et al., 1997). Biotopes along the cable route were classified as belonging to Mackie's *Abra* community (equivalent of the MNCRs CMS.AbrNucCor (*Abra alba*, *Nucula nitida* and *Corbula gibba* in circalittoral muddy sand or slightly mixed sediment). This biotope is known to occur in a number of inshore pockets in Liverpool bay, including this part of the North Wales coast. These biotopes were then used to construct a biotope map (see Figure 5.21).

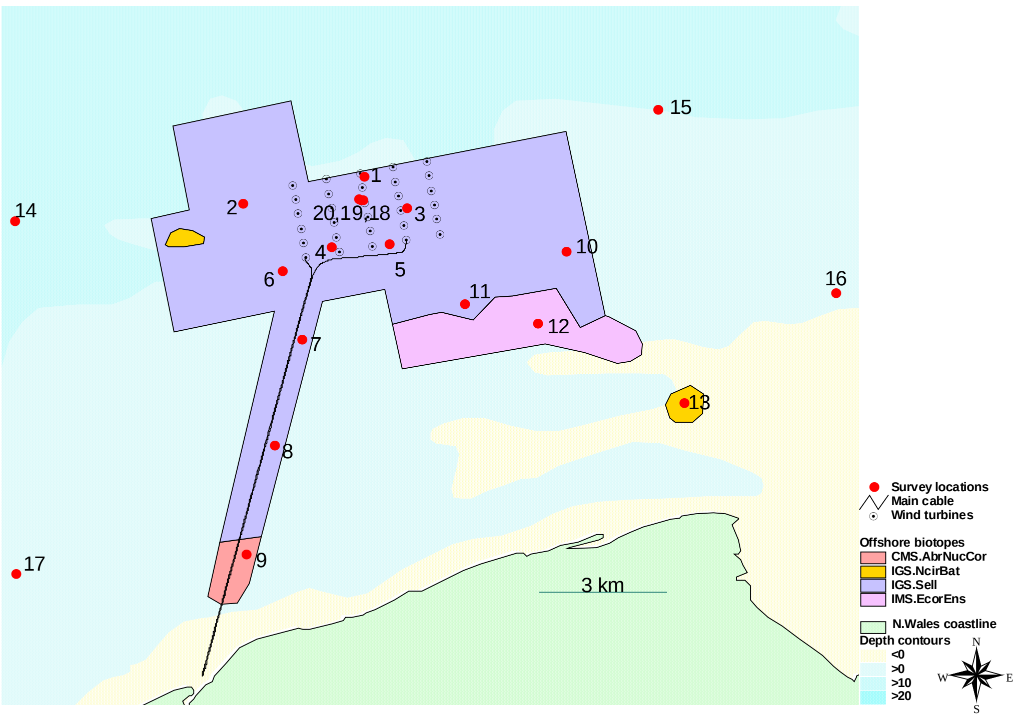


Figure 5.21 Baseline biotope classifications for North Hoyle after baseline survey

As stated in 2001, this method of biotope classification is indicative only, since i) it is difficult to assign biotopes to wide areas based on small numbers of samples; ii) there is little apparent relationship between the communities found in the biological sampling and the seabed descriptions (mostly sandy gravel, megaripples, and sand ripples) found in the geophysical survey; ii) the biotope classification system is less well developed, and more difficult to apply, for sublittoral sediments than for most other habitats, and is in the process of being improved (Connor, pers comm). The original biotopes in 2001 were assigned after using a larger number of grabs and also using anchor dredge samples (and to a lesser extent beam trawl data) for some of the larger indicators. The small number of grab samples in 2003 is insufficient to identify biotopes. However, the results from the 2003 survey are broadly in agreement with the classifications made in 2001 and certainly do not give any reason to alter the biotope map as it currently stands.

5.1.3.8 Thumbnail Crab (*Thia scutellata*) Distribution

The Thumbnail crab *Thia scutellata* is a small crab (carapace width typically 10-20mm) known to have very specific requirements for sediment with a geographical distribution from southern Sweden to the Gulf of Guinea. It is a specialist species adapted to live in loose well-sorted medium sand (median phi 1.1-1.3) into which the crab can easily burrow. Within UK waters it is perceived as being a scarce species because even within fields of sand waves the precise locations with the conditions they prefer are limited (Rees, 2001). It is considered to be a species of concern by the Countryside Council for Wales (Moore, 2002) and its main Irish Sea populations are 6-12 miles offshore from the North Wales coast, with some off the east coast of Anglesey. These appear to represent the major known populations in British waters. It is also known to occur in limited areas in central Cardigan Bay and Carmarthern Bay. Other records for North Wales include Constable Bank and Menai Straits (Rees, 2001).

The 2001 baseline survey found sparse populations of *T. scutellata* living in sub-optimal habitat and further sparse numbers were again observed in 2002. The 2002 and 2003 distributions of this species have been mapped in Figure 5.22.

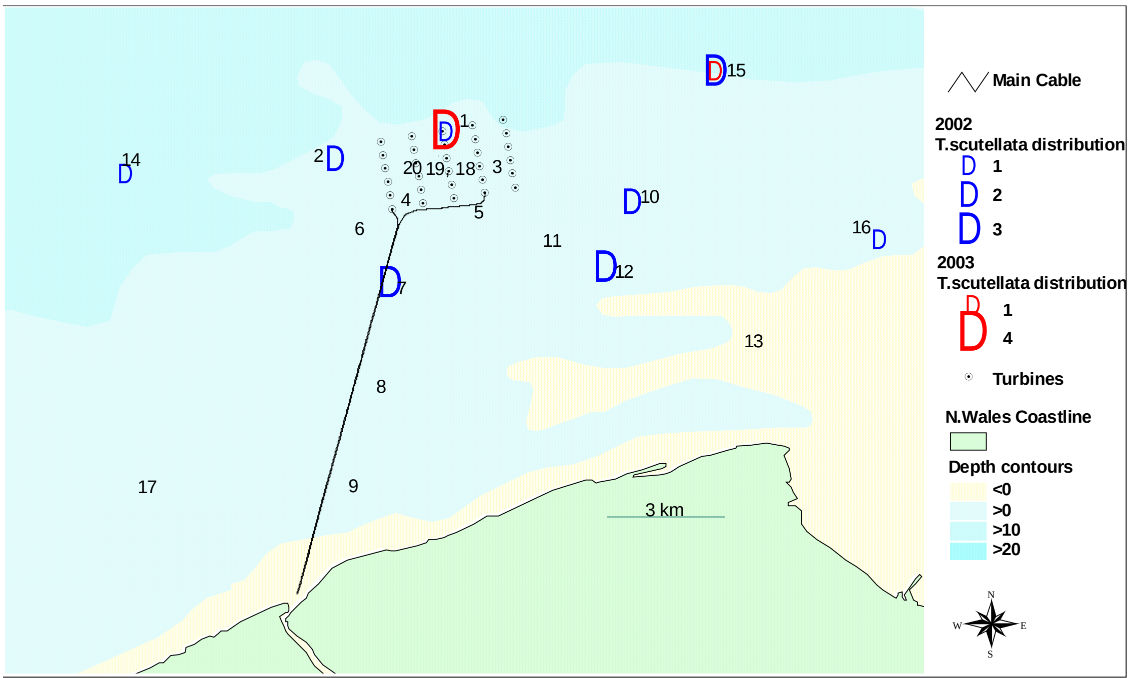


Figure 5.22 Distribution of *Thia scutellata* from 2003 surveys with comparison to 2002 data

Overall five *Thia scutellata* were found at two sites in 2003 (sites 1 and 15) compared to 16 individuals from eight sites in 2002. Of the sites where *Thia scutellata* was found in 2002, three (sites 14, 2 and 10) appeared to consist of coarse sediments normally considered unfavourable for *Thia scutellata* (Table 4.5). The remaining sites appear to have quite suitable sediments, and there has been little or no change in the sediment classifications at most of the *Thia* sites between 2002 and 2003. It is therefore slightly surprising that so few were recorded in 2003. However, site 1 in 2003 yielded the highest number (4) of *Thia scutellata* from any one site from both the 2002 or the 2003 surveys, and is within the confines of the wind farm construction area. It therefore appears likely that the overall reduction in *Thia scutellata* numbers for 2003 can be attributed to natural fluxes in the *Thia scutellata* population, although it could well be at least be partly due to chance. Future monitoring will help to clarify this.

5.1.4 Beam Trawl Results

The North Hoyle Environmental Statement stated that the possible impacts on fish for the construction phase would include the effects of piling noise, which can be very considerable. Loud noises might be expected to affect fish with swim bladders (e.g. gadoids), which tend to be more sensitive to noise, more than those without (e.g. flatfish and elasmobranches). Potential impacts on elasmobranchs from cable electromagnetic fields were also recognised as a concern and fish aggregations around turbines may also occur. After the beam trawls of 2001 it was concluded that the benthic communities of North Hoyle and its surrounding area were broadly similar to two of the six assemblages described by Ellis *et al* (2000) for the Irish Sea, St Georges Channel and Bristol Channel. These communities were named the *Pleuronectes-Limanda* (Plaice-Dab) assemblage, found more or less within the 20m contour in the Liverpool Bay area, and the *Microcheirus-Pagurus* (thickback sole-hermit crab) assemblage, which occurred slightly further offshore. The results from the survey found elements of both of these communities, though were rather more similar to the former. Other species typical of coarser, stony grounds such as Alcyonium *digitatum* (Dead Man's Fingers), hydroids and bryozoans were also present.

Data from the 2003 beam trawl surveys is presented in Appendices 5.6 and 5.7 along with survey data for the numbers of organisms in the original 2001 surveys (Appendix 5.6), which were originally provided in the benthic ecology technical report (2002). A very broad overview of the results indicates that there were some consistencies between the years. Those sites to the east and south (9, 10, 11, 12, 13, 14, 19, 20, 21, 22) along with site 1, were, in both surveys, dominated by fauna found on sandy grounds. Organisms such as such as dead man's fingers (*Alcyonium digitatum*), the anemone *Metridium senile*, large bushy hydroids and bryozoans, or the urchin *Psammechinus miliaris*, which are indicative of harder or coarse bottomed grounds, were abundant at sites 2, 3, 4, 15, 16, 17, and 18. The remaining sites (5, 6, 7 and 8), all within the development area, bore fauna, which suggested they were somewhat intermediate, but probably rather more similar to the sandy grounds than the coarse ones. Minor changes to the trawl locations between the two surveys appear to have made no great difference to these broad conclusions, suggesting the type of ground covered has remained similar in each case.

Viewed overall, the assemblages were again broadly similar to those found in the 2001 surveys, being most similar to the plaice /dab assemblage found by Ellis et al (2000). Ellis et al regarded the hermit crab *Pagurus bernhardus*, the sand star *Astropecten irregularis*, and the flatfish *L. limanda* and *Buglossidium luteum* as important discriminating species, although *A. irregularis*, which does not inhabit coarse sediments, was found in only low numbers here. Again some sites showed evidence of harder bottoms as indicated by dead man's fingers *Alcyonium digitatum*, plumose anemones *Metridium senile* and bushy hydroids and bryozoans.

Despite the above, at many of the sites there were obvious differences in assemblages found, in terms of both invertebrates as well as fish, between the two surveys. This is illustrated in multi-dimensional (MDS) scaling plots of the assemblages (Figures 5.23 and 5.24), in which it is clear that the relationships between the catches from the various sites in the two surveys was not consistent. With regards to invertebrates, sites clustering together when both surveys were analysed together included some sites in the general vicinity of the wind farm (7 and 18) and some further a field (10, 14, 15 and 16). With regards to fish, only sites 2, 13, 19 and 22 clustered closely together when both surveys were analysed together, indicating strong similarity of the fish catches from the two surveys at these sites. In all other cases there were showed clear differences between the two surveys. Seasonal changes, changes between years (inter-annual variation) and simple random effects, as well as possible effects of the development could all contribute to these differences. Distribution of total numbers of invertebrate epifauna, and number of epifaunal taxa recorded, are shown in Figure 5.25. The number of invertebrates was noticeably reduced at sites 7 and 8 in 2003, but this was largely due to substantial reductions in the common starfish *Asterias rubens*, which was greatly reduced in number at most sites. This species is highly variable in numbers form year to year, and is also quite highly mobile. The number of invertebrate taxa recorded was broadly similar in the two years at all sites.

Distribution of total numbers of fish, no of fish species and a number of individual fish species are given in Figure 5.26. Total numbers of fish found in the autumn 2003 surveys were increased at 857 as opposed to 513 in 2001. Changes were not uniform, with reduced numbers at some sites, and increased numbers at others. The biggest change (+103) was at the inshore end of the cable route, where greatly increased numbers of solenette were found. Within the development area the number of fish found was slightly increased overall, though very marginally reduced at sites 7 and 18. Interestingly, although the numbers of species found were slightly reduced in the survey overall compared to 2001 (to 18 from 22) the numbers of taxa at individual sites were marginally higher. Within the development area, the numbers of species found were broadly similar in both surveys except at site eighteen (increased to 10 species in 2003, from 4 in 2001). Looking at individual fish species, there was a great deal of variation in the type and scale of changes seen.

The potentially commercially valuable flatfish, sole and plaice, both appeared to change distribution noticeably. Sole were much reduced in numbers in the 2003 surveys, being limited to a few small specimens at shallow inshore sites. This was a widespread change from 2003 with no suggestion of any particular relationship to the wind farm development. Plaice were also noticeably reduced in numbers in 2003, but most of this reduction was in the vicinity of the wind farm. Of the fish which were found, there was very clear demarcation of size ranges with distance offshore, with the sites at the deeper north west corner (1,2,15,16,17) containing almost entirely fish of 200-270 mm length, the sites in the south-east (10,11,12,20,21) yielding fish almost entirely in the range 125-175 mm, while the six plaice at the inshore site 14 were of 110mm or less; a distribution which is typical of plaice in coastal waters. Plaice caught in 2001 were not routinely measured. Flatfish such as plaice, sole and dab may aggregate around structures, probably primarily for foraging (summarised in Hoffman et al, 2000) and it is therefore possible that some plaice may still have been in the area but were much closer to the turbines than the fishing tows allowed, but this is speculative. Alternatively, the figures may be the result of natural fluctuations, or may represent a real response to wind farm construction activities. Future surveys should help to clarify the situation. Dab were found in slightly increased numbers and over a wider area than in 2001, with increased numbers more noticeably at the offshore sites. Numbers at the development area were similar overall to numbers in 2001 (i.e. not increased), so that the possibility of a slight effect at the disturbed sites from construction activities cannot be ruled out.

Only two elasmobranch species were recorded fom both surveys with Thornback rays being absent from the November 2003 surveys, although this is perhaps not surprising in view of the time of year, as they are thought to migrate offshore after the summer. Only three were caught in 2001, two of which were in and around the array area. Two dogfish were caught at one site in 2003 compared to five dogfish at three sites in August 2001, none of which were in the array area. It is not possible to draw firm conclusions from such small catches.

Of the other main fish species present in both surveys, none offer any suggestion of negative association with development activities. Dragonets *Callionymus lyra* were reduced markedly in number at almost all sites, but still occurred in the development area. Pogge *Agonus* *cataphractus* were almost absent from the development area on both occasions. Solenette *Buglossidium luteum* were present in much larger numbers in 2003 than in 2001, though more or less absent from the development area on both occasions. The increase was most noticeable in the sandier areas. Three species (scaldfish *Arnoglossus laterna*, lesser weever *Echiichtherus vipera* and sand goby *Pomatoschistus minutus*, which is a protected species under the Berne convention), were found at more sites and in larger numbers in November 2003 than in August 2001, and the increased numbers seem to have been at least as noticeable in and around the development site as further afield. The main exception was at the inshore site 14, which had the highest number of sand gobies, as well as considerable numbers of weevers in 2001, but none of either in 2003.

Finally, moderate numbers of the gadoids poor cod (*Trisopterus minutus*) and juvenile whiting (*Merlangius merlangus*) were found in 2003, although both of these species had been absent in 2001. The juvenile whiting were found in very small numbers (1 or 2 per site) except at the most offshore site, and their distribution appears to be largely unrelated to the development. They are in, any case; a highly mobile and small beam trawl surveys would not be expected to provide reliable estimates of numbers. Poor cod were less uniformly distributed and appeared to be in reduced numbers in the vicinity of the wind farm, although the possibility of their aggregation close to the turbines cannot be ruled out. Schools of gadoid-like fish were reported by divers working on the site to be present in large numbers within a few metres of many of the turbine bases, though from their descriptions it seemed these were more likely to have been the closely related bib (=pouting, *Trisopterus luscus*). Juvenile bib have been reported to associate closely with small artificial reefs during the day, probably in order to reduce their exposure to currents, foraging further afield at night (Fowler et al, 1999). Gadoids in general are well known to aggregate around man made structures in the marine environment such as artificial reefs and oil and gas platforms. Cod catches within 50-200m of offshore wind turbine bases at Svante (Sweden) were found to be similar to those at reference sites when the turbines were operating, but higher when the turbines were inactive (Westerberg, 1999).

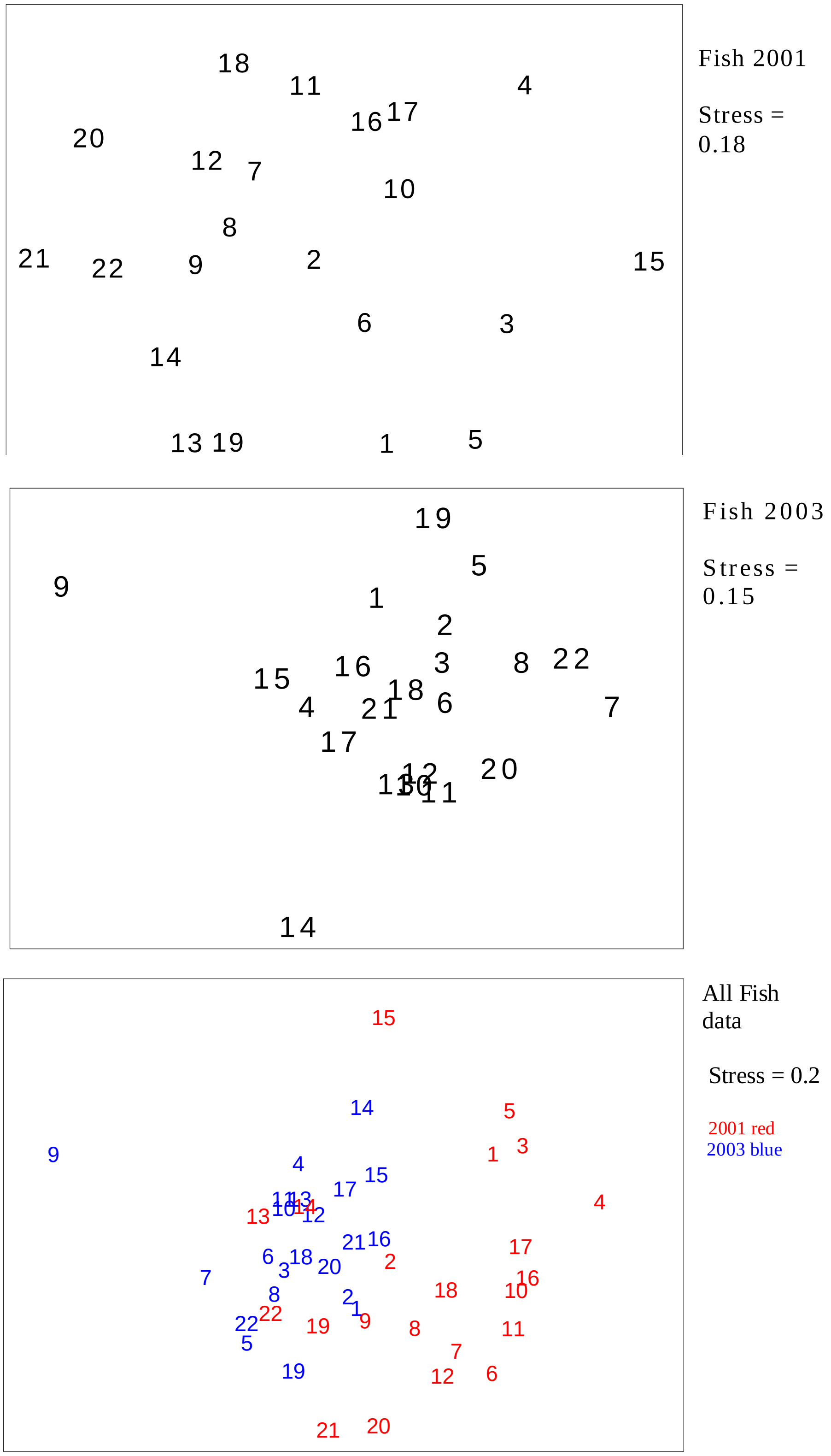


Figure 5.23 Multi dimensional scaling (MDS) plot summarising similarities of fish communities as found in the beam trawls. Top = 2001 data only, middle = 2003 data only, bottom = 2001 and 2003 data. Numbers represent the beam trawl sites as shown in Figure 4.2.

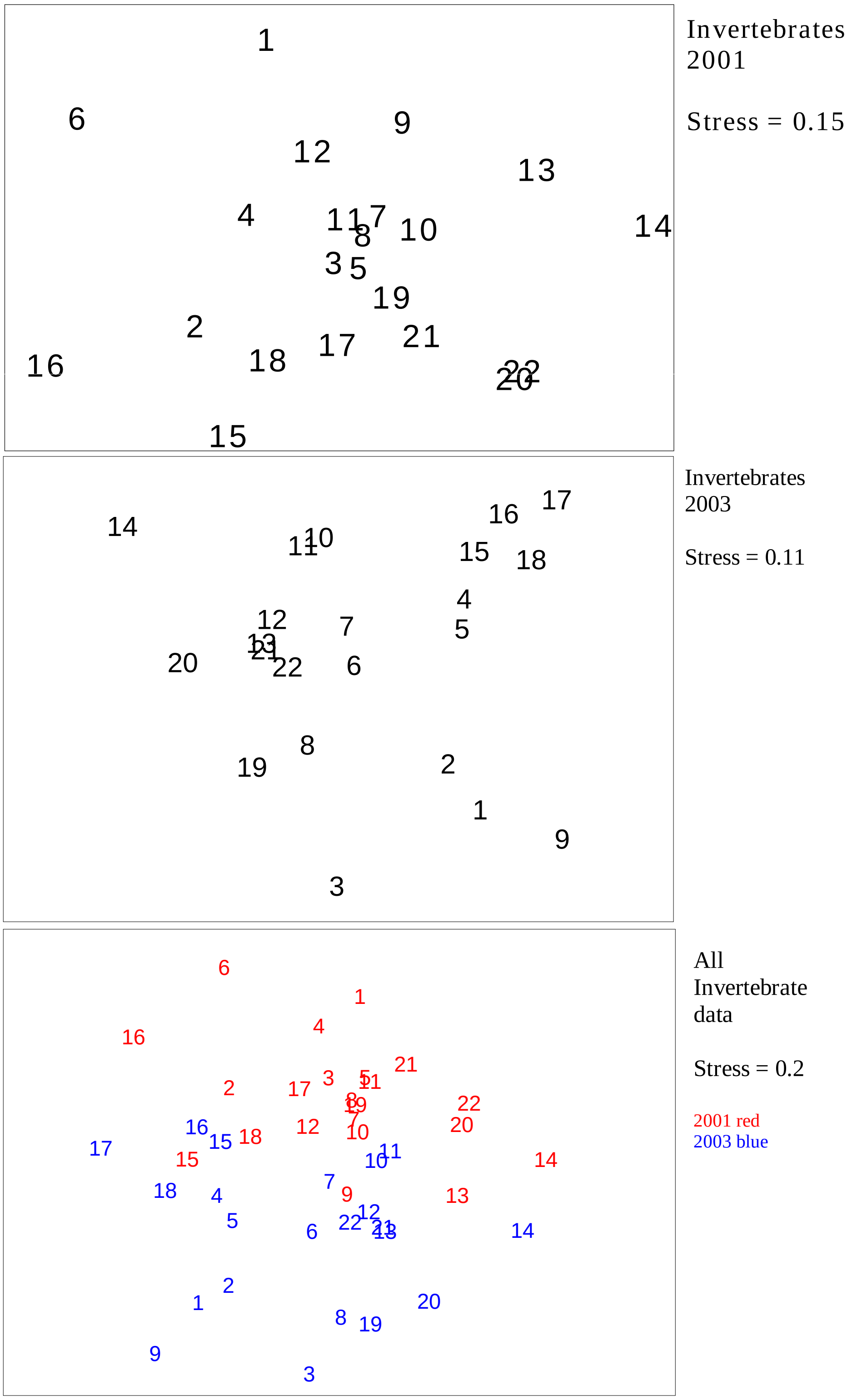
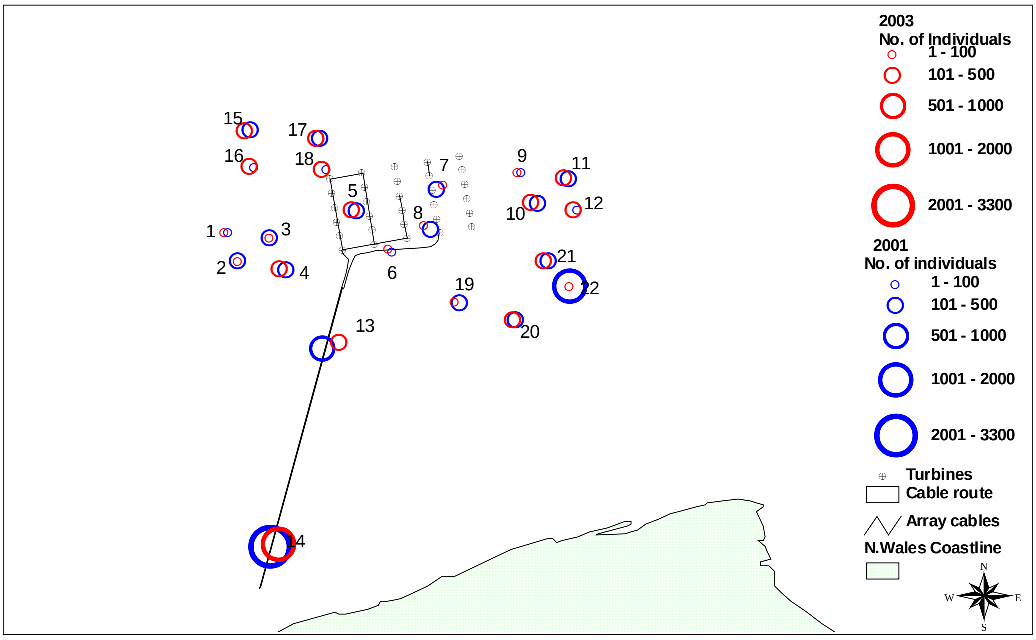


Figure 5.24 MDS plot displaying the similarities of invertebrate communities from beam trawl data.. Top = 2001, middle = 2003 , bottom = 2001 (red) and 2003 (blue) .



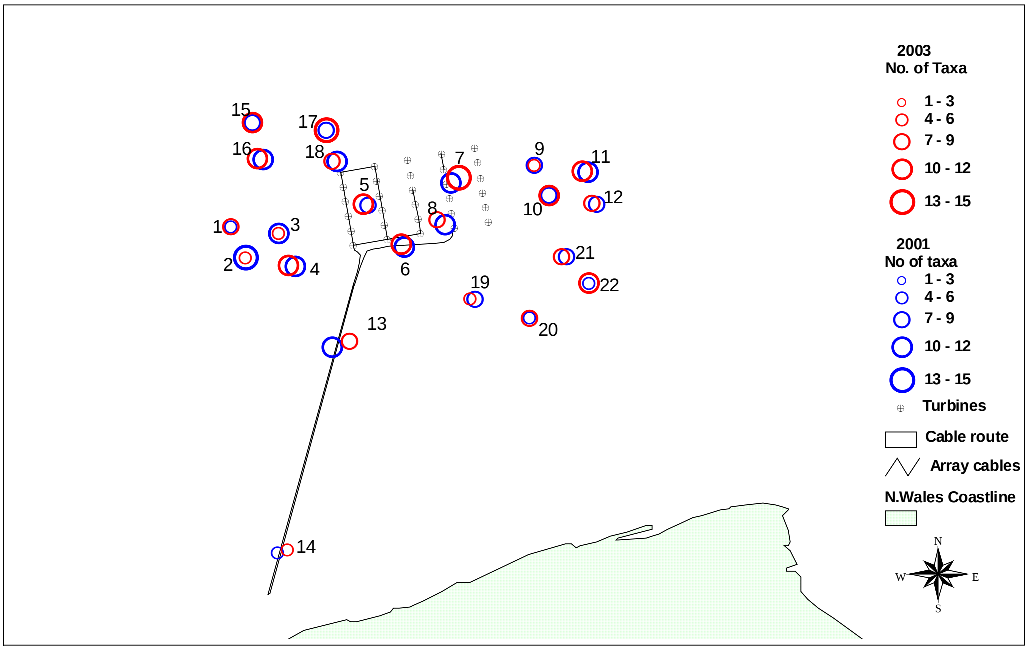


Figure 5.25 Distribution of epifauna by site for 2001 (blue) and 2003 (red) beam trawls as indicated by total number of individuals (top) and number of taxa (bottom).

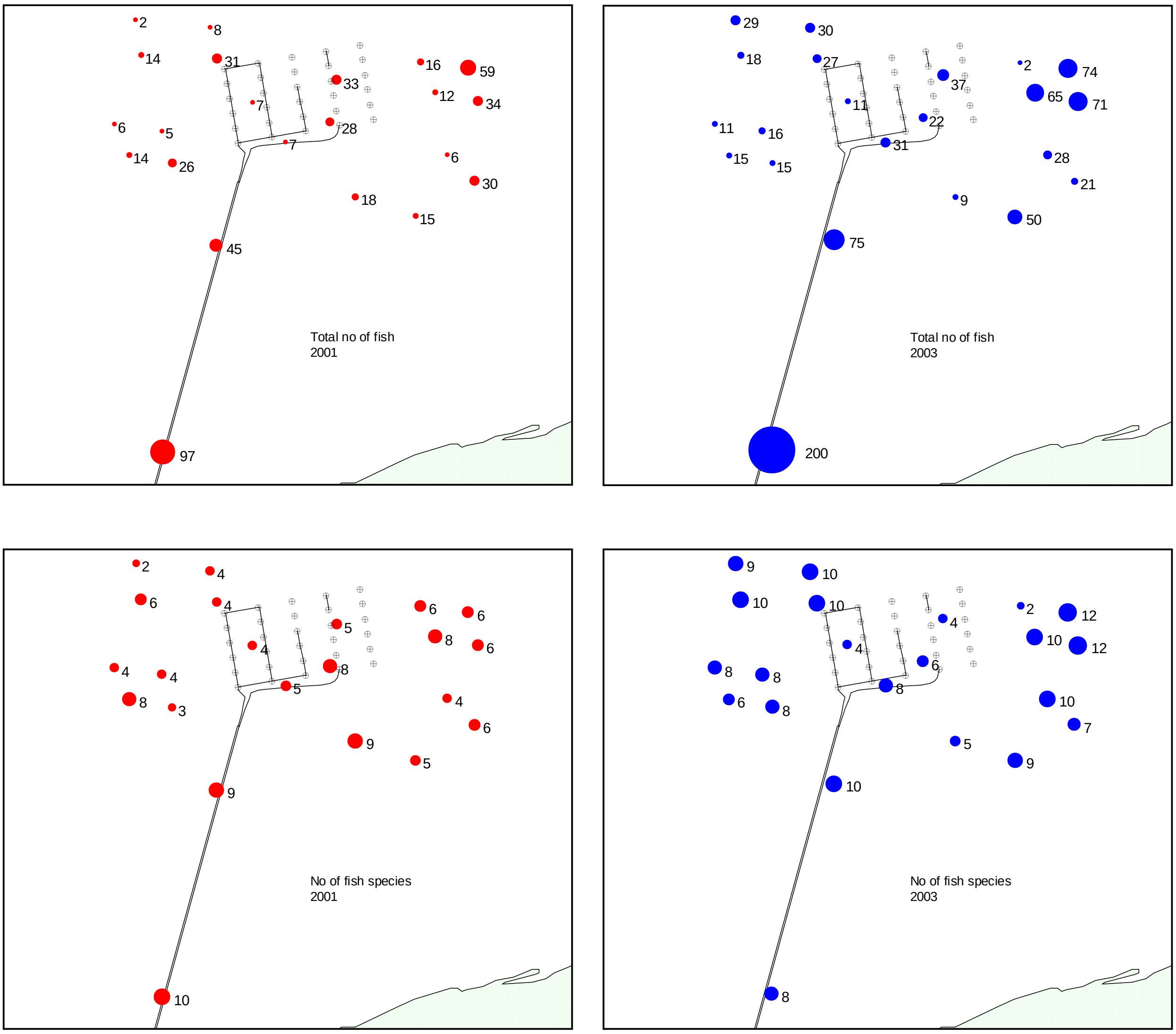


Figure 5.26 Distribution of fish by total no of fish caught, total no of species caught, and (following pages) by individual species. Note varying scales in these diagrams.

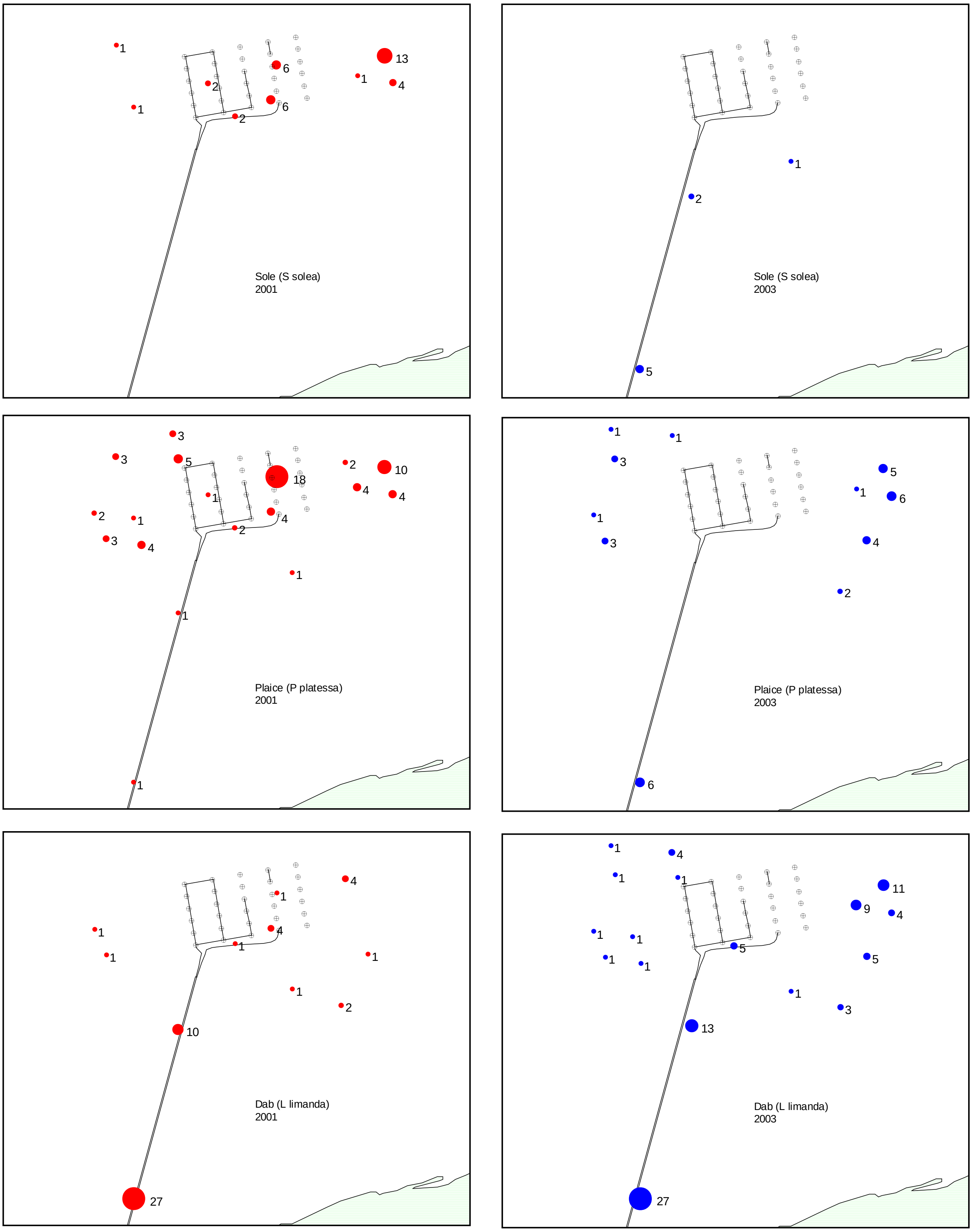


Figure 5.26 continued – the commercially exploitable flatfishes sole and plaice, plus dab which may be landed occasionally.

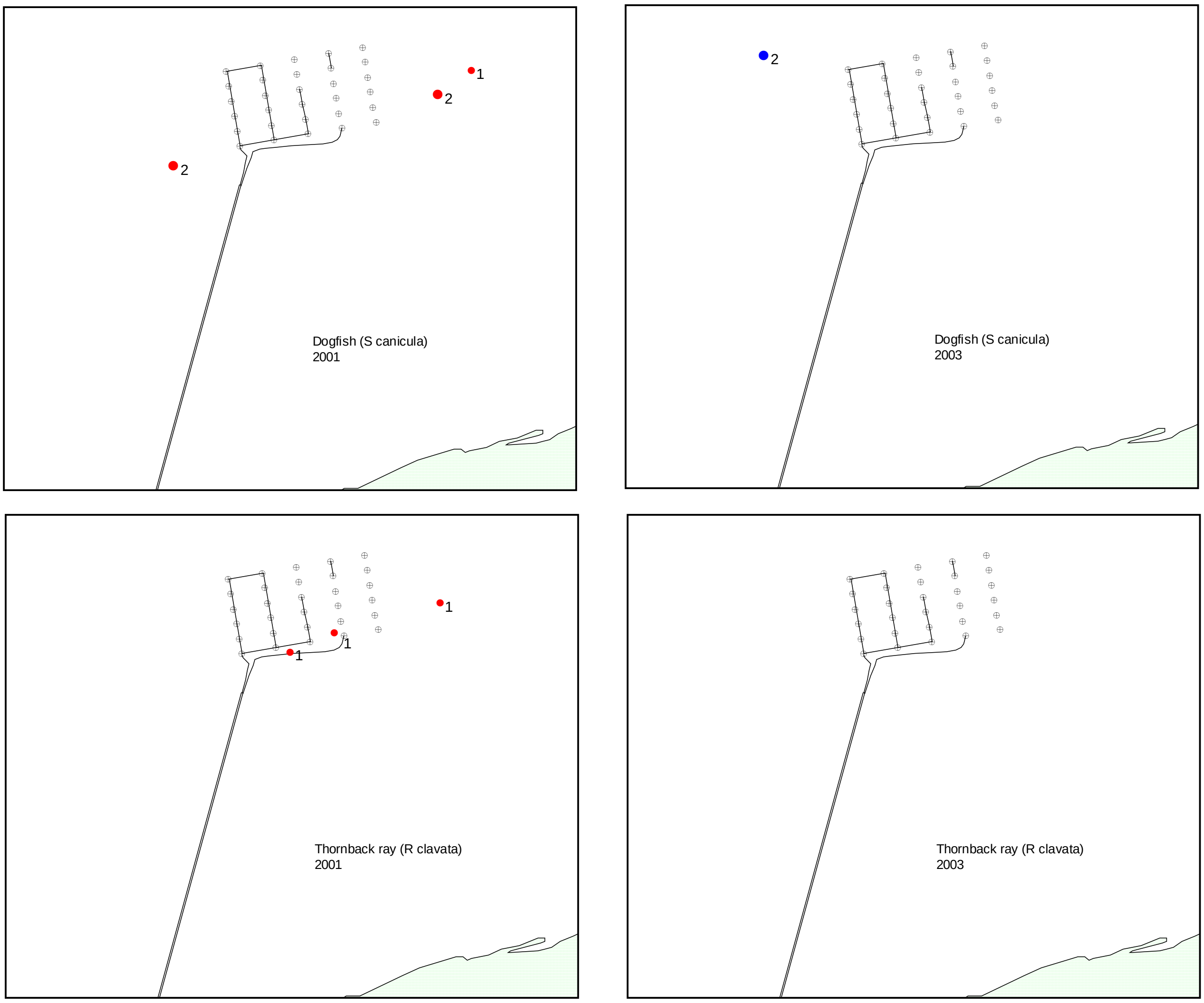


Figure 5.26 continued – elasmobranchs.

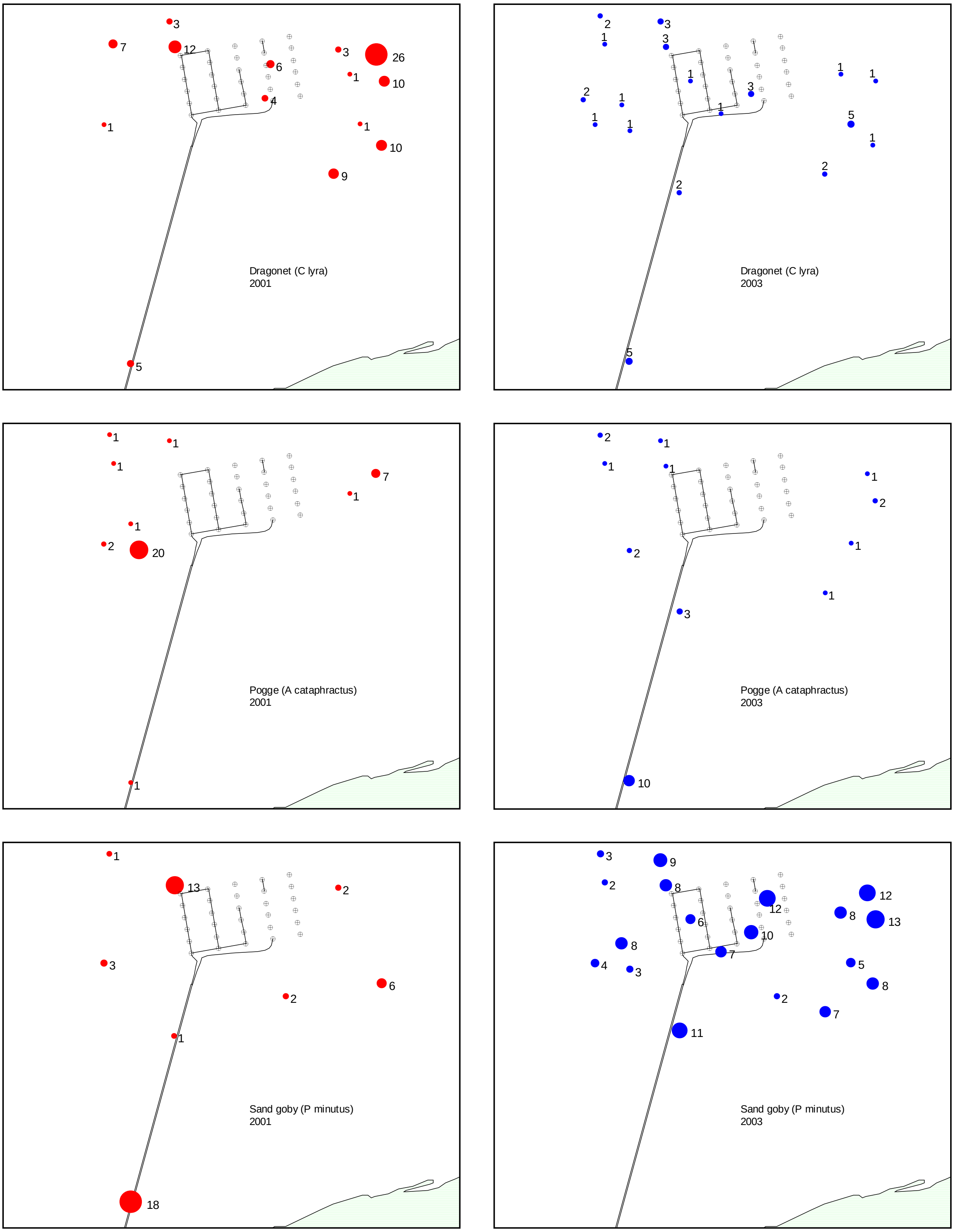


Figure 5.26 continued – common or ecologically important fish found in both surveys.

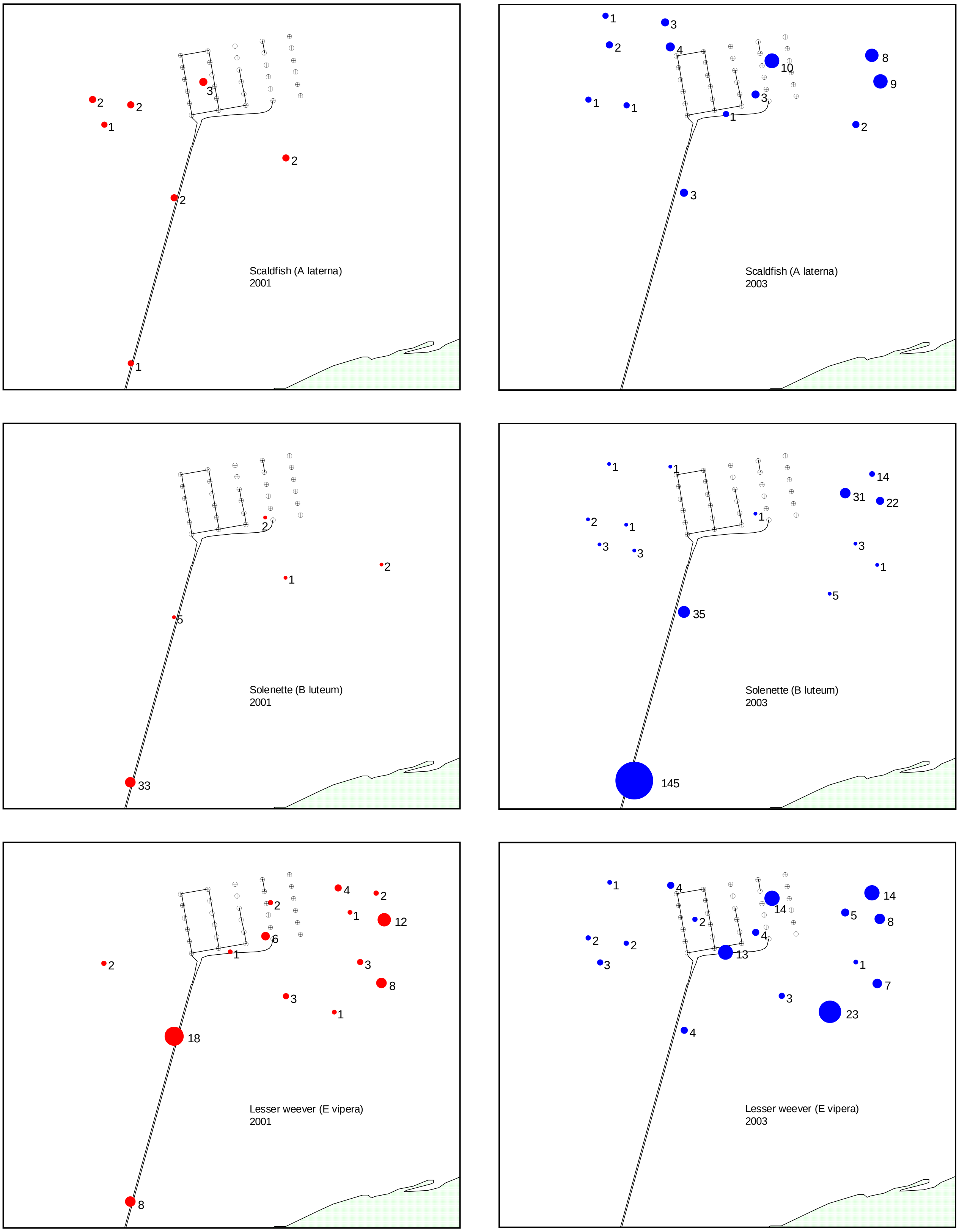


Figure 5.26 continued – common or ecologically important fish found in both surveys.

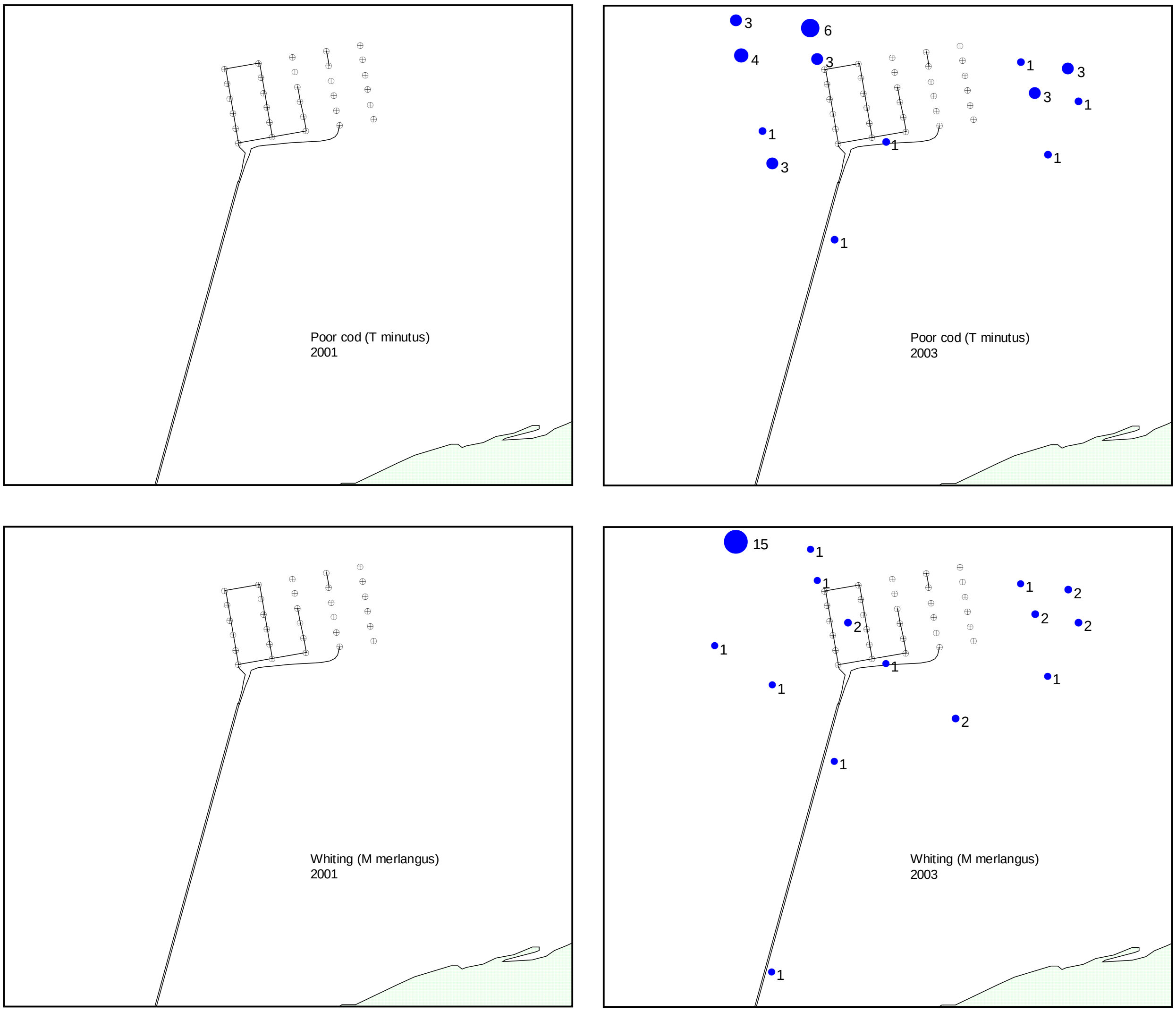


Figure 5.26 (continued) species not found during 2001 surveys (both are gadoids).

In summary, those sites likely to have been most affected by construction disturbance supported broadly similar numbers of invertebrate and fish species, and slightly increased numbers of fish, in November 2003 compared to August 2001. Numbers of invertebrates were reduced at sites 7 and 8, within the wind farm area, but this was due mainly to changes in the numbers of the common starfish *Asterias rubens*, a highly variable and often quite mobile species. Many of the sites further way from the development supported larger numbers of fish, and slightly more species, in November 2003 compared to August 2001, but this was not universal. The fish communities were somewhat different at 18 of the 24 sites in 2003 compared to 2001 but seasonal changes, changes between years (inter-annual variation) and simple random effects, as well as possible effects of the development could all contribute to these differences. There was no indication of any detrimental changes to invertebrate or fish communities in the vicinity of the cable route to Rhyl. It is probably unwise, given the short tows and relatively small scale of the surveys, and the fact that they were carried out at different times of year, to place too much emphasis on results for individual species, especially fish, but there is some suggestion of a reduction in abundance of a couple of fish species (most notably plaice) in the development area, while changes in numbers of the great majority of species, whether positive or negative, appear to be largely unrelated to their position relative to the development activities.

5.1.5 Summary and Conclusions

The summary findings here are all based upon the initial findings from surveys undertaken during the construction phase (March 2003 to March 2004) at North Hoyle. It is not possible to formulate any definite conclusions with regard to construction impacts until further monitoring has undertaken the results from this 2003 survey can then be then used in conjunction with results from the future-monitoring programme to ascertain any effects of wind farm development at North Hoyle.

5.1.5.1 Biota

Changes have been observed in the number of species and individuals with reductions noted at most sites, however, major species from 2001 and 2002 still dominate or remain common. Those species which were present during 2002 but absent in 2003 were only present in very low numbers in the baseline surveys. Communities therefore appear similar to those of the baseline. There appears to be no discernible pattern for this reduction in taxa and individuals, rather this has occurred at sites across the entire area including those within the wind farm and at distant control sites. Reasons for such changes are alterations in sediment characteristics at particular sites, chance and inter-annual variations at the population level. Summary findings are:

- Replicates clustered well together in 2003 indicating that there would have been little value in taking more than three replicates at each site.
- Major species present in 2002 still dominate or remain common in 2003 with those which were absent only being present in very low numbers in the 2002 survey.
- Although grab numbers are insufficient to identify definitive biotopes they are in agreement with the classifications made in 2001 and certainly do not give any reason to alter the biotope map as it currently stands.
- Overall a reduction in taxa and individuals was seen at most sites during 2003. There appears to be no uniform pattern for this reduction in taxa and individuals, rather this has occurred at sites across the entire area including those within the wind farm and at distant control sites

- Sites, which had experienced a large decrease in taxa and individuals in 2003, had experienced a change in substratum to one that would generally support a less diverse benthic community (e.g. site 4 altered from poorly sorted gravel in 2002 to medium sand in 2003 which will generally support a less diverse benthic community).

- Those sites which also experienced benthic population fluctuations but had similar sediment characteristics to previous surveys were, due to their locations away from wind farm construction activity, attributed either to chance or as a result of inter-annual variation. Many infauna can experience huge variations in numbers from one year to the next.

- Those sites both within the wind farm and its surrounding area, which had a similar benthic community composition in 2002, were still similar in 2003 indicating no impact. This includes sites within the construction area still clustering well together with control sites indicating that changes solely within the wind farm area have not been experienced

- Sites along the cable route in 2003 were still very similar to other inshore control sites indicating no impact.

- The Thumbnail crab *Thia scutellata* appeared to be present in reduced numbers in 2003, but this did not seem to be related to the wind farm construction.

5.1.5.2 Beam Trawls

Overall, there is no evidence of any major changes to invertebrate or fish numbers and distribution as a result of the installation and operational activities of the wind farm, though minor changes cannot be discounted. It is recommended that the results from this small study are not used in isolation, but in conjunction with the future monitoring programme which will take place following completion of the development. Summary findings are:

- Those sites likely to have been most affected by construction disturbance supported broadly similar numbers of invertebrate and fish species, and slightly increased numbers of fish, in November 2003 compared to August 2001.

- Numbers of invertebrates were reduced at some sites within the wind farm but this was attributed to highly variable and mobile species.

- Fish communities were different at most sites in 2003 compared with 2001. Attributed to seasonal changes, inter-annual variation and simple random effects, as well as possible effects of the development.

- Although not universal, many of the sites further way from the development supported larger numbers and more species of fish 2003 compared with 2001.

- There was no indication of any detrimental changes to invertebrate or fish communities in the vicinity of the cable route to Rhyl.

This section has presented the findings from the construction phase survey of 2003. The North Hoyle environmental statement stated that: “Overall only minor, and localised impacts would arise during construction. These are not significant in terms of impacts on the benthic community types present”. After the initial consideration of these results it is probable that this statement is correct, however, it is not possible to formulate any definite conclusions with regard to such impacts from construction until further monitoring has been completed over the course of the next few monitoring phases.

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5.2 COLONISATION OF MONOPILES AND ANY SCOUR PROTECTION

5.2.1 Background

CMACS has undertaken a report titled “Biology & Video Surveys of North Hoyle Wind Turbines. 11th to 13th August 2004” on behalf of npower renewables Ltd (NRL). The following salient points and conclusions of the report are given.

The document reports an investigation into the marine colonisation of the North Hoyle monopile foundations 1 year after installation and also of the more recently constructed met mast monopile (installed February 2004).

In all cases the turbines were operating at the time of the visits, although not all were necessarily generating. At the time, wind speeds were generally low and power generation was intermittent.

This survey was carried out as a requirement of the FEPA licence associated with the North Hoyle wind farm. Although some rock protection had been placed at the time of the survey, it was clearly too early to evaluate the effects of colonisation on the scour protection rock. The full report is provided in Appendix 5.8.

5.2.2 Methods

Descriptive information was obtained from two wind turbines (WTG 5 and 30) and the met mast using standard Phase 2 methodology (semi-quantitative).

A further four turbines (WTG 7, 9, 21, 23) were surveyed briefly for comparison and to determine the zonation of communities.

Digital underwater video was taken of all structures studied.

A series of 0.01 m^2 quadrats were scraped clear of attached organisms in each zone (where practicable) on two turbines and the met mast. The samples were then weighed in order to obtain a rough estimate of biomass (wet weight).

Small invertebrate worms and crustaceans were picked out from the cleared quadrat samples and preserved for later laboratory determination.

5.2.3 Results

59 species of animal and 4 plants were identified from the monopile structures. A characteristic vertical zonation of communities was found to occur up and down these artificial structures. Up to 9 biota zones were identified, although not all zones were experienced at all survey sites.

The species colonising the wind farm structure were all common species found on nearby hard substrata and have most likely been recruited from nearby locations.

Although there was some variation between the turbines, the dominant species included the barnacle *Balanus crenatus*, the amphipod *Jassa falcata* and the mussel *Mytilus edulis*. The common starfish *Asterias rubens* and the sea anemones *Metridium senile, Sagartia elegans* and *Sagartia troglodytes* were also conspicuous.

Based on the data obtained, it was calculated that the turbines would each have born around 1000 - 1300kg of attached marine life. The met mast having been in place for only six months bore just under 300 kg.

The most common member of the macro biota encountered on the structures studied was the barnacle *Balanus crenatus*. This was a dominant species both on the wind turbines and the recently installed Met Mast.

Commercially fished species encountered included the whiting *Merlangius merlangu*s and the edible crab *Cancer pagurus* as well as mussels.

The most dramatic observation made was of large shoals of juvenile whiting *Merlangius merlangus*. These were present around all the underwater structures studied and appeared to be feeding on the amphipod *Jassa falcata*.

At the base of WTG 30 a single specimen of the cod *Gadus morhua* was found swimming amongst the whiting, and the plaice *Pleuronectes platessa* was recorded at low abundance from the adjacent seabed, this record probably representing a single specimen.

The mixed substrata encountered at the base of the monopiles were generally pretty scoured and barren apart from the occasional barnacle or tube worm. The richest colonisation of seabed substrata was found around the Met Mast where cobbles bore scattered clumps of hydroids and encrusting bryozoa.

5.2.4 Discussion

Very large numbers of the amphipod *Jassa falcata* were present on the surface of the barnacles. This species builds tubes from collected silt and then feeds on matter suspended in the water column. The turbid waters off North Hoyle and the tide swept wind farm structures provide an ideal habitat for *J. falcata*. This species is well known as a 'fouling organism' due to its habitat of occurring in large numbers.

It is almost certain that the communities present in August 2004 will change over time. Exactly how the communities might develop is unclear and it is not certain that there will be a succession to a stable 'climax community'. In the case of the North Hoyle turbines, it is anticipated that the piles will be scraped periodically in order to reduce pile loading and hydrodynamic drag.

The divers were aware of noises associated with the operation of the turbines. However, there was no obvious indication that the whiting (or other fish) were affected by the noise.

Mussels were abundant on all the structures studied apart from the Met Mast. From a commercial point of view it is probable that North Hoyle wind farm is too exposed a location for successful cultivation of mussels for commercial purposes as they are likely to get torn off during storms once they reach a large size However, there may be potential to harvest the small mussels for seed to be relayed in more sheltered locations.

The importance of the monopile structures as artificial reefs and their significance as fish refugia, species nursery or feeding areas cannot be established from this study. CMACS have been requested to provide recommendations to NR as to how this could be ascertained or predicted for the benefit of future projects.

Monopiles will need to be physically scraped of encrusting organisms periodically as a necessary operational procedure to reduce hydrodynamic drag and minimise the additional weight exerted on the monopile structure. Development of encrusting communities will therefore be controlled when required. The procedure for undertaking this activity is currently incorporated into Operation and Maintenance procedures. Clearly the balance between the environmental benefit of encouraging encrustation of organisms needs to be carefully assessed against the operational need to restrict encrustation at defined frequencies throughout the life of the wind farm.

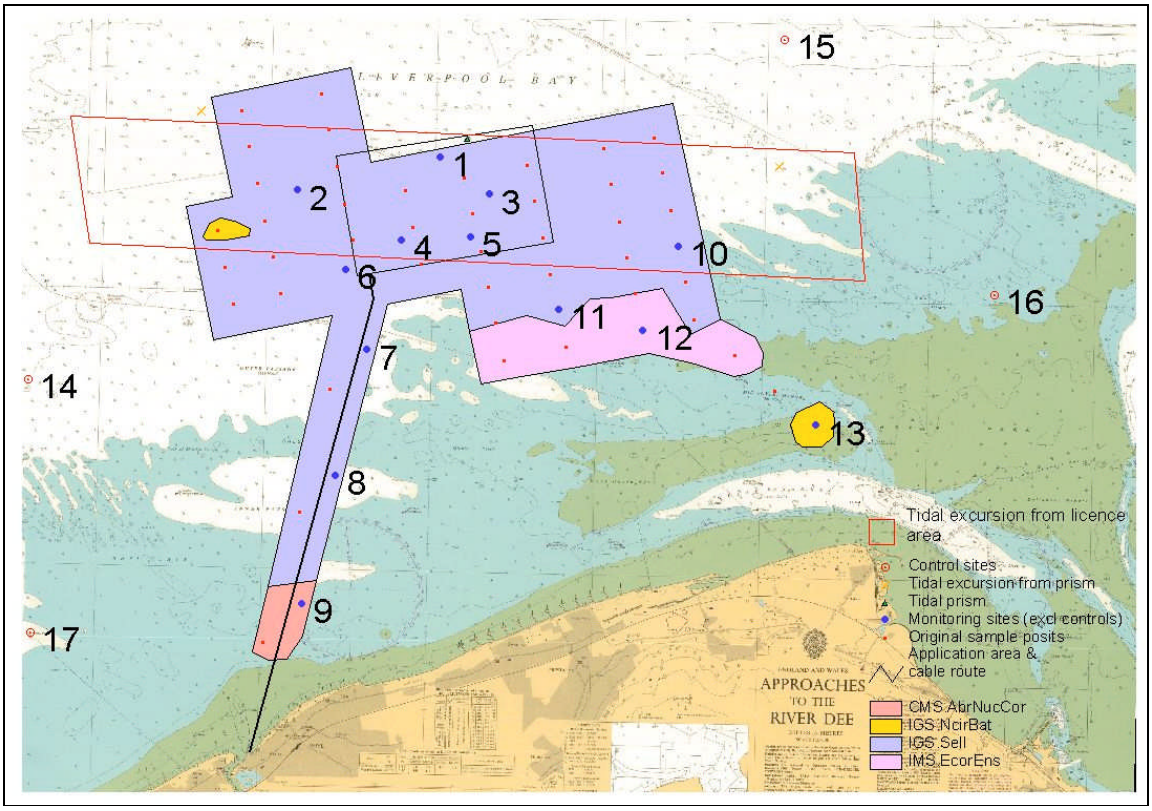

Figure 5.27 Location of September 2002 benthic monitoring points overlaying biotopes identified from September 2001 survey

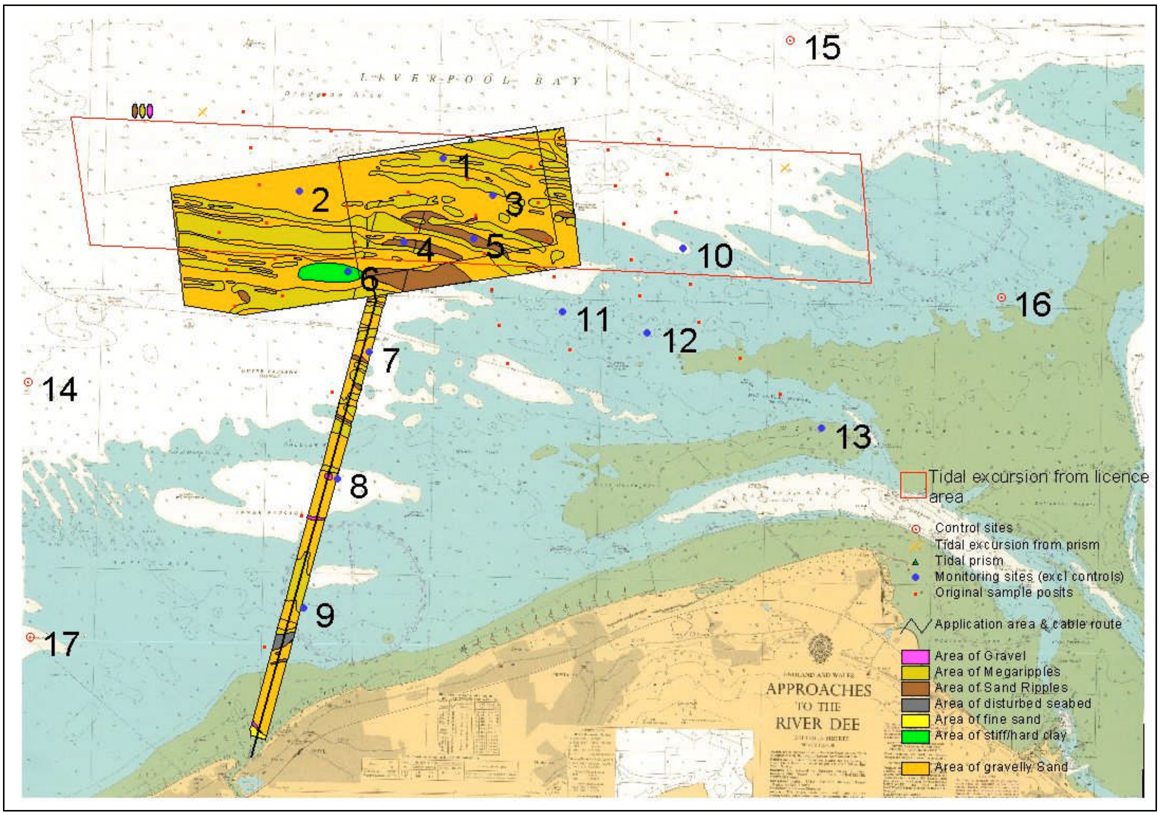

Figure 5.28 Location of September 2002 benthic monitoring points overlaying September 2001 geophysical survey results