CENTRE FOR ECOLOGY AND HYDROLOGY
(NATURAL ENVIRONMENT RESEARCH COUNCIL)

Project C03421

A Black and Veatch / NERC Contract on behalf of Essex and Suffolk Water

NATIONAL ENVIRONMENT PROGRAMME: MONITORING OF THE DENVER LICENCE. THE 2007-2008 SURVEYS OF INTER-TIDAL SEDIMENTS, INVERTEBRATES AND BIRDS OF THE S E WASH.

Mick YATES*, Ed RISPIN**, Angus GARBUTT***, Tony TURK*, Paul BELLAMY*, & Nigel BROWN*.

* CEH, Monks Wood
** GT Environmental, Winfrith Technology Centre, Dorset
*** CEH, Bangor

Monks Wood,
Abbots Ripton,
HUNTINGDON,
PE28 2LS

April 2008

CONTENTS

EXECUTIVE SUMMARY

1. The work reported here forms part of a study whose purpose is to monitor and evaluate the impact on the inter-tidal sediments, invertebrates and the shorebirds that eat them, of variations in the flow of freshwater into the south-east corner of the Wash via the river Great Ouse. This report deals with the results of sediment, invertebrate and shorebird surveys of the inter-tidal areas of the Wash adjacent to the outfall of the river Great Ouse made during autumn and winter of 2007-2008 (September -January). Comparisons are made with the results of 2006-2007 surveys, with particular consideration being given to how any changes were related to the distance from the river's outfall.

2. Sediment and invertebrate samples were taken from 42 sites during late September and October 2007. Bird surveys were undertaken during the period late-November 2007 to late January 2008. These surveys followed a 12 month period (September 2006 to August 2007) during which freshwater flow into the Wash from the Gt Ouse of 1290.9 Mm^3 was higher than the long-term average of 1005 Mm^3 for the period 1974 to 2006.

Changes in sediment particle size and organic content between the 2006 and 2007 surveys

3. Of the 42 sites sampled, 28 were muddy and 14 were sandy. With the exception of two sandy sites all sites located on the shore to the west of the Gt Ouse were muddy. Most sites (13 out of 22 sites) on the shore to the east of the river were also muddy. The exceptions were mid-to low- level sites of transects 18, 19 and 20 which were sandy. On the outer banks three sites were muddy and three were sandy.

4. Overall there was very little change in the sediment type of sites within the study area between the 2006 and 2007 surveys. Of the 42 sites there were 28 muddy sites in 2007 compared to 30 in 2006. The difference was due to three sites changing from mud to sand in 2007 (sites 17.7, 17.8 on the west shore and E.8 on east shore) and one site changing from sand to mud (19.3 on the east shore). Most sites became sandier with just nine sites, all located either on the east shore or the outer banks, being recorded as muddier.

5. There was also a statistically significant positive relationship between the change in fine sediment at a site and its distance from the high tide outfall point indicating that sites became sandier the nearer they were to the outfall.

6. After the effect of changes in the proportion of fines in the sediment was taken into account, the sediment's organic content over the whole of the study area in 2007 differed significantly from that in 2006 due to sandier sites being more organically rich in 2007 than they were in the previous year. The organic content of the muddier sites was unchanged.

7. Within six of the 10 individual sampling transects, the sediment organic content did not differ significantly between 2006 and 2007. In the remaining four, sediments in transects 19 and the muddier sites of D were organically richer in 2007, while the muddier sites in transects 20 and P were less organically rich in 2007 than they were in 2006.

8. During the course of the study sediments were muddiest in 2000 and sandiest in 1998 in both the inner bank areas and the entire area. Sediments in the current survey were the second sandiest after 1998 in both areas. Sediment organic content was highest in 2005 and lowest in 1999 in both areas. In the current survey the organic content was the third highest out of the 13 surveys of the inner banks and third highest of the 11 surveys of the entire study area.

Changes in invertebrate densities between the 2006 and 2007 surveys

9. Of the 74 invertebrate families or species and species size categories that were sufficiently abundant to allow statistical comparisons to be made, the densities of 15 of them changed significantly over the whole study area between the 2006 and 2007 surveys.

10. Of the worms, five increased in density while that of two other species decreased in 2007 compared with 2006.

11. Of the crustaceans, small (<3mm) and large (3+mm) *Corophium volutator* increased in density in 2007 compared with 2006.

12. The density of four molluscs increased significantly in 2007 compared with 2006 densities while two others decreased in density.

13. There was some evidence of the spatial changes in invertebrate densities being associated with the distance from the Gt Ouse outfall after changes in sediment particle size and organic content between the two years and shore level had been taken into account. Increased densities of both juvenile and adult densities of ragworms, *Hediste* were significantly and negatively related to distance from the high water outfall of the river. That is to say their density increased most in sites nearer to that outfall than in sites located farther away. In contrast, decreases in densities of Capitellid worms were greatest in sites near to the low water outfall than in those farther away. Increases in the densities of the crustacean *Corophium* were greater in sites nearer the low water outfall of the river while the decreases in density of small cockles, *Cerastoderma*, were greater in sites farther away from that outfall.

14. The inner banks of the study area have now been surveyed each year for a total of thirteen years and the changes in the densities of the main invertebrate classes, worms, crustacean, gastropod molluscs (snails) and bivalve molluscs are summarised. Worm densities were at their lowest in 1996 and with the exception of 1998, increased annually until 2003 but have declined since then to a point where the 2006 density was almost as low as that in 1996. In the current survey the density increased to near average density for the study period. Crustacean density was lowest in 1996 and again in 2000 since when it has increased annually to the highest density recorded in 2003. It dropped to near average density in 2004, and remained close to level until the current year where it has increased to above average density. There had been a general upward trend in snail densities between 1996 and 2001 but they dropped in 2002 since when they rose annually to the highest density ever recorded in the study area in the 2005 survey. However, densities have dropped in the last two surveys. Bivalve mollusc density was at its highest in 2000 when there was a large spatfall of many species, notably cockle and *Macoma*. Since then their densities have remained relatively low

with the 2007 density a little below the average for the period of the study.

Changes in bird numbers between the 2006-2007 and 2007-2008 surveys

15. As in previous winters, the number and distribution of seven species of wading birds and the shelduck feeding at low tide in the study area was surveyed on two occasions between late November 2007 and late January 2008.

16. Dunlin, knot, bar-tailed godwit, curlew and shelduck were less abundant in 2007-08 than they were in the previous winters' survey, while redshank grey plover and oystercatcher were more abundant.

17. A feature of the birds' distribution in 2007-08 was that most species were widespread across the study area. Previously dunlin, redshank, and curlew were the most widespread with the remaining species being more aggregated in certain areas. But in the current survey knot, grey plover, bar-tailed godwit, oystercatcher and shelduck were more widely spread than they had been in previous winters.

18. There was no evidence of any relationship between the change in bird distribution since the previous survey and distance from the Gt Ouse outfall for any species.

19. Change in shorebird numbers within the study area between the current winters' survey and the previous winter was compared with that recorded in the whole Wash to determine whether changes were local or Wash-wide. Relative to the winter of 2006-07, the numbers of all species except redshank, grey plover and oystercatcher decreased in the study area in winter 2007-08. In the case of dunlin, knot and shelduck, this decrease was of a similar proportion to that for the whole Wash implying that changes were Wash-wide. In the cases of bar-tailed godwit and curlew the proportional decrease was more pronounced in the study area than in the whole Wash implying that the study area was a much less preferred feeding area for these species in winter 2006-07. In contrast, the increases in redshank, grey plover and oystercatcher numbers in the study area were not matched by those for the whole Wash implying that the study area was a preferred feeding site for those species.

20. The numbers of shorebirds feeding on the inner banks of the Gt Ouse study area at low tide have been surveyed for a total of 16 winters to date and were summarised to put into perspective the changes that have occurred during the course of this study. Dunlin, bar-tailed godwit, curlew and shelduck numbers were all below the average for the study period in 2007 while those of redshank, knot, grey plover and oystercatcher were around or a little above the average.

1. INTRODUCTION

The work reported here forms part of a study whose purpose is to monitor and evaluate the impact on the inter-tidal sediments, invertebrates and the shorebirds that eat them, of variations in the flow of freshwater into the south-east corner of the Wash via the river Great Ouse.

1.1 Objectives

Our study has the following objectives.

i) To monitor the particle size and organic content of sediments, the densities of invertebrates and the numbers of shorebirds feeding on the inter-tidal area adjacent to the Great Ouse outfall by annual surveys.

ii) To relate changes detected by the monitoring surveys to the distance from the outfall and to variations in river flow.

1.2 Reporting strategy

This report, like those produced annually since 1996-97, deals with objective i) and addresses year on year changes in distribution of sediments, invertebrates and birds and how these changes relate to the distance of the areas concerned from the Gt Ouse outfall. The underlying assumption being that any impact of variations in freshwater flow is most likely to be evident in those areas closest to the river outfall. Objective ii) is ongoing and was reviewed in Yates *et al* 2004.

1.3 River flow conditions prior to the 2006-2007 surveys

River flows in the Gt Ouse during the 12 months (September 2006 to August 2007) preceding the 2007-2008 surveys resulted in a discharge volume into the Wash of 1290.9 million cubic metres (Mm^3) which was approximately 842 Mm^3 more than was discharged prior to the previous years' survey. The average for the same 12-month period from 1974 to 2006 was 1005 Mm^3, therefore, the current survey followed a period of higher than average river flow. Indeed it was the 3rd highest recorded over the period of this study (behind flows preceding the 2001 and 2003 surveys).

2. SURVEY AND SAMPLING METHODS

Full descriptions of the survey and sampling methods used in this study were given in Volume 2 of our report of the 1996-97 surveys (Yates *et al* 1998) so only a summary is given here. Readers requiring details are referred to that report, copies of which are held by Black and Veatch, or to the author. Details of specific statistical analyses used are presented in the relevant parts of the Results and Discussion section.

2.1 Survey areas and sample sites

Sediment and invertebrate samples are taken from sites, 1 ha in area, arranged in 10 transect lines orientated from upper to lower levels of the shore within the Gt Ouse study area (Figure 2.1)

Forty-two of the 45 sites that had been sampled since 1997 were again sampled in 2007. The exceptions were site 2 of transect 19 which was abandoned in 2002 because of encroaching salt-marsh vegetation and site 2 in transects 17 and B which were abandoned in 2003 for the same reason.

At each site, samples of sediment were taken to a depth of 2.5cm from five, randomly selected locations and placed in sealed plastic bags. These samples were frozen as soon as possible after collection. In addition five samples of substrate were taken using two 10cm diameter by 30cm deep cores and the invertebrates were sieved from them on site using a 0.5mm mesh sieve. These invertebrate samples were placed in plastic pots and fixed in 4% buffered formaldehyde solution made up with sea-water.

Shorebird surveys were made over the inter-tidal areas shown in Figure 3.3.1. The distribution and number of feeding shorebirds was determined by walking an area, following a route that minimised disturbance, and observing the birds through a telescope.

Sediment and invertebrate sampling was undertaken during spring tides during late September and early October 2007. Two shorebird surveys were undertaken during the period late-November 2007 to late January 2008. Each survey was conducted at the same time of year as previous surveys to allow them to be directly compared.

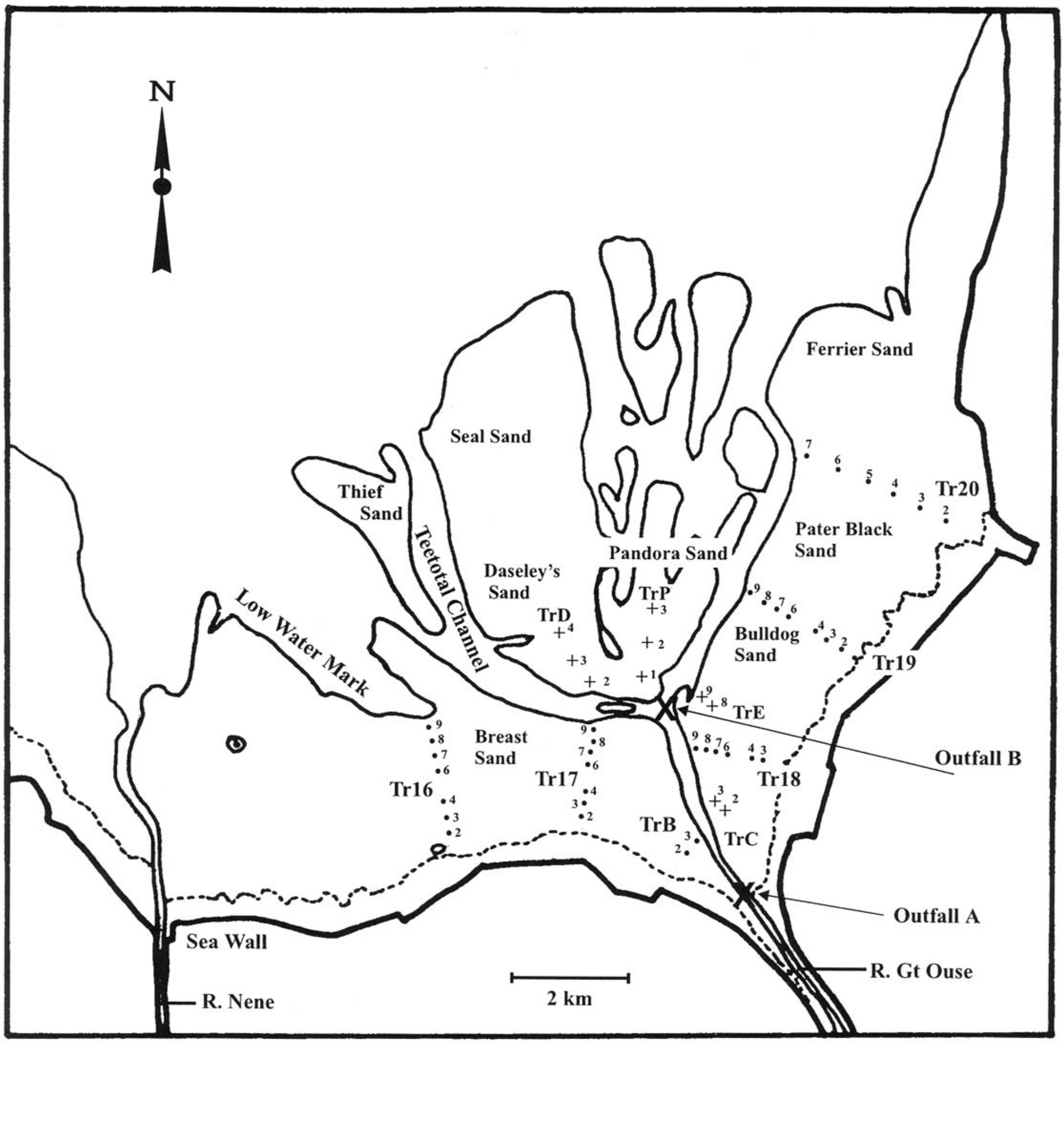
Section 2

Figure Legends

Figure 2.1 The ITE (now CEH) sediment and invertebrate sample sites. Sites that have been sampled each year since 1996 are shown as solid circles. Additional sites on Bulldog, Daseley's and Pandora Sands that were first established and sampled in 1997 and sampled thereafter are shown as crosses. *Note that sites 2 in transects 19 and in transects 17and B were abandoned in 2002 and 2003 respectively, because of encroaching salt-marsh vegetation.

Figure 2.1 The sediment and invertebrate sample sites. Sites that have been sampled each year since 1996 are shown as solid circles. Additional sites on Bulldog, Daseley's and Pandora Sands that were first established and sampled in 1997 and sampled thereafter are shown as crosses. *Note that sites 2 in transect 19 and in transects 17and B were abandoned in 2002 and 2003 respectively, because of encroaching salt-marsh vegetation.

Fig 2.1 CEH Sediment and Invertebrate Sampling Sites



3. RESULTS AND DISCUSSION OF THE 2007-2008 SURVEYS

3.1 Sediments

The sediments' particle size distribution has been summarised using the proportion of the particles less than 63 microns (<63μm) in diameter as in the reports of our previous surveys. This fraction contains silts and clays, and is collectively termed 'fines'. The fraction greater than 63 microns (>63μm) is called 'sands'. We have found this summary statistic, rather than mean or median particle size, to be the most useful for understanding the influence of particle size on the sediments' organic content and on the invertebrate fauna. Using this convention we defined muddy sediments as those in which the proportion of fines exceeds 25% as opposed to sandy sediments in which the fine fraction was 25% or less.

3.1.1 Sediment distribution in 2007

Figure 3.1.1 shows the spatial distribution of muddy and sandy sites within the study area in 2007. Of the 42 sites sampled, 28 were muddy and 14 were sandy. With the exception of two sandy sites, all sites located on the shore to the west of the Gt Ouse were muddy. Most sites (13 out of 22 sites) on the shore to the east of the river were also muddy. The exceptions were mid-to low- level sites of transects 18, 19 and 20 which were sandy. On the outer banks three were muddy and the remaining three were sandy.

3.1.2 Changes in sediment particle size between 2006 and 2007

There were changes in the sediment type of sites within the study area between the 2006 and 2007 surveys. Of the 42 sites, 28 were muddy in 2007 compared to 30 in 2006 (Figures 3.1.1 and 3.1.2). The difference was due to three sites changing from mud to sand in 2007 (sites 17.7, 17.8 on the west shore and E.8 on east shore) and one site changing from sand to mud (19.3 on the east shore). Overall most sites became sandier with just nine sites, all located either on the east shore or the outer banks, being recorded as muddier.

The amount by which the proportion of fines in the sediment changed between the two surveys is shown for each site within a sampling transect in Figures 3.1.3a-j. Because the same 1 hectare blocks are sampled in each survey, we were able to determine the statistical significance of annual changes by performing one-way ANOVA on the mean of the five random samples taken at each site. All sites in transect 16 were muddy in both years, but in 2007 all sites except sites 8 and 9 had become significantly sandier than in 2006 (Figure 3.1.3a). This was also the case in transect 17, where all sites except site 9 were significantly sandier than they were in 2006 (Figure 3.1.3b). The single remaining site in transect B was less muddy in 2007 than it was in 2006 (Figures 3.1.3c). Transect C sites remained muddy in 2007 but both sites became significantly sandier compared to 2006 (Figure 3.1.3d). All sites, except site 9 in transect 18 were sandier in 2007 with sites 4 and 8 becoming significantly so (Figure 3.1.3e). Both sites in transect E became sandier in 2007 with site 8 changing from being classed as sand to mud and site 9, though still classed as mud, becoming significantly sandier (Figure 3.1.3f). In transect 19, sites 3, 8 and 9 became significantly muddier in 2007 than in the previous year (Figure 3.1.3g). Sites 2 and 4 in Transect 20 were significantly muddier in 2007 than they were in 2006 though site 4 was still classed as sand (Figure 3.1.3h). Sediment on Daseley's Sand (Figure 3.1.3i) became muddier at site D2 and D4 the change at the latter site being significant in 2006 while in contrast site D became significantly sandier. On Pandora Sand site 1 and 3 became significantly sandier in 2007, while site 2 though classed as sandy, became significantly muddier (Figure 3.1.3j).

Figure 3.1.4 shows the changes in the proportion of fines in the sediment between 2006 and 2007 at each sample site in relation to its distance from two points labelled A and B in Figure 2.1. We defined these points respectively as the high tide and low tide outfalls of the river Gt Ouse. There was a statistically significant positive relationship between sediment change at a site and distance from the high tide outfall point (Figure 3.1.4a) indicating that sample sites became sandier the nearer they were to the outfall. In contrast, there was no relationship between sediment change and distance from the low tide outfall.

3.1.3 Organic content in 2007

Sediment organic content, as determined by loss on ignition (LOI), is positively related to the proportion of fines in the sediment; that is, muddy sediments have a higher organic content than sandy ones. This relationship was curvilinear and was apparent in the sediments from the 2007 survey (Figure 3.1.5) as it had been in all previous surveys.

Having taken this relationship into account, the issue most relevant to this study was whether there was any pattern in the sediment's organic content in relation to its distance from the outfall of the Gt Ouse. For example, it might be anticipated that if river inputs were the major source of organics then, at times of low flows, those transects nearer the river would have a higher organic content. Conversely, after periods of high flow the influence of organic inputs might be more widely spread. This was explored statistically using regression analysis. First, the %LOI was transformed into logarithms to the base *e* ($\log_e$) to linearise the curvilinear relationship with the proportion of fine sediment and normalise the variation around it. Plots were then made between the residual variation in sediment organic content remaining after the influence of sediment particle size was removed and the distance of transects from the Gt Ouse outfall (Figure 3.1.6a and b). Any indication of a trend was explored by regression analysis. However, there was no statistically significant evidence of the sediment organic content of transects being related to their distance from either the high water or low water outfall of the river.

3.1.4 Changes in sediment organic content between 2006 and 2007

Comparisons in the sediment organic content between years were made after first using $\log_e$ transformation of the %LOI data to both linearise and normalise the relationship with the proportion of fine particles. Whether a transect's organic content differed between years was tested for by taking into account both the influence of fine sediment and the location of the sample site on the shore. Site location was included as it was possible that for a given proportion of fine sediment, upper shore sites might have a different organic content than those sites at lower shore levels because of the presence of more algae, diatoms and detritus in the sediment. The statistical procedure was, therefore, to test whether the response or dependent variable, $\log_e$%LOI, varied between years by including the proportion of fines in the sediment as a covariate with site location and the year as factors, in an analysis of variance. The general linear model (GLM) procedure in the MINITAB statistical software package was used.

The sediment's organic content over the whole of the study area in 2007 differed significantly from that in 2006 (Figure 3.1.7). This difference was due to sandier sites being more organically rich in 2007 than they were in the previous year while the organic content of the muddier sites was unchanged.

Differences in sediment organic content within individual transects between the current and previous survey are shown Figure 3.1.8a-j. Within six of the 10 individual sampling transects, the sediment organic content did not differ significantly between 2006 and 2007 (Figures 3.1.8a, b, c, d, e and f). In the remaining four, all sites in transects 19 (Figure 3.1.8g) and the muddier sites of D (Figure 3.1.8i) were organically richer in 2007, while the muddier sites in transects 20 (Figure 3.1.8h) and P (Figure 3.1.8j) were less organically rich in 2007 than they were in 2006.

3.1.5 Annual changes in sediments and organic content.

Figures 3.1.9 and 3.1.10 illustrate the changes that have occurred in sediments and their organic content during the course of the whole study to help put the current survey data into a study-long perspective.

Two datasets were available. The first spanned the years 1986 and 1996 to the present and related to the inner banks of the Gt Ouse study area. The second spanned the period 1997 to the present and related to the entire Gt Ouse study area, that is both inner bank and outer bank areas.

Sediment was muddiest in 2000 and sandiest in 1998 in both the inner banks alone (Figure 3.1.9a) and the entire area (Figure 3.1.9b), Sediments in the current survey were the second sandiest after 1998 in both areas. Having statistically taking into account the influence of changes in the proportion of fine sediment, the sediment organic content was highest in 2005 and lowest in 1999 in both areas. In the current survey the organic content was the third highest out of the 13 surveys of the inner banks and third highest of the 11 surveys of the entire study area (Figure 3.1.10a and b).

3.1.6 Summary and conclusions

Of the 42 sites sampled, 28 were muddy and 14 were sandy. With the exception of two sandy sites, all sites located on the shore to the west of the Gt Ouse were muddy. Most sites (13 out of 22 sites) on the shore to the east of the river were also muddy. The exceptions were mid-to low- level sites of transects 18, 19 and 20 which were sandy. On the outer banks three were muddy and the remaining three were sandy.

Overall there was very little change in the sediment type of sites within the study area between the 2006 and 2007 surveys. Of the 42 sites there were 28 muddy sites in 2007 compared to 30 in 2006. The difference was due to three sites changing from mud to sand in

2007 (sites 17.7, 17.8 on the west shore and E.8 on east shore) and one site changing from sand to mud (19.3 on the east shore). Overall most sites became sandier with just nine sites, all located either on the east shore or the outer banks, being recorded as muddier.

There was also a statistically significant positive relationship between the change in fine sediment at a site and its distance from the high tide outfall point indicating that sites became sandier the nearer they were to the outfall.

After the effect of changes in the proportion of fines in the sediment was taken into account, the sediment's organic content over the whole of the study area in 2007 differed significantly from that in 2006 due to sandier sites being more organically rich in 2007 than they were in the previous year. The organic content of the muddier sites was unchanged.

Within six of the 10 individual sampling transects the sediment organic content did not differ significantly between 2006 and 2007. In the remaining four, sediments in transects 19 and the muddier sites of D were organically richer in 2007, while the muddier sites in transects 20 and P were less organically rich in 2007 than they were in 2006.

During the course of the study sediments were muddiest in 2000 and sandiest in 1998 on both the inner bank areas and the entire area. Sediments in the current survey were the second sandiest after 1998 in both areas. Sediment organic content was highest in 2005 and lowest in 1999 in both areas. In the current survey the organic content was the third highest out of the 13 surveys of the inner banks and third highest of the 11 surveys of the entire study area.

Section 3.1
Figure legends

Figures 3.1.1 and 2.

Map of sediment type at our sample sites in 2007 (Fig 3.1.1) and 2006 (Figure 3.1.2) as determined by ground survey. Shaded symbols indicate the site was sandy (<25% fine sediment), closed symbols indicate the site was mud (>25% fine sediment).

Figure 3.1.3 a-j

The percentage of fine sediment (particles <63 microns) that occurred in 2006 and 2007 within each transect. **a,** transect 16, **b,** transect 17, **c,** transect B, **d,** transect C, **e,** transect 18, **f**, transect E, **g**, transect 19, **h**, transect 20, **i,** transect D and **j**, transect P. Statistically significant differences in the percentage of fine sediment between years are shown as asterisks above the relevant sample block as follows:- *$p<0.05$, ** $p<0.01$ and *** $p<0.001$.

Figure 3.1.4a and b

Changes in the percentage of fine sediment (particles<63 microns) that occurred between 2006 and 2007 in relation to the distance of the sample site from **a**, the Gt Ouse high tide outfall and **b**, low tide outfall (points A and B in Figure 2.1). The horizontal dotted line indicates zero change and in **a**, the solid line indicates the fitted relationship between the change in fine sediment and distance from the Gt Ouse high tide outfall. Each data point relates to a sample site and its symbol indicates in which transect it occurred as shown in the legend box.

Figure 3.1.5 The average sediment organic content, expressed as the average %Loss On Ignition, in relation to fine sediment (particles <63 microns) in each transect in 2007.

Figure 3.1.6 The residual variation in sediment organic content (Log_e %LOI), after the influence of particle size has been statistically accounted for, in relation to the sample transects' distance from the Gt Ouse outfall in 2007. Each label identifies the transect to which each data point relates.

Figure 3.1.7 The relationship between sediment organic content (log_e % Loss On Ignition) and the percentage of fine sediment (% of particles <63 microns) in 2006 and 2007 for the whole Gt Ouse study area. The fitted regression lines relating sediment organic content (log_e % Loss On Ignition) to the percentage of fine sediment (% of particles <63 microns) in 2006 (solid line) and 2007 (dashed line) had significantly different intercepts and slopes.

Figure 3.1.8a-j

The relationship between sediment organic content (log_e % Loss On Ignition) and the percentage of fine sediment (% of particles <63 microns) in each transect in 2006 and 2007. The fitted regression lines (solid line for 2006 and

dashed line for 2007) are shown where there was a significant difference between years.
a, transect 16, **b,** transect 17, **c,** transect B, **d,** transect C, **e,** transect 18, **f**, transect E, **g**, transect 19, **h**, transect 20 **i**, transect D and **j,** transect P.

Figure 3.1.9a and b

Annual changes in the mean percentage of fine sediment on **a**, the inner banks alone from 1986 and 1996-2007 and **b**, on the entire Gt Ouse study area from 1997-2007.

Figure 3.1.10a and b.

Annual changes in the mean organic content of sediment (%LOI) on **a**, the inner banks alone from 1986 and 1996-2007 and **b**, on the entire Gt Ouse study area from 1997-2007. The organic content has been adjusted to take into account variation in the % of fine sediment in each year.

Figures 3.1.1 and 2. Map of sediment type at our sample sites in 2007 (Fig 3.1.1) and 2006 (Figure 3.1.2) as determined by ground survey. Shaded symbols indicate the site was sandy (<25% fine sediment), black symbols indicate the site was mud (25+% fine sediment).

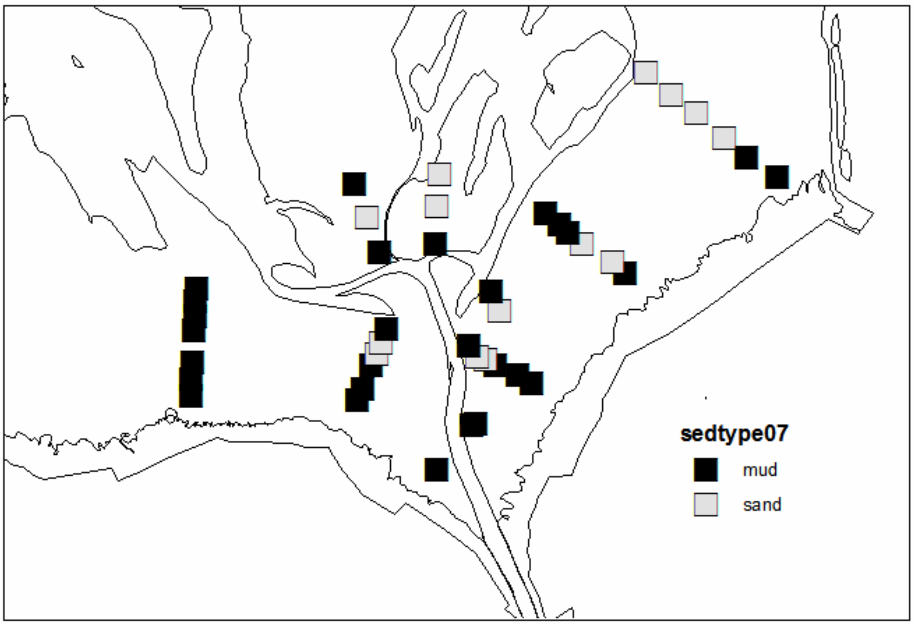


Figure 3.1.1 Sediment type in 2007 (above) and Figure 3.1.2 in 2006 (below)

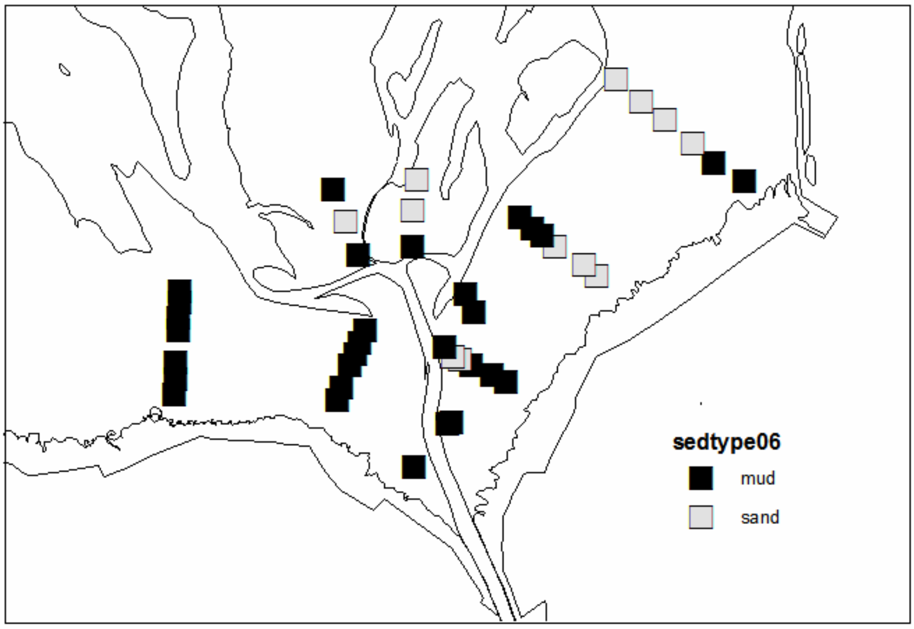
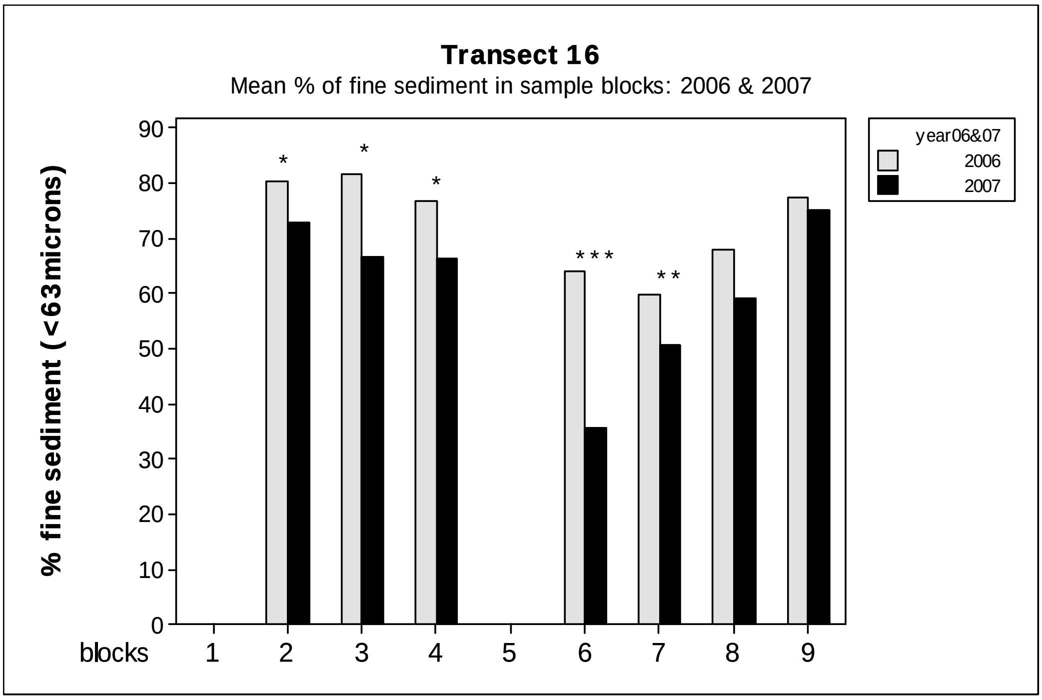


Figure 3.1.3 a-j. The percentage of fine sediment (particles <63 microns) that occurred in 2006 and 2007 within each transect. **a,** transect 16, **b,** transect 17, **c,** transect B, **d,** transect C, **e,** transect 18, **f**, transect E, **g**, transect 19, **h**, transect 20, **i,** transect D and **j**, transect P. Statistically significant differences in the percentage of fine sediment between years are shown as asterisks above the relevant sample block as follows:- *$p<0.05$, ** $p<0.01$ and *** $p<0.001$.

a,



b,

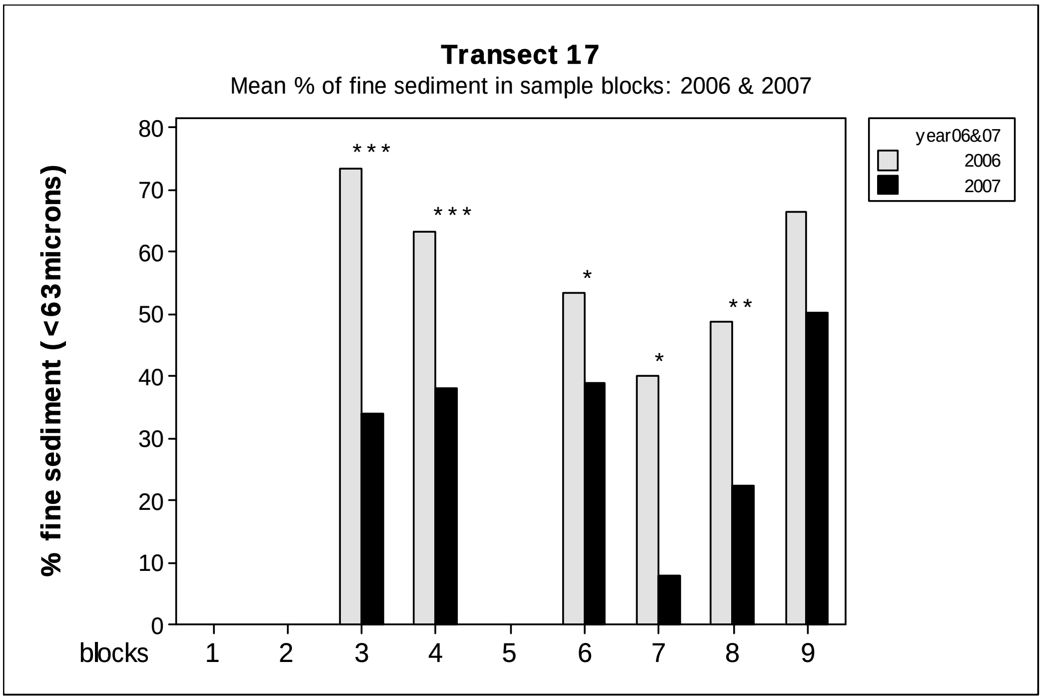
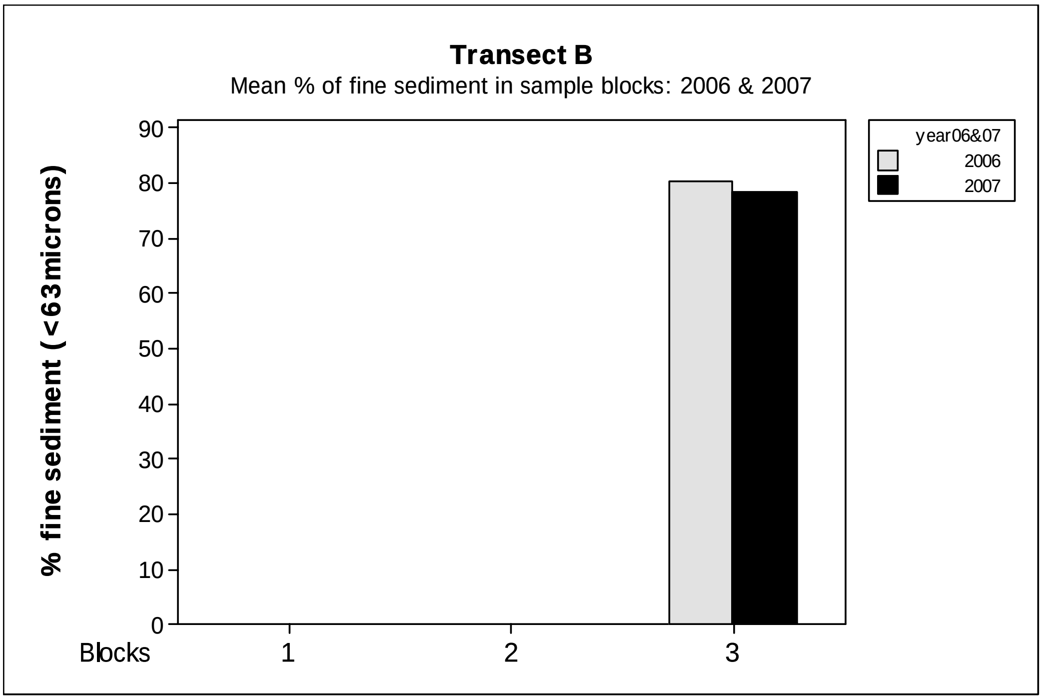


Figure 3.1.3 a-j. continued

c,



d,

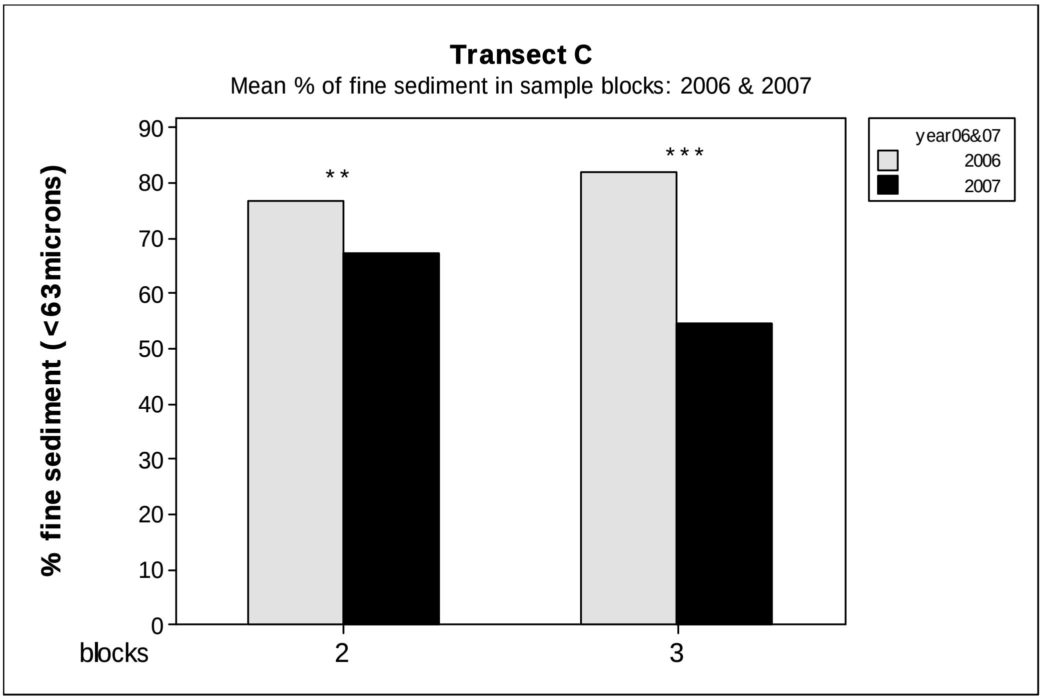
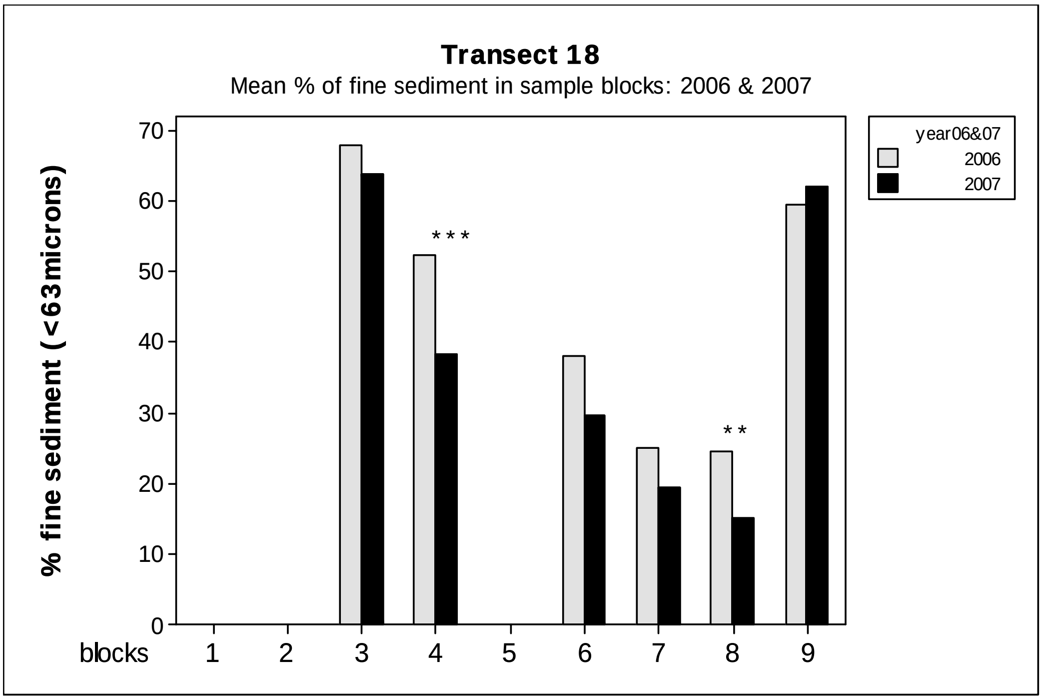


Figure 3.1.3 a-j. continued

e,



f,

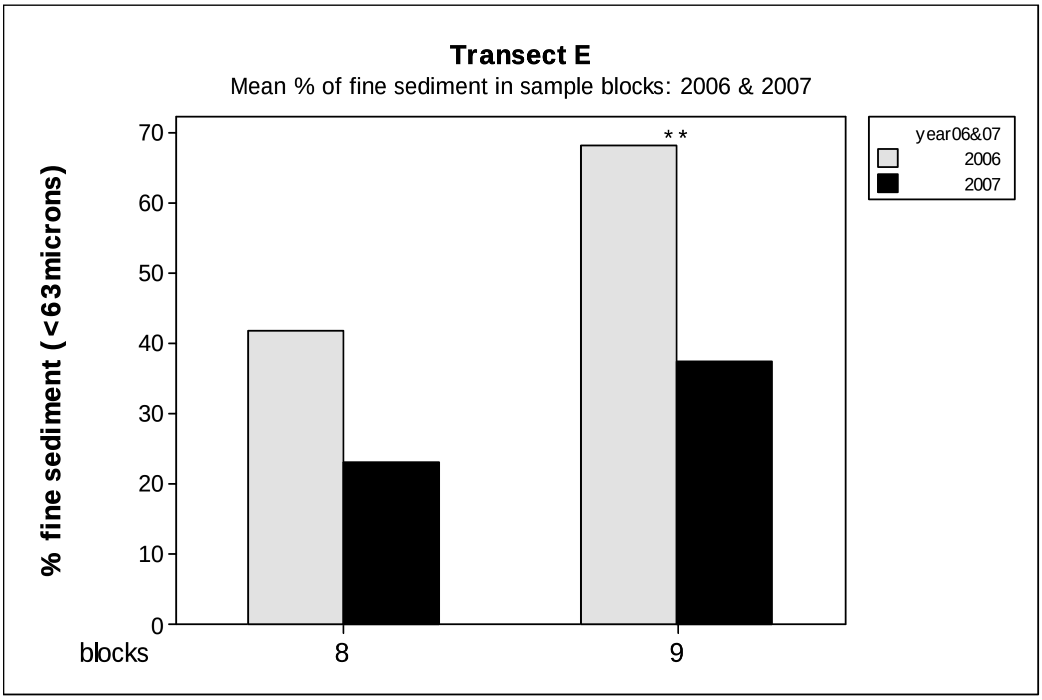
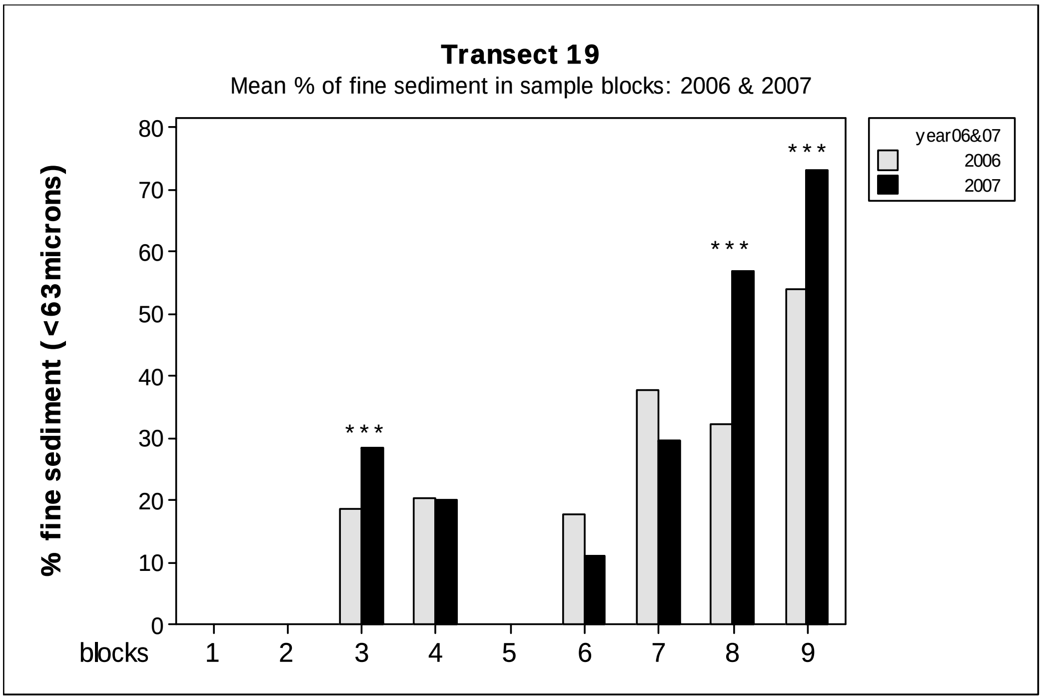


Figure 3.1.3 a-j. continued

g,



h,

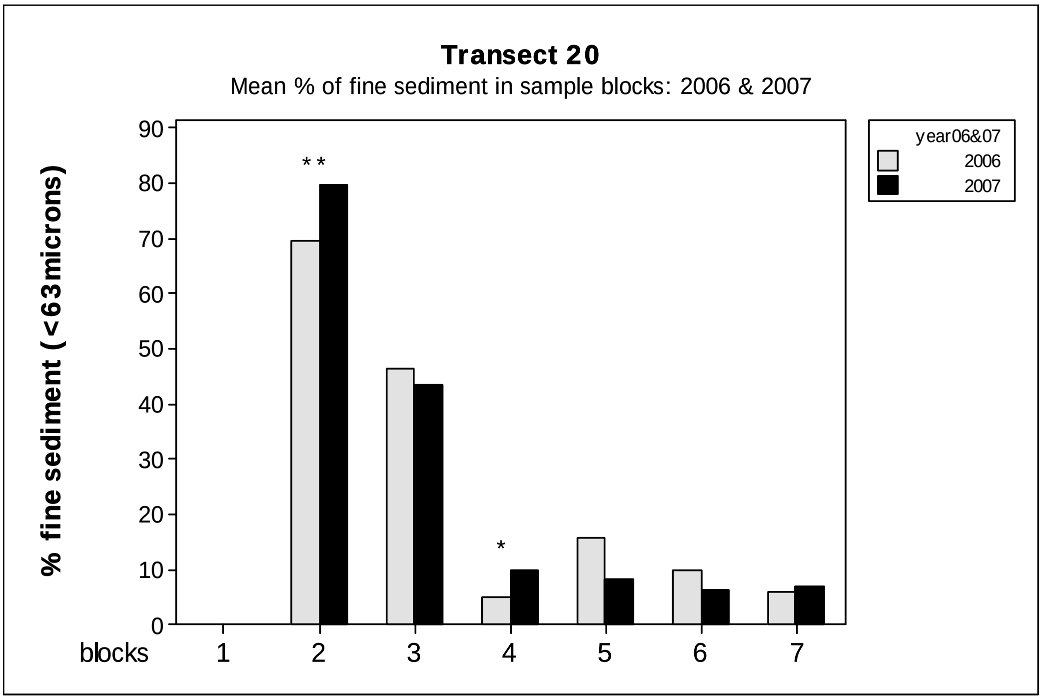
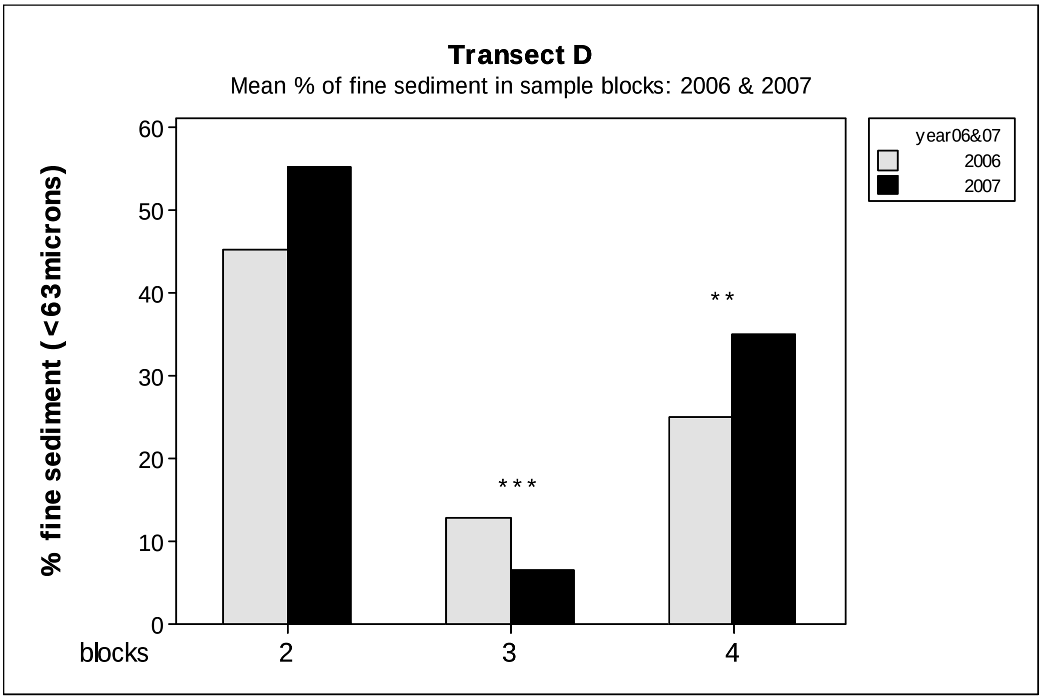


Figure 3.1.3 a-j. continued

i,



j,

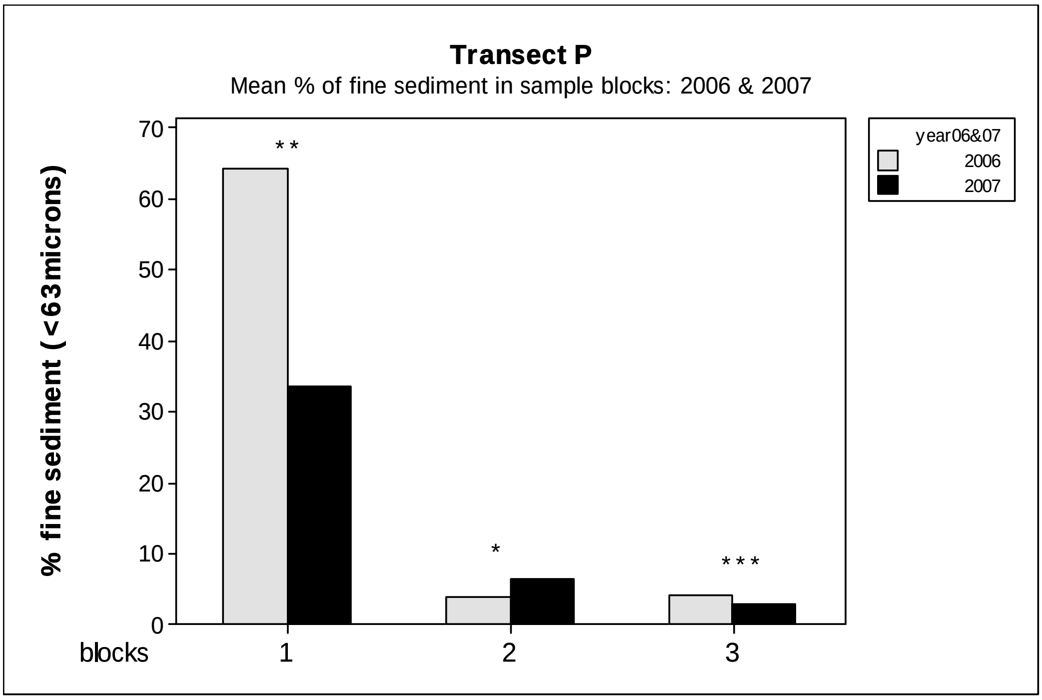
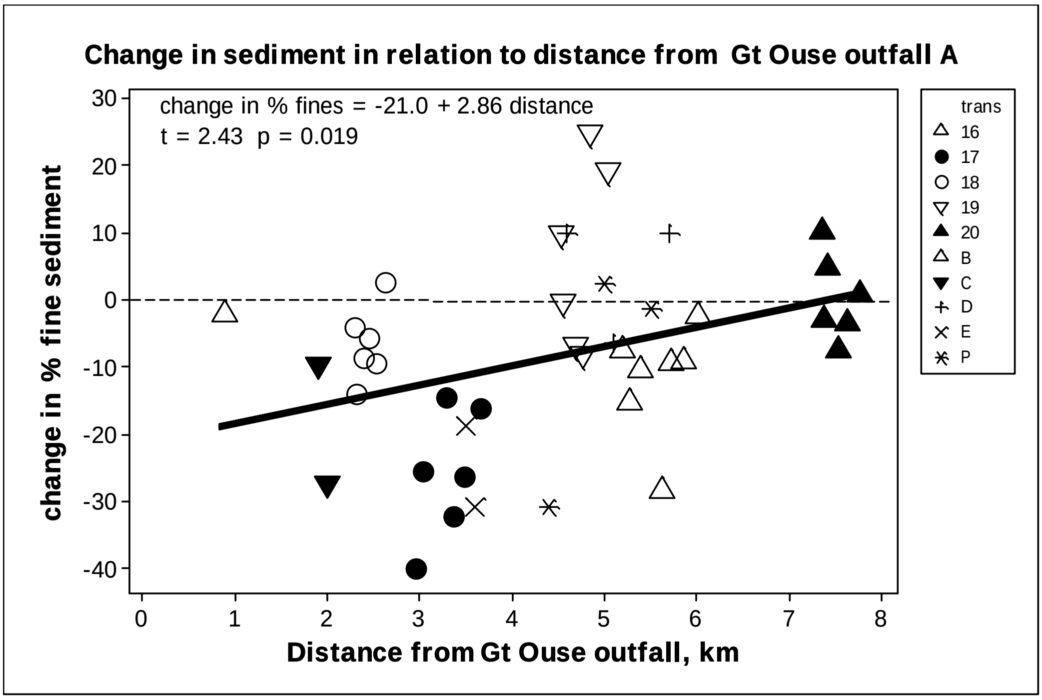


Figure 3.1.4a and b Changes in the percentage of fine sediment (particles<63 microns) that occurred between 2006 and 2007 in relation to the distance of the sample site from a, the Gt Ouse high tide outfall and b, low tide outfall (points A and B in Figure 2.1). The horizontal dotted line indicates zero change and in a, the solid line indicates the fitted relationship between the change in fine sediment and distance from the Gt Ouse high tide outfall. Each data point relates to a sample site and its symbol indicates in which transect it occurred as shown in the legend box.

a,



b,

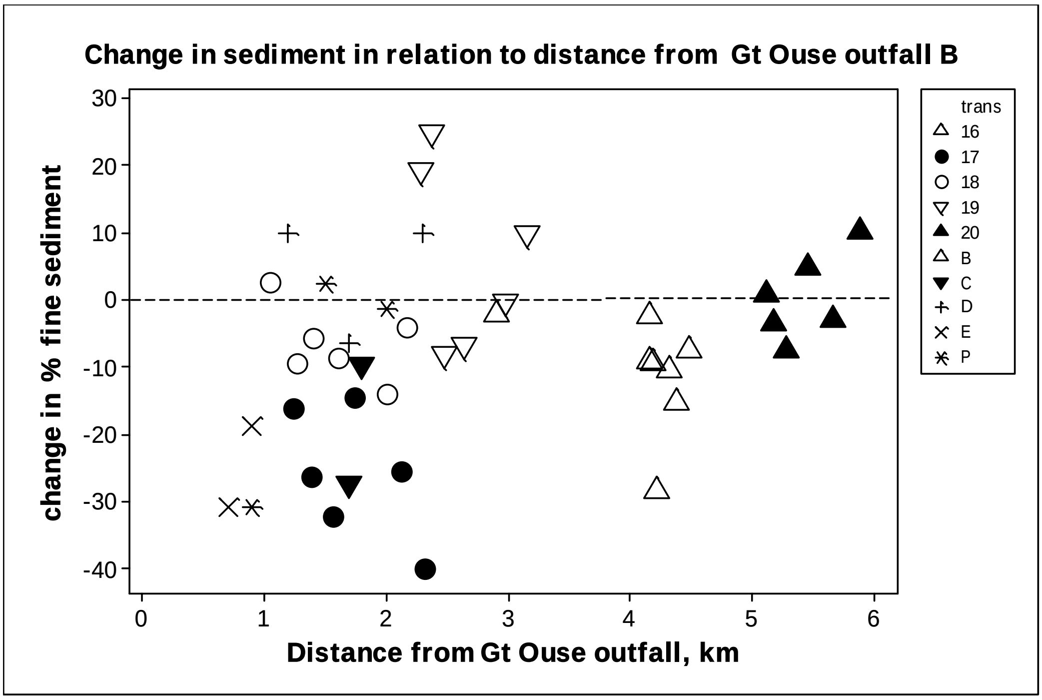


Figure 3.1.5 The average sediment organic content, expressed as %Loss On Ignition, in relation to fine sediment (particles <63 microns) in each transect in 2007.

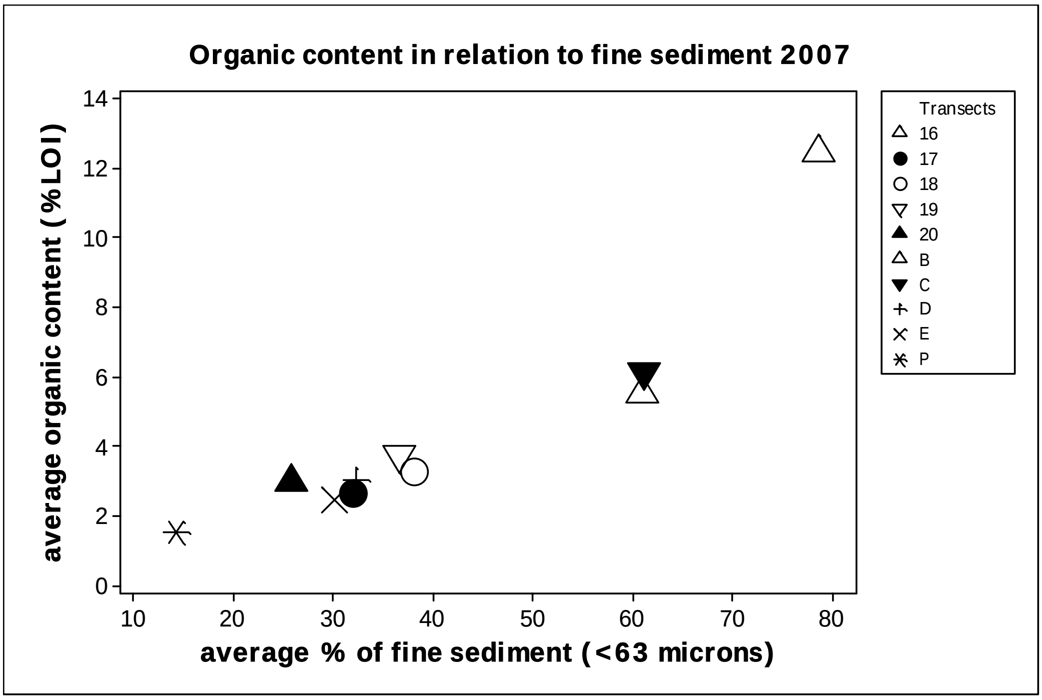


Figure 3.1.6a and b. The residual variation in sediment organic content (Log$_e$ %LOI), after the influence of particle size has been statistically accounted for, in relation to the sample transects' distance from a, the Gt Ouse high tide outfall and b, low tide outfall (points A and B in Fig 2.1) in 2007. The labels identify the transect to which each data point relates.

a,

b,

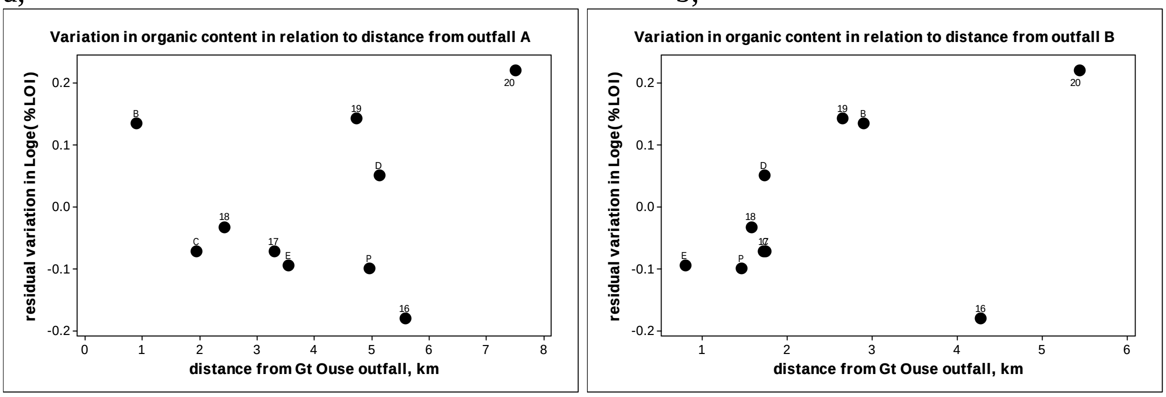


Figure 3.1.7 The relationship between sediment organic content ($\log_e$ % Loss On Ignition) and the percentage of fine sediment (% of particles <63 microns) in 2006 and 2007 for the whole Gt Ouse study area. The fitted regression lines relating sediment organic content ($\log_e$ % Loss On Ignition) to the percentage of fine sediment (% of particles <63 microns) in 2006 (solid line) and 2007 (dashed line) had significantly different intercepts and slopes.

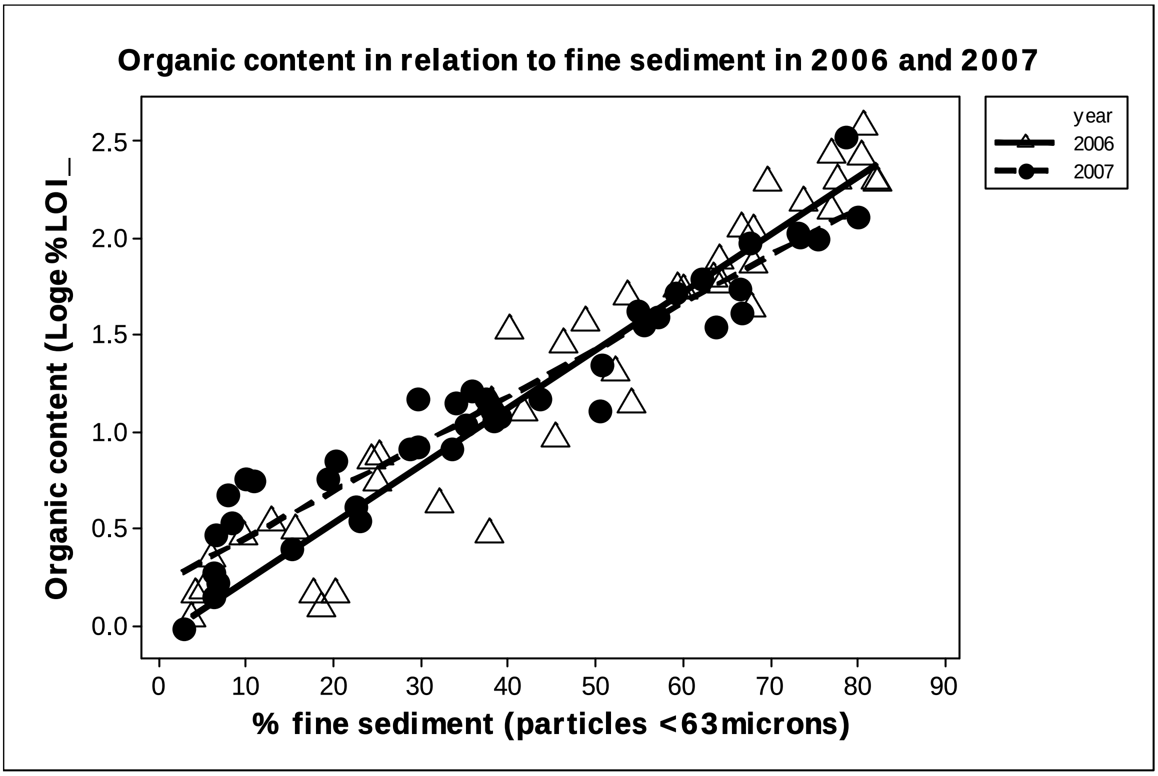
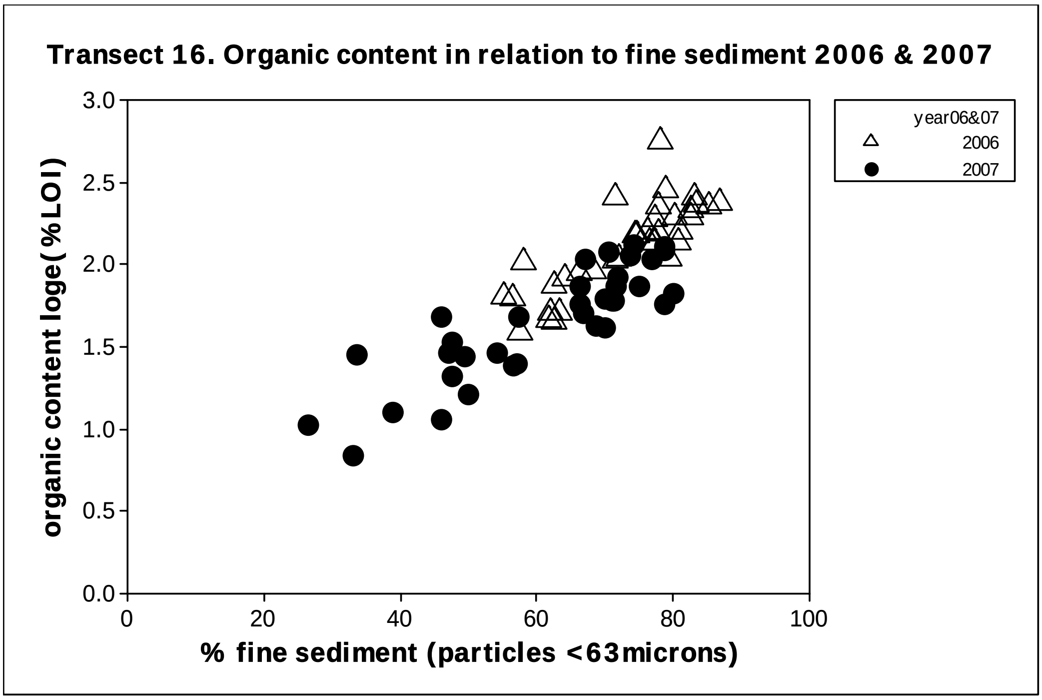


Figure 3.1.8a-j. The relationship between sediment organic content ($\log_e$ % Loss On Ignition) and the percentage of fine sediment (% of particles <63 microns) in each transect in 2006 and 2007. The fitted regression lines (solid line for 2006 and dashed line for 2007) are shown where there was a significant difference between years.**a,** transect 16, **b,** transect 17, **c,** transect B, **d,** transect C, **e,** transect 18, **f**, transect E, **g**, transect 19, **h**, transect 20 **i**, transect D and **j,** transect P.

a,



b,

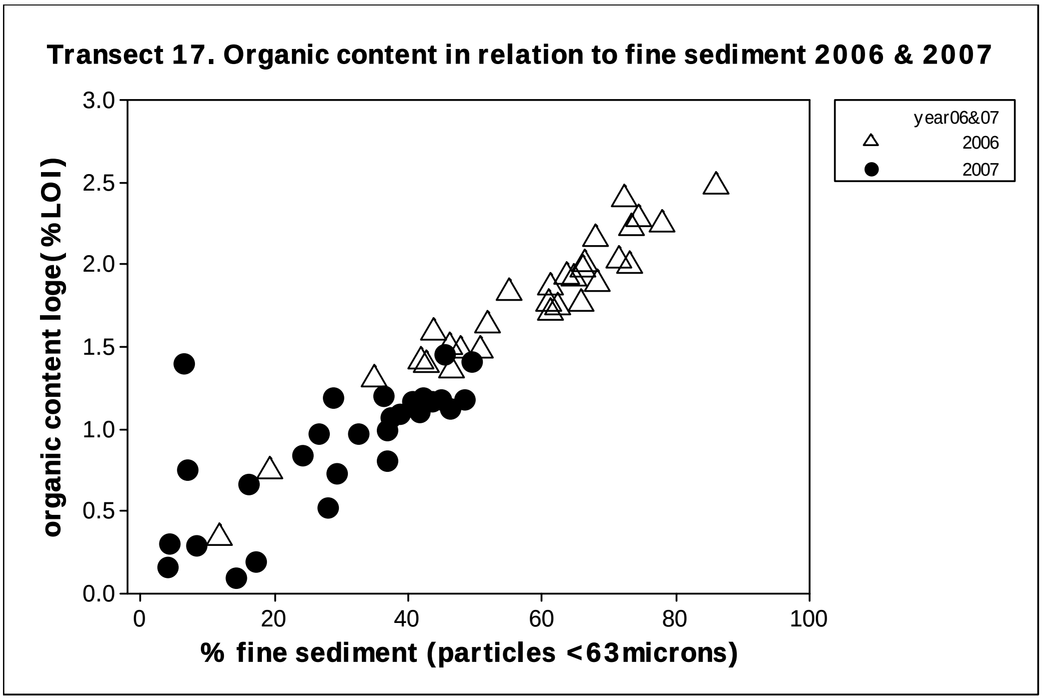
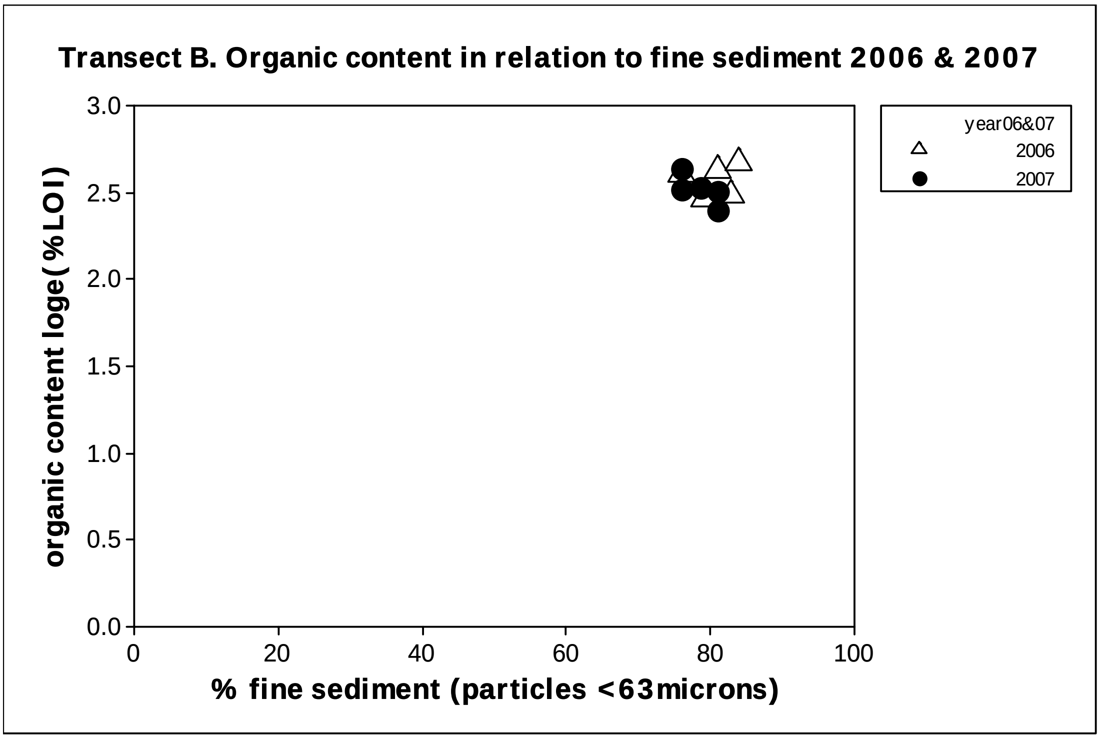


Figure 3.1.8a-j continued

c,



d,

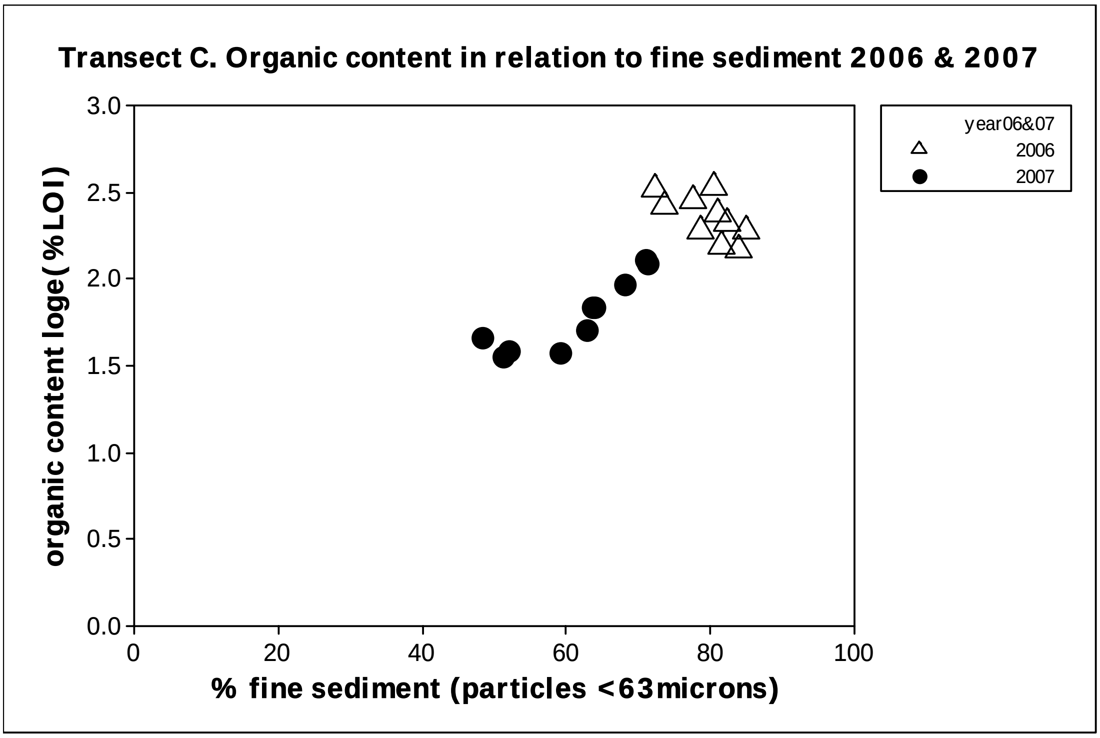
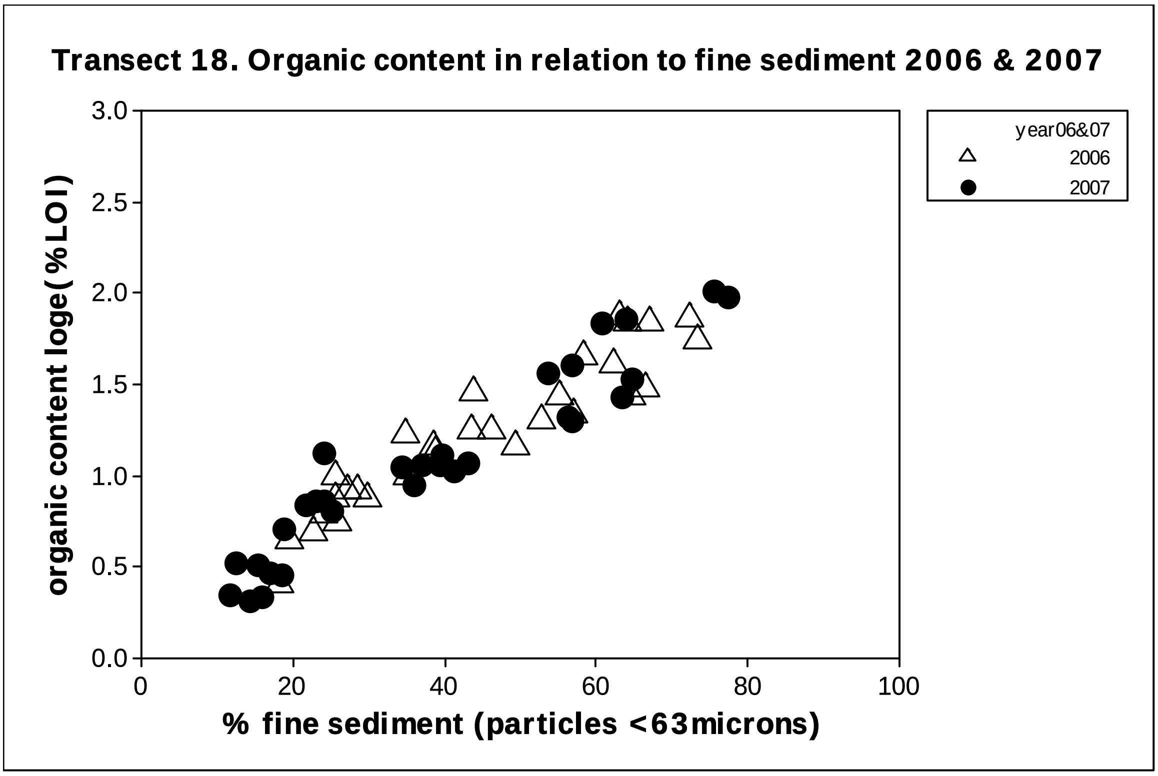


Figure 3.1.8a-j continued

e,



f,

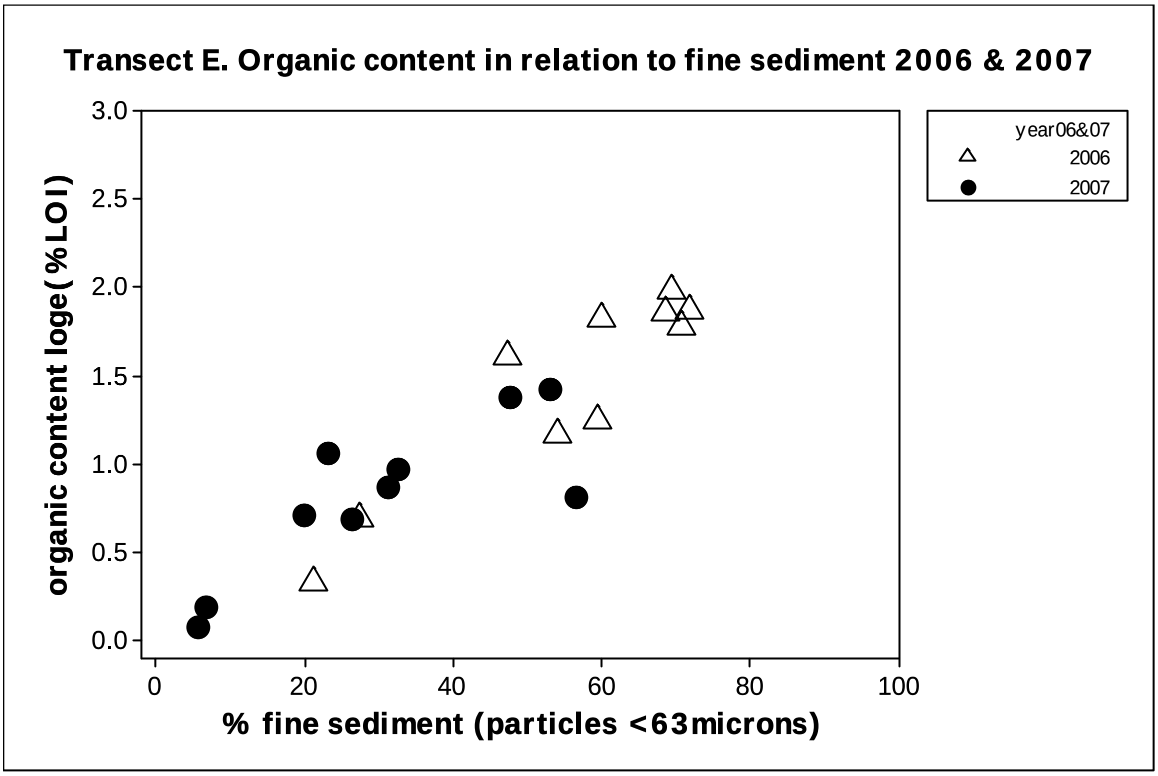
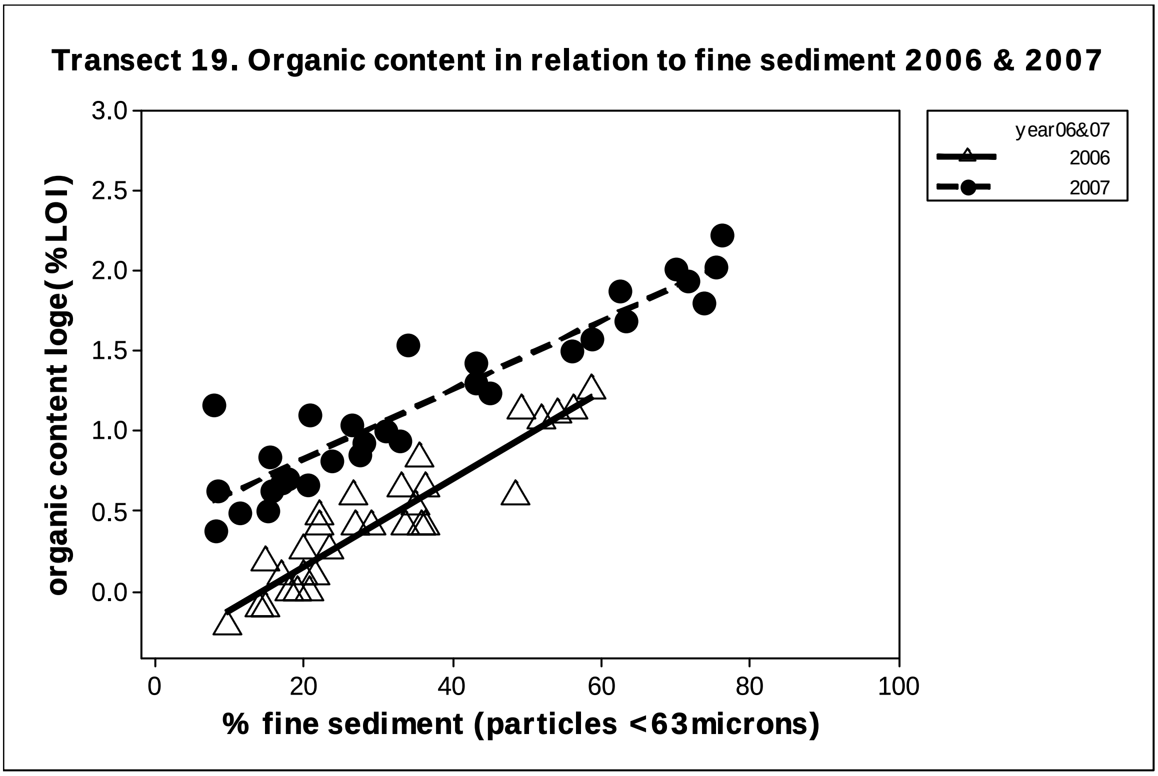


Figure 3.1.8a-j continued

g,



h,

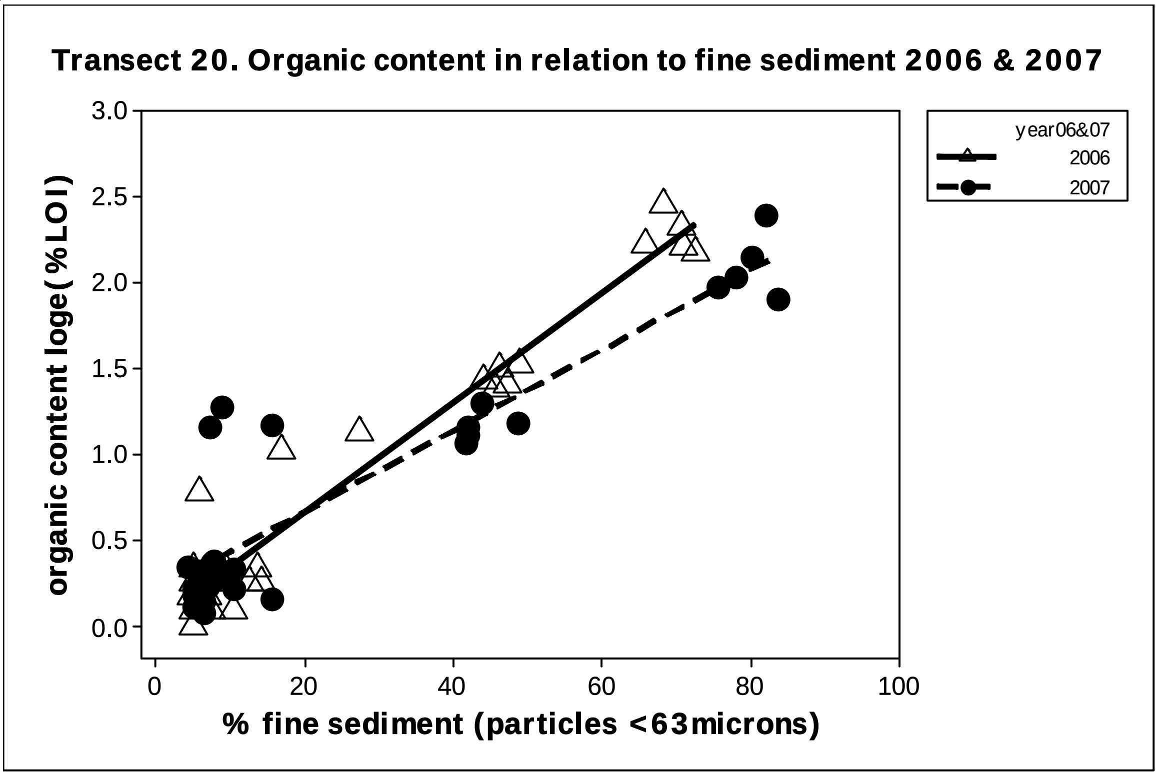
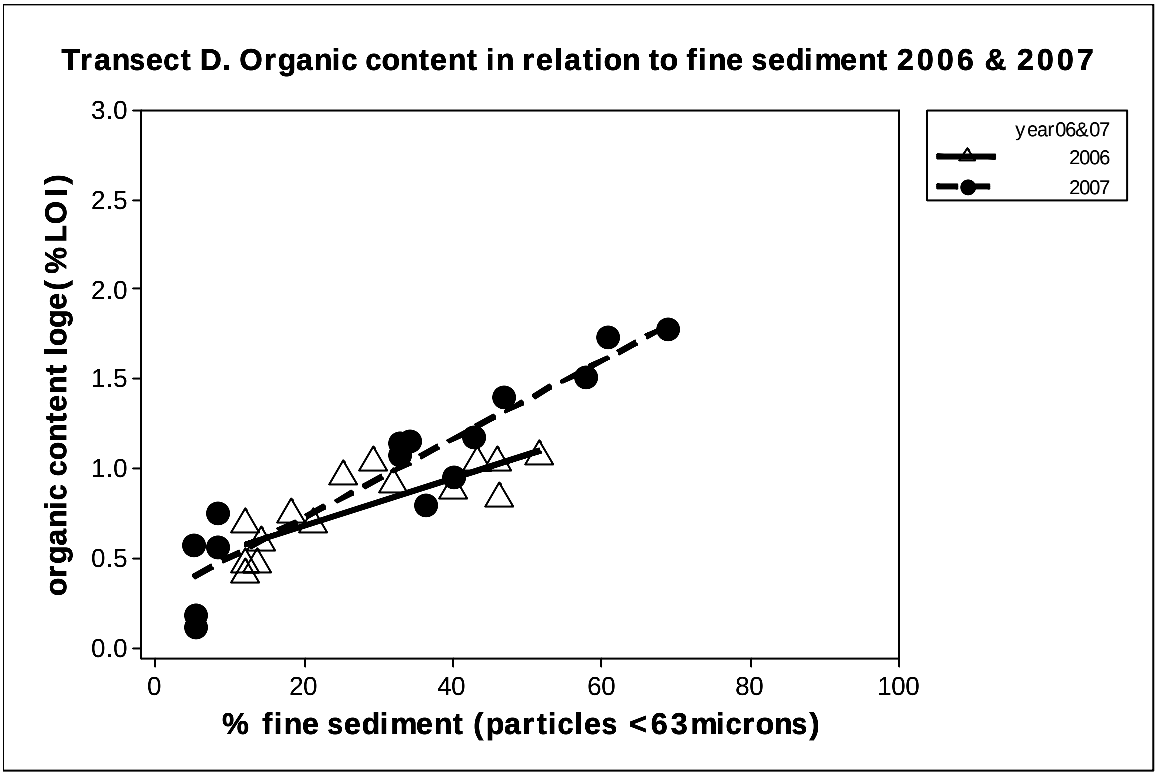


Figure 3.1.8a-j continued

i,



j,

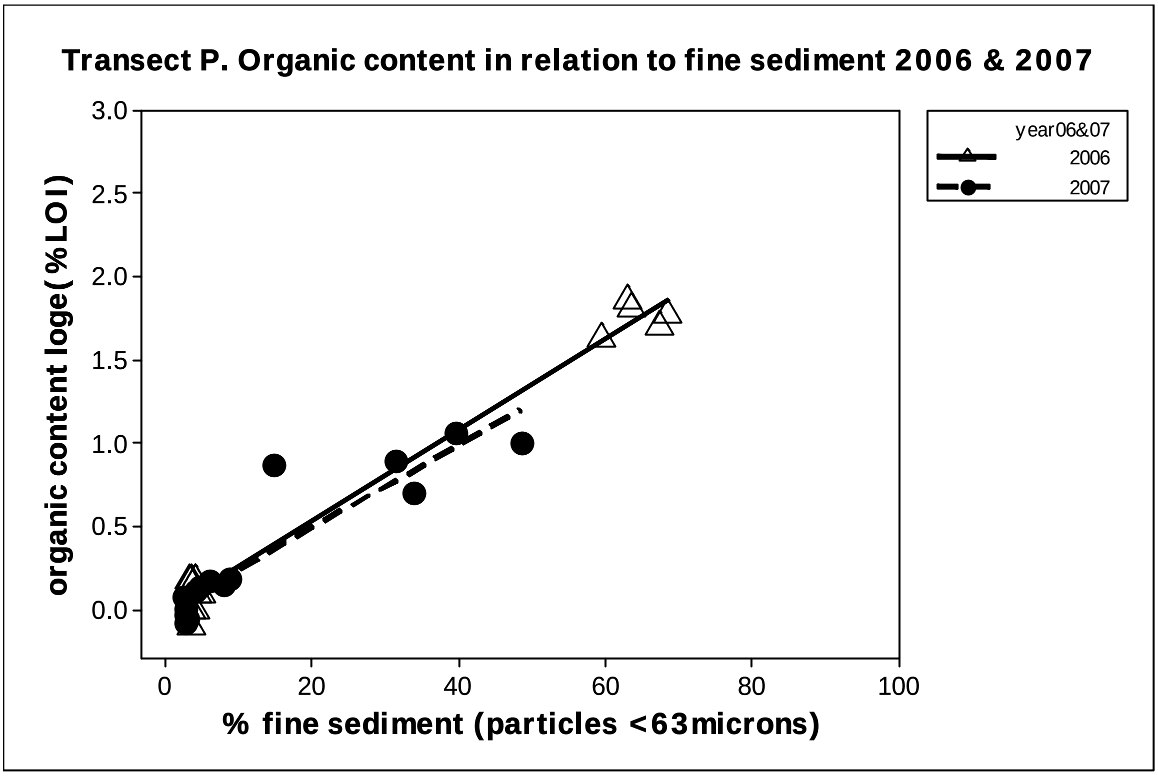
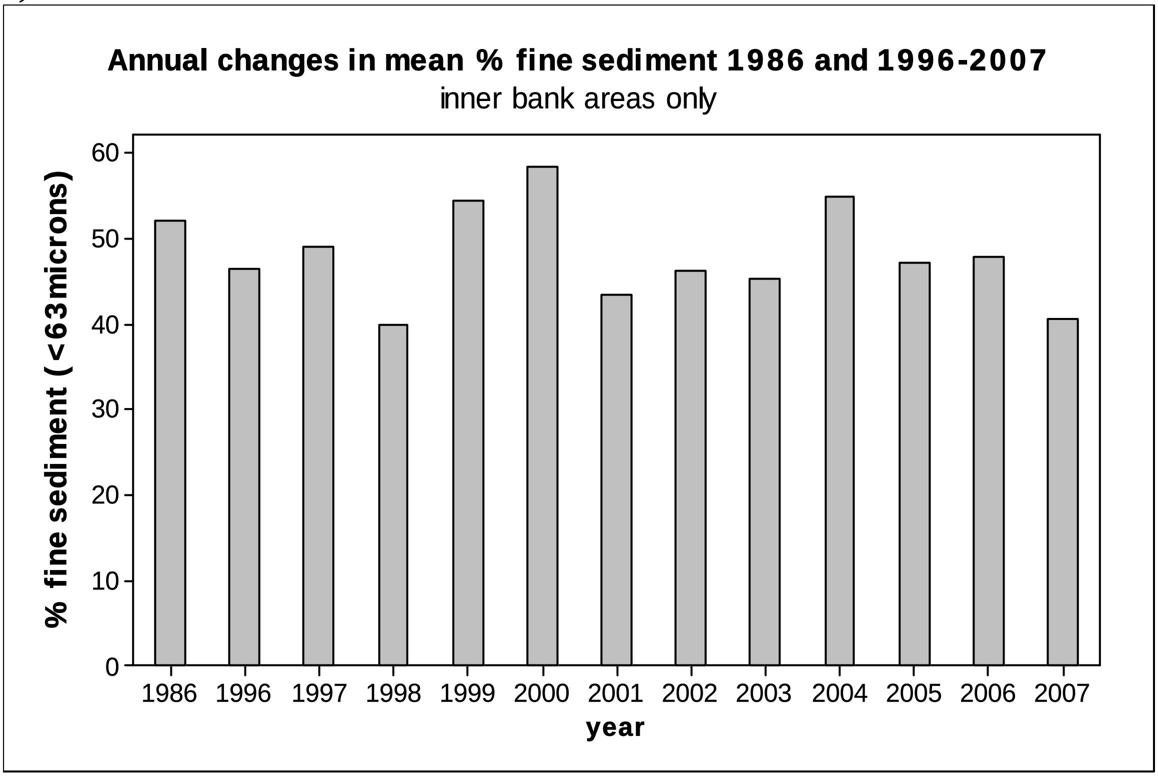


Figure 3.1.9a and b Annual changes in the mean percentage of fine sediment on **a**, the inner banks alone from 1986 and 1996-2007 and **b**, on the entire Gt Ouse study area from 1997-2007.

a,



b

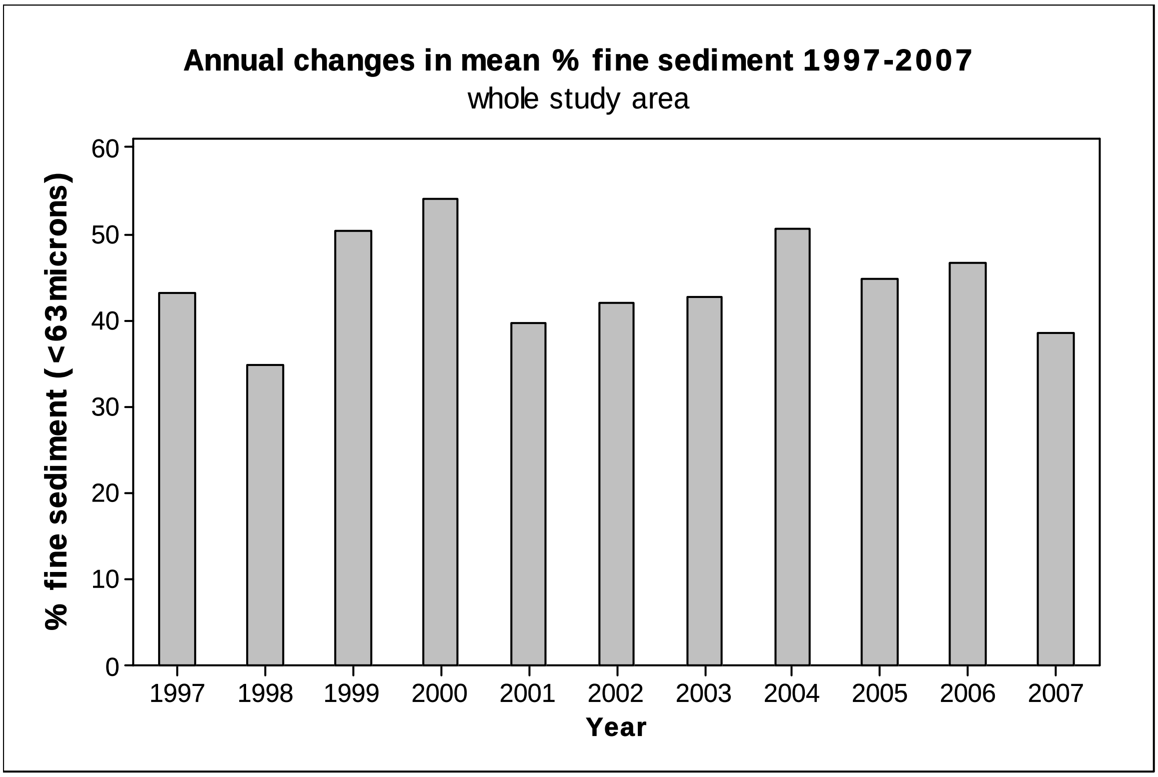
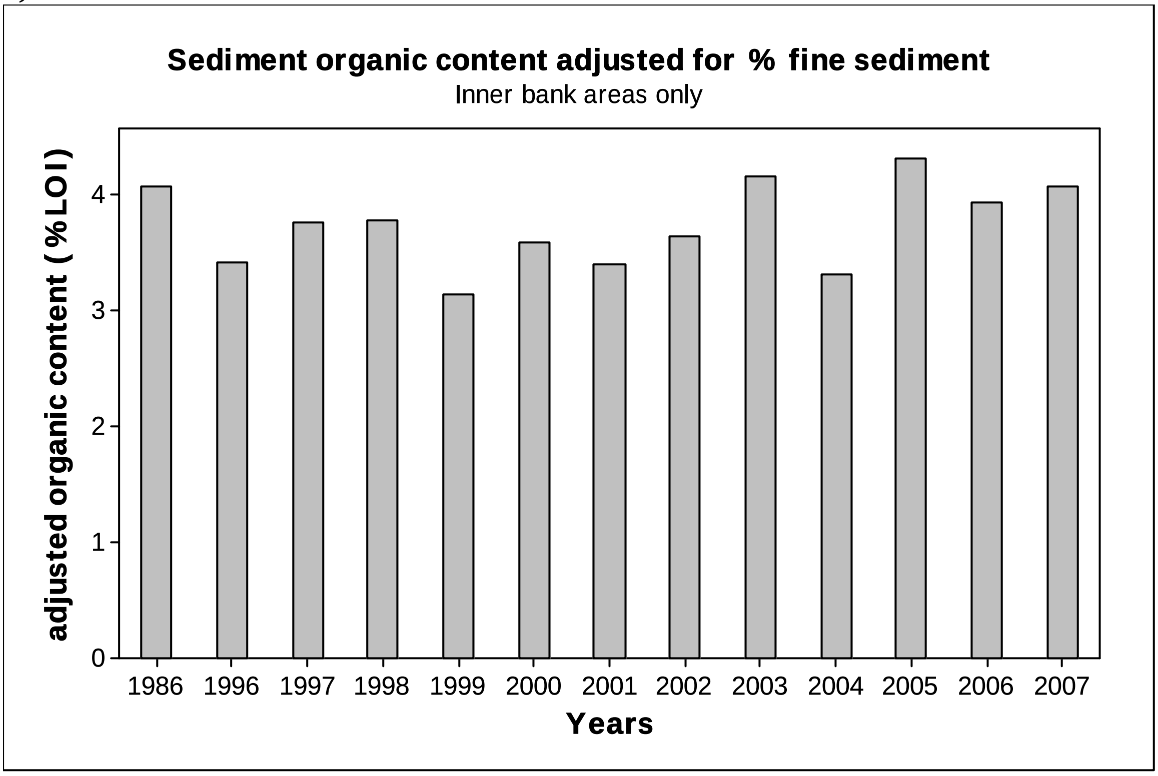
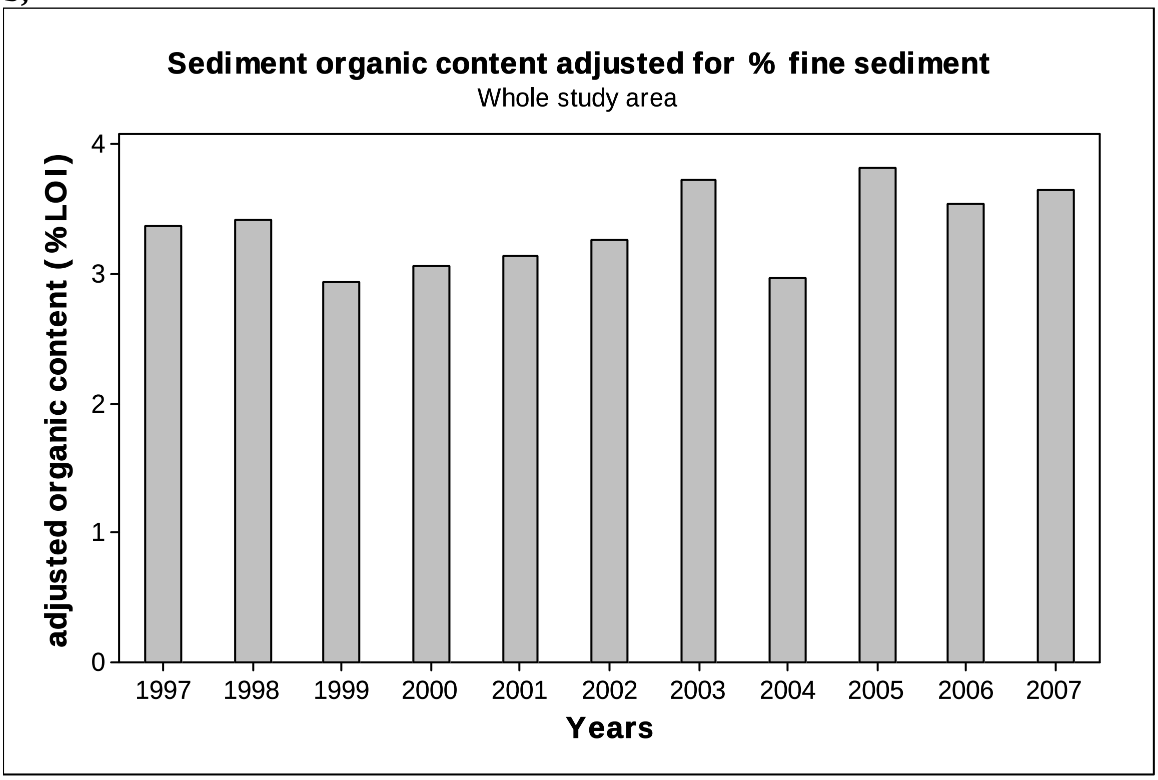


Figure 3.1.10a and b. Annual changes in the mean organic content of sediment (%LOI) on **a**, the inner banks alone from 1986 and 1996-2007 and **b**, on the entire Gt Ouse study area from 1997-2007. The organic content has been adjusted to take into account variation in the % of fine sediment in each year.

a,



b,



3.2. Invertebrates

3.2.1 Introduction

This section describes the distribution of the inter-tidal invertebrates within the study area in 2007. It is supplemented by the data tables presented in Appendix 1 which give the mean densities of invertebrates recorded in each 1hectare sample site and in Appendix 2 which give comparisons of densities of all but the least abundant species between 2006 and 2007 for the whole study area.

Distribution maps showing the density of an invertebrate species/species size category in each sample site in 2007 and the change in density compared to that in 2006 are presented (Figures 3.2.1a-q). Not all species were mapped. Only those whose density changed significantly over the whole study area (Appendix 2) between the two surveys are included.

A brief description of the invertebrates' biology and of the shorebirds that prey on them was given in Volume 2 of our 1996 study Report (Yates *et al* 1998).

3.2.2 Invertebrate distribution in 2007 and changes compared with the 2006 survey.

The uppermost maps in Figures 3.2.1a-o show the spatial distribution and density (expressed as numbers m^{-2}) of the invertebrates in the 2007 survey, while the lower maps show the changes in densities at a site between 2006 and 2007. Tables 3.2a-c summarises for each transect the results of analyses comparing densities of all invertebrates that occurred between the two surveys. These comparisons were made by doing paired t-tests on the mean density of an invertebrate in each 1 hectare sampling site.

Statistical analyses were also made for those invertebrates in which the change in density between the two surveys was significant to determine whether the changes were related to sediment particle size, sediment organic content and shore level and to the proximity to the Gt Ouse outfall. Multiple regression analysis was used for this purpose. The procedure was to regress the change in invertebrate density at each of the 42 sample sites against the site variables, change in sediment particle size, change in sediment organic content and shore level, to account for any influence they had and then to include distance of the site from the Gt Ouse to determine if it had any significant additional influence.

Table 3.2 a-c. Summary of changes in invertebrate densities within transects between 2006 and 2007 surveys. Plus signs (+) indicate an increase in 2007, a minus (-) indicates a decrease and an equal sign (=) indicates no change. Empty cells indicate that the invertebrate did not occur in that transect in either survey. The statistical significance of the change is indicated as follows:- * p<0.05 and ** p<0.01. The overall change in the whole study area (see also Appendix 2) is given in the final column headed 'All' and where significant, the invertebrate concerned is shown in bold type.

a, worms

Invertebrate	Transect										
	16	17	B	C	18	E	19	20	D	P	**All**
Nemerteans			-	+	-	+	-	+			+
Nematodes	+	+	+	+	+	-**	+	+	+		+*
Pholoe inornata		+			+						
Anaitides mucosa	+	+			-	=	-	+	+	+	+**
Eteone longa	+	+	-	+	+*	+**	+	+	-	+*	+**
Hediste diversicolor <15mm	+	-	+	+	+		+	+			+*
H. diversicolor 15-30mm	+	-		+	+		-				+
***H. diversicolor* >30mm**	+	+		+	+			+			+*
Nephtys cirrosa 15-30mm		+						+		-	+
N. cirrosa >30mm										-	-
***Nephtys* juveniles <15mm**	-*	-	+		-	-	-	-	+	-	-*
N. hombergii 15-30mm	-	+			-*	-	+	+	+	+	-
N. hombergii >30mm	-	+			-	+	+	+	+	=	+
Scoloplos armiger <15mm		-						+	+		+
S. armiger 15-30mm		+						+		-	+
S. armiger >30mm		-						-	+	-	+
Polydora sp? *ciliata*					+	+					+
Pygospio elegans	+	-	+	+	-	-	+	+	+	+	+
Spio martinensis	-	-				-		-	-	+	-
Spiophanes bombyx		-			-		-	+		+	-
Magelona mirabilis		+									+
Tharyx sp complex A	+	+	+		-	-	-	+	+	+	+
Capitellids	+	-			-	-	-	+	-	-	-*
Heteromastus filiformis										+	+
Ampherete grubei	+										+
Arenicola marina casts		-				-	+	+	-	-	+
Tubificoides benedii	+	+	-	+	-	-	+	+	-		+
Enchytraeidea	+	+	-	+	-	-	+	+	-		+

Table 3.2 a-c. continued.

b, molluscs

Invertebrate	Transect									
	16	17	B	C	18	E	19	20	D	P	**All**
Hydrobia ulvae <3mm	-	-	-	+*	+	+	+	-	+	+	+
H. ulvae 3+mm	+	+	-	+	-	-	+	+	+		+*
Retusa obtusa <3mm	+	-						-		+	+
R. obtusa 3+mm	+	+					-	+			+
Pleurobranch indet	+										+
***Mytilus edulis* <5mm**	+	-	+		+	+	+	+	+	+	+**
Mytilus edulis 11-15mm								+			+
Mysella bidentata <5mm	+	+			+		+				+
Cerastoderma edule <5mm	-*	+			-	-	-	-	+		-
***C. edule* 6-10mm**	-	-			-	-	-	-	+		-*
C. edule 11-20mm	+	+					-	-	-		+
C. edule 20-30mm	+						+		-		-
Ensis arcuatus 11-15mm							+	+			+
Ensis arcuatus 16-20mm	+									+	+
Angulus tenius <5mm										+	+
***Macoma balthica* <5mm**	+	+		+	+*	+	+	+	+	+	+**
M. balthica 6-10mm	-	-			+	+	+	+	-	+	-
***M. balthica* 11-20mm**	+	+			+	=	+	+	+	-	+*
Abra nitida 6-10mm	-								+		=
***Scrobicularia plana* <5mm**	+	+		+	-	-	-	-			-*
S. plana 5-10mm	-*	+		+	-	-	-	+			-
S. plana 11-20mm	+*	-	-	+	-	+	+	+			+
S. plana 21-25mm	=	+			-		+				-
S. plana 26-30mm	+	-			+						+
S. plana >30mm	+	+									+

Table 3.2 a-c continued.

c, crustaceans

Invertebrate	Transect										
	16	17	B	C	18	E	19	20	D	P	**All**
Elminius modestus	-								+		-
Balanuc balanus							-		-	-	-
Indeterminate copepod	-			+				-			=
Urothoe poseidonis <3mm								-			-
Bathyporeia sarsi <3mm		+			+		+	+	+	+	+
B. sarsi 3+mm		+						+			=
Corophium arenarium <3mm		-									-
C. arenarium 3+mm								-			-
***C. volutator* <3mm**	+*	+	+	+	+	+	-	-			+*
***C. volutator* 3+mm**	-	+		+	+**	+	+	-		+	+*
Cyathura carinata					+		+	-			+
Tanaids								+			-
Vauntompsonia cristata								+			+
Bodotria arenosa										-	-
Psuedocuma longicornis								-			-
Cumaceans		+				+	+	+		+	+
Crangon crangon	-	+		-	+	-	+	-	+	+	+
Carcinus maenas	-						+		-		-

Out of the 74 invertebrate families or species/species size categories that were considered, the densities of 15 differed significantly between 2006 and 2007. The mean density over the whole study area of five worms, two crustaceans and four bivalve molluscs increased significantly in 2007, while the density of two worms and two molluscs decreased significantly compared with 2006 (Table 3.2 a, b and c, Appendix 2). This was a similar proportion (20%) to that which might be expected by chance given the 5 percent level of probability that was used as the statistical significance criteria. However, the species concerned have all shown significant year on year changes in density at some time during this study, consequently we consider the changes to be biologically significant as opposed to having occurred by chance.

Nematode densities were significantly higher in 2007 (p=0.033) than in the previous year. These worms were most abundant on upper levels of the shore (Figure 3.2.1a) but the change in their density compared to that in the previous year was not related to changes in sediments, organic content or to shore level or distance from the Gt Ouse outfall.

Densities of the Phyllodocid worms *Eteone longa* and *Anaitides mucosa* were significantly higher ($p=<0.0001$ and $p = 0.006$ respectively) in 2007 than in 2006 (Table 3.2a and Appendix 2). *Eteone* was widespread in 2007 and most abundant in upper and mid-shore areas. It was in these same areas that its densities had increased the most (Figure 3.2.1b). Changes in its density were not significantly related to the change in sediment characteristics, shore level or to the distance from the river outfall. *Anaitides* occurred in increased numbers in lower shore sites in 2007 having been much less abundant or widespread in the previous year (Figure 3.2.1c). Changes in its density were not significantly related to either sediment characteristics, shore level or to the distance from the Gt. Ouse outfall.

Densities of both juvenile (<15mm in size) and adult (30+mm in size) ragworms *Hediste diversicolor*, increased significantly ($p=0.024$ and $p=0.014$ respectively) in 2007 (Table 3.2a and Appendix 2) compared with 2006. They were most abundant in muddy sediments at upper shore levels of the study area (Figures 3.2.1d and e) and the changes in their density were significantly related to the distance from the Gt Ouse high water outfall indicating that both size categories increased most at sites nearer that outfall compared to those farther away (Figures 3.2.2 a and b).

Density of juvenile *Nephtys* worms (<15mm in size) decreased significantly ($p=0.041$) in 2007 compared to that in the previous year (Table 3.2a and Appendix 2 Figure 3.2.1f). These worms occurred predominantly in mid- and lower-shore sites but the decrease in their density occurred primarily in mid-shore sites. These changes were negatively related to shore level and positively related to changes in the percentage of fine sediments between 2006 and 2007 but not to the distance from the river outfall.

The density of Capitellid worms decreased ($p=0.037$) in 2007 (Table 3.2a and Appendix 2). They occurred mainly in mid- and lower-shore sites on the shore to the west of the river outfall in 2007 having been more widespread on both shores in the previous year (Figure 3.2.1g) There was no statistically significant relationship between the change in its density from 2006 to 2007 and changes in sediment characteristics or shore level but there was to the distance from the rivers' low water outfall (Figure 3.2.2c) indicating that their density decreased more at sites near that outfall than at those farther away.

Both the small (<3mm) and large (3+mm) size categories of the crustacean *Corophium volutator* increased in density in 2007 ($p=0.046$ and $p=0.013$ respectively) compared to the previous year (Table 3.2c and Appendix 2). They were most abundant in sites on the shore to the east of the river outfall (Figures 3.2.1h and i). Increases in their density were not statistically related to sediment characteristics or shore level but they were negatively related to the distance from the river low water outfall, that is, they increased most in density in sites near that outfall than they did in sites farther away (Figures 3.2.2d and e).

The density of large *Hydrobia ulvae* (3+mm) increased significantly in 2007 ($p=0.029$) compared to the previous year (Table 3.2b and Appendix 2). It was widespread in the study area as was the increase in its density (Figure 3.2.1j). Changes in its density were not related to changes in sediment characteristics, shore level or to distance from the river outfall.

The density of small mussel *Mytilus edulis* (<5mm) increased significantly in 2007 ($p=0.001$) compared to 2006 (Table 3.2b and Appendix 2). It occurred primarily in lower- shore sites apart from in transects 16 and 20 where it was abundant in the upper shore (Figure 3.2.1k). However, these changes were not significantly related to sediment changes, site level variables or to the distance from the Gt Ouse.

The density of cockle spat *Cerastoderma edule* (6-10mm) decreased significantly in 2007 (p=0.05) compared to 2006 (Table 3.2b and Appendix 2). It occurred at sites on lower shore levels of most transects (Figure 3.2.1l) where it also showed the largest decrease in density. With the effect of shore accounted for these changes were also significantly and negatively related to the distance from the Gt Ouse low water outfall, that is to say its density decreased most in sites farther from the outfall than it did in sites that were near to it (Figure 3.2.2f).

The density of both small *Macoma balthica* (<5mm in size) and larger *Macoma* (11-20mm) increased significantly (p<0.0001 and p=0.01 respectively) in 2007 (Table 3.2b and Appendix 2). Both size categories were widespread in the study area and those sites in which its density increased most were similarly widespread (Figures 3.2.1m and n). In neither size category were the changes in density related to distance from the outfall after the effect of shore level or sediments characteristics had been accounted for.

The bivalve, *Scrobicularia plana* in the <5mm size category decreased in density in 2007 (p=0.016) compared with the previous year (Table 3.2b and Appendix 2). They occurred primarily in the muddier mid- and lower-shore sites of the study area and it was in those same sites that decreases in density occurred (Figure 3.2.1o). However, the decreases in density were not significantly related to sediment changes, site level variables or to the distance from the Gt Ouse.

3.2.2.1 Annual changes in invertebrate density: 1986 and 1996-2007

The inner banks of the study area have now been surveyed on a total of thirteen occasions and the changes in the densities of the main invertebrate classes, worms, crustacean, gastropod molluscs (snails) and bivalve molluscs are summarised in Figures 3.2.3a-d. Worm densities were at their lowest in 1996 and with the exception of 1998, increased annually until 2003 but have declined since then to a point where the 2006 density was almost as low as that in 1996. In the current survey the density increased to near average density for the study period. Crustacean density was lowest in 1996 and again in 2000 since when it has increased annually to the highest density recorded in 2003. It dropped to near average density in 2004, and remained close to level until the current where it has increased to above average density. (Figure 3.2.3b). There had been a general upward trend in snail densities between 1996 and 2001 but they dropped in 2002 since when they have risen annually to the highest density ever recorded in the study in the 2005 survey (Figure 3.2.3c). However, densities have dropped in in the last two surveys. Bivalve mollusc density was at its highest in 2000 (Figure 3.2.3d) when there was a large spatfall of many species, notably cockle and *Macoma*. Since then their densities have remained relatively low with the 2007 density a little below the average for the period of the study.

3.2.3 Summary and conclusions

There were a few changes in the densities or spatial distribution of the invertebrates recorded in the Gt Ouse study area between the 2006 and 2007 surveys. Of the 71 species/species size categories that were sufficiently numerous to be considered, the mean density of five worms, two crustaceans and four bivalve molluscs increased significantly in 2007, while the density of two worms and two molluscs decreased significantly compared with 2006. Nematodes, the phyllodocid worms *Eteone longa* and *Anaitides mucosa,* juvenile and adult *Hediste diversicolor*, small and large size categories of the crustacean *Corophium volutator* , the gastropod *Hydrobia ulvae*, and the bivalves, *Mytilus* edulis (<5mm) and small and large *Macoma balthica* (<5mm and 11-20mm in size respectively) all increased in density. Whereas the juvenile *Nepthys* worms (<15mm), Capitellid worms and the bivalve molluscs *Cerastoderma edule* (6-10mm) and *Scrobicularia plana* (<5mm) all decreased in density.

There was some evidence of the spatial changes in invertebrate densities being associated with the distance from the Gt Ouse outfall after changes in sediment particle size and organic content between the two years and shore level had been taken into account. Increased densities of both juvenile and adult densities of *Hediste* were significantly and negatively related to distance from the high water outfall of the river. That is to say their density increased most in sites nearer to that outfall than in sites located farther away. In contrast, decreases in densities of Capitellid worms were greatest in sites near to the low water outfall than in those farther away. Increases in *Corophium* densites were greater in sites nearer the low water outfall of the river while the decreases in density of small *Cerastoderma* were greater in sites farther away from that outfall.

The inner banks of the study area have now been surveyed each year for a total of thirteen years and the changes in the densities of the main invertebrate classes, worms, crustacean, gastropod molluscs (snails) and bivalve molluscs are summarised in Figures 3.2.3a-d. Worm densities were at their lowest in 1996 and with the exception of 1998, increased annually until 2003 but have declined since then to a point where the 2006 density was almost as low as that in 1996. In the current survey the density increased to near average density for the study period. Crustacean density was lowest in 1996 and again in 2000 since when it has increased annually to the highest density recorded in 2003. It dropped to near average density in 2004, and remained close to level until the current where it has increased to above average density. (Figure 3.2.3b). There had been a general upward trend in snail densities between 1996 and 2001 but they dropped in 2002 since when they have risen annually to the highest density ever recorded in the study in the 2005 survey (Figure 3.2.3c). However, densities have dropped in in the last two surveys. Bivalve mollusc density was at its highest in 2000 (Figure 3.2.3d) when there was a large spatfall of many species, notably cockle and *Macoma*. Since then their densities have remained relatively low with the 2007 density a little below the average for the period of the study.

Section 3.2

Figure legends

Figure 3.2.1a-o.

Maps showing the density of an invertebrate family, species or species size category within the sample sites in 2007 (upper map) and the change in density that occurred at each site between 2006 and 2007 (lower map). **Appendix 2** gives the mean density of each invertebrate within the whole study area in both surveys. Only those invertebrates whose density changed significantly between the two surveys and those that were present in both surveys were mapped.

Figure 3.2.2 a-f.

The relationship between the density change or the residual variation in invertebrate density change between 2006 and 2007 and the distance of the sample sites from the Gt Ouse high water (HW) and low water (LW) outfall (points A and B in Figure 2.1). The fitted relationships are statistically significant ($p<0.05$). The residual variation was that remaining after the effect of sediment particle size and organic content and shore level had been taken into account statistically. Data points represent each of the 42 sample sites in the study area. **a**, *Hediste diversicolor*<15mm, **b**, *Hediste diversicolor* >30mm **c**, Capitellid worms , **d**, *Corophium volutator* <3mm, **e**, *Corophium volutator* 3+mm and **f**, *Cerastoderma edule* 6-10mm.

Figure 3.2.3 a-d.

The mean density of **a**, worms, **b**, crustacean, **c**, gastropod molluscs (snails) and **d**, bivalve molluscs on the inner banks of the Gt Ouse study area in the surveys of 1986 and 1996-2007. Densities are expressed as numbers/m^2.

Figure 3.2.1a-o. Maps showing the density of an invertebrate family, species or species size category within the sample sites in 2007 (upper map) and the change in density that occurred at each site between 2006 and 2007 (lower map). **Appendix 2** gives the mean density of each invertebrate within the whole study area in both surveys. Only those invertebrates whose density changed significantly between the two surveys and those that were present in both surveys were mapped.

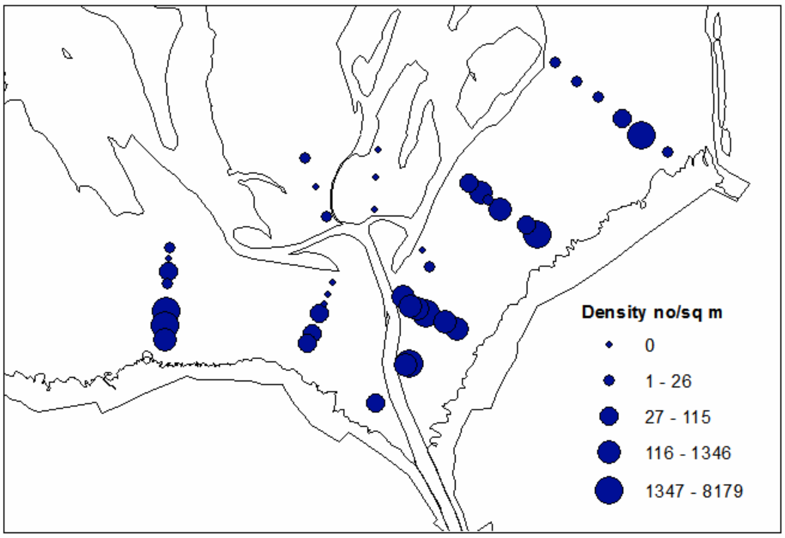


Figure 3.2.1a. Nematodes

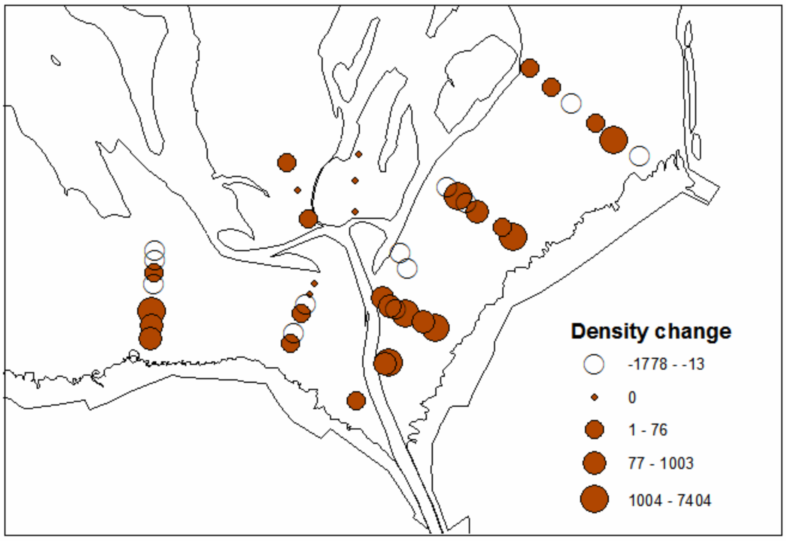


Figure 3.2.1 continued

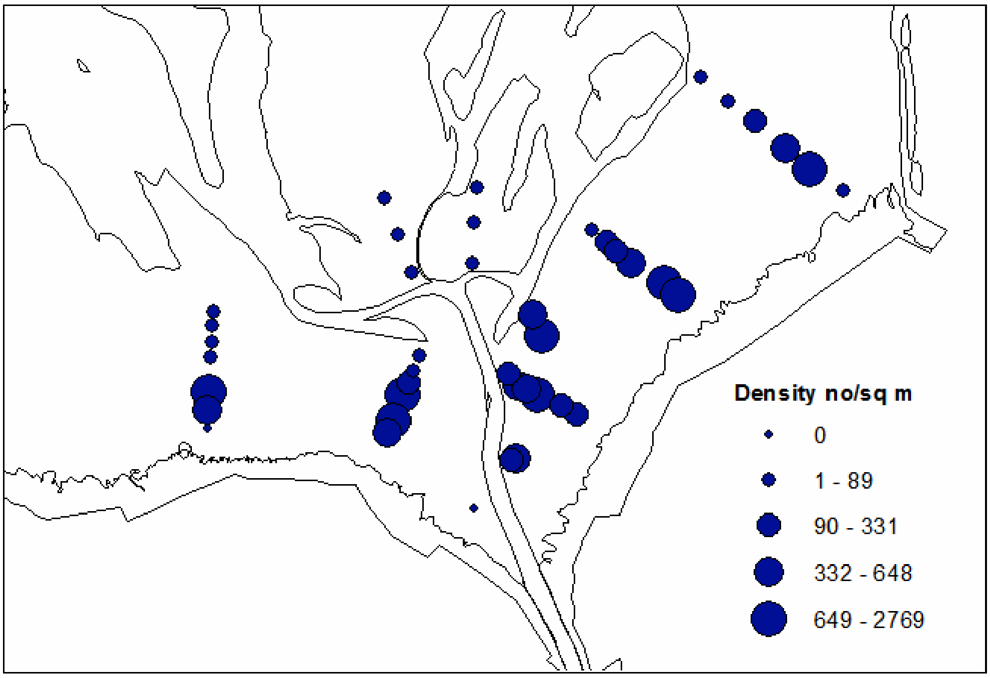


Figure 3.2.1b. Eteone longa

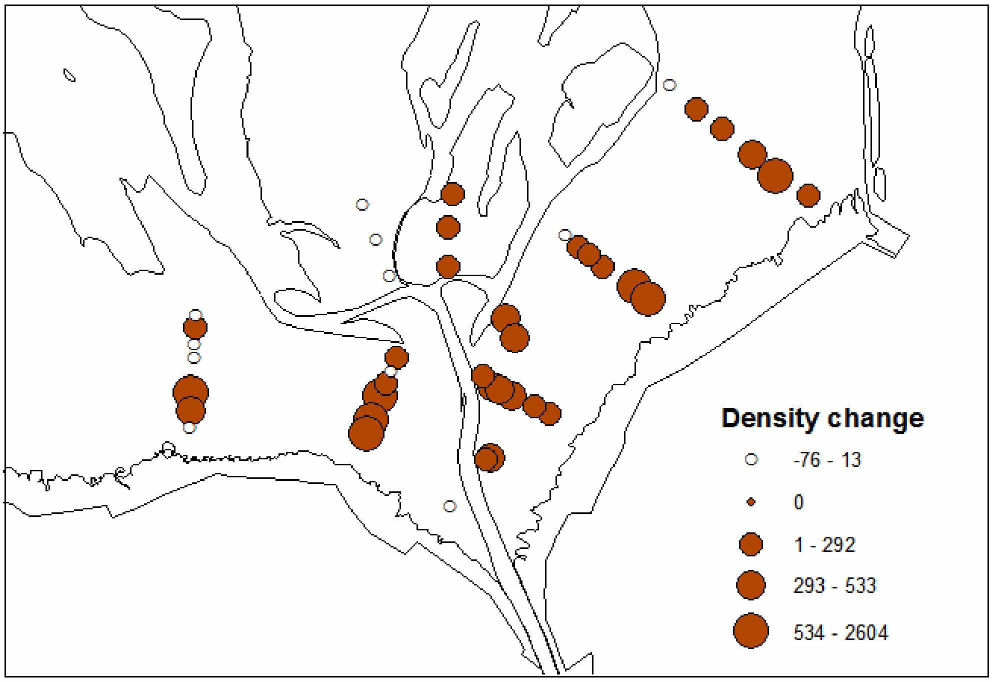


Figure 3.2.1 continued

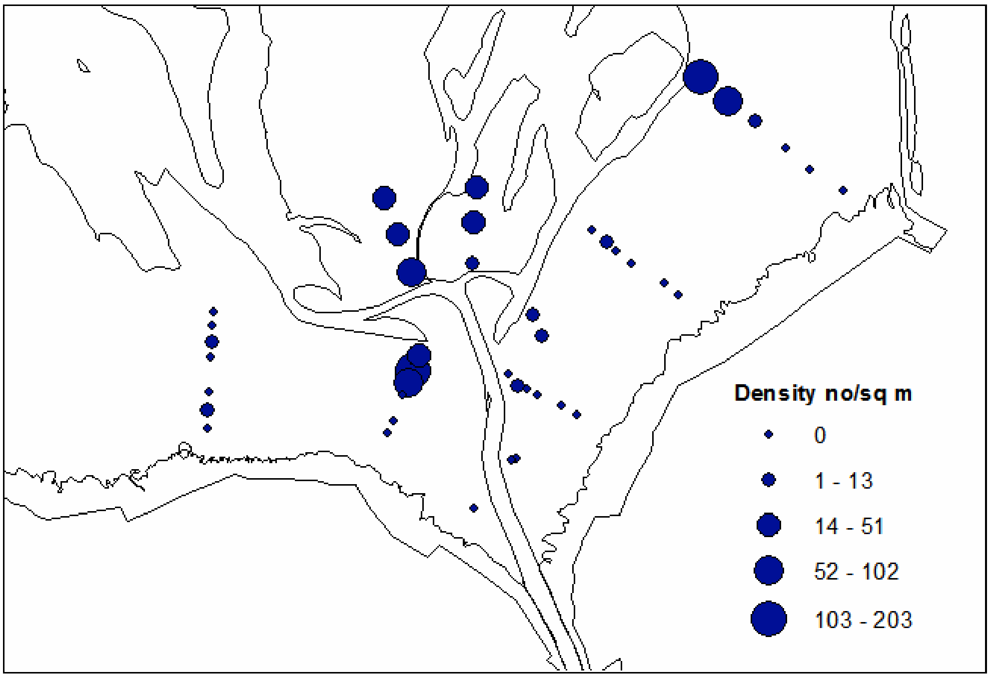


Figure 3.2.1c. Anaitides mucosa

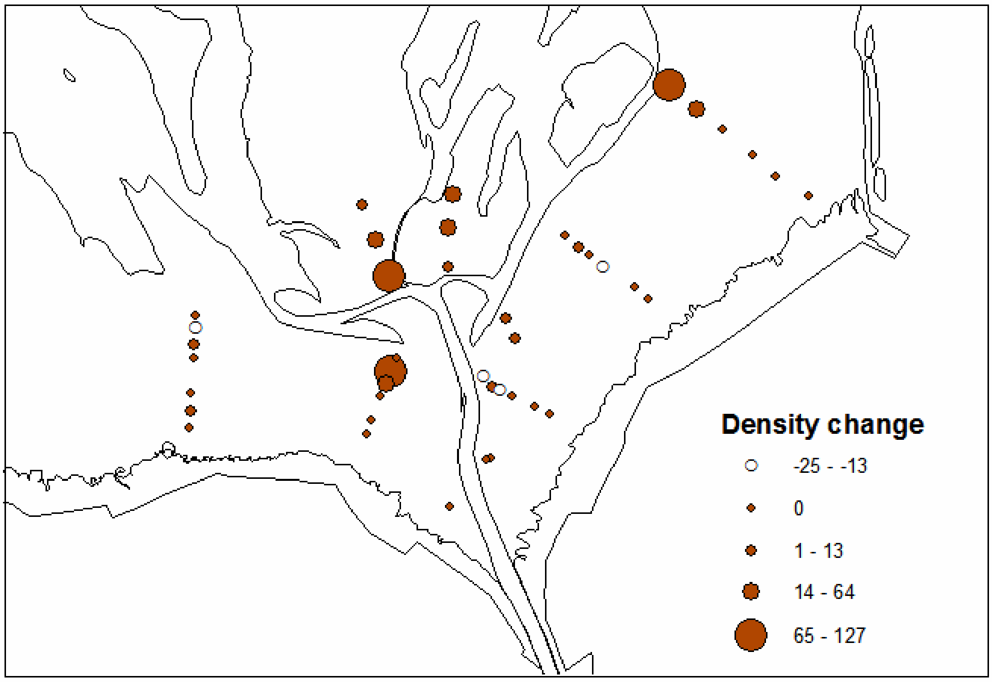


Figure 3.2.1 continued

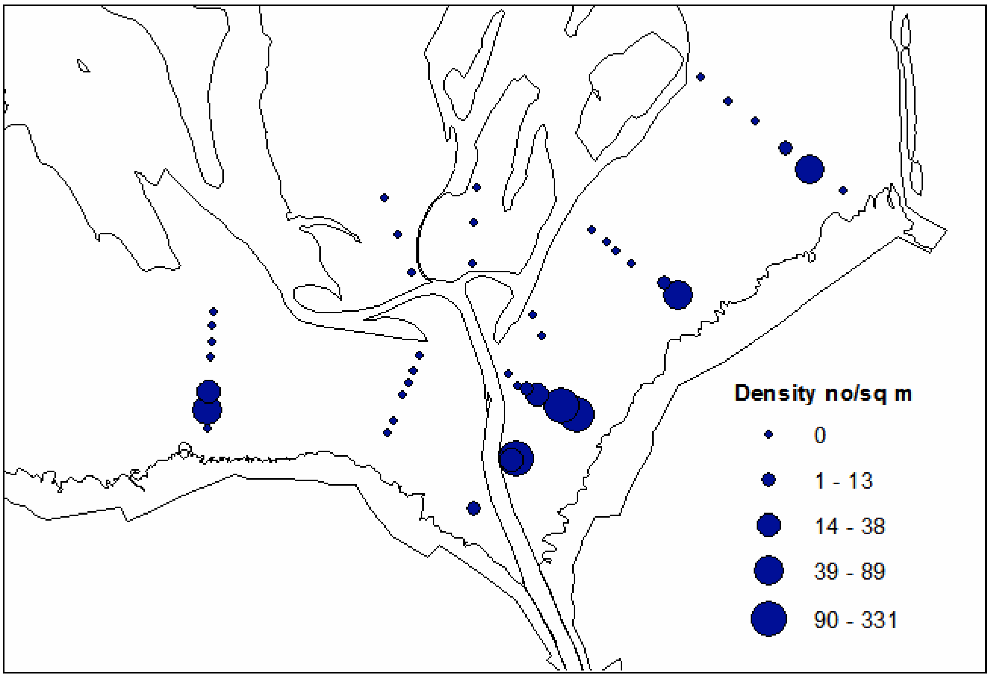


Figure 3.2.1d. Hediste diversicolor <15mm

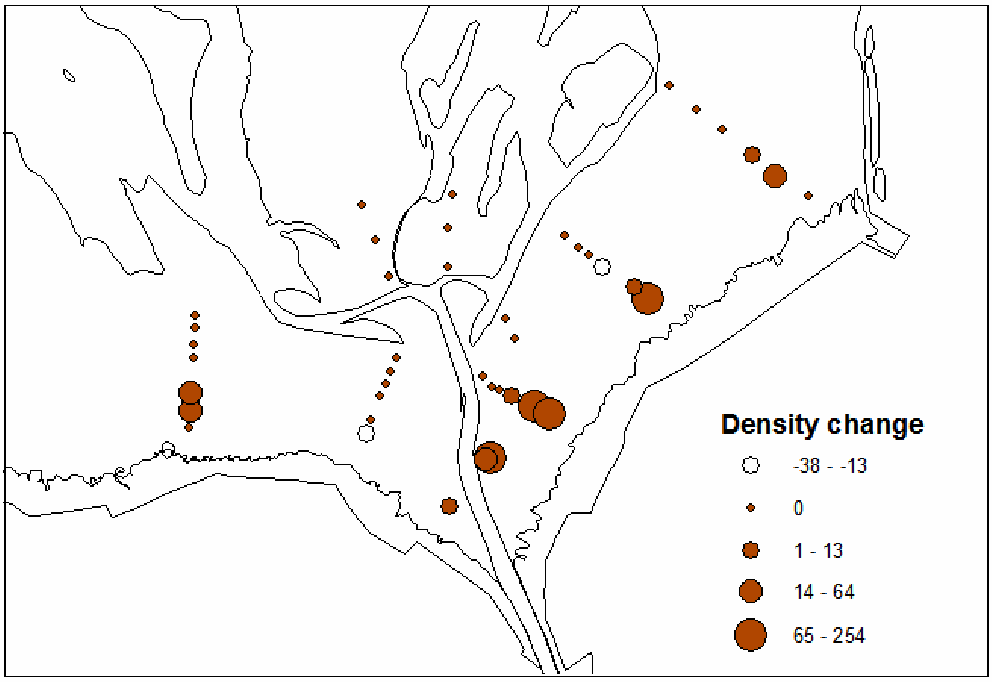


Figure 3.2.1 continued

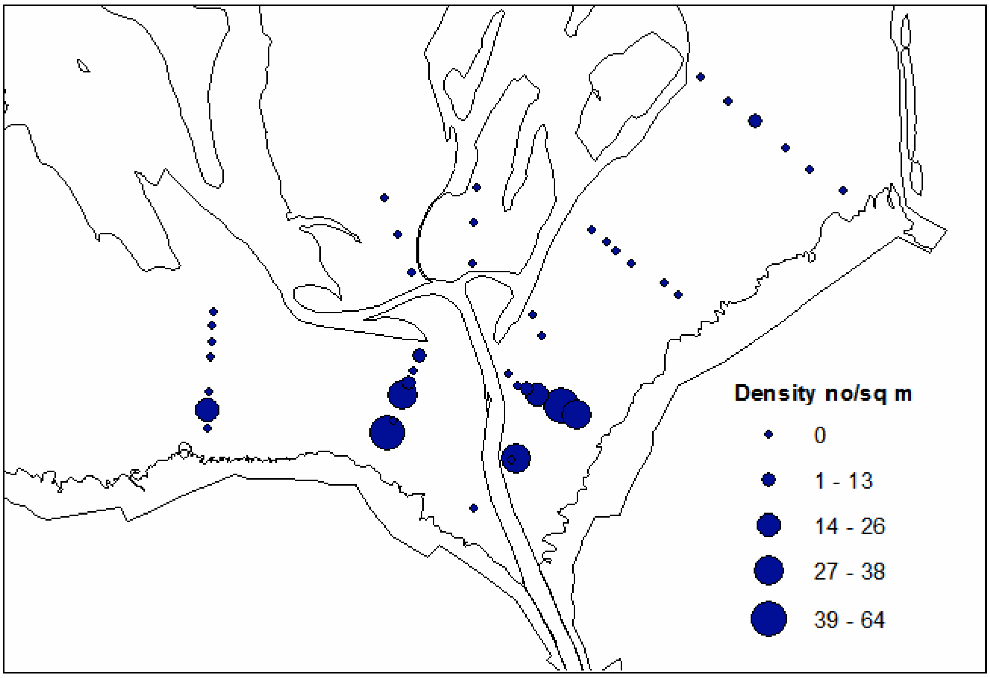


Figure 3.2.1e. Hediste diversicolor 30+mm

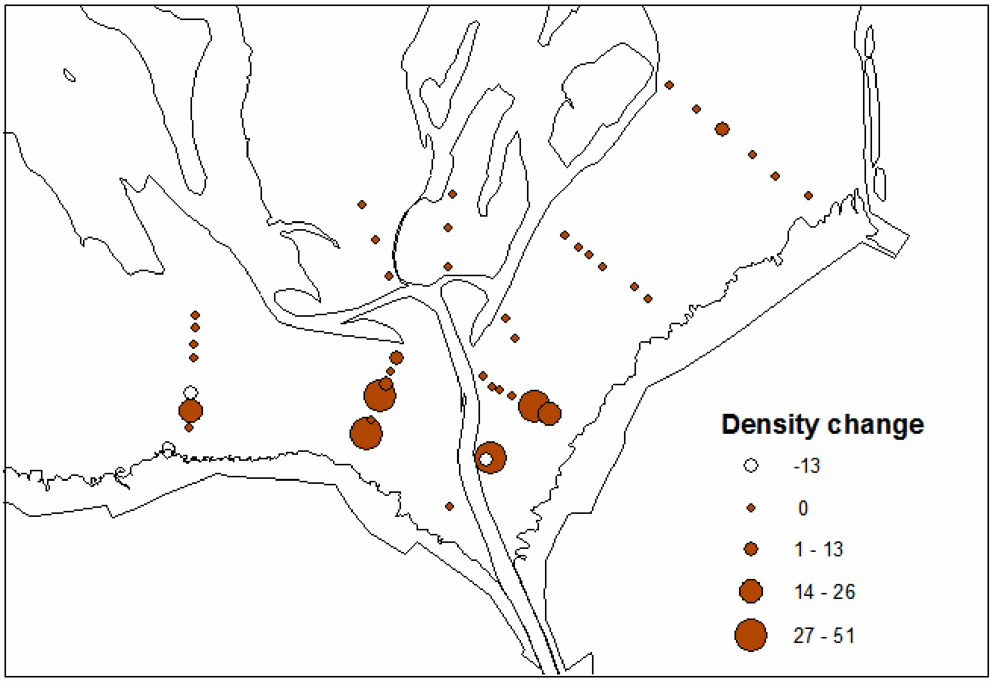


Figure 3.2.1 continued

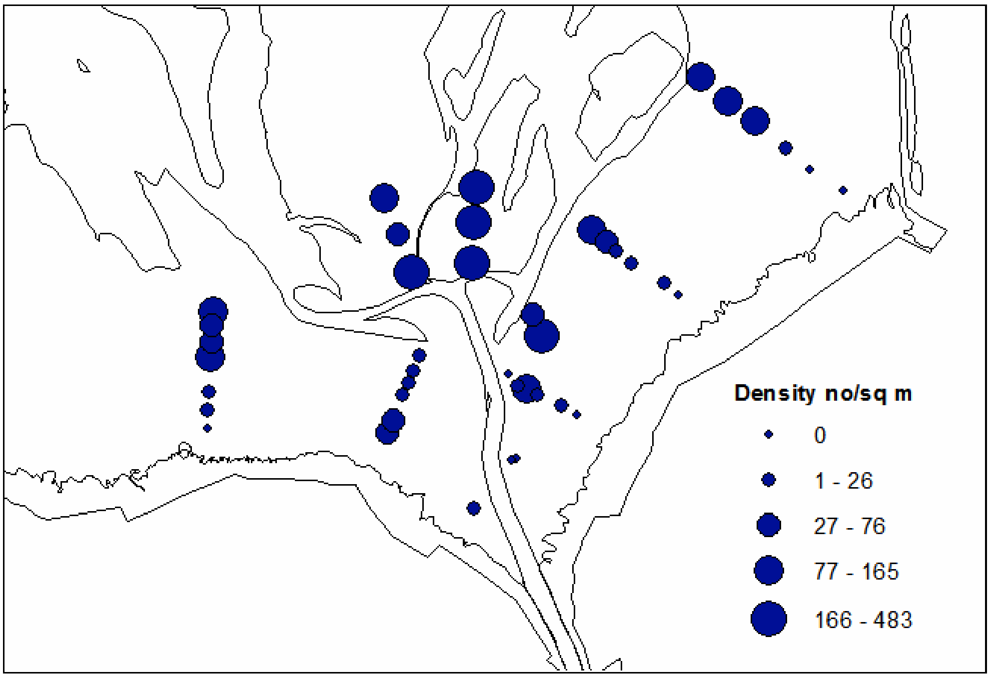


Figure 3.2.1f. juvenile Nephtys species

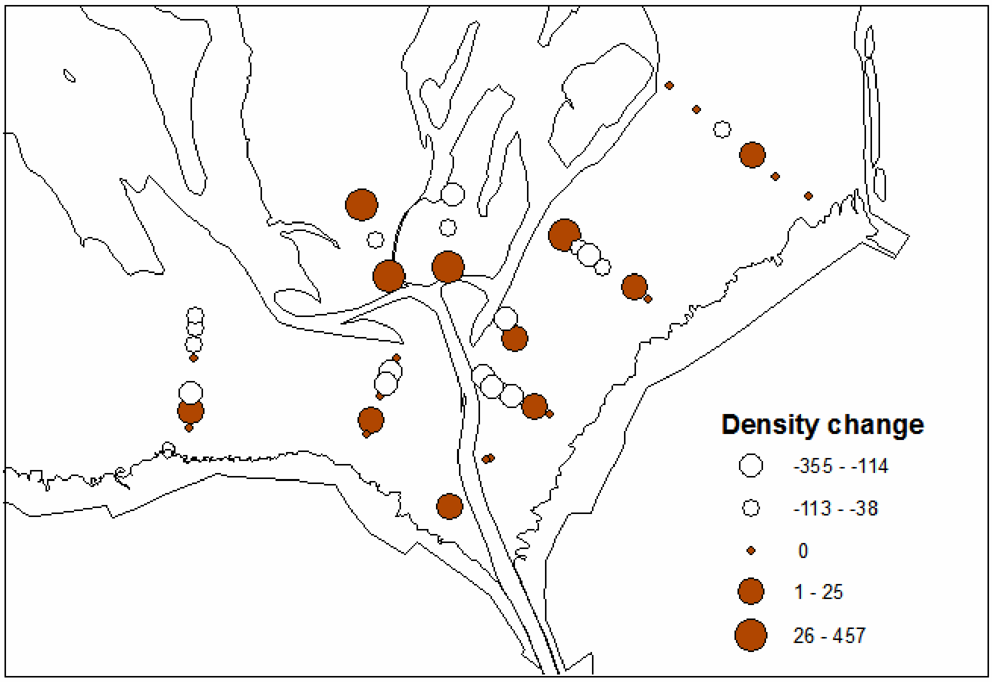


Figure 3.2.1 continued

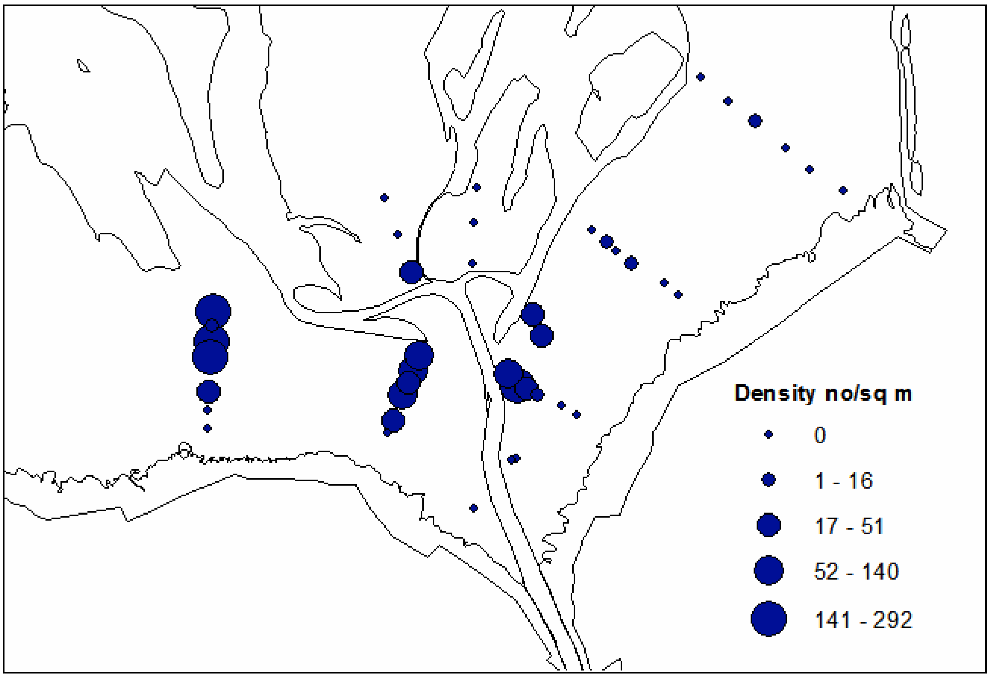


Figure 3.2.1g. Capitellid worms

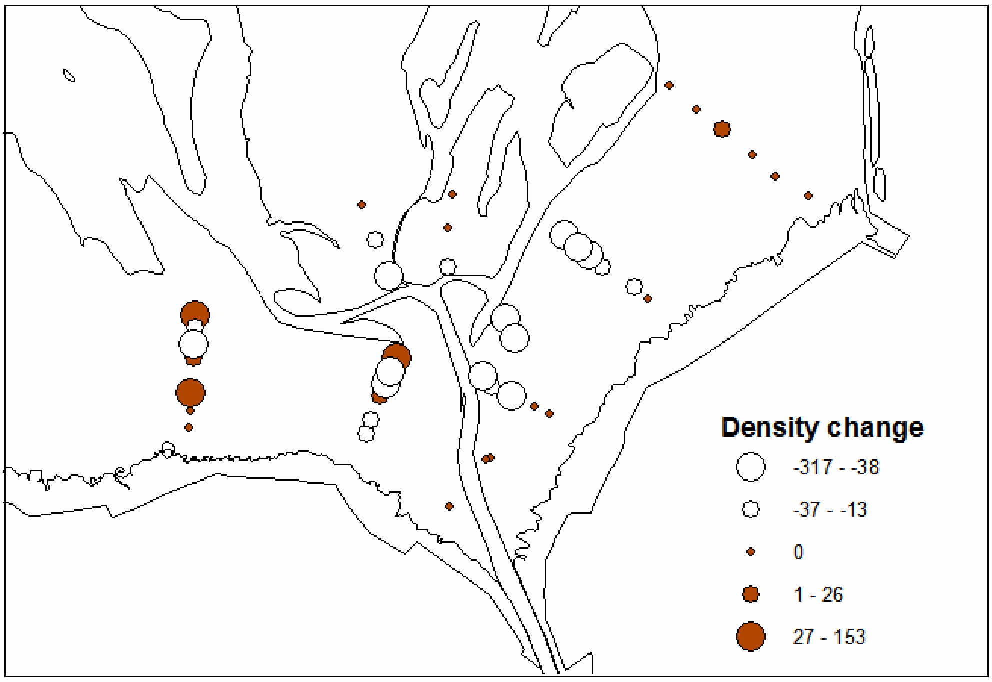


Figure 3.2.1 continued

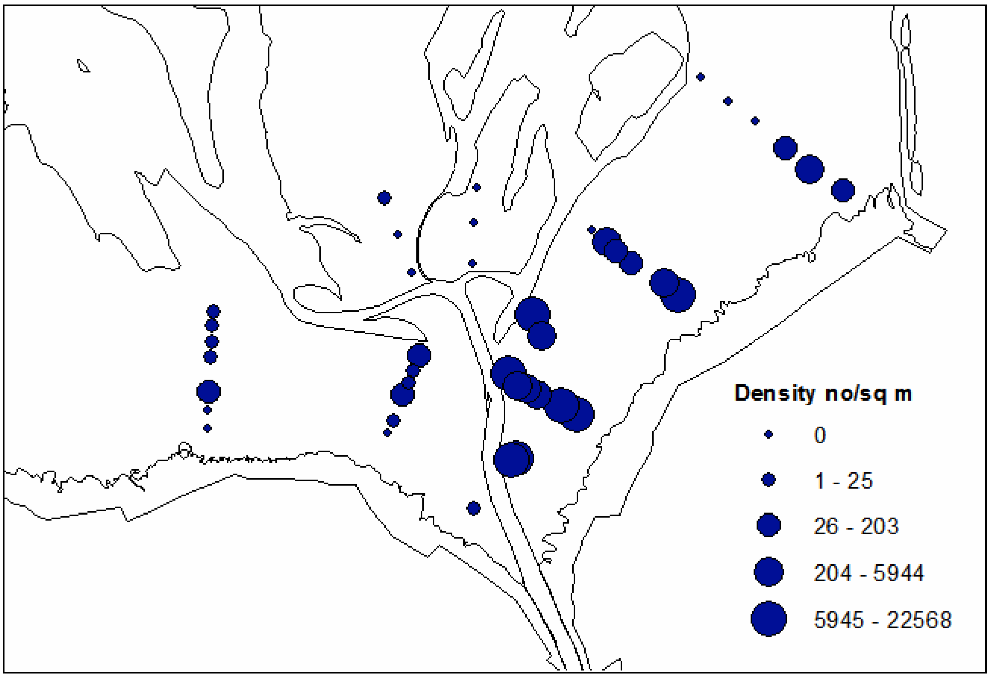


Figure 3.2.1h. Corophium volutator <3mm

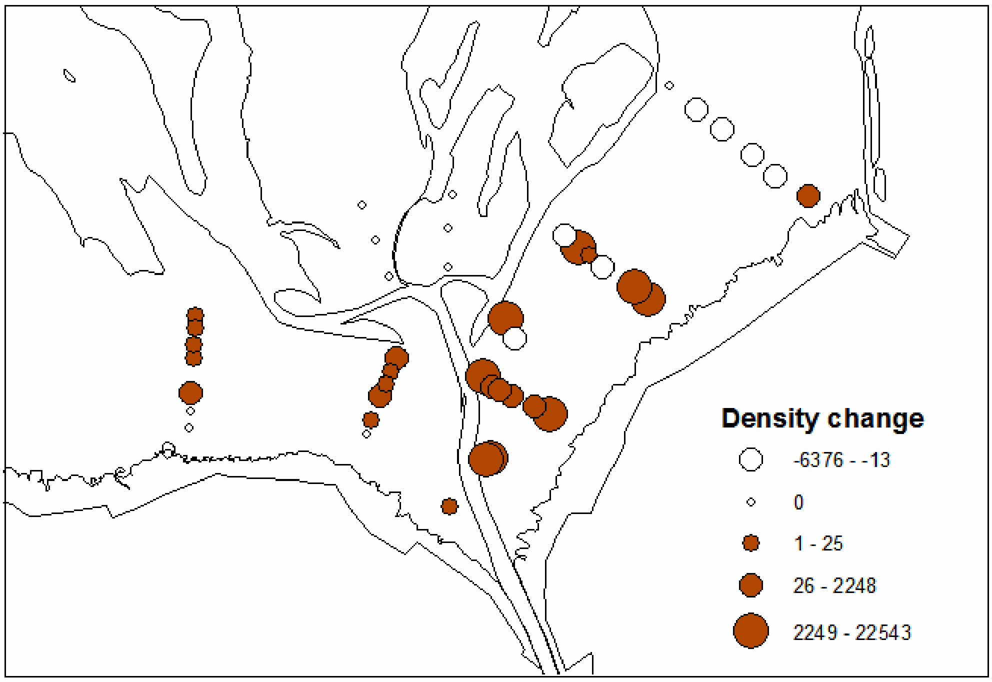


Figure 3.2.1 continued

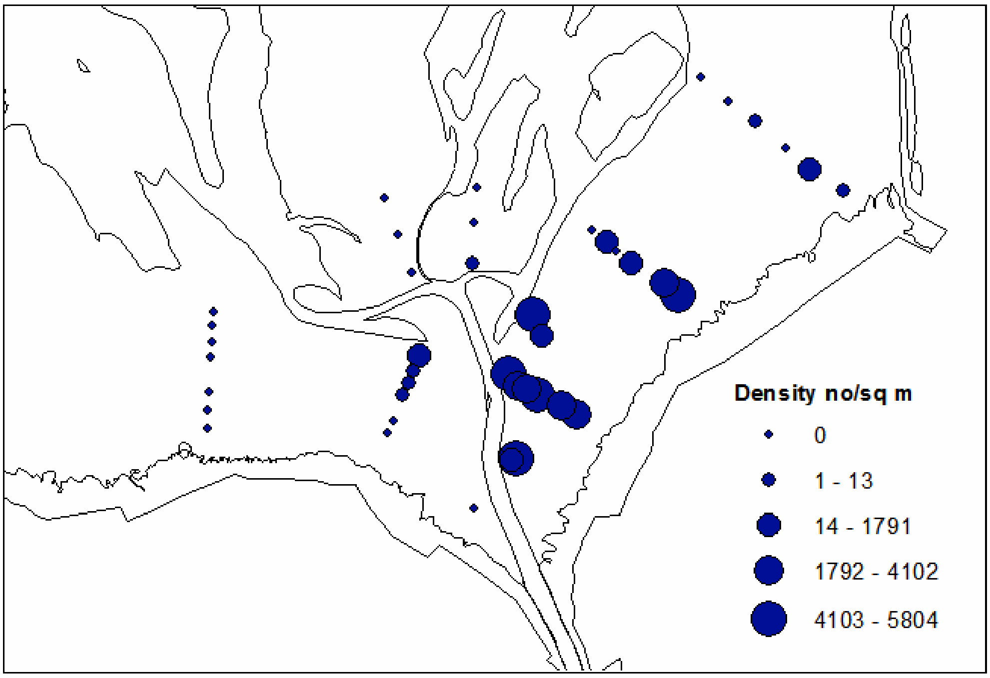


Figure 3.2.1i. Corophium volutator 3+mm

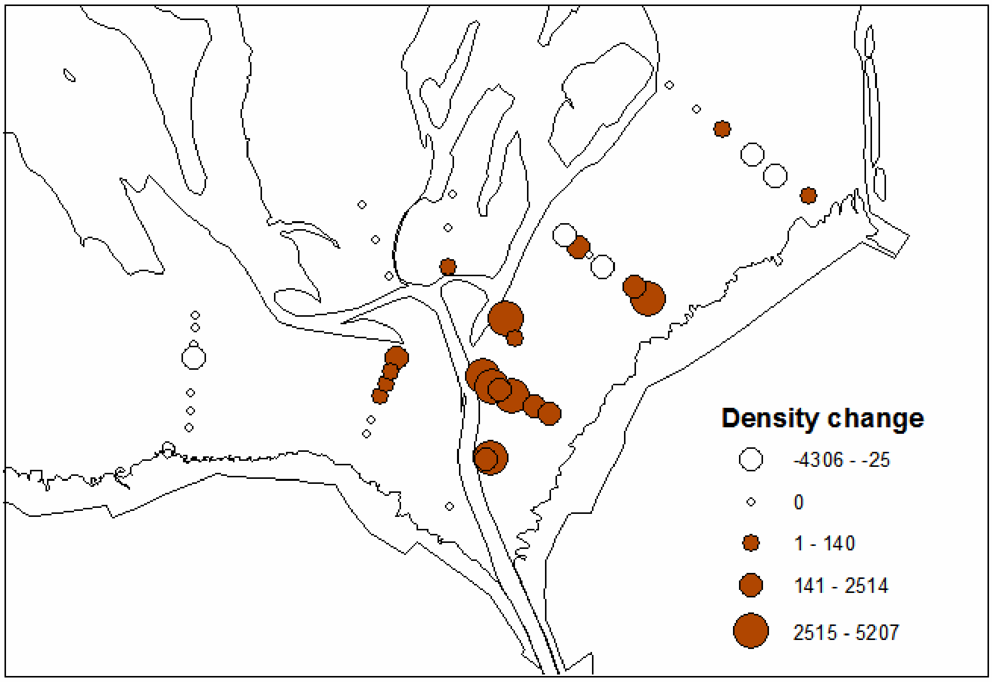


Figure 3.2.1 continued

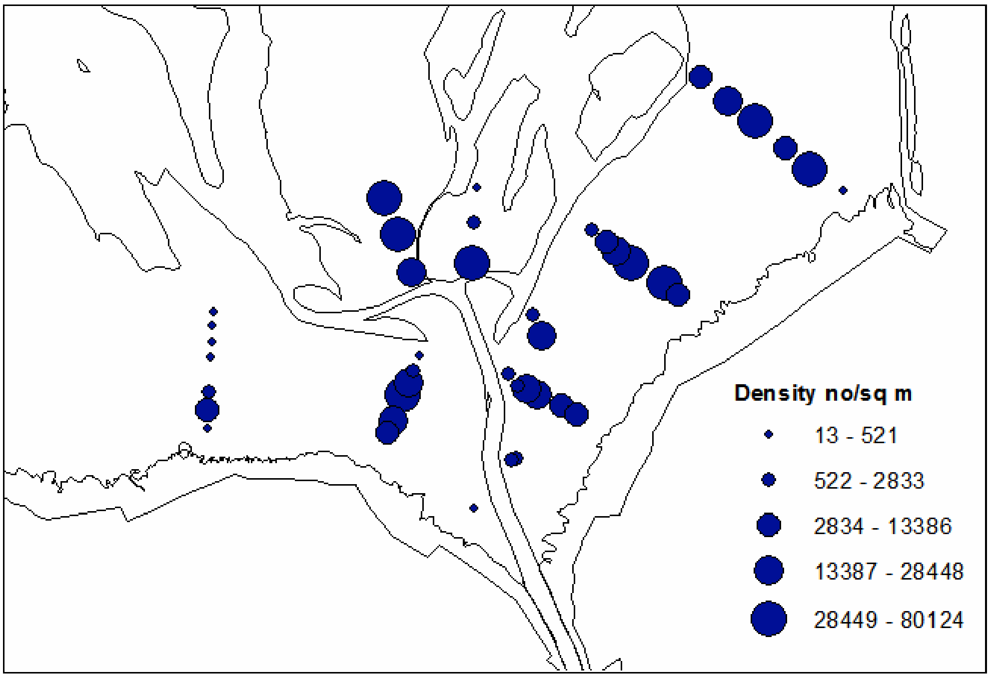


Figure 3.2.1j. Hydrobia ulvae <3mm

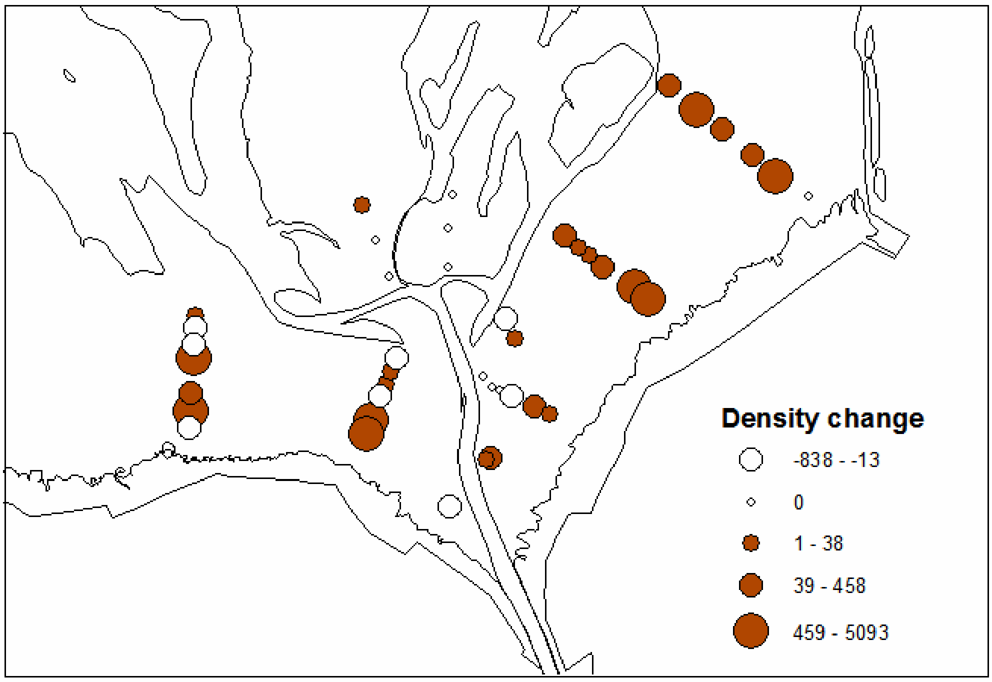


Figure 3.2.1 continued

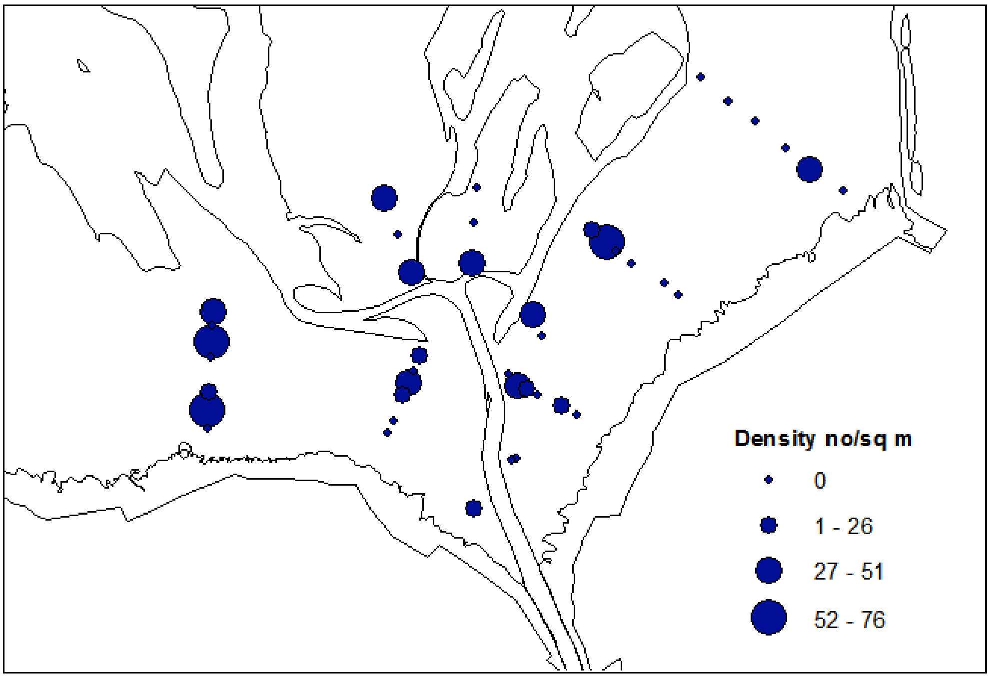


Figure 3.2.1k. Mytilus edulis <5mm

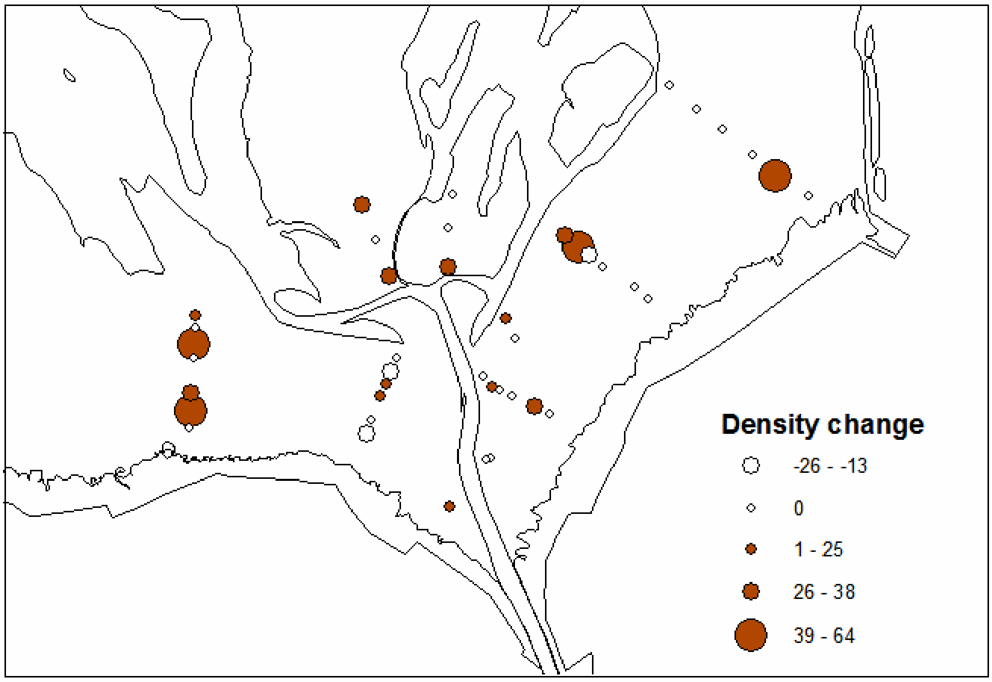


Figure 3.2.1 continued

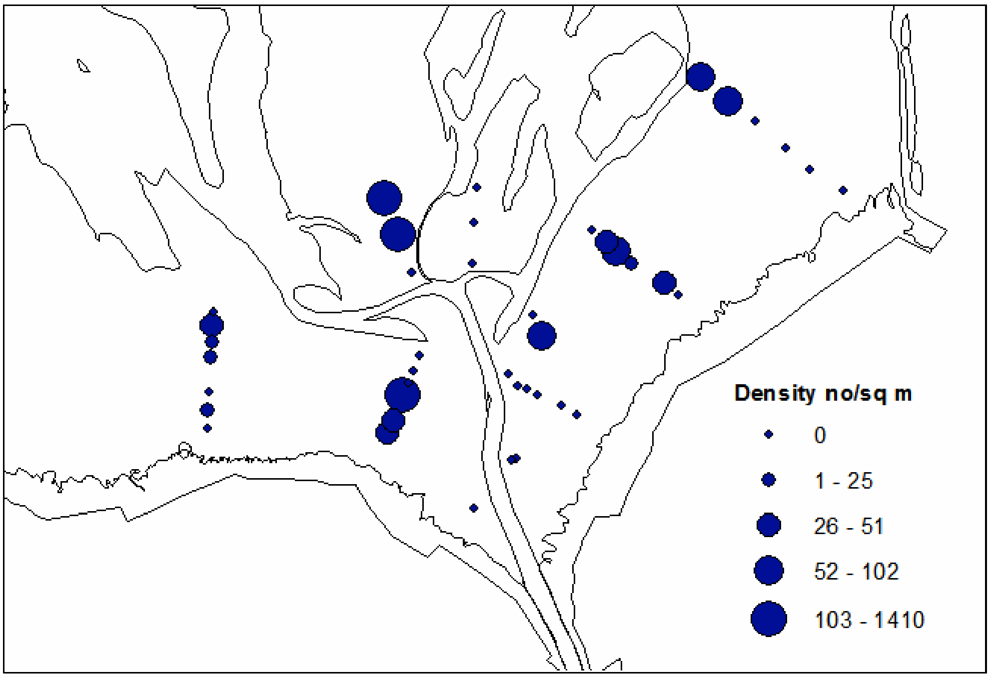


Figure 3.2.1l. Cerastoderma edule 6-10mm

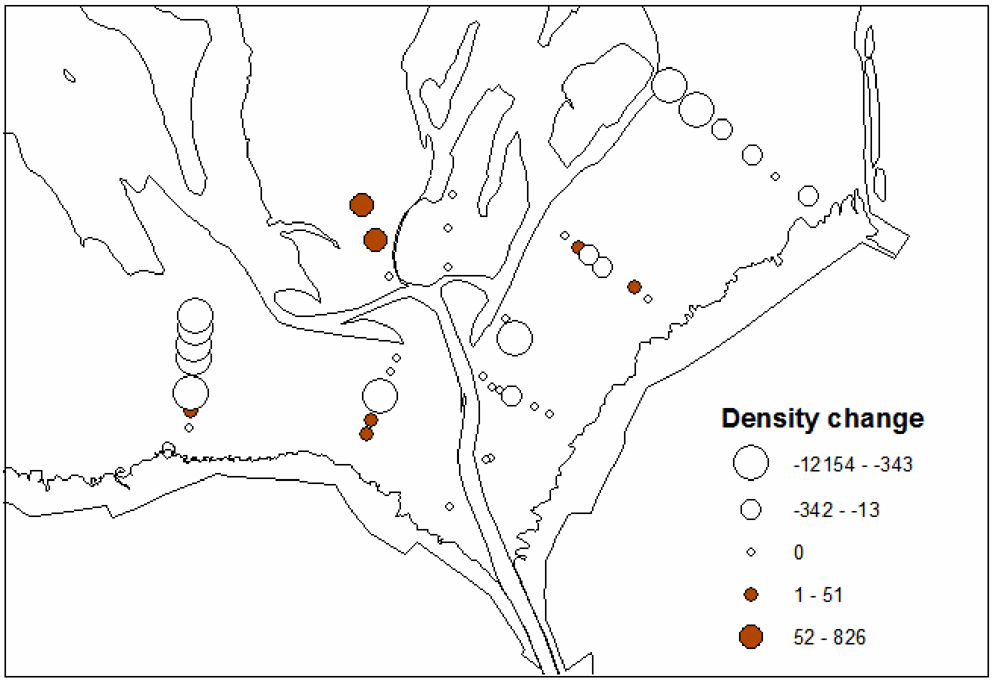


Figure 3.2.1 continued

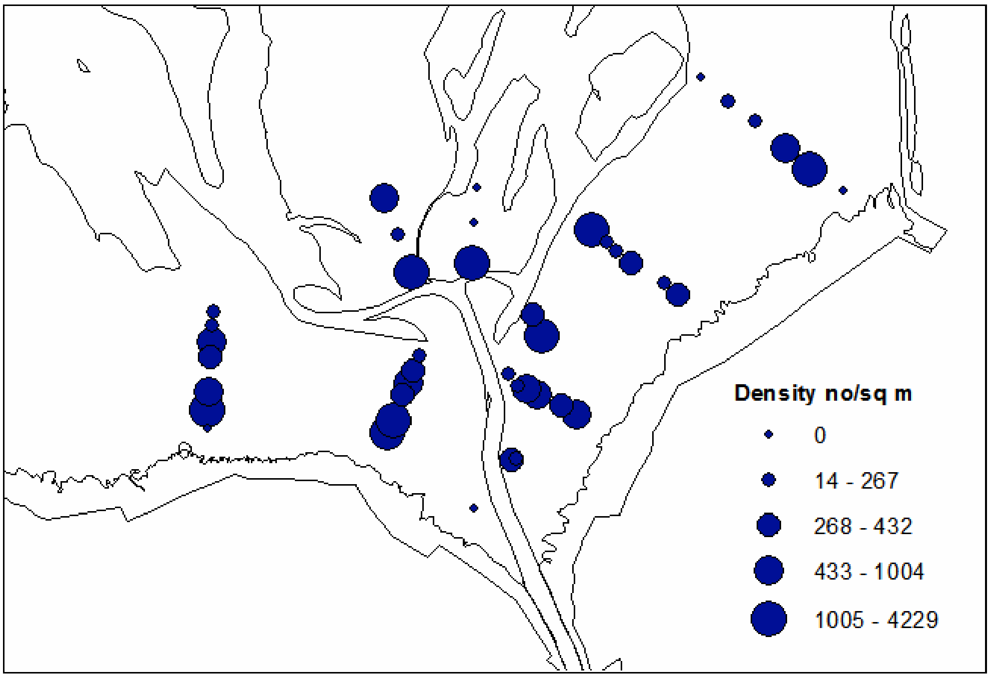


Figure 3.2.1m. Macoma balthica <5mm

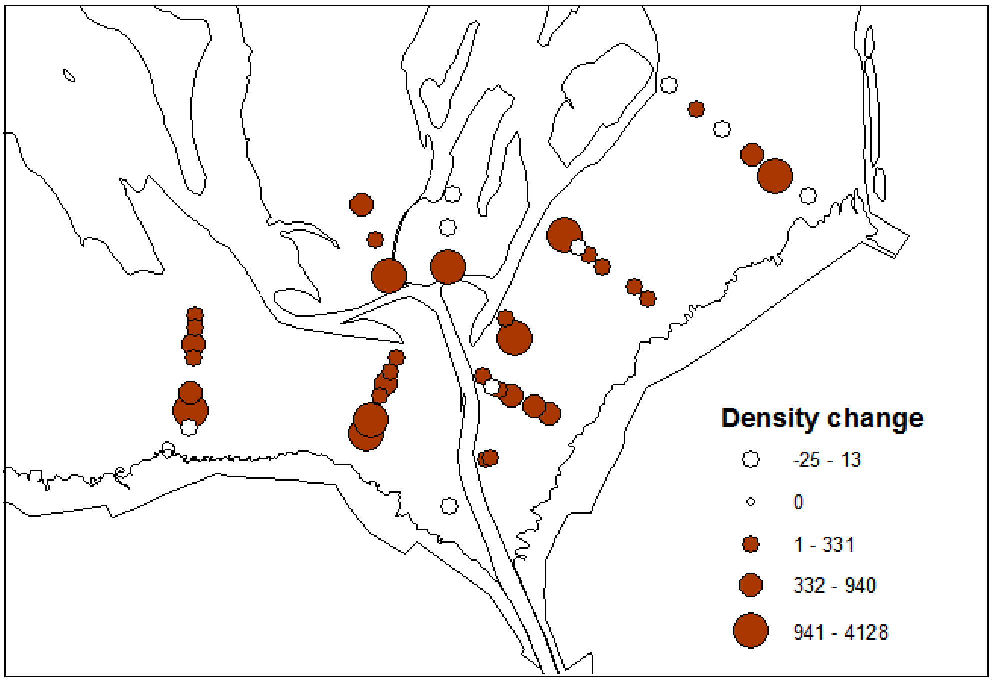


Figure 3.2.1 continued

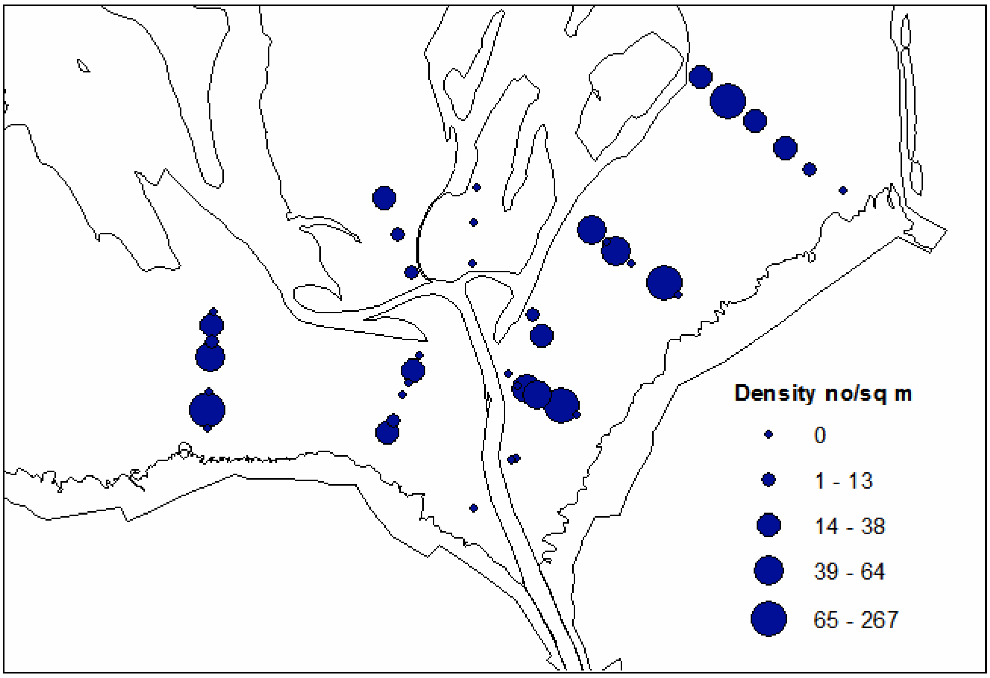


Figure 3.2.1n. Macoma balthica 11-20mm

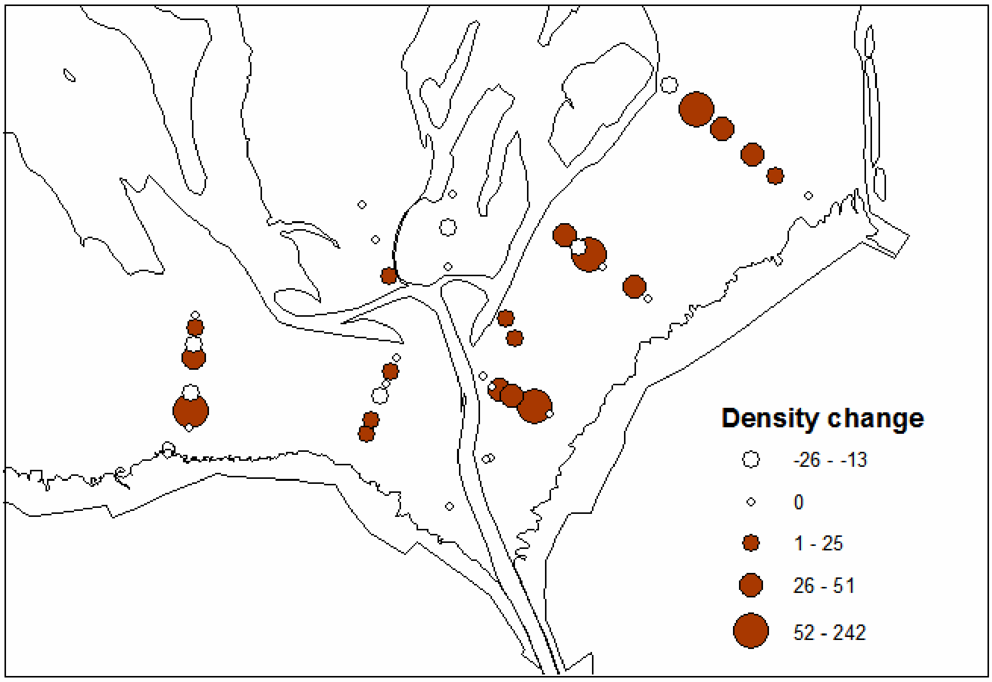


Figure 3.2.1 continued

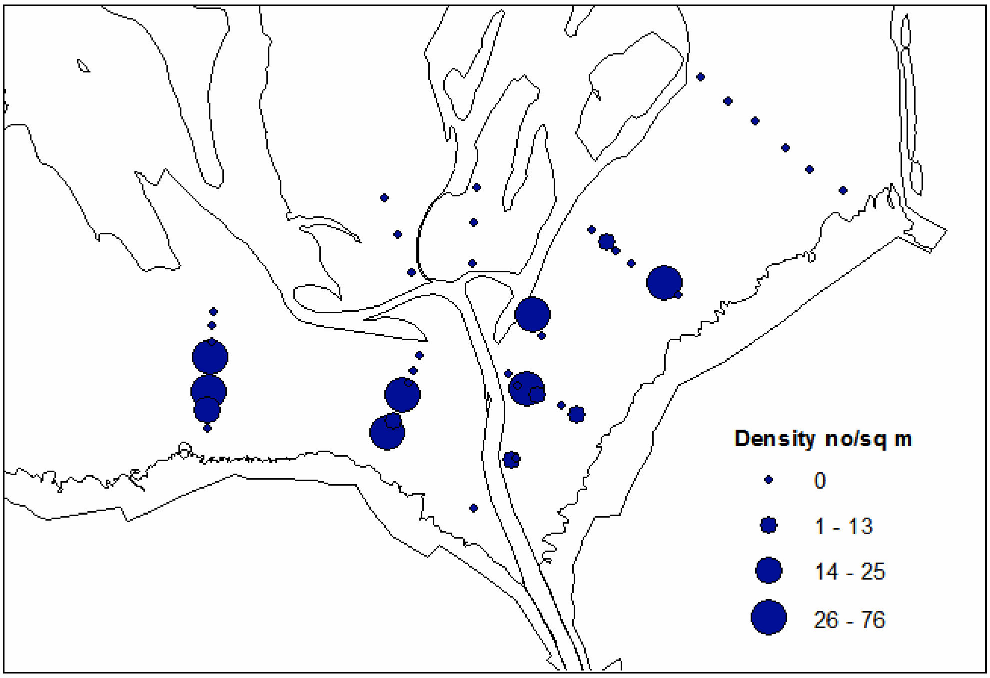


Figure 3.2.1o. Scrobicularia plana <5mm

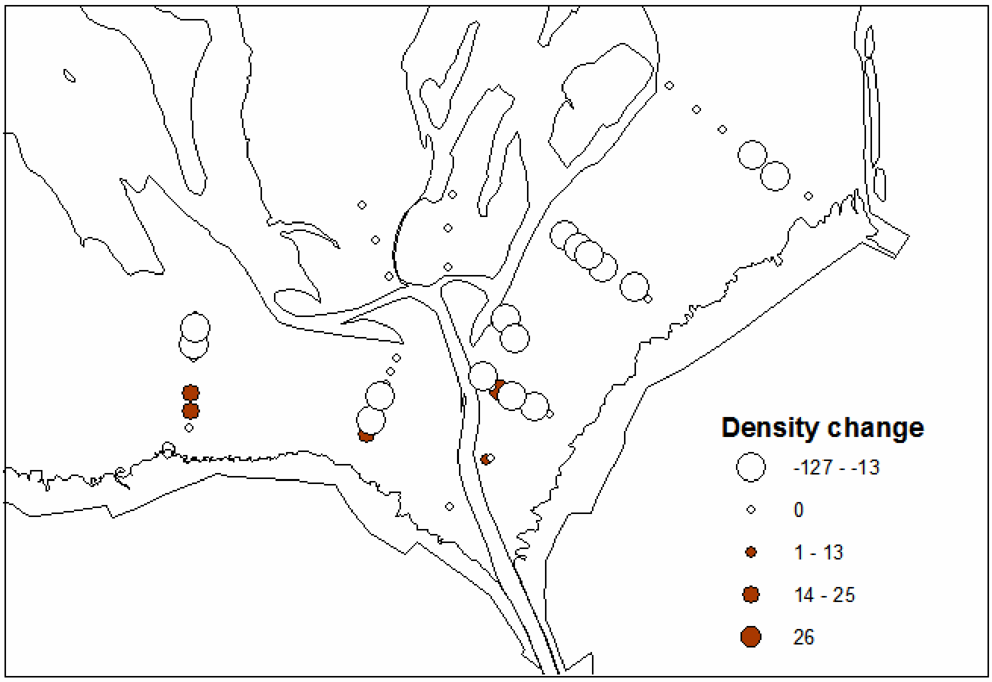
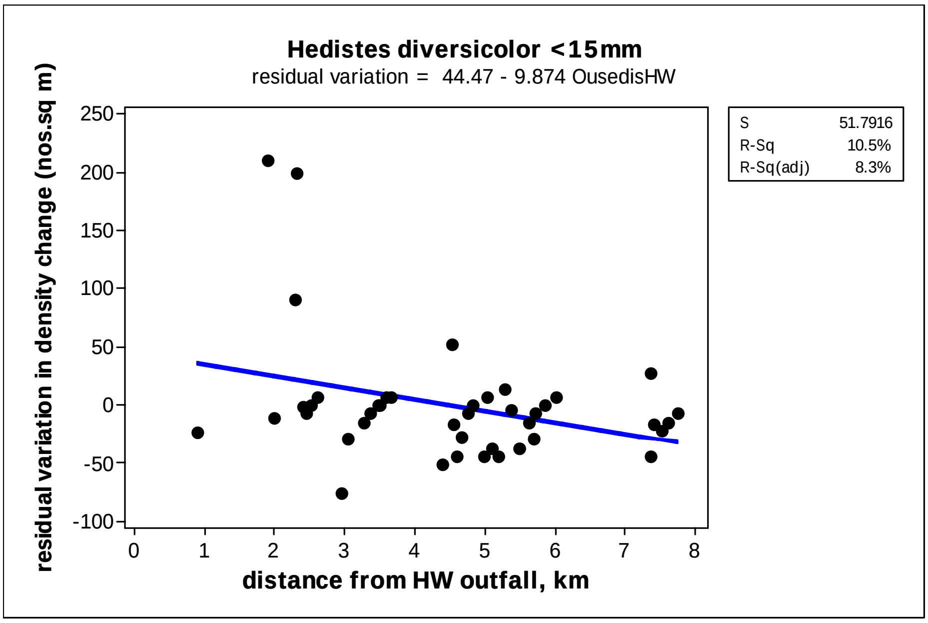


Figure 3.2.2 a-f.
The relationship between the density change, or the residual variation in invertebrate density change between 2006 and 2007, and the distance of the sample sites from the Gt Ouse high water (HW) and low water (LW) outfall (points A and B in Figure 2.1). The fitted relationships are statistically significant ($p<0.05$). The residual variation was that remaining after the effect of sediment particle size and organic content and shore level had been taken into account statistically. Data points represent each of the 42 sample sites in the study area. **a**, *Hediste diversicolor*<15mm, **b**, *Hediste diversicolor* >30mm **c**, Capitellid worms , **d**, *Corophium volutator* <3mm, **e**, *Corophium volutator* >3mm and **f**, *Cerastoderma edule* 6-10mm.

a,



b,

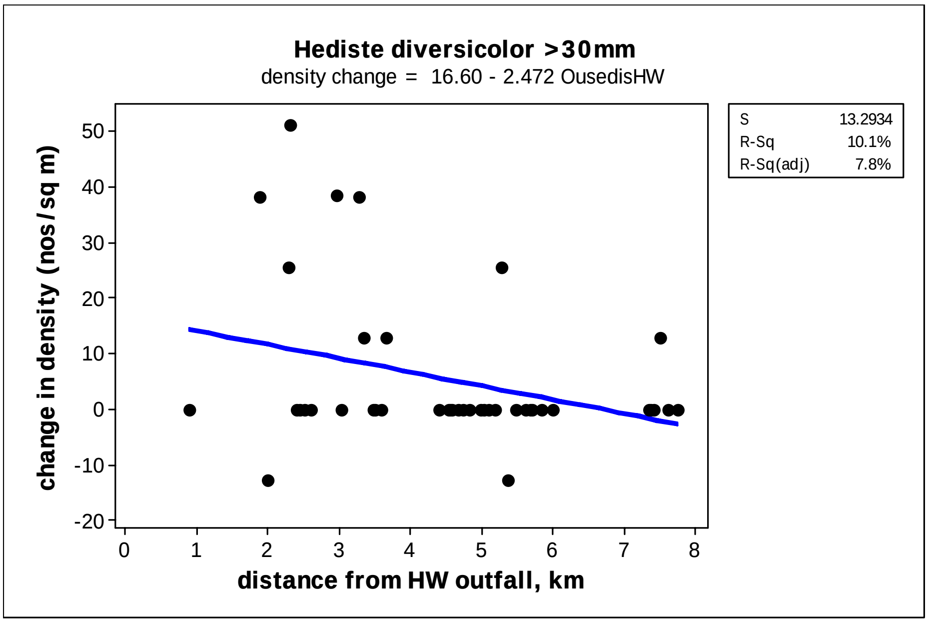
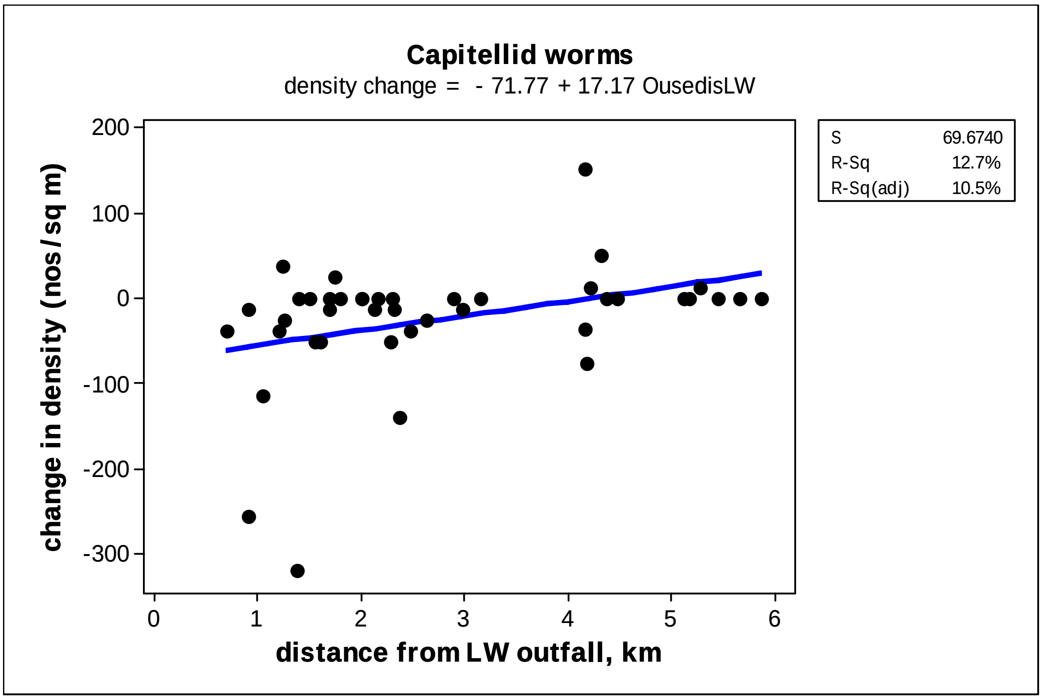


Figure 3.2.2 continued

c,



d,

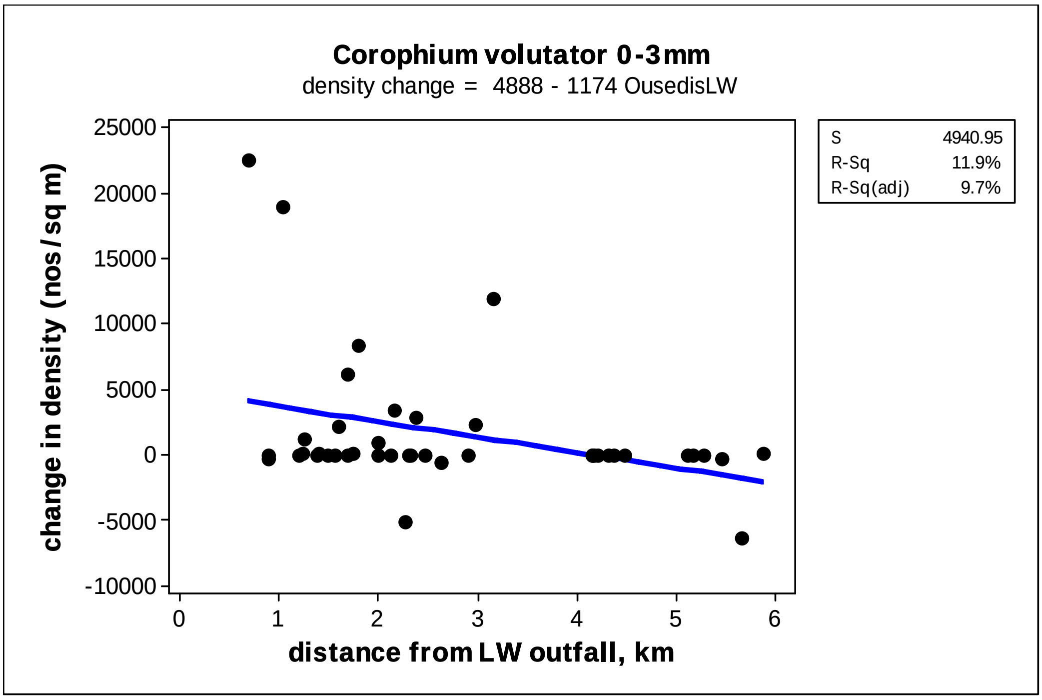
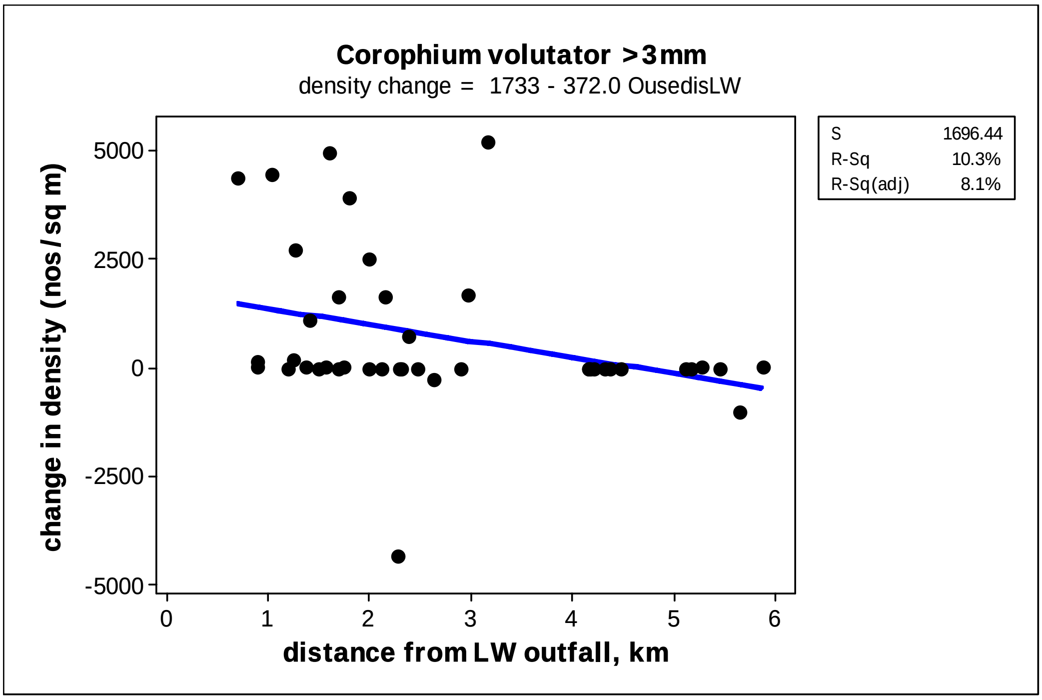


Figure 3.2.2 continued

e,



f,

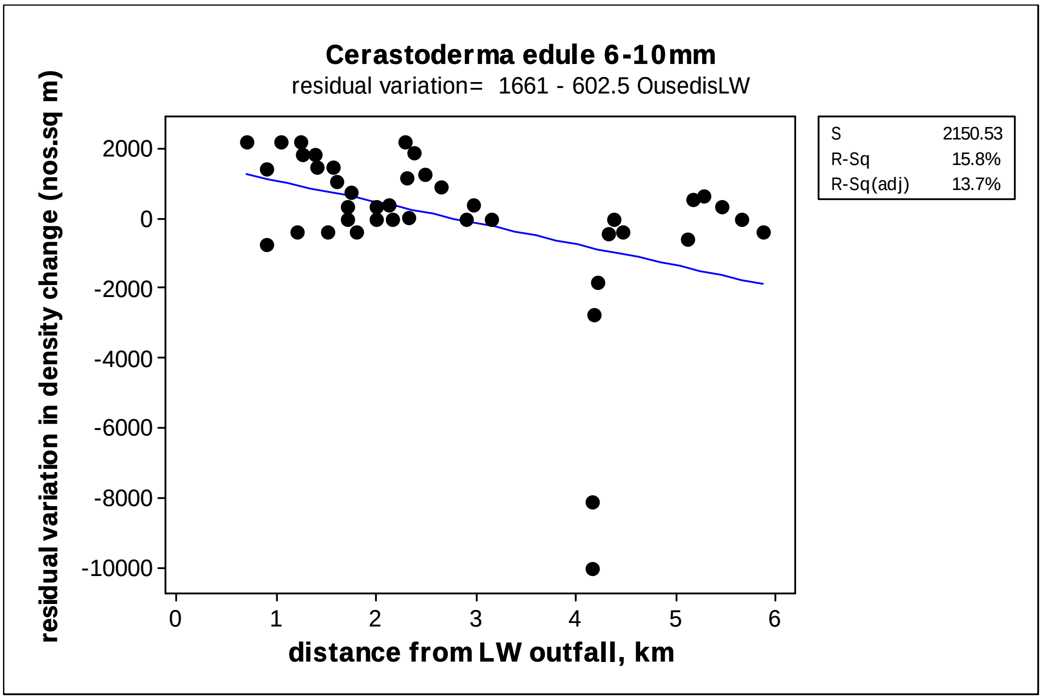
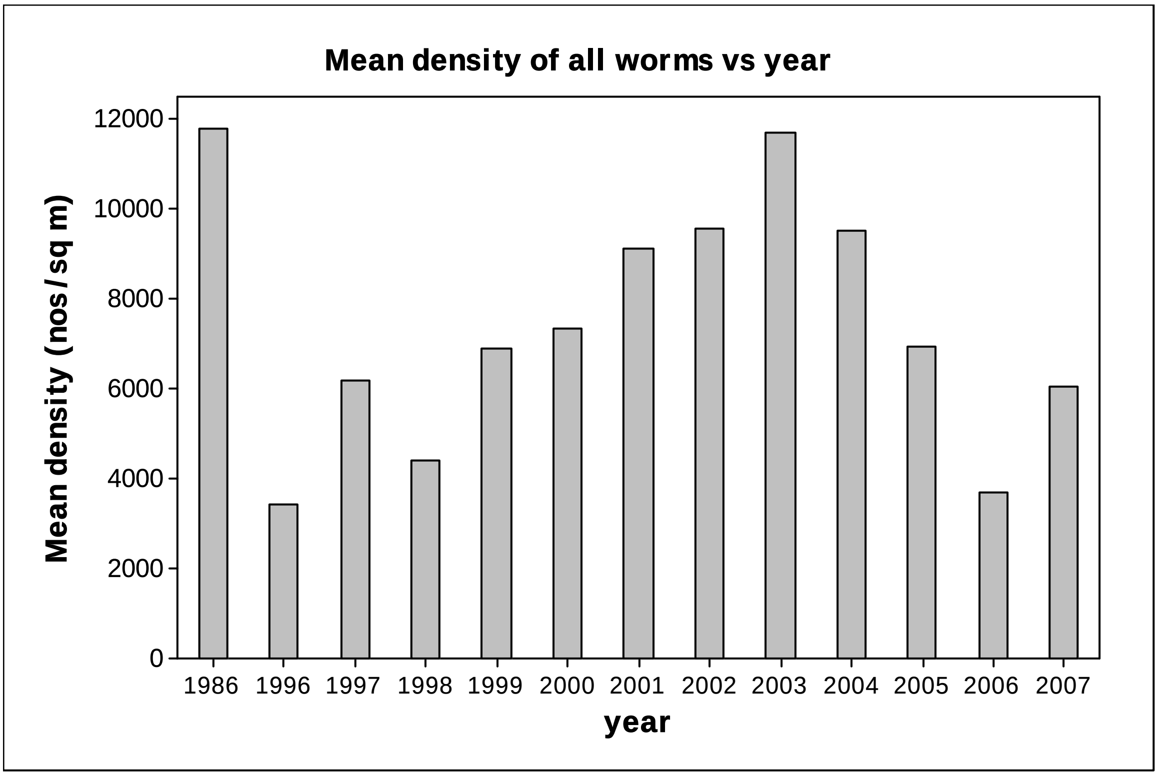


Figure 3.2.3 a-d. The mean density of **a**, worms, **b**, crustaceans, **c**, gastropod molluscs (snails) and **d**, bivalve molluscs on the inner banks of the Gt Ouse study area in the surveys of 1986 and 1996-2007. Densities are expressed as numbers/m^2.

a,



b,

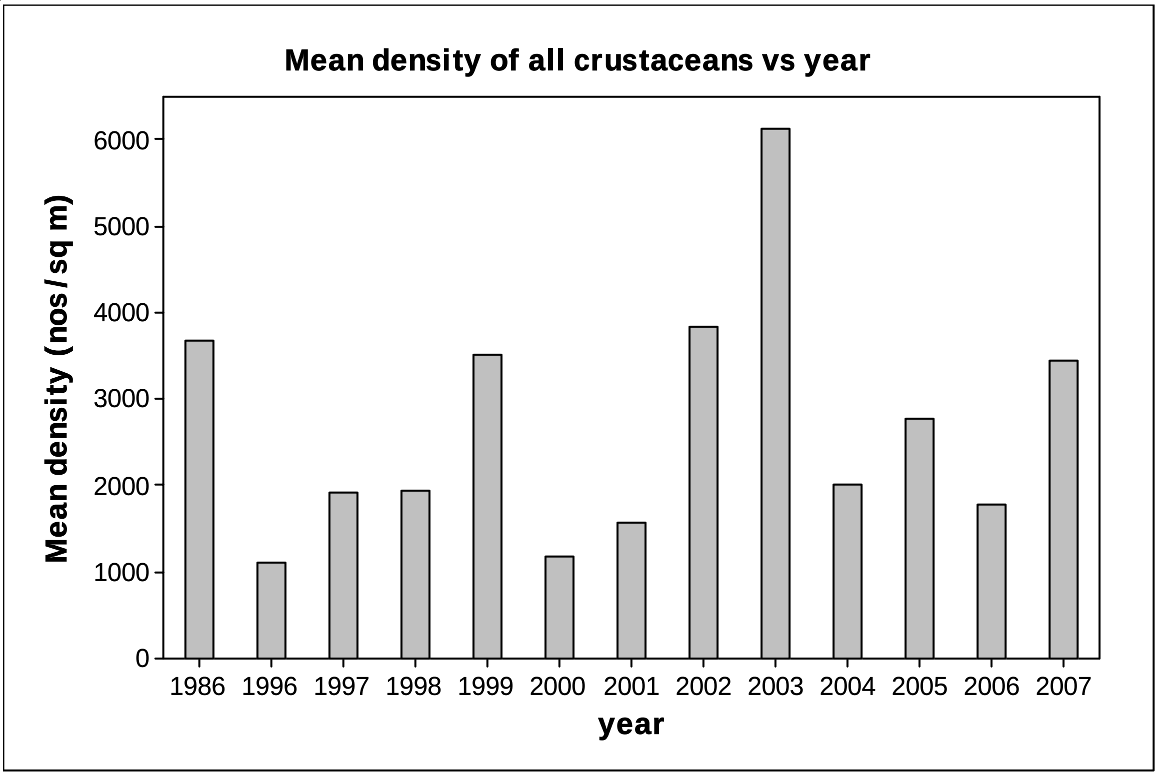
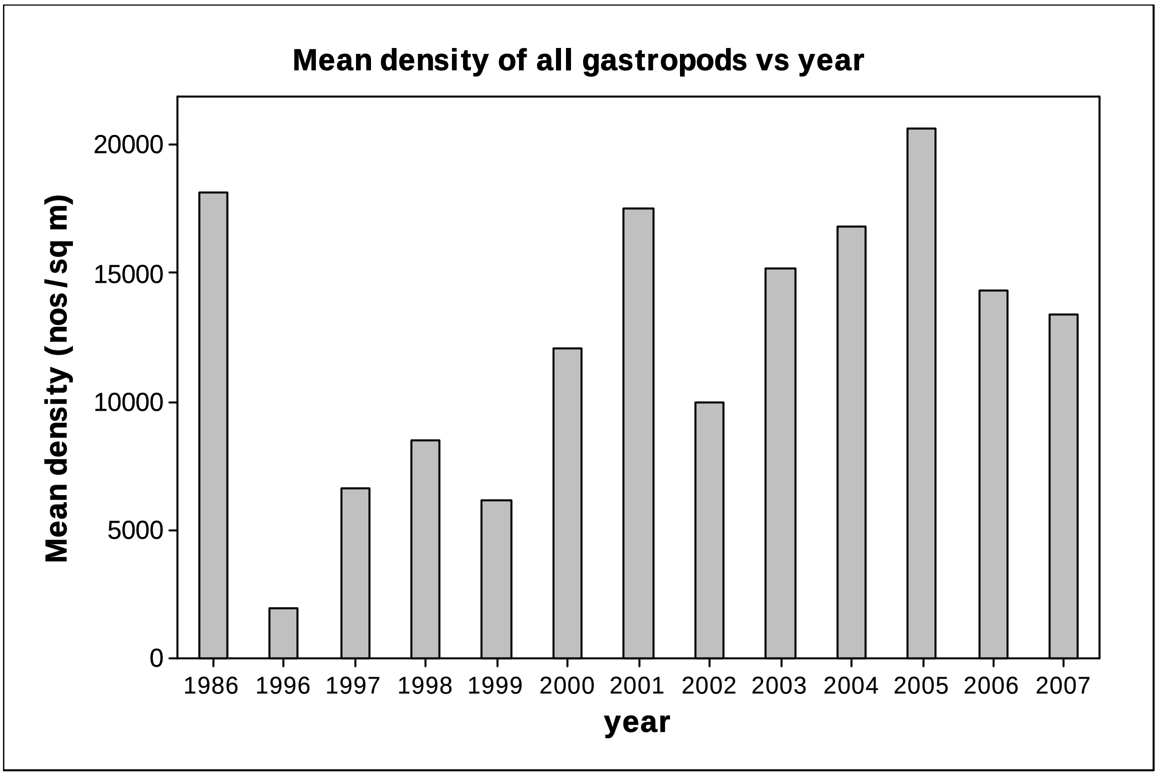
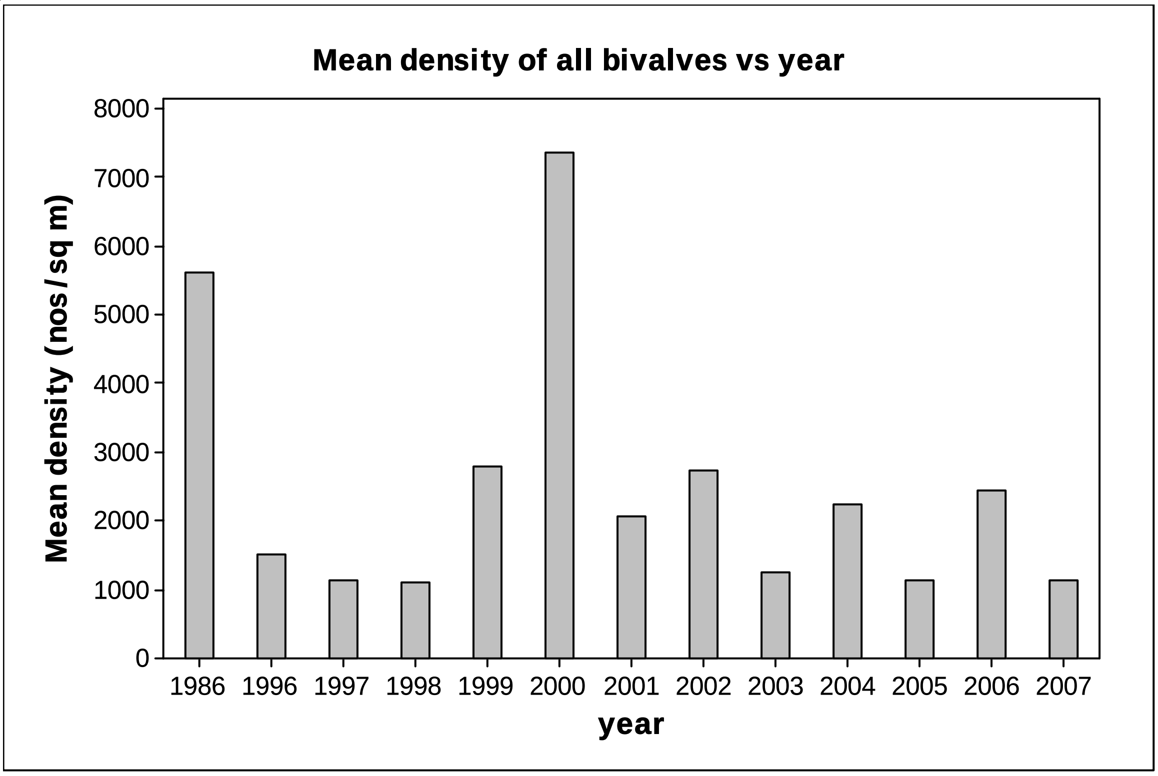


Figure 3.2.3 a-d continued.

c,



d,



3.3 Shorebirds

3.3.1 Introduction

This section deals with the distribution of shorebirds feeding at low-water on the inter-tidal mud and sand flats adjacent to the Gt Ouse outfall. It also compares bird distribution in surveys made in winter 2006-2007 with those made in the previous winter's survey. Data are presented as summary tables and figures within the section and tabulated in Appendix 3. Each winter's survey data has been entered into a GIS-compatible database, an electronic version of which will be submitted at the end of the study.

The transects, labelled 51 to 66, DS and PS in Figure 3.3.1, indicate those parts of the inter-tidal areas adjacent to the Gt Ouse that were surveyed on two occasions in winter 2007-2008.

3.3.2 Shorebird distribution in the 2007-2008 survey and changes compared with 2006-2007 survey.

Both the distribution and abundance of birds in the 2007-2008 survey and in the previous survey are summarised in Figures 3.3.2a-h which chart the mean numbers recorded within each survey transect while Table 3.3.1 summarises the numbers of birds on shores either side the Gt Ouse outfall in the two surveys.

Table 3.3.1. The numbers of seven wader species and Shelduck recorded feeding within the study area adjacent to the Gt Ouse outfall in surveys made during the winters of 2006-07 and 2007-08. Numbers are the mean of two surveys made during mid November to early February each winter. The whole area incorporates the inter-tidal mud and sand flats spanned by transects 51-66 and D and P in Figure 3.3.1. The area defined as the west shore, ie to the west of the River Gt Ouse, is covered by transects 51-55, the outer banks by DS and PS and the east shore by transects 56-66.

Bird species	West shore		Outer banks		East shore		Whole study area	
survey	2006	2007	2006	2007	2006	2007	2006	2007
Dunlin	541	119	556	223	2538	2925	3634	3266
Redshank	82	42	12	7	237	316	331	365
Knot	3527	1766	607	280	10220	6816	14354	8862
Grey Plover	37	61	23	11	48	161	107	232
Bar-tailed Godwit	214	42	72	12	343	282	628	335
Oystercatcher	294	294	216	107	421	784	931	1184
Curlew	146	41	16	8	145	121	306	170
Shelduck	854	368	1	0	741	948	1596	1316

Dunlin, knot, bar-tailed godwit, curlew and shelduck were less abundant in 2007-08 than they were in the previous winters' survey, while redshank grey plover and oystercatcher were more abundant. (Table 3.3.1).

A feature of the birds’ distribution in 2007-08 was that most species were widespread across the study area and occurred in the majority of the survey transects. Previously dunlin (*Calidris alpina,* Figure 3.3.2a), redshank (*Tringa totanus,* Figure 3.3.2b), and curlew (*Numenius arquata* Figure 3.3.2g) were the most widespread with the remaining species being more aggregated. But in the current survey knot (*Calidris canutus,* Figure 3.3.2c), grey plover (*Pluvialis squatarola* Figure 3.3.2d), bar-tailed godwit (*Limosa lapponica*, Figure 3.3.2e), oystercatcher (*Haematopus ostralegus,* Figure 3.3.2f) and shelduck (*Tadorna tadorna,* Figure 3.3.2g) were also more widely spread.

In 2007-08 dunlin were most numerous on areas of Bulldog Sand (transects 57, 58 and 60). Peaks in redshank numbers occurred in areas of Bulldog and Peter Black Sands spanned by transects 57 to 60 on the east shore and in transect 52 on the west shore. Peaks in the numbers of knot occurred on Ferrier and Stubborn Sands (transect 63-66). Grey plover were most numerous Breast Sand (transect 51) and on Ferrier Sand (Transect 63). Bar-tailed godwit were most numerous on Stubborn Sand with notably less abundant on shore to the west of the river than in previous surveys. Oystercatchers were most numerous on Stubborn Sand (transect 64-66) but were noticeably more widespread across the study area than in previous years. Curlew numbers peaked on Stubborn Sand on the east shore. The peak in shelduck numbers occurred on Ferrier Sand.

In order to detect whether the within-transect change in bird numbers between years was related to proximity to the Gt Ouse outfall, the logarithm ($\log_{10}$) of ratios between 2007-2008 to 2006-2007 numbers were plotted against the transect’s distance from the outfall. Any visual indication of a pattern in the plots was tested by regression analysis. However there was no evidence of any relationship for any species.

Year on year changes in abundance within the study area and the whole Wash.

The year on year change in bird numbers in the study area (Table 3.3.1) could represent localised changes around the Gt Ouse outfall or changes that occurred at a Wash-wide scale. We checked these possibilities by comparing the change in numbers between the current and previous winter’s survey of the study area with that in the whole Wash (Table 3.3.2) by expressing the numbers recorded in winter 2006-07 as a percentage of those in the previous winter. The whole Wash data were calculated from the Wetlands and Estuary Birds Scheme (WeBS) counts that were made independently of our own.

Table 3.3.2. Bird numbers in winter 2007-2008 expressed as a percentage of those in winter 2006-2007 for the study area and the whole Wash (WeBS counts).

Bird species	Study area	Whole Wash
	2007 numbers as % of 2006 numbers	2007 numbers as % of 2006 numbers
Dunlin	90	88
Redshank	110	73
Knot	62	61
Grey Plover	217	175
Bar-tailed Godwit	53	88
Oystercatcher	127	99
Curlew	56	85
Shelduck	83	88

Relative to the winter of 2006-07, the numbers of all species except redshank, grey plover and oystercatcher decreased in the study area in winter 2007-08. In the case of dunlin, knot and shelduck, this decrease was of a similar proportion to that in the whole Wash implying that changes were Wash-wide. In the cases of bar-tailed godwit and curlew the proportional decrease was more pronounced in the study area than in the Wash as a whole implying that the study was a much less preferred feeding area for these species in winter 2006-07. The increases in redshank, grey plover and oystercatcher numbers in the study area were not matched by those for the Wash implying that area was a preferred feeding site for those species.

3.3.2.1 Changes in bird numbers: 1986, 1989-1991 and 1996-2007

The numbers of shorebirds feeding on the inner banks of the Gt Ouse study area at low tide have been surveyed for a total of 16 winters to date and they have been summarised (Figure 3.3.3) to put into perspective the changes that have occurred during the course of this study.

Dunlin numbers have steadily declined during the last eight years of this study from a peak in 1998. Numbers in the current survey were similar to the low numbers recorded in the winters of 1986 and 1991. Redshank numbers were at their high in 1990 but had dropped to their lowest in 1996 at the start of the study. Since then numbers have increased steadily to their highest in 2003, although their numbers have declined annually since then. Knot were most abundant in 1990 and least abundant in 1999 since when their numbers have remained relatively stable until increases in 2004 and 2006 but not to numbers as high as those recorded in the late 1980’s and early 1990’s. Grey plover numbers in the current survey were similar to the average for the study period having been at their lowest during the previous year. Peak numbers were previously recorded in 1990 and 2003. Bar-tailed godwit numbers were highest in 1996 when those of most other species were at or near their lowest. Then numbers decreased annually until 1999-2000 since when they have risen steadily until to last two years during which numbers have decreased to the second lowest recorded over the entire study period. Oystercatcher numbers were at their lowest in early to mid 1990’s following the decline in cockle and mussel stocks in the Wash. However, numbers had steadily increased until 2003, but have declined since then. Curlew numbers reached a peak in 2002 similar to that in 1989 but have since declined steadily to an extent that the numbers in the current survey were the lowest recorded during the course of the study. Shelduck numbers were consistently higher in the late 1980's to early 1990's than they have been since 1996. Lowest numbers were recorded in 1999 after when they increased but have dropped again in last two winters surveys.

3.3.3 Summary and conclusions

Dunlin, knot, bar-tailed godwit, curlew and shelduck were less abundant in 2007-08 than they were in the previous winters' survey, while redshank grey plover and oystercatcher were more abundant.

A feature of the birds' distribution in 2007-08 was that most species were widespread across the study area and occurred in the majority of the survey transects. Previously dunlin, redshank, and curlew were the most widespread with the remaining species being more aggregated. But in the current survey knot, grey plover, bar-tailed godwit, oystercatcher and shelduck were more widely spread than they had been in previous winters.

There was no evidence of any relationship between the change in bird distribution between the current and previous survey and distance from the Gt Ouse outfall for any species.

Change in shorebird numbers within the study area between the current winters' survey and the previous winter was compared with that recorded in the whole Wash to determine whether changes were local or Wash-wide. Relative to the winter of 2006-07, the numbers of all species except redshank, grey plover and oystercatcher decreased in the study area in winter 2007-08. In the case of dunlin, knot and shelduck, this decrease was of a similar proportion to that in the whole Wash implying that changes were Wash-wide. In the cases of bar-tailed godwit and curlew the proportional decrease was more pronounced in the study area than in the Wash as a whole implying that the study area was a much less preferred feeding area for these species in winter 2006-07. The increases in redshank, grey plover and oystercatcher numbers in the study area were not matched by those for the whole Wash implying that the study area was a preferred feeding site for those species.

The numbers of shorebirds feeding on the inner banks of the Gt Ouse study area at low tide have been surveyed for a total of 16 winters to date and were summarised to put into perspective the changes that have occurred during the course of this study. Dunlin, bar-tailed godwit, curlew and shelduck numbers were all below the average for the study period in 2007 while those of redshank, knot, grey plover and oystercatcher were around or a little above the average.

Section 3.3

Figure legends

Figure 3.3.1

The ITE shorebird transects, numbered 51-66, within which the distribution of shorebirds feeding at low water was surveyed. Transects were aligned along the direction of flow of the ebbing tide. Areas of the outer banks, Daseley's Sand (DS) and Pandora Sand (PS), that were surveyed are indicated by cross-hatch shading.

Figure 3.3.2a-h

The numbers of shorebirds in each survey transect in the winters of 2006-2007 and 2007-2008. Numbers are the mean of two counts made during November to January in each winter. Transects are those shown in Figure 3.3.1(note; ‘OBs’ refer to the outer banks, Daseley’s and Pandora Sands). **a**, Dunlin **b,** Redshank **c,** Knot **d,** Grey plover **e,** Bar-tailed godwit **f,** Oystercatcher **g,** Curlew and **h,** Shelduck.

Figure 3.3.3

The total numbers of shorebirds feeding on the inner banks of the Gt Ouse study area in winters 1986-87, 1989-90 to 1991-92 and 1996-97 to 2007-08.

Figure 3.3.1

The ITE shorebird transects, numbered 51-66, within which the distribution of shorebirds feeding at low water was surveyed. Transects were aligned along the direction of flow of the ebbing tide. Areas of the outer banks, Daseley's Sand (DS) and Pandora Sand (PS) that were surveyed are indicated by cross-hatch shading.

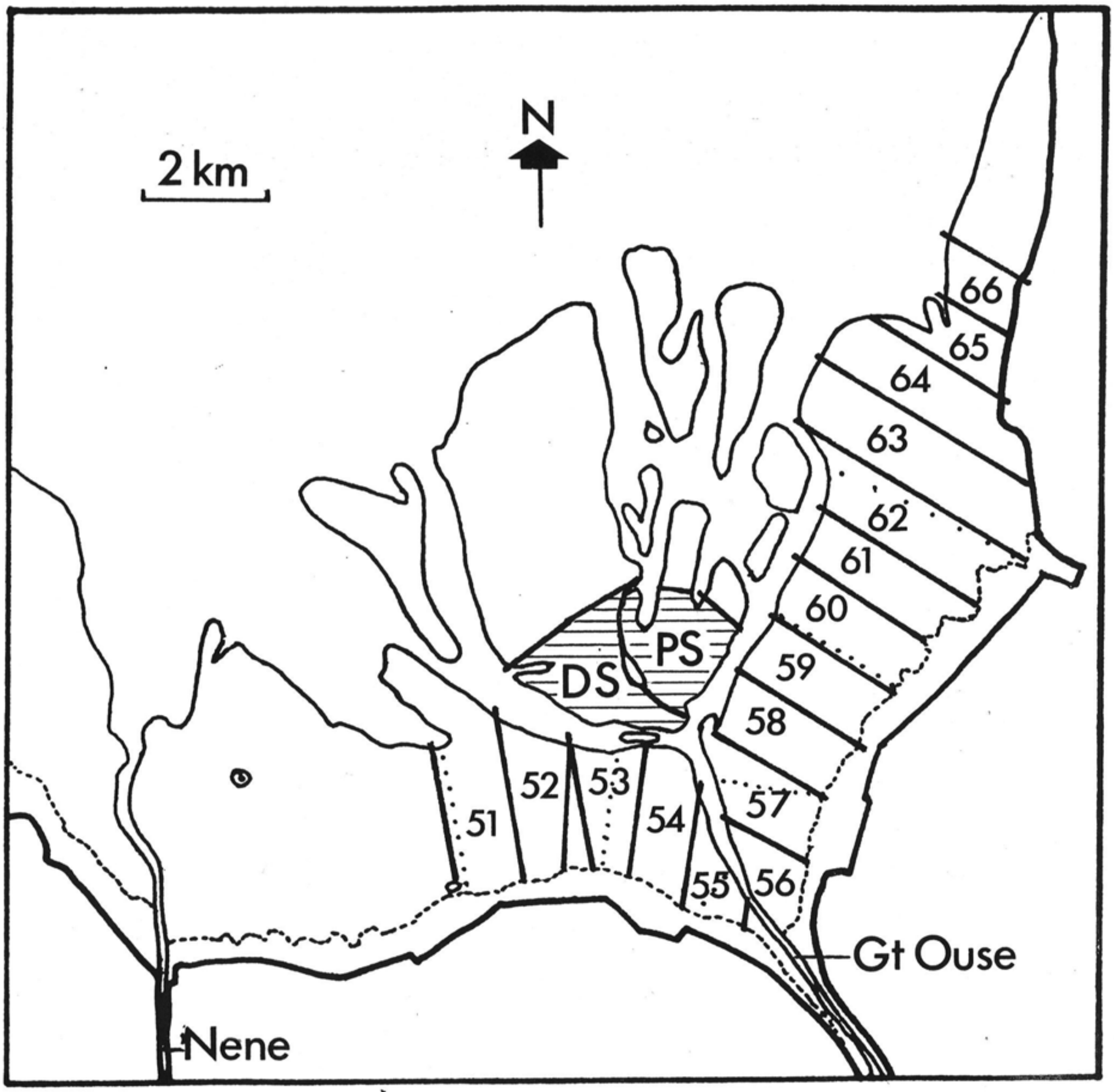
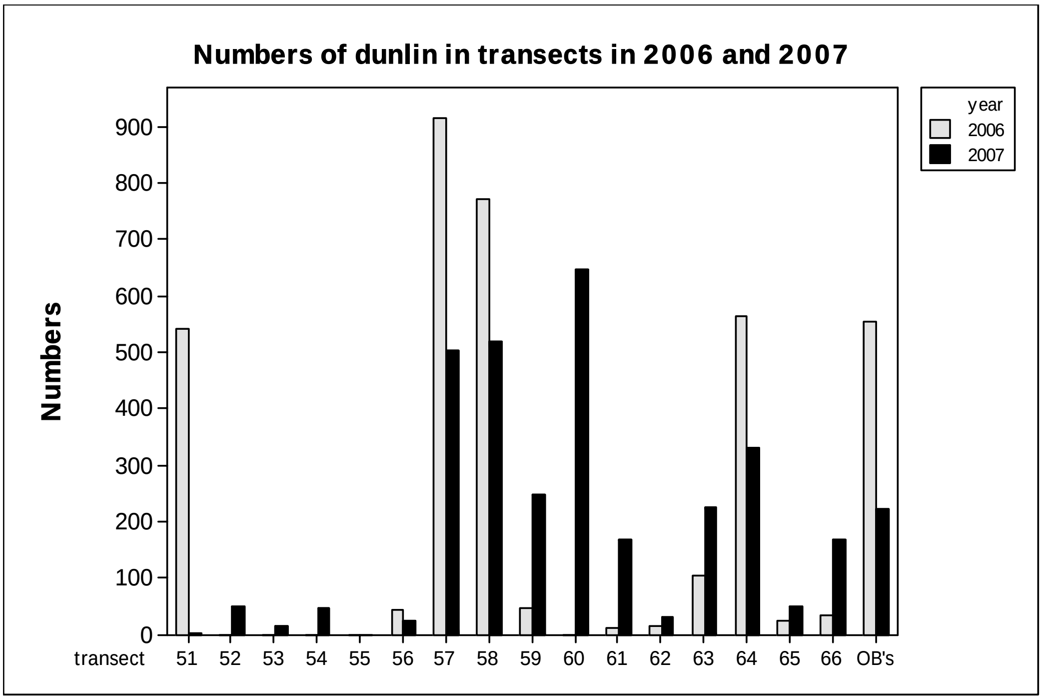


Figure 3.3.2a-h The numbers of shorebirds in each survey transect in the winters of 2006-2007 and 2007-2008. Numbers are the mean of two counts made during November to January in each winter. Transects are those shown in Figure 3.3.1(note; 'OBs' refer to the outer banks, Daseley's and Pandora Sands). **a**, Dunlin **b,** Redshank **c,** Knot **d,** Grey plover **e,** Bar-tailed godwit **f,** Oystercatcher **g,** Curlew and **h,** Shelduck.

a,



b,

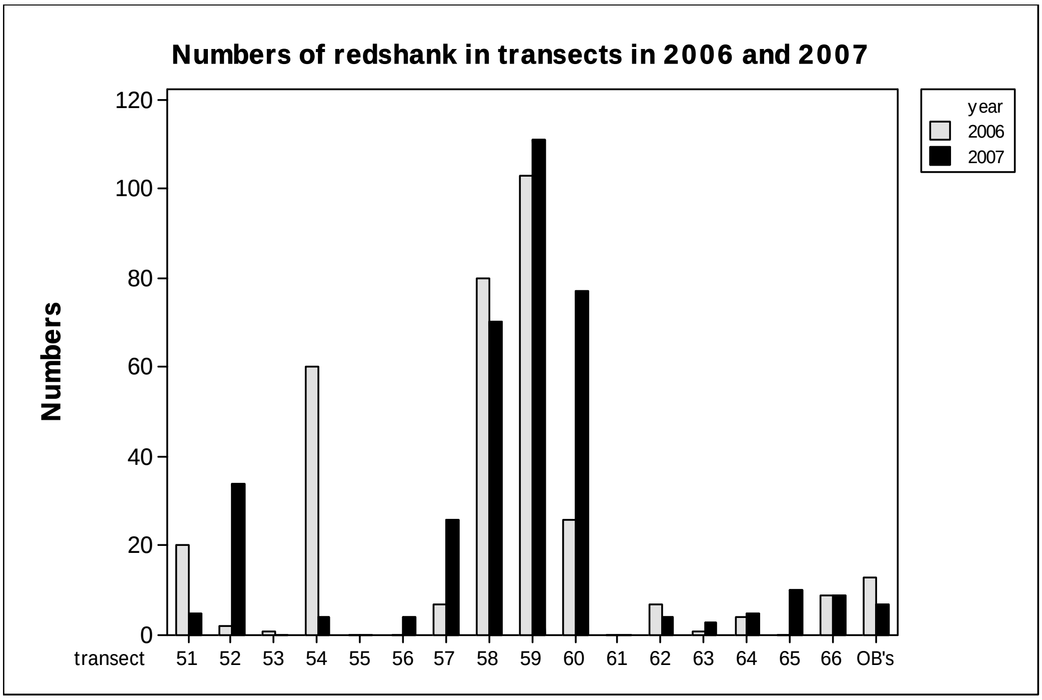
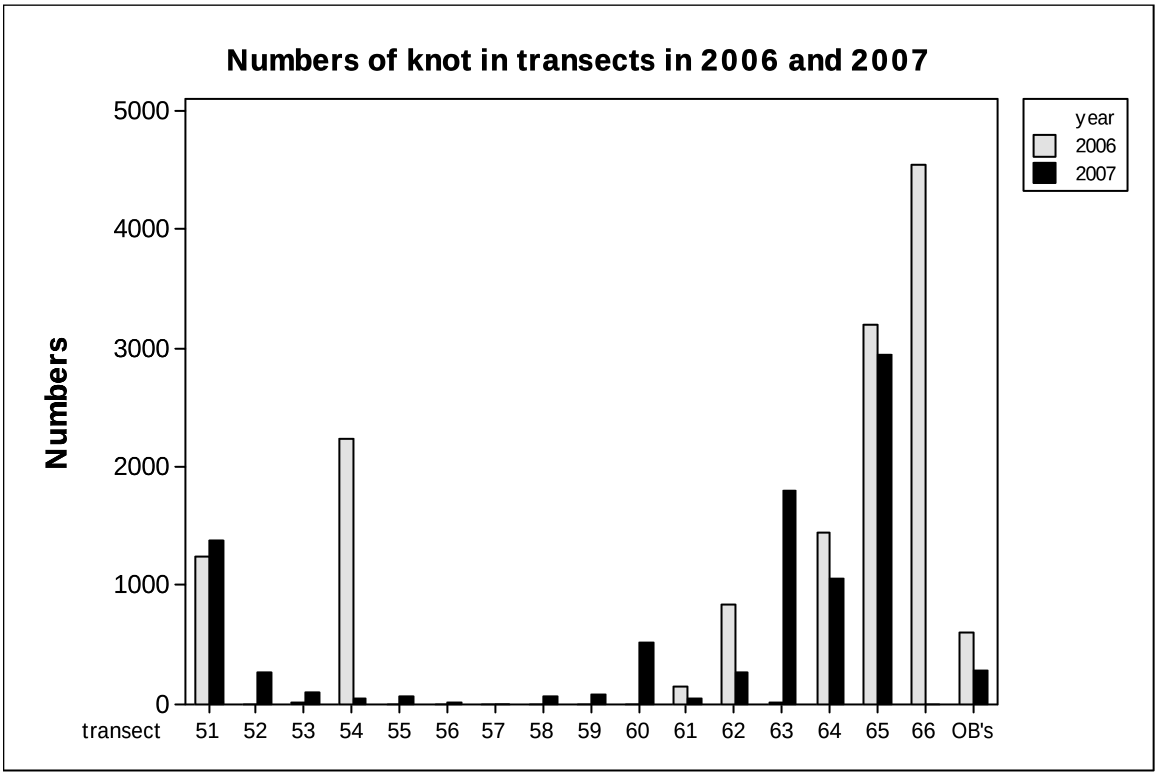


Figure 3.3.2a-h continued

c,



d,

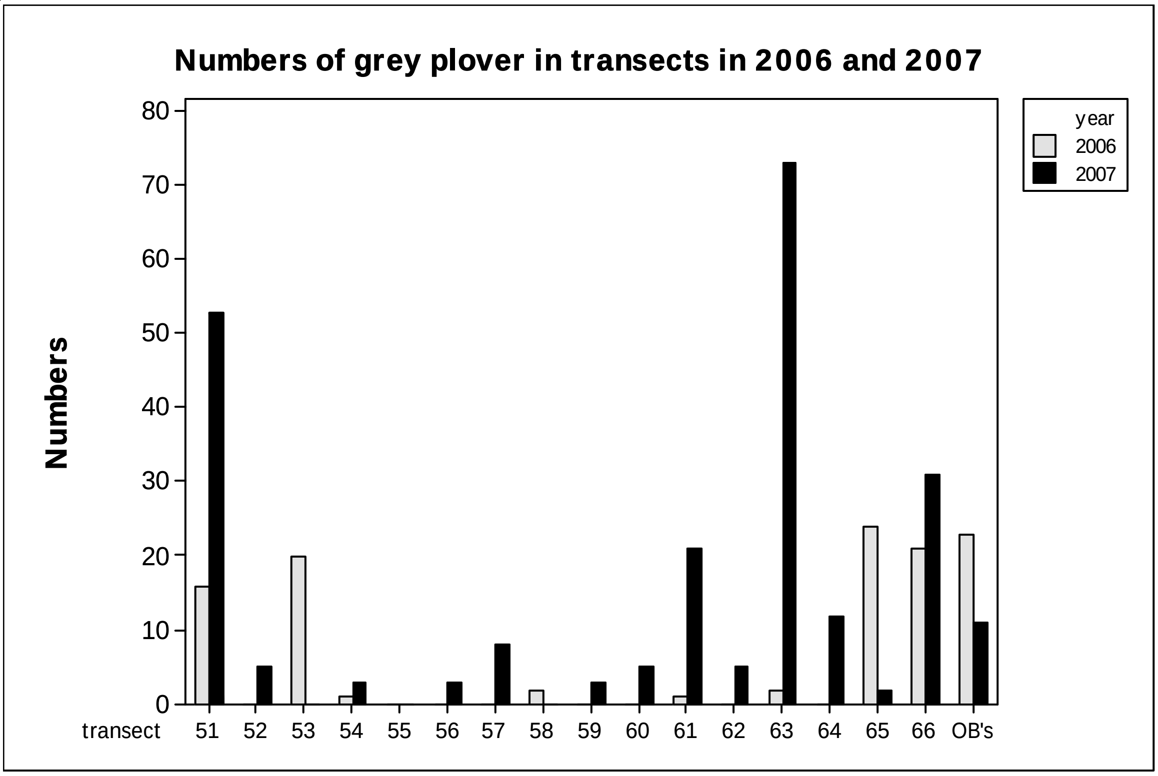
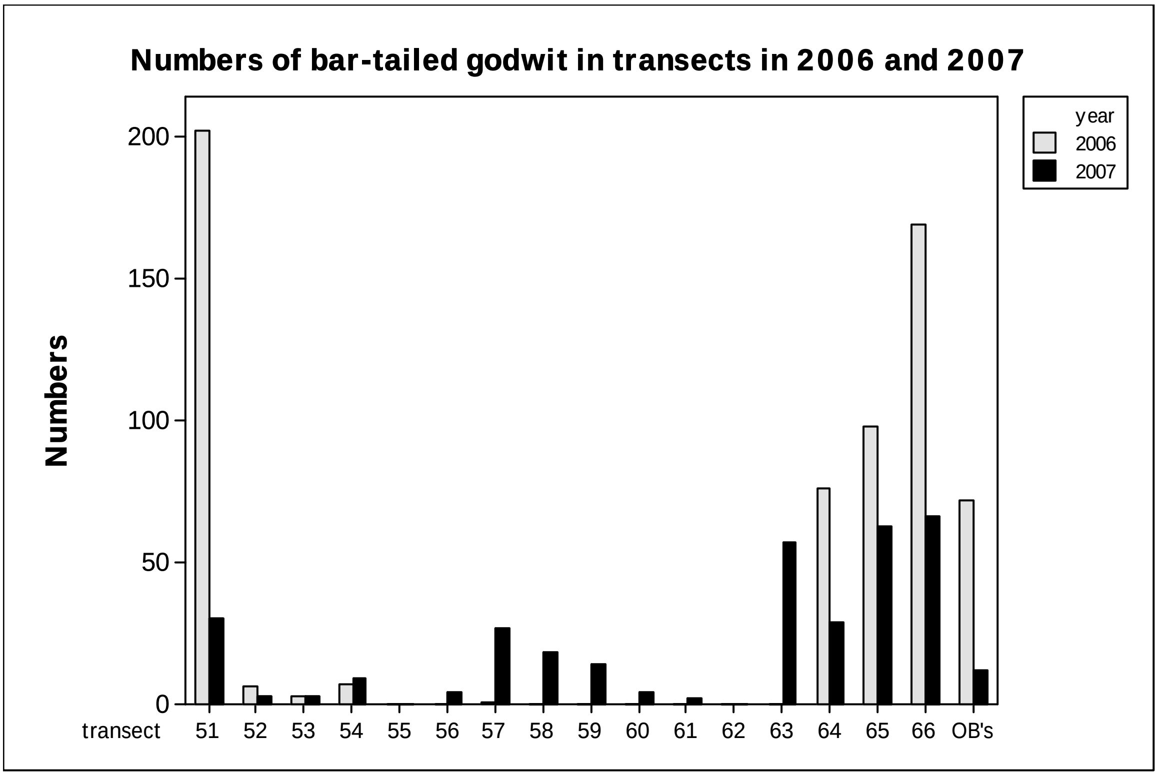


Figure 3.3.2a-h continued

e,



f,

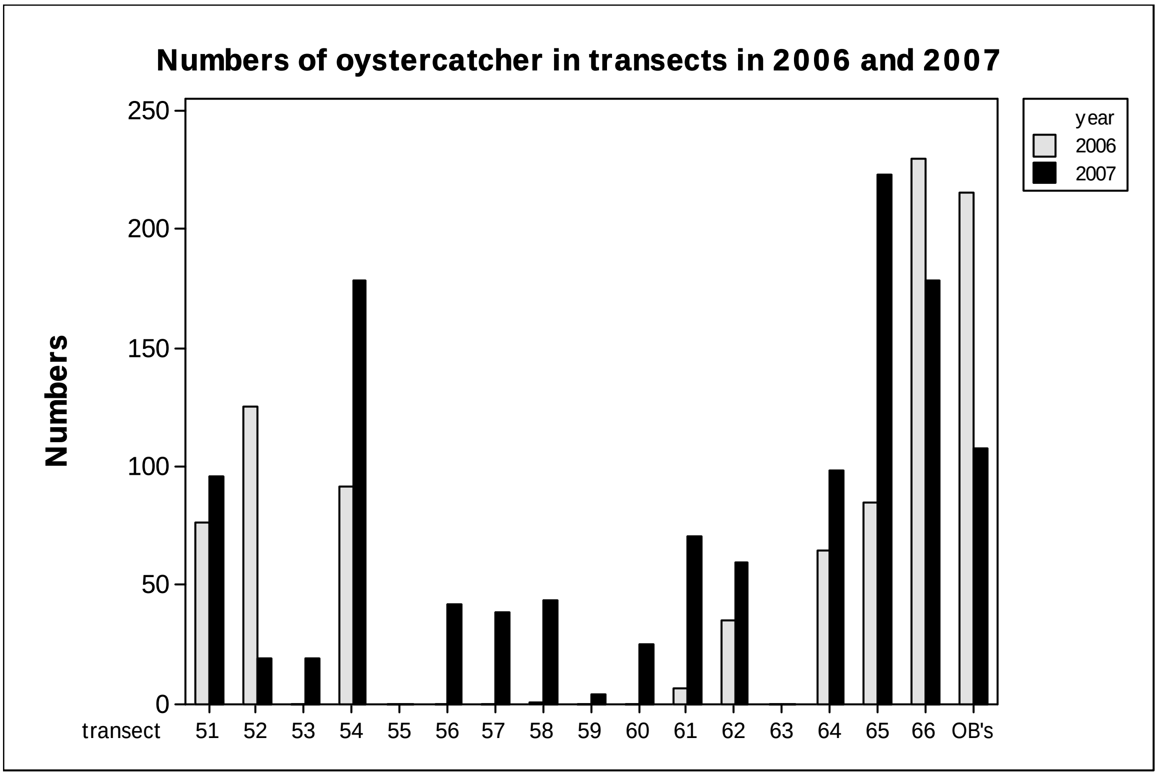
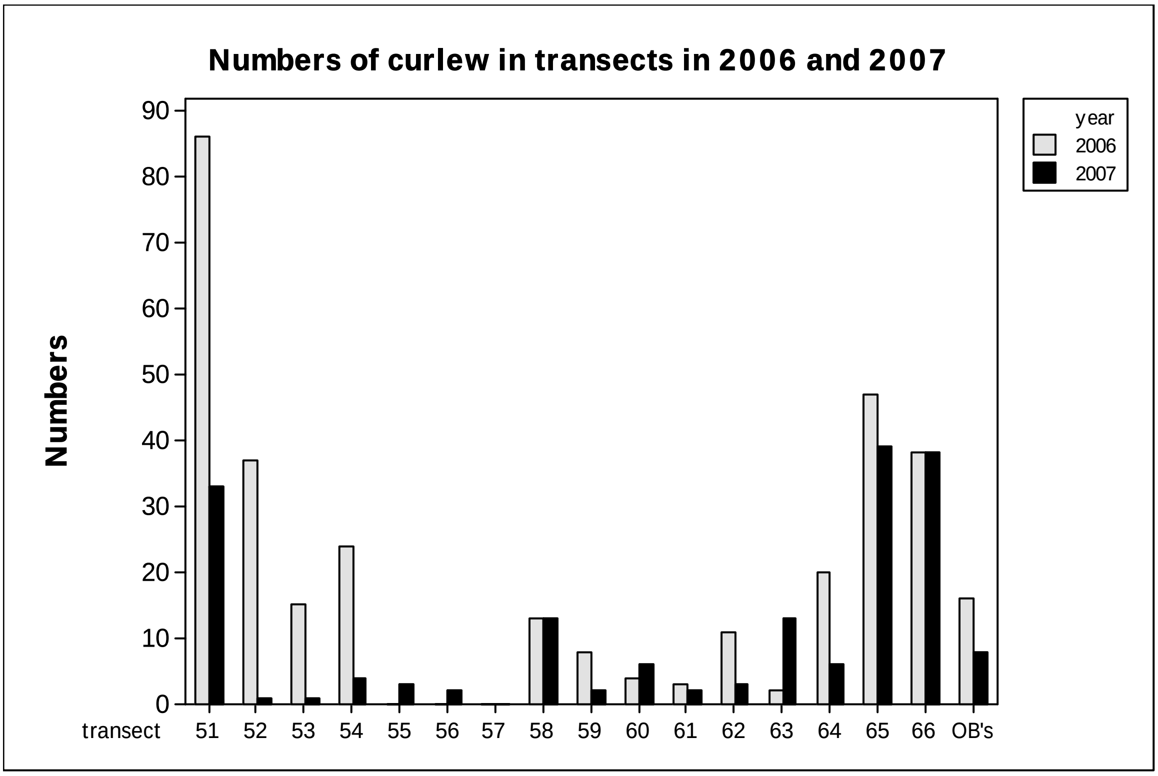


Figure 3.3.2a-h continued

g,



h,

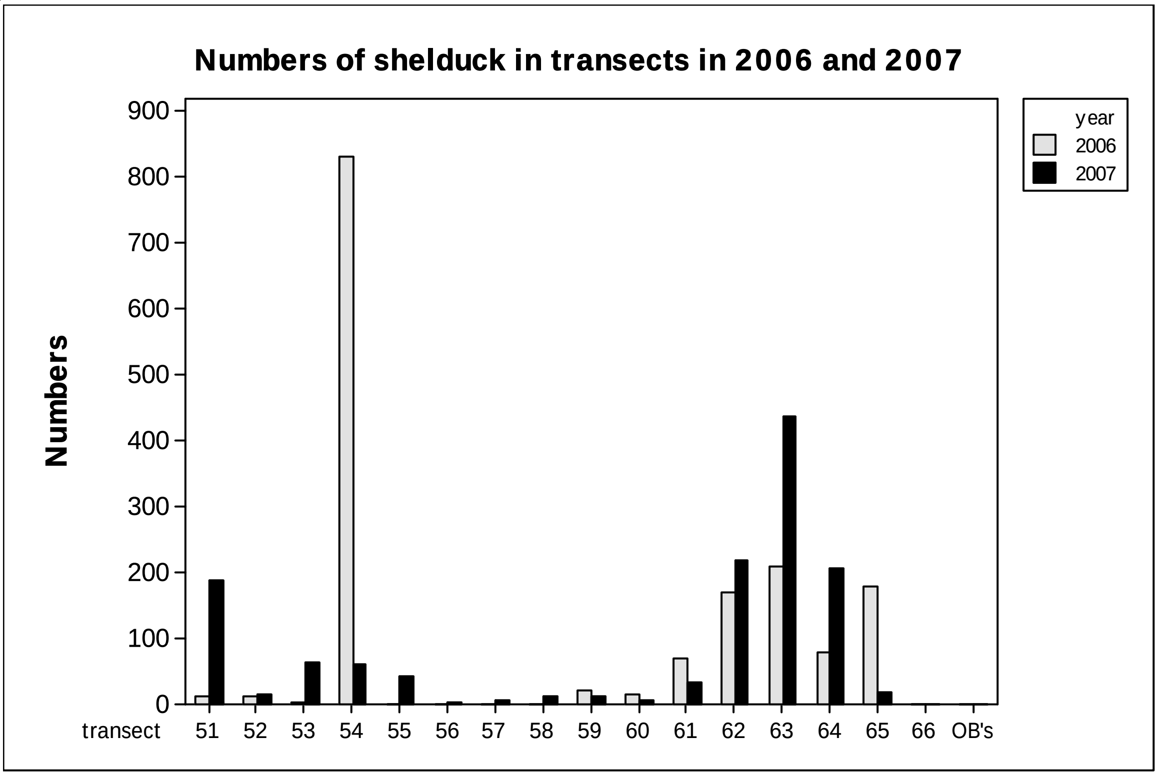
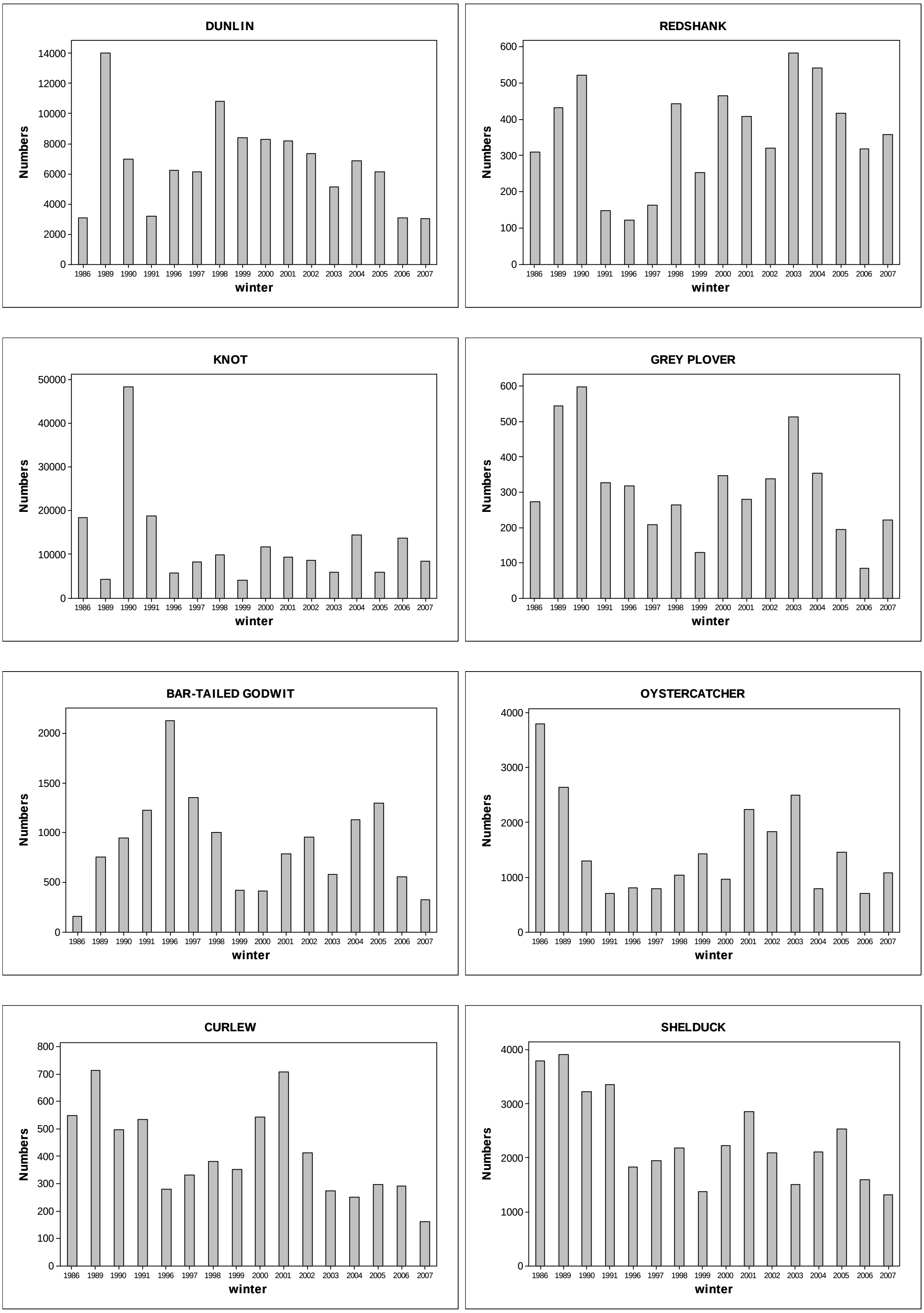


Figure 3.3.3. The total numbers of shorebirds feeding on the inner banks of the Gt Ouse study area in winters 1986-87, 1989-90 to 1991-92 and 1996-97 to 2007-08.



4.REFERENCES

Goss-Custard, J. D., Yates M. G., McGrorty S., Lakhani K., leV dit Durell S. E. A, Clarke R T., Rispin W. E., Moy I., Parsell R. and Yates T. J. 1988.Wash Birds and Invertebrates, Volumes 1 and 2. ITE Report to the Department of the Environment.

Yates, M.G., Garbutt, A., Wyatt, C.L., Shore, R.F., Eastwood J.A., Yates T.J. McGrorty, S., Goss-Custard, J.D., le V dit Durell S. E. A., Rispin, W.E., Woods C. & Parrington, J. 1998. Environmental assessment of increased Ely Ouse abstraction:- Final Report of 1996-97 studies. Volumes 1 and 2. ITE report to Binnie, Black and Veatch.

Yates, M.G., Garbutt, A., Freestone P.F, Wienburg, C.L., Finnie, J.K., Shore, R.F., Rispin, W.E., McGrorty, S., Goss-Custard, J.D. & le V dit Durell S. E. A. 1999. Freshwater abstraction from the river Great Ouse; monitoring the Denver licence variation. The 1997-8 surveys of inter-tidal sediment, invertebrates and birds. ITE final report to Binnie, Black and Veatch.

Yates, M.G., Garbutt, R.A., Barratt, D., Turk, T., Brown, N., Wienburg, C.L., Finnie, J.K., Shore, R.F., Rispin, W.E., McGrorty, S., Goss-Custard, J.D. & le V dit Durell S. E. A. 2000. Freshwater abstraction from the river Great Ouse; monitoring the Denver licence variation. The 1998-9 surveys of inter-tidal sediment, invertebrates and birds. ITE final report to Binnie, Black and Veatch.

Yates, M.G., Rispin, W.E., Garbutt, R.A., le V dit Durell S. E. A., Turk, A., McGrorty, S., , Wienburg, Sparks, T., Rothery, P., Brown, N., McClennan D., & Goss-Custard, J.D. & 2004. Freshwater abstraction from the river Great Ouse; monitoring the Denver licence variation. A review and analysis of surveys of inter-tidal sediments, invertebrates and birds. ITE final report to Binnie, Black and Veatch.
.

APPENDICES

Appendix 1

Site location (as Ordnance Survey coordinates), invertebrate densities (numbers/square metre) and the sediment characteristics for each 1ha sample block in the 2006 survey.

Appendix 2

Comparisons between the mean density of invertebrates in the 2005 and 2006 surveys of the Gt Ouse study area.

Appendix 3

Shorebird numbers in each transect during the winter 2006-07 surveys. Column 1 of each table indicates the transect number or area name. Remaining columns give the numbers of dunlin, redshank, knot, grey plover, bar-tailed godwit, oystercatcher, curlew and shelduck recorded in the first and second counts and mean count for the whole survey. ‘OB’ refers to outer bank areas.

Appendix 1

Site location (as Ordnance Survey coordinates), invertebrate densities (numbers/square metre) and the sediment characteristics for each 1ha sample block in the 2007 survey.

sites	easting	northing	Hydrozoa	Nemertean indet	Nematode indet	Pholoe inornata
16.2	554630	327254	0.0	0.0	292.4	0.0
16.3	554647	327518	0.0	0.0	1562.4	0.0
16.4	554655	327782	0.0	0.0	1727.2	0.0
16.6	554682	328299	0.0	0.0	12.8	0.0
16.7	554698	328517	0.0	0.0	38.2	0.0
16.8	554715	328768	0.0	0.0	0.0	0.0
16.9	554722	328949	0.0	0.0	25.6	0.0
17.3	557279	327181	0.0	0.0	64.0	0.0
17.4	557354	327364	0.0	0.0	76.2	0.0
17.6	557501	327737	0.0	0.0	114.6	12.8
17.7	557582	327924	0.0	0.0	0.0	0.0
17.8	557649	328099	0.0	0.0	0.0	12.8
17.9	557741	328309	12.8	0.0	0.0	0.0
18.3	560050	327461	12.8	25.6	1346.4	0.0
18.4	559811	327581	0.0	0.0	1092.4	0.0
18.6	559476	327732	12.8	0.0	8179.0	0.0
18.7	559305	327823	12.8	0.0	317.8	0.0
18.8	559187	327882	0.0	0.0	127.2	0.0
18.9	559050	328046	0.0	0.0	165.4	25.4
19.3	561530	329206	0.0	38.2	3530.8	0.0
19.4	561330	329390	0.0	0.0	76.4	0.0
19.6	560833	329670	0.0	0.0	343.0	0.0
19.7	560629	329854	0.0	0.0	12.8	0.0
19.8	560482	329974	12.8	0.0	1346.4	0.0
19.9	560266	330150	38.4	0.0	63.6	0.0
20.2	563950	330740	25.6	12.8	25.4	0.0
20.3	563450	331050	0.0	343.2	6794.6	0.0
20.4	563090	331350	12.8	12.8	63.8	0.0
20.5	562650	331750	12.8	0.0	12.8	0.0
20.6	562250	332050	38.2	0.0	12.8	0.0
20.7	561850	332400	0.0	0.0	25.6	0.0
B3	558543	326079	0.0	0.0	76.4	0.0
C2	559156	326812	0.0	0.0	2184.6	0.0
C3	559082	326779	0.0	38.4	1308.2	0.0
D2	557639	329536	76.4	0.0	25.4	0.0
D3	557427	330087	0.0	0.0	0.0	0.0
D4	557221	330620	0.0	0.0	12.8	0.0
E8	559525	328614	12.8	0.0	12.8	0.0
E9	559392	328907	0.0	101.8	0.0	0.0
P1	558509	329675	25.6	0.0	0.0	0.0
P2	558529	330268	12.8	0.0	0.0	0.0
P3	558591	330779	0.0	0.0	0.0	0.0

Appendix 1 continued. Invertebrate densities (numbers/square metre).

sites	Eteone longa	Anaitides mucosa	Hediste diversicolor <15mm	Hediste diversicolor 16-30mm
16.2	0.00	0.0	0.0	0.0
16.3	394.00	12.8	50.8	51.0
16.4	825.80	0.0	25.6	38.2
16.6	51.00	0.0	0.0	0.0
16.7	12.80	12.8	0.0	0.0
16.8	47.75	0.0	0.0	0.0
16.9	12.80	0.0	0.0	0.0
17.3	648.00	0.0	0.0	25.6
17.4	876.40	0.0	0.0	0.0
17.6	1397.20	0.0	0.0	0.0
17.7	127.20	63.6	0.0	0.0
17.8	76.60	203.4	0.0	0.0
17.9	51.00	25.6	0.0	0.0
18.3	330.60	0.0	330.6	305.0
18.4	330.40	0.0	330.4	178.0
18.6	774.80	0.0	38.2	25.6
18.7	520.80	0.0	12.8	0.0
18.8	609.80	12.8	0.0	0.0
18.9	127.00	0.0	0.0	0.0
19.3	1105.20	0.0	89.4	12.8
19.4	1257.60	0.0	12.8	25.4
19.6	432.20	0.0	0.0	0.0
19.7	241.60	0.0	0.0	0.0
19.8	330.60	12.8	0.0	0.0
19.9	51.00	0.0	0.0	0.0
20.2	25.60	0.0	0.0	0.0
20.3	2768.80	0.0	63.6	0.0
20.4	520.80	0.0	12.8	0.0
20.5	127.20	12.8	0.0	0.0
20.6	38.20	101.8	0.0	0.0
20.7	38.20	140.0	0.0	0.0
B3	0.00	0.0	12.8	0.0
C2	495.60	0.0	254.4	114.6
C3	267.00	0.0	25.6	12.8
D2	63.80	89.2	0.0	0.0
D3	12.80	38.2	0.0	0.0
D4	51.00	51.0	0.0	0.0
E8	660.60	12.8	0.0	0.0
E9	508.20	12.8	0.0	0.0
P1	89.20	12.8	0.0	0.0
P2	89.20	50.8	0.0	0.0
P3	89.20	25.6	0.0	0.0

Appendix 1 continued. Invertebrate densities (numbers/square metre).

sites	Hediste diversicolor >30mm	Nephtys cirrosa <15mm	Nephtys cirrosa 16-30mm	Nephtys cirrosa >30mm
16.2	0.0	0.0	0.0	0.0
16.3	25.4	0.0	0.0	0.0
16.4	0.0	0.0	0.0	0.0
16.6	0.0	0.0	0.0	0.0
16.7	0.0	0.0	0.0	0.0
16.8	0.0	0.0	0.0	0.0
16.9	0.0	0.0	0.0	0.0
17.3	63.8	0.0	0.0	0.0
17.4	0.0	0.0	0.0	0.0
17.6	38.2	0.0	0.0	0.0
17.7	12.8	0.0	12.8	0.0
17.8	0.0	0.0	0.0	0.0
17.9	12.8	0.0	0.0	0.0
18.3	38.4	0.0	0.0	0.0
18.4	63.8	0.0	0.0	0.0
18.6	25.6	0.0	0.0	0.0
18.7	12.8	0.0	0.0	0.0
18.8	0.0	0.0	0.0	0.0
18.9	0.0	0.0	0.0	0.0
19.3	0.0	0.0	0.0	0.0
19.4	0.0	12.8	0.0	0.0
19.6	0.0	0.0	0.0	0.0
19.7	0.0	0.0	0.0	0.0
19.8	0.0	0.0	0.0	0.0
19.9	0.0	0.0	0.0	0.0
20.2	0.0	0.0	0.0	0.0
20.3	0.0	0.0	0.0	0.0
20.4	0.0	0.0	0.0	0.0
20.5	12.8	38.2	12.8	0.0
20.6	0.0	25.4	12.8	0.0
20.7	0.0	63.6	12.8	0.0
B3	0.0	0.0	0.0	0.0
C2	38.2	0.0	0.0	0.0
C3	0.0	0.0	0.0	0.0
D2	0.0	0.0	0.0	0.0
D3	0.0	0.0	0.0	0.0
D4	0.0	0.0	0.0	0.0
E8	0.0	0.0	0.0	0.0
E9	0.0	0.0	0.0	0.0
P1	0.0	0.0	0.0	0.0
P2	0.0	0.0	63.8	0.0
P3	0.0	0.0	38.2	0.0

Appendix 1 continued. Invertebrate densities (numbers/square metre).

sites	Nephtys hombergii <15mm	Nephtys hombergii 16-30mm	Nephtys hombergii >30mm
16.2	0.0	0.0	0.0
16.3	12.8	25.6	25.4
16.4	25.4	12.8	12.8
16.6	89.2	63.6	38.4
16.7	76.4	101.8	38.2
16.8	63.5	0.0	0.0
16.9	89.2	51.0	12.8
17.3	38.2	38.4	12.8
17.4	38.2	25.4	0.0
17.6	25.4	0.0	0.0
17.7	25.4	76.4	12.8
17.8	25.6	51.0	63.8
17.9	25.6	63.6	12.8
18.3	0.0	0.0	12.8
18.4	12.8	0.0	0.0
18.6	12.8	38.2	0.0
18.7	89.0	25.6	12.8
18.8	25.6	25.6	76.4
18.9	0.0	0.0	38.4
19.3	0.0	0.0	0.0
19.4	0.0	38.2	25.4
19.6	12.8	38.2	76.4
19.7	25.6	12.8	38.2
19.8	38.2	101.8	25.6
19.9	165.2	114.4	0.0
20.2	0.0	0.0	0.0
20.3	0.0	0.0	0.0
20.4	25.6	0.0	12.8
20.5	63.8	51.0	12.8
20.6	101.8	63.8	38.4
20.7	76.4	38.4	0.0
B3	12.8	0.0	0.0
C2	0.0	0.0	0.0
C3	0.0	0.0	0.0
D2	483.0	241.4	0.0
D3	76.4	25.6	12.8
D4	165.2	25.6	0.0
E8	190.8	25.6	51.0
E9	76.4	38.2	114.6
P1	368.6	254.4	12.8
P2	178.2	12.8	0.0
P3	279.8	12.8	0.0

Appendix 1 continued. Invertebrate densities (numbers/square metre).

sites	All Nephtys juveniles <15mm	Scoloplos armiger <15mm	Scoloplos armiger 16-30mm	Scoloplos armiger >30mm
16.2	0.0	0.0	0.0	0.0
16.3	12.8	0.0	0.0	0.0
16.4	25.4	0.0	0.0	0.0
16.6	89.2	0.0	0.0	0.0
16.7	76.4	0.0	0.0	0.0
16.8	63.5	0.0	0.0	0.0
16.9	89.2	0.0	0.0	0.0
17.3	38.2	0.0	0.0	0.0
17.4	38.2	0.0	0.0	0.0
17.6	25.4	0.0	0.0	0.0
17.7	25.4	0.0	12.8	0.0
17.8	25.6	0.0	0.0	0.0
17.9	25.6	0.0	0.0	0.0
18.3	0.0	0.0	0.0	0.0
18.4	12.8	0.0	0.0	0.0
18.6	12.8	0.0	0.0	0.0
18.7	89.0	0.0	0.0	0.0
18.8	25.6	0.0	0.0	0.0
18.9	0.0	0.0	0.0	0.0
19.3	0.0	0.0	0.0	0.0
19.4	12.8	0.0	0.0	0.0
19.6	12.8	0.0	0.0	0.0
19.7	25.6	0.0	0.0	0.0
19.8	38.2	0.0	0.0	0.0
19.9	165.2	0.0	0.0	0.0
20.2	0.0	0.0	0.0	0.0
20.3	0.0	0.0	0.0	0.0
20.4	25.6	0.0	0.0	0.0
20.5	102.0	25.4	12.8	0.0
20.6	127.2	38.2	12.8	0.0
20.7	165.4	101.8	76.4	0.0
B3	12.8	0.0	0.0	0.0
C2	0.0	0.0	0.0	0.0
C3	0.0	0.0	0.0	0.0
D2	483.0	12.8	0.0	0.0
D3	76.4	0.0	0.0	0.0
D4	165.2	38.2	0.0	152.4
E8	190.8	0.0	0.0	0.0
E9	76.4	0.0	0.0	0.0
P1	368.6	0.0	0.0	0.0
P2	178.2	0.0	0.0	0.0
P3	279.8	0.0	0.0	0.0

Appendix 1 continued. Invertebrate densities (numbers/square metre).

sites	Polydora sp.?ciliata	Pygospio elegans	Spio martinensis	Spiophanes bombyx
16.2	0.0	0.0	0.0	0.0
16.3	0.0	3962.6	0.0	0.0
16.4	0.0	5359.8	0.0	0.0
16.6	0.0	876.6	0.0	0.0
16.7	0.0	724.2	0.0	0.0
16.8	0.0	159.0	0.0	0.0
16.9	0.0	1029.0	0.0	0.0
17.3	0.0	267.0	0.0	0.0
17.4	0.0	660.8	0.0	0.0
17.6	0.0	1270.4	0.0	0.0
17.7	0.0	444.6	114.6	0.0
17.8	0.0	139.8	38.4	0.0
17.9	0.0	203.4	25.4	0.0
18.3	12.8	292.2	0.0	0.0
18.4	0.0	165.4	0.0	0.0
18.6	0.0	343.0	0.0	0.0
18.7	0.0	190.8	0.0	0.0
18.8	0.0	76.4	0.0	0.0
18.9	0.0	25.4	0.0	0.0
19.3	0.0	3645.4	0.0	0.0
19.4	0.0	1676.6	0.0	0.0
19.6	0.0	330.4	0.0	0.0
19.7	0.0	114.8	25.6	0.0
19.8	0.0	38.2	0.0	0.0
19.9	0.0	25.4	0.0	0.0
20.2	0.0	38.2	0.0	0.0
20.3	0.0	5220.0	0.0	0.0
20.4	0.0	304.8	0.0	0.0
20.5	0.0	114.6	12.8	25.6
20.6	0.0	51.0	177.8	0.0
20.7	0.0	25.6	50.8	0.0
B3	0.0	76.2	12.8	0.0
C2	0.0	241.6	0.0	0.0
C3	0.0	89.0	0.0	0.0
D2	0.0	863.8	0.0	0.0
D3	0.0	12.8	102.0	0.0
D4	0.0	38.4	178.0	0.0
E8	0.0	127.2	0.0	0.0
E9	12.8	63.6	0.0	0.0
P1	0.0	1905.2	12.8	0.0
P2	0.0	76.2	76.4	190.6
P3	0.0	0.0	38.2	89.2

Appendix 1 continued. Invertebrate densities (numbers/square metre).

sites	Magelona mirabilis	Tharyx "A"	Capitella capitata / sp.indet.	Heteromastus filiformis
16.2	0.0	12.8	0.0	0.0
16.3	0.0	101.6	0.0	0.0
16.4	0.0	178.0	50.8	0.0
16.6	0.0	1867.0	152.8	0.0
16.7	0.0	8483.8	216.2	0.0
16.8	0.0	23590.3	16.0	0.0
16.9	0.0	4191.0	152.6	0.0
17.3	0.0	76.4	0.0	0.0
17.4	0.0	178.0	25.6	0.0
17.6	0.0	51.0	140.0	0.0
17.7	0.0	952.8	38.2	0.0
17.8	0.0	2680.0	140.0	0.0
17.9	38.2	2870.4	139.8	0.0
18.3	0.0	0.0	0.0	0.0
18.4	0.0	0.0	0.0	0.0
18.6	0.0	0.0	12.8	0.0
18.7	0.0	254.2	51.0	0.0
18.8	0.0	419.4	292.4	0.0
18.9	0.0	228.8	76.4	0.0
19.3	0.0	0.0	0.0	0.0
19.4	0.0	38.2	0.0	0.0
19.6	0.0	0.0	12.8	0.0
19.7	0.0	51.0	0.0	0.0
19.8	0.0	0.0	12.8	0.0
19.9	0.0	546.2	0.0	0.0
20.2	0.0	12.8	0.0	0.0
20.3	0.0	0.0	0.0	0.0
20.4	0.0	0.0	0.0	0.0
20.5	0.0	12.8	12.8	0.0
20.6	0.0	38.4	0.0	0.0
20.7	0.0	267.2	0.0	0.0
B3	0.0	25.4	0.0	0.0
C2	0.0	0.0	0.0	0.0
C3	0.0	0.0	0.0	0.0
D2	0.0	165.4	50.8	0.0
D3	0.0	50.8	0.0	0.0
D4	0.0	38.2	0.0	0.0
E8	0.0	495.6	25.6	0.0
E9	0.0	381.2	38.2	0.0
P1	0.0	190.8	0.0	0.0
P2	12.8	12.8	0.0	0.0
P3	102.0	0.0	0.0	25.6

Appendix 1 continued. Invertebrate densities (numbers/square metre).

sites	Ampharete grubei	Arenicola marina casts	Lanice conchilega	?Tubificoides benedii
16.2	0.0	0.0	0.0	0.0
16.3	12.8	0.0	0.0	2095.6
16.4	0.0	0.0	0.0	5601.0
16.6	0.0	0.0	0.0	5931.2
16.7	0.0	0.0	25.6	5029.4
16.8	0.0	0.0	0.0	2032.5
16.9	0.0	0.0	0.0	648.0
17.3	0.0	0.0	0.0	10363.4
17.4	0.0	0.0	0.0	4166.0
17.6	0.0	0.0	0.0	368.4
17.7	0.0	0.0	0.0	89.2
17.8	0.0	0.0	0.0	292.4
17.9	0.0	0.0	0.0	89.2
18.3	0.0	0.0	0.0	89.2
18.4	0.0	0.0	0.0	5727.8
18.6	0.0	0.0	0.0	9690.2
18.7	0.0	0.0	0.0	1295.8
18.8	0.0	0.0	0.0	2400.6
18.9	0.0	0.0	0.0	2045.0
19.3	0.0	0.0	0.0	152.6
19.4	0.0	0.2	0.0	4597.6
19.6	0.0	0.4	0.0	89.0
19.7	0.0	1.2	0.0	38.2
19.8	0.0	0.0	0.0	152.8
19.9	0.0	0.0	0.0	38.2
20.2	0.0	0.0	0.0	25.6
20.3	0.0	0.0	0.0	1143.2
20.4	0.0	14.2	0.0	178.0
20.5	0.0	2.2	0.0	12.8
20.6	0.0	2.6	0.0	0.0
20.7	0.0	2.0	0.0	0.0
B3	0.0	0.0	0.0	0.0
C2	0.0	0.0	0.0	5118.4
C3	0.0	0.0	0.0	7937.8
D2	0.0	0.0	0.0	0.0
D3	0.0	0.2	0.0	0.0
D4	0.0	0.0	0.0	0.0
E8	0.0	0.0	0.0	38.4
E9	0.0	0.0	0.0	394.0
P1	0.0	0.4	0.0	12.8
P2	0.0	0.2	0.0	0.0
P3	0.0	0.0	0.0	0.0

Appendix 1 continued. Invertebrate densities (numbers/square metre).

sites	Enchytraeidae	?Golfingia vulgaris	Nymphon gracile	Elminius modestus
16.2	698.8	0.0	0.0	0.0
16.3	2032.2	0.0	0.0	0.0
16.4	12.8	0.0	0.0	0.0
16.6	0.0	0.0	0.0	12.8
16.7	0.0	0.0	0.0	0.0
16.8	0.0	0.0	0.0	0.0
16.9	0.0	0.0	0.0	0.0
17.3	0.0	0.0	0.0	0.0
17.4	0.0	0.0	0.0	0.0
17.6	0.0	0.0	0.0	0.0
17.7	0.0	0.0	0.0	0.0
17.8	0.0	0.0	0.0	0.0
17.9	0.0	0.0	0.0	0.0
18.3	51.0	0.0	0.0	0.0
18.4	0.0	0.0	0.0	0.0
18.6	0.0	0.0	0.0	0.0
18.7	0.0	0.0	0.0	0.0
18.8	25.4	0.0	0.0	0.0
18.9	12.8	0.0	0.0	0.0
19.3	12.8	0.0	0.0	0.0
19.4	0.0	0.0	0.0	0.0
19.6	0.0	0.0	0.0	0.0
19.7	0.0	0.0	0.0	0.0
19.8	0.0	0.0	0.0	0.0
19.9	0.0	0.0	0.0	0.0
20.2	12.8	0.0	0.0	0.0
20.3	0.0	0.0	0.0	0.0
20.4	0.0	0.0	0.0	0.0
20.5	0.0	0.0	0.0	0.0
20.6	0.0	0.0	0.0	0.0
20.7	0.0	0.0	0.0	0.0
B3	978.2	0.0	0.0	0.0
C2	1333.8	0.0	0.0	0.0
C3	38.4	0.0	0.0	0.0
D2	12.8	0.0	0.0	0.0
D3	0.0	0.0	0.0	190.6
D4	0.0	0.0	0.0	0.0
E8	38.2	0.0	0.0	0.0
E9	0.0	0.0	0.0	0.0
P1	0.0	0.0	0.0	0.0
P2	0.0	0.0	0.0	0.0
P3	0.0	0.0	0.0	0.0

Appendix 1 continued. Invertebrate densities (numbers/square metre).

sites	Balanus balanus	Copepod indet	Urothoe poseidonis 0-3mm	Bathyporeia sarsi 0-3mm
16.2	0.0	0.0	0.0	0.0
16.3	0.0	0.0	0.0	0.0
16.4	0.0	0.0	0.0	0.0
16.6	0.0	0.0	0.0	0.0
16.7	0.0	0.0	0.0	0.0
16.8	0.0	0.0	0.0	0.0
16.9	0.0	0.0	0.0	0.0
17.3	0.0	0.0	0.0	0.0
17.4	0.0	0.0	0.0	0.0
17.6	0.0	0.0	0.0	0.0
17.7	0.0	0.0	0.0	152.6
17.8	0.0	0.0	0.0	0.0
17.9	0.0	0.0	0.0	0.0
18.3	0.0	0.0	0.0	0.0
18.4	0.0	0.0	0.0	0.0
18.6	0.0	0.0	0.0	0.0
18.7	0.0	0.0	0.0	0.0
18.8	0.0	0.0	0.0	12.8
18.9	0.0	0.0	0.0	0.0
19.3	0.0	0.0	0.0	0.0
19.4	0.0	0.0	0.0	0.0
19.6	0.0	0.0	0.0	12.8
19.7	0.0	0.0	0.0	0.0
19.8	0.0	0.0	0.0	0.0
19.9	0.0	0.0	0.0	0.0
20.2	0.0	0.0	0.0	0.0
20.3	0.0	0.0	0.0	0.0
20.4	0.0	0.0	0.0	0.0
20.5	0.0	0.0	0.0	368.4
20.6	0.0	0.0	0.0	152.4
20.7	0.0	0.0	0.0	12.8
B3	0.0	0.0	0.0	0.0
C2	0.0	0.0	0.0	0.0
C3	0.0	12.8	0.0	0.0
D2	0.0	0.0	0.0	0.0
D3	0.0	0.0	0.0	12.8
D4	0.0	0.0	0.0	0.0
E8	0.0	0.0	0.0	0.0
E9	0.0	0.0	0.0	0.0
P1	0.0	0.0	0.0	0.0
P2	0.0	0.0	0.0	12.8
P3	0.0	0.0	0.0	12.8

Appendix 1 continued. Invertebrate densities (numbers/square metre).

sites	Bathyporeia sarsi >3mm	Gammarus indet. 0-3mm	Corophium arenarium 0-3mm
16.2	0.0	0.0	0.0
16.3	0.0	0.0	0.0
16.4	0.0	0.0	0.0
16.6	0.0	0.0	0.0
16.7	0.0	0.0	0.0
16.8	0.0	0.0	0.0
16.9	0.0	0.0	0.0
17.3	0.0	0.0	0.0
17.4	0.0	0.0	0.0
17.6	0.0	0.0	0.0
17.7	38.2	0.0	0.0
17.8	12.8	0.0	0.0
17.9	0.0	0.0	0.0
18.3	0.0	0.0	0.0
18.4	0.0	0.0	0.0
18.6	0.0	0.0	0.0
18.7	0.0	0.0	0.0
18.8	0.0	0.0	0.0
18.9	0.0	0.0	0.0
19.3	0.0	0.0	0.0
19.4	0.0	0.0	0.0
19.6	0.0	0.0	0.0
19.7	0.0	0.0	0.0
19.8	0.0	0.0	0.0
19.9	0.0	0.0	0.0
20.2	0.0	0.0	0.0
20.3	0.0	0.0	0.0
20.4	0.0	0.0	0.0
20.5	101.8	0.0	0.0
20.6	38.4	0.0	0.0
20.7	25.6	0.0	0.0
B3	0.0	0.0	0.0
C2	0.0	0.0	0.0
C3	0.0	0.0	0.0
D2	0.0	0.0	0.0
D3	0.0	0.0	0.0
D4	0.0	0.0	0.0
E8	0.0	0.0	0.0
E9	0.0	0.0	0.0
P1	0.0	0.0	0.0
P2	0.0	0.0	0.0
P3	25.6	0.0	0.0

Appendix 1 continued. Invertebrate densities (numbers/square metre).

sites	Corophium arenarium >3mm	Corophium volutator 0-3mm	Corophium volutator >3mm	Cyathura carinata
16.2	0.0	0.0	0.0	0.0
16.3	0.0	0.0	0.0	0.0
16.4	0.0	38.2	0.0	0.0
16.6	0.0	25.4	0.0	0.0
16.7	0.0	12.8	0.0	0.0
16.8	0.0	16.0	0.0	0.0
16.9	0.0	25.4	0.0	0.0
17.3	0.0	0.0	0.0	0.0
17.4	0.0	12.8	0.0	0.0
17.6	0.0	89.2	12.8	0.0
17.7	0.0	12.8	12.8	0.0
17.8	0.0	25.4	12.8	0.0
17.9	0.0	139.8	203.2	0.0
18.3	0.0	17310.4	4102.2	0.0
18.4	0.0	12941.4	3886.2	0.0
18.6	0.0	5943.8	5804.2	12.8
18.7	0.0	1232.0	1943.2	0.0
18.8	0.0	1194.2	2718.0	0.0
18.9	0.0	19177.2	4470.6	0.0
19.3	0.0	12090.4	5283.4	0.0
19.4	0.0	2705.4	1816.4	38.2
19.6	0.0	165.4	190.6	216.2
19.7	0.0	51.0	0.0	0.0
19.8	0.0	2895.8	736.8	241.6
19.9	0.0	0.0	0.0	0.0
20.2	0.0	203.4	12.8	0.0
20.3	0.0	305.0	165.2	0.0
20.4	0.0	38.2	0.0	0.0
20.5	0.0	0.0	12.8	0.0
20.6	0.0	0.0	0.0	0.0
20.7	0.0	0.0	0.0	0.0
B3	0.0	25.4	0.0	0.0
C2	0.0	11214.4	4166.0	0.0
C3	0.0	6934.6	1791.2	0.0
D2	0.0	0.0	0.0	0.0
D3	0.0	0.0	0.0	0.0
D4	0.0	12.8	0.0	0.0
E8	0.0	419.4	241.6	0.0
E9	0.0	22568.2	4381.8	0.0
P1	0.0	0.0	12.8	0.0
P2	0.0	0.0	0.0	0.0
P3	0.0	0.0	0.0	0.0

Appendix 1 continued. Invertebrate densities (numbers/square metre).

sites	Tanaissus lilljeborgi	Vauntompsonia cristata	Bodotria arenosa	Pseudocuma longicornis
16.2	0.0	0.0	0.0	0.0
16.3	0.0	0.0	0.0	0.0
16.4	0.0	0.0	0.0	0.0
16.6	0.0	0.0	0.0	0.0
16.7	0.0	0.0	0.0	0.0
16.8	0.0	0.0	0.0	0.0
16.9	0.0	0.0	0.0	0.0
17.3	0.0	0.0	0.0	0.0
17.4	0.0	0.0	0.0	0.0
17.6	0.0	0.0	0.0	0.0
17.7	0.0	0.0	0.0	0.0
17.8	0.0	0.0	0.0	0.0
17.9	0.0	0.0	0.0	0.0
18.3	0.0	0.0	0.0	0.0
18.4	0.0	0.0	0.0	0.0
18.6	0.0	0.0	0.0	0.0
18.7	0.0	0.0	0.0	0.0
18.8	0.0	0.0	0.0	0.0
18.9	0.0	0.0	0.0	0.0
19.3	0.0	0.0	0.0	0.0
19.4	0.0	0.0	0.0	0.0
19.6	0.0	0.0	0.0	0.0
19.7	0.0	0.0	0.0	0.0
19.8	0.0	0.0	0.0	0.0
19.9	0.0	0.0	0.0	0.0
20.2	0.0	0.0	0.0	0.0
20.3	0.0	0.0	0.0	0.0
20.4	0.0	0.0	0.0	0.0
20.5	0.0	12.8	0.0	0.0
20.6	0.0	0.0	0.0	0.0
20.7	12.8	0.0	0.0	0.0
B3	0.0	0.0	0.0	0.0
C2	0.0	0.0	0.0	0.0
C3	0.0	0.0	0.0	0.0
D2	0.0	0.0	0.0	0.0
D3	0.0	0.0	0.0	0.0
D4	0.0	0.0	0.0	0.0
E8	0.0	0.0	0.0	0.0
E9	0.0	0.0	0.0	0.0
P1	0.0	0.0	0.0	0.0
P2	101.8	0.0	0.0	0.0
P3	521.0	0.0	0.0	0.0

Appendix 1 continued. Invertebrate densities (numbers/square metre).

sites	Cumacean indet.	All Cumaceans	Crangon crangon	Carcinus maenas
16.2	0.0	0.0	12.8	0.0
16.3	0.0	0.0	0.0	0.0
16.4	0.0	0.0	0.0	0.0
16.6	0.0	0.0	0.0	0.0
16.7	0.0	0.0	0.0	0.0
16.8	0.0	0.0	0.0	0.0
16.9	0.0	0.0	0.0	0.0
17.3	0.0	0.0	127.0	12.8
17.4	0.0	0.0	51.0	0.0
17.6	0.0	0.0	0.0	0.0
17.7	38.2	38.2	0.0	0.0
17.8	12.8	12.8	0.0	0.0
17.9	0.0	0.0	0.0	0.0
18.3	0.0	0.0	0.0	0.0
18.4	0.0	0.0	0.0	0.0
18.6	0.0	0.0	38.2	0.0
18.7	0.0	0.0	38.2	0.0
18.8	0.0	0.0	12.8	0.0
18.9	0.0	0.0	0.0	0.0
19.3	0.0	0.0	0.0	12.8
19.4	0.0	0.0	38.4	0.0
19.6	12.8	12.8	0.0	0.0
19.7	0.0	0.0	12.8	0.0
19.8	0.0	0.0	12.8	0.0
19.9	0.0	0.0	0.0	0.0
20.2	0.0	0.0	12.8	0.0
20.3	0.0	0.0	0.0	0.0
20.4	0.0	0.0	0.0	0.0
20.5	0.0	12.8	0.0	0.0
20.6	0.0	0.0	25.4	0.0
20.7	101.8	101.8	12.8	0.0
B3	0.0	0.0	0.0	0.0
C2	0.0	0.0	0.0	0.0
C3	0.0	0.0	0.0	0.0
D2	0.0	0.0	12.8	0.0
D3	0.0	0.0	0.0	12.8
D4	0.0	0.0	51.2	12.8
E8	38.2	38.2	0.0	0.0
E9	0.0	0.0	12.8	0.0
P1	25.4	25.4	38.2	0.0
P2	51.0	51.0	12.8	0.0
P3	165.4	165.4	0.0	0.0

Appendix 1 continued. Invertebrate densities (numbers/square metre).

sites	Hydrobia ulvae <3mm	Hydrobia ulvae >3mm	Retusa obtusa <3mm	Retusa obtusa >3mm
16.2	127.2	0.00	0.0	0.0
16.3	6642.2	5575.40	12.8	12.8
16.4	2336.8	4597.60	0.0	12.8
16.6	368.6	1486.20	508.4	267.0
16.7	50.8	101.80	25.6	139.8
16.8	79.5	254.25	0.0	0.0
16.9	12.8	38.20	0.0	0.0
17.3	9360.2	5639.20	0.0	12.8
17.4	22377.8	4547.00	0.0	101.8
17.6	36995.4	419.40	0.0	12.8
17.7	14808.4	178.00	0.0	0.0
17.8	813.0	25.40	0.0	0.0
17.9	317.8	0.00	0.0	0.0
18.3	3162.6	38.20	0.0	0.0
18.4	8077.4	483.00	0.0	0.0
18.6	27356.0	101.60	0.0	0.0
18.7	23711.2	25.60	0.0	0.0
18.8	2832.6	0.00	0.0	0.0
18.9	889.2	0.00	0.0	0.0
19.3	13386.0	863.80	0.0	0.0
19.4	52362.4	1130.60	0.0	0.0
19.6	28841.8	89.20	0.0	0.0
19.7	21501.4	12.80	0.0	0.0
19.8	3556.0	12.80	0.0	0.0
19.9	1346.4	76.40	0.0	0.0
20.2	520.8	12.80	0.0	0.0
20.3	30175.4	1003.40	0.0	0.0
20.4	5753.4	76.40	0.0	12.8
20.5	45301.2	279.60	0.0	12.8
20.6	25108.2	1333.60	0.0	12.8
20.7	10338.2	114.60	0.0	0.0
B3	139.8	38.20	0.0	0.0
C2	1283.0	139.80	0.0	0.0
C3	1117.6	25.60	0.0	0.0
D2	15278.4	0.00	0.0	0.0
D3	37185.8	0.00	0.0	0.0
D4	80124.4	12.80	0.0	0.0
E8	28448.2	38.20	0.0	0.0
E9	1638.4	0.00	0.0	0.0
P1	46621.8	0.00	0.0	0.0
P2	876.4	0.00	0.0	0.0
P3	216.2	0.00	12.8	0.0

Appendix 1 continued. Invertebrate densities (numbers/square metre).

sites	Pleurobranch indet.	Mytilus edulis <5mm	Mytilus edulis 11-15mm
16.2	12.8	0.0	0.0
16.3	12.8	63.6	0.0
16.4	0.0	25.6	0.0
16.6	0.0	0.0	0.0
16.7	0.0	63.8	0.0
16.8	0.0	0.0	0.0
16.9	0.0	51.0	0.0
17.3	0.0	0.0	0.0
17.4	0.0	0.0	0.0
17.6	0.0	12.8	0.0
17.7	0.0	50.8	0.0
17.8	0.0	0.0	0.0
17.9	0.0	12.8	0.0
18.3	0.0	0.0	0.0
18.4	0.0	25.6	0.0
18.6	0.0	0.0	0.0
18.7	0.0	12.8	0.0
18.8	0.0	38.2	0.0
18.9	0.0	0.0	0.0
19.3	0.0	0.0	0.0
19.4	0.0	0.0	0.0
19.6	0.0	0.0	0.0
19.7	0.0	0.0	0.0
19.8	0.0	76.2	0.0
19.9	0.0	25.6	0.0
20.2	0.0	0.0	0.0
20.3	0.0	51.0	0.0
20.4	0.0	0.0	0.0
20.5	0.0	0.0	0.0
20.6	0.0	0.0	0.0
20.7	0.0	0.0	12.8
B3	0.0	12.8	0.0
C2	0.0	0.0	0.0
C3	0.0	0.0	0.0
D2	0.0	38.4	0.0
D3	0.0	0.0	0.0
D4	0.0	38.2	0.0
E8	0.0	0.0	0.0
E9	0.0	50.8	0.0
P1	0.0	38.2	0.0
P2	0.0	0.0	0.0
P3	0.0	0.0	0.0

Appendix 1 continued. Invertebrate densities (numbers/square metre).

sites	Mysella bidentata <5mm	Cerastoderma edule <5mm	Cerastoderma edule 6-10mm	Cerastoderma edule 11-15mm
16.2	0.00	0.0	0.0	0.00
16.3	0.00	12.8	12.8	0.00
16.4	0.00	0.0	0.0	0.00
16.6	25.40	63.8	12.8	1079.80
16.7	38.20	0.0	25.4	825.60
16.8	47.75	111.3	31.7	2111.75
16.9	0.00	63.8	0.0	38.20
17.3	12.80	12.8	38.2	12.80
17.4	0.00	228.8	38.2	0.00
17.6	12.80	686.2	114.4	0.00
17.7	0.00	0.0	0.0	0.00
17.8	0.00	12.8	0.0	0.00
17.9	0.00	12.8	0.0	0.00
18.3	0.00	0.0	0.0	0.00
18.4	0.00	0.0	0.0	0.00
18.6	12.80	0.0	0.0	0.00
18.7	12.80	0.0	0.0	0.00
18.8	0.00	0.0	0.0	0.00
18.9	0.00	0.0	0.0	0.00
19.3	0.00	0.0	0.0	0.00
19.4	0.00	51.0	51.0	0.00
19.6	0.00	76.4	12.8	0.00
19.7	0.00	254.4	63.6	0.00
19.8	0.00	368.6	51.0	0.00
19.9	0.00	12.8	0.0	0.00
20.2	0.00	0.0	0.0	0.00
20.3	0.00	0.0	0.0	0.00
20.4	0.00	0.0	0.0	0.00
20.5	0.00	12.8	0.0	0.00
20.6	0.00	165.2	101.8	0.00
20.7	0.00	12.8	63.8	0.00
B3	0.00	0.0	0.0	0.00
C2	0.00	0.0	0.0	0.00
C3	0.00	0.0	0.0	0.00
D2	0.00	51.0	0.0	0.00
D3	0.00	533.6	1410.0	12.80
D4	0.00	698.6	863.8	0.00
E8	0.00	203.4	64.0	0.00
E9	0.00	12.8	0.0	0.00
P1	0.00	51.0	0.0	0.00
P2	0.00	0.0	0.0	0.00
P3	0.00	0.0	0.0	0.00

Appendix 1 continued. Invertebrate densities (numbers/square metre).

sites	Cerastoderma edule 16-20mm	Cerastoderma edule 11-20mm	Cerastoderma edule 21-25mm
16.2	0.0	0.00	0.0
16.3	0.0	0.00	0.0
16.4	0.0	0.00	0.0
16.6	254.0	1333.80	12.8
16.7	190.6	1016.20	0.0
16.8	587.5	2699.25	0.0
16.9	139.8	178.00	0.0
17.3	25.6	38.20	0.0
17.4	0.0	0.00	0.0
17.6	0.0	0.00	0.0
17.7	0.0	0.00	0.0
17.8	0.0	0.00	0.0
17.9	0.0	0.00	0.0
18.3	0.0	0.00	0.0
18.4	0.0	0.00	0.0
18.6	0.0	0.00	0.0
18.7	0.0	0.00	0.0
18.8	0.0	0.00	0.0
18.9	0.0	0.00	0.0
19.3	0.0	0.00	0.0
19.4	0.0	0.00	0.0
19.6	0.0	0.00	0.0
19.7	0.0	0.00	12.8
19.8	0.0	0.00	0.0
19.9	0.0	0.00	0.0
20.2	0.0	0.00	0.0
20.3	0.0	0.00	0.0
20.4	0.0	0.00	0.0
20.5	0.0	0.00	0.0
20.6	0.0	0.00	0.0
20.7	12.8	12.80	0.0
B3	0.0	0.00	0.0
C2	0.0	0.00	0.0
C3	0.0	0.00	0.0
D2	0.0	0.00	0.0
D3	0.0	12.80	0.0
D4	0.0	0.00	0.0
E8	0.0	0.00	0.0
E9	0.0	0.00	0.0
P1	0.0	0.00	0.0
P2	0.0	0.00	0.0
P3	0.0	0.00	0.0

Appendix 1 continued. Invertebrate densities (numbers/square metre).

sites	Cerastoderma edule 26-30mm	Cerastoderma edule 20-30mm	Ensis arcuatus 11-15mm	Ensis arcuatus 16-20mm
16.2	0.0	0.0	0.0	0.0
16.3	0.0	0.0	0.0	0.0
16.4	12.8	12.8	0.0	0.0
16.6	0.0	12.8	0.0	12.8
16.7	0.0	0.0	0.0	0.0
16.8	0.0	0.0	0.0	0.0
16.9	0.0	0.0	0.0	0.0
17.3	0.0	0.0	0.0	0.0
17.4	0.0	0.0	0.0	0.0
17.6	0.0	0.0	0.0	0.0
17.7	0.0	0.0	0.0	0.0
17.8	0.0	0.0	0.0	0.0
17.9	0.0	0.0	0.0	0.0
18.3	0.0	0.0	0.0	0.0
18.4	0.0	0.0	0.0	0.0
18.6	0.0	0.0	0.0	0.0
18.7	0.0	0.0	0.0	0.0
18.8	0.0	0.0	0.0	0.0
18.9	0.0	0.0	0.0	0.0
19.3	0.0	0.0	0.0	0.0
19.4	0.0	0.0	0.0	0.0
19.6	0.0	0.0	0.0	0.0
19.7	0.0	12.8	0.0	0.0
19.8	0.0	0.0	12.8	0.0
19.9	0.0	0.0	0.0	0.0
20.2	0.0	0.0	0.0	0.0
20.3	0.0	0.0	0.0	0.0
20.4	0.0	0.0	0.0	0.0
20.5	0.0	0.0	0.0	0.0
20.6	0.0	0.0	0.0	0.0
20.7	0.0	0.0	12.8	0.0
B3	0.0	0.0	0.0	0.0
C2	0.0	0.0	0.0	0.0
C3	0.0	0.0	0.0	0.0
D2	0.0	0.0	0.0	0.0
D3	38.4	38.4	0.0	0.0
D4	0.0	0.0	0.0	0.0
E8	0.0	0.0	0.0	0.0
E9	0.0	0.0	0.0	0.0
P1	0.0	0.0	0.0	12.8
P2	0.0	0.0	0.0	0.0
P3	0.0	0.0	0.0	0.0

Appendix 1 continued. Invertebrate densities (numbers/square metre).

sites	Angulus tenuis <5mm	Macoma balthica <5mm	Macoma balthica 6-10mm	Macoma balthica 11-15mm
16.2	0.0	12.8	0.0	0.0
16.3	0.0	1829.0	89.0	89.0
16.4	0.0	965.4	12.8	0.0
16.6	0.0	343.0	38.2	63.8
16.7	0.0	444.8	51.0	12.8
16.8	0.0	143.0	79.5	0.0
16.9	0.0	267.0	76.4	0.0
17.3	0.0	3759.6	216.2	38.2
17.4	0.0	1194.0	152.8	12.8
17.6	0.0	330.6	0.0	0.0
17.7	0.0	1003.6	51.0	0.0
17.8	0.0	393.8	63.8	38.2
17.9	0.0	152.6	0.0	0.0
18.3	0.0	749.6	178.0	0.0
18.4	0.0	419.4	571.8	267.0
18.6	0.0	762.2	546.4	51.0
18.7	0.0	533.8	178.2	51.0
18.8	0.0	114.6	76.6	0.0
18.9	0.0	254.2	0.0	0.0
19.3	0.0	406.8	533.6	0.0
19.4	0.0	216.0	508.4	76.4
19.6	0.0	330.2	51.0	0.0
19.7	0.0	254.2	165.4	63.6
19.8	0.0	114.6	25.6	0.0
19.9	0.0	1410.0	127.2	51.0
20.2	0.0	12.8	0.0	0.0
20.3	0.0	2476.6	381.4	12.8
20.4	0.0	521.0	76.2	38.4
20.5	0.0	51.0	101.8	25.6
20.6	0.0	38.2	51.0	89.0
20.7	0.0	0.0	12.8	38.2
B3	0.0	0.0	0.0	0.0
C2	0.0	152.4	152.6	0.0
C3	0.0	432.2	50.8	0.0
D2	0.0	4115.2	38.4	12.8
D3	0.0	127.0	0.0	0.0
D4	0.0	635.2	0.0	25.6
E8	0.0	1778.4	228.8	25.6
E9	0.0	368.6	76.6	12.8
P1	0.0	4229.4	38.2	0.0
P2	0.0	0.0	0.0	0.0
P3	12.8	12.8	0.0	0.0

Appendix 1 continued. Invertebrate densities (numbers/square metre).

sites	Macoma balthica 16-20mm	Macoma balthica 11-20mm	Abra nitida 6-10mm	Scrobicularia plana <5mm
16.2	0.0	0.0	0.0	0.0
16.3	0.0	89.0	0.0	25.4
16.4	0.0	0.0	0.0	38.2
16.6	0.0	63.8	0.0	25.6
16.7	0.0	12.8	0.0	0.0
16.8	16.0	16.0	0.0	0.0
16.9	0.0	0.0	0.0	0.0
17.3	0.0	38.2	0.0	76.4
17.4	0.0	12.8	0.0	12.8
17.6	0.0	0.0	0.0	25.6
17.7	0.0	0.0	0.0	0.0
17.8	0.0	38.2	0.0	0.0
17.9	0.0	0.0	0.0	0.0
18.3	0.0	0.0	0.0	12.8
18.4	0.0	267.0	0.0	0.0
18.6	0.0	51.0	0.0	12.8
18.7	12.8	63.8	0.0	38.4
18.8	0.0	0.0	0.0	0.0
18.9	0.0	0.0	0.0	0.0
19.3	0.0	0.0	0.0	0.0
19.4	0.0	76.4	0.0	25.6
19.6	0.0	0.0	0.0	0.0
19.7	0.0	63.6	0.0	0.0
19.8	0.0	0.0	0.0	12.8
19.9	0.0	51.0	0.0	0.0
20.2	0.0	0.0	0.0	0.0
20.3	0.0	12.8	0.0	0.0
20.4	0.0	38.4	0.0	0.0
20.5	12.8	38.4	0.0	0.0
20.6	0.0	89.0	0.0	0.0
20.7	0.0	38.2	0.0	0.0
B3	0.0	0.0	0.0	0.0
C2	0.0	0.0	0.0	0.0
C3	0.0	0.0	0.0	12.8
D2	0.0	12.8	25.6	0.0
D3	12.8	12.8	0.0	0.0
D4	0.0	25.6	0.0	0.0
E8	0.0	25.6	0.0	0.0
E9	0.0	12.8	0.0	25.6
P1	0.0	0.0	0.0	0.0
P2	0.0	0.0	0.0	0.0
P3	0.0	0.0	0.0	0.0

Appendix 1 continued. Invertebrate densities (numbers/square metre).

sites	Scrobicularia plana 6-10mm	Scrobicularia plana 11-15mm	Scrobicularia plana 16-20mm	Scrobicularia plana 11-20mm
16.2	0.0	0.00	0.0	0.00
16.3	0.0	0.00	0.0	0.00
16.4	76.4	63.60	25.4	89.00
16.6	25.6	50.80	25.4	76.20
16.7	25.6	25.60	12.8	38.20
16.8	16.0	63.75	0.0	63.75
16.9	0.0	51.00	0.0	51.00
17.3	152.6	203.40	152.8	356.00
17.4	63.6	38.20	0.0	38.20
17.6	25.6	12.80	0.0	12.80
17.7	0.0	0.00	0.0	0.00
17.8	12.8	0.00	0.0	0.00
17.9	0.0	0.00	0.0	0.00
18.3	101.8	76.60	38.2	114.60
18.4	51.0	101.80	25.6	127.20
18.6	12.8	63.80	12.8	76.40
18.7	12.8	25.40	25.6	51.00
18.8	0.0	12.80	0.0	12.80
18.9	0.0	0.00	0.0	0.00
19.3	12.8	0.00	0.0	0.00
19.4	76.4	12.80	0.0	12.80
19.6	0.0	0.00	0.0	0.00
19.7	25.6	0.00	0.0	0.00
19.8	25.6	0.00	25.4	25.40
19.9	12.8	12.80	0.0	12.80
20.2	0.0	0.00	0.0	0.00
20.3	38.4	101.80	0.0	101.80
20.4	0.0	0.00	0.0	0.00
20.5	0.0	0.00	0.0	0.00
20.6	0.0	0.00	0.0	0.00
20.7	0.0	0.00	0.0	0.00
B3	0.0	0.00	0.0	0.00
C2	12.8	12.80	12.8	25.40
C3	0.0	0.00	0.0	0.00
D2	0.0	0.00	0.0	0.00
D3	0.0	0.00	0.0	0.00
D4	0.0	0.00	0.0	0.00
E8	76.4	38.20	12.8	50.80
E9	51.0	38.20	38.2	76.40
P1	0.0	0.00	0.0	0.00
P2	0.0	0.00	0.0	0.00
P3	0.0	0.00	0.0	0.00

Appendix 1 continued. Invertebrate densities (numbers/square metre).

sites	Scrobicularia plana 21-25mm	Scrobicularia plana 26-30mm	Scrobicularia plana >30mm
16.2	0.0	0.0	0.0
16.3	0.0	0.0	12.8
16.4	25.4	12.8	0.0
16.6	0.0	0.0	0.0
16.7	0.0	12.8	0.0
16.8	0.0	0.0	0.0
16.9	0.0	12.8	0.0
17.3	51.2	0.0	12.8
17.4	12.8	0.0	0.0
17.6	12.8	0.0	0.0
17.7	0.0	0.0	0.0
17.8	0.0	0.0	0.0
17.9	0.0	0.0	0.0
18.3	0.0	0.0	0.0
18.4	0.0	12.8	0.0
18.6	25.6	12.8	0.0
18.7	12.8	12.8	0.0
18.8	0.0	0.0	0.0
18.9	0.0	0.0	0.0
19.3	0.0	0.0	0.0
19.4	0.0	0.0	0.0
19.6	0.0	0.0	0.0
19.7	0.0	0.0	0.0
19.8	12.8	0.0	0.0
19.9	0.0	0.0	0.0
20.2	0.0	0.0	0.0
20.3	0.0	0.0	0.0
20.4	0.0	0.0	0.0
20.5	0.0	0.0	0.0
20.6	0.0	0.0	0.0
20.7	0.0	0.0	0.0
B3	0.0	0.0	0.0
C2	0.0	0.0	0.0
C3	0.0	0.0	0.0
D2	0.0	0.0	0.0
D3	0.0	0.0	0.0
D4	0.0	0.0	0.0
E8	0.0	0.0	0.0
E9	0.0	0.0	0.0
P1	0.0	0.0	0.0
P2	0.0	0.0	0.0
P3	0.0	0.0	0.0

Appendix 1 continued. Invertebrate densities (numbers/square metre).

sites	allWorms	allCrust	allGasts	allbivalves
16.2	1004.0	12.8	140.0	12.80
16.3	10365.0	0.0	12256.0	2134.40
16.4	13870.2	38.2	6947.2	1258.40
16.6	9082.6	38.2	2630.2	2033.80
16.7	14759.4	12.8	318.0	1729.00
16.8	25909.0	16.0	333.8	3208.25
16.9	6212.0	25.4	51.0	700.00
17.3	11597.6	139.8	15012.2	4765.40
17.4	6046.6	63.8	27026.6	1754.00
17.6	3418.0	102.0	37427.6	1233.60
17.7	1983.2	292.8	14986.4	1105.40
17.8	3723.8	76.6	838.4	521.40
17.9	3570.6	343.0	317.8	178.20
18.3	2847.4	21412.6	3200.8	1157.00
18.4	7901.0	16827.6	8560.4	1475.00
18.6	19153.0	11799.0	27457.6	1513.00
18.7	2796.2	3213.4	23736.8	929.20
18.8	4091.6	3937.8	2832.6	242.20
18.9	2744.6	23647.8	889.2	254.20
19.3	8587.2	17386.6	14249.8	953.20
19.4	7761.2	4598.4	53493.0	1017.60
19.6	1335.2	610.6	28931.0	470.40
19.7	561.8	63.8	21514.2	839.60
19.8	2072.0	3887.0	3568.8	725.40
19.9	1042.4	0.0	1422.8	1652.20
20.2	178.8	229.0	533.6	12.80
20.3	16333.4	470.2	31178.8	3062.00
20.4	1158.4	38.2	5842.6	635.60
20.5	588.8	508.6	45593.6	204.00
20.6	754.0	216.2	26454.6	445.20
20.7	944.2	267.6	10452.8	166.00
B3	1194.6	25.4	178.0	12.80
C2	9781.2	15380.4	1422.8	343.40
C3	9717.2	8738.6	1143.2	495.80
D2	2084.8	12.8	15278.4	4281.40
D3	331.6	216.2	37185.8	2134.60
D4	750.8	76.8	80137.2	2261.40
E8	1691.4	737.4	28486.4	2427.60
E9	1741.8	26962.8	1638.4	674.60
P1	2885.4	101.8	46621.8	4369.60
P2	776.6	229.4	876.4	0.00
P3	700.6	890.2	229.0	25.60

Appendix 1 continued. Sediment details and distance of sites from the Gt Ouse outfalls shown as points A and B in Figure 2.1

sites	%<63um 2007	%LOI 2007	sedtype07	OusedisA km	OusedisB km
16.2	73.0305	7.614	mud	5.2	4.48
16.3	66.6329	5.046	mud	5.28	4.38
16.4	66.5443	5.714	mud	5.38	4.32
16.6	35.7257	3.358	mud	5.62	4.22
16.7	50.6476	3.844	mud	5.72	4.18
16.8	59.1010	5.588	mud	5.86	4.16
16.9	75.4053	7.370	mud	6.02	4.16
17.3	33.9358	3.168	mud	2.96	2.32
17.4	38.0296	3.052	mud	3.04	2.12
17.6	39.0397	2.930	mud	3.28	1.74
17.7	7.8667	1.980	sand	3.36	1.56
17.8	22.4874	1.846	sand	3.48	1.38
17.9	50.4173	3.030	mud	3.66	1.24
18.3	63.6733	4.694	mud	2.3	2.16
18.4	38.2954	2.896	mud	2.32	2
18.6	29.5407	2.522	mud	2.4	1.6
18.7	19.4215	2.134	sand	2.46	1.4
18.8	15.1328	1.494	sand	2.52	1.26
18.9	61.9897	6.012	mud	2.62	1.04
19.3	28.6546	2.490	mud	4.54	3.16
19.4	20.1835	2.342	sand	4.56	2.98
19.6	10.9149	2.110	sand	4.68	2.64
19.7	29.6471	3.236	mud	4.76	2.48
19.8	57.0453	4.950	mud	4.84	2.38
19.9	73.3495	7.480	mud	5.04	2.28
20.2	79.8181	8.238	mud	7.36	5.88
20.3	43.5766	3.238	mud	7.38	5.66
20.4	9.8516	2.140	sand	7.42	5.46
20.5	8.2566	1.702	sand	7.52	5.28
20.6	6.2363	1.312	sand	7.62	5.18
20.7	6.8566	1.252	sand	7.76	5.12
B3	78.5244	12.458	mud	0.9	2.9
C2	67.5190	7.232	mud	1.94	1.8
C3	54.7237	5.060	mud	1.96	1.7
D2	55.3794	4.708	mud	4.56	1.18
D3	6.5376	1.600	sand	5.1	1.68
D4	35.1941	2.814	mud	5.74	2.3
E8	23.0191	1.722	sand	3.46	0.9
E9	37.4270	3.224	mud	3.62	0.68
P1	33.5814	2.508	mud	4.44	0.86
P2	6.3072	1.170	sand	5	1.46
P3	2.8160	0.988	sand	5.52	1.96

Appendix 2
Comparisons between the mean density of invertebrates in the 2006 and 2007 surveys of the Gt Ouse study area. Invertebrates whose density differed significantly between surveys are shown in bold text.

Worm species, whole study area

Invertebrate group, family or species/species size category	Whole study area (N=42)			
	mean density±SE 2006	2007	t value	p value
Nemerteans	4.9±2.6	13.6±8.5	1.12	0.27
Nematodes	**274 ±102**	**740±263**	**2.21**	**0.033**
Pholoe inornata	0	1.2 ±0.7	1.67	0.103
Anaitides mucosa	**7.9 ±2.7**	**21.2 ±6.5**	**2.9**	**0.006****
Eteone longa	**73±12**	**392±812**	**4.18**	**0.0001*****
***Hediste diversicolor* <15mm**	**9.4±5.4**	**30±12.4**	**2.34**	**0.024***
H. diversicolor 15-30mm	9.1±3.7	18.8±8.7	1.5	0.14
***H. diversicolor* >30mm**	**2.7 ±1.0**	**8.2 ±2.6**	**2.56**	**0.014***
Nephtys juveniles**<15mm**	**118 ±19.1**	**76 ±16.0**	**-2.11**	**0.041***
N. hombergii 15-30mm	42.5 ±7.5	40.3 ±8.6	-0.25	0.804
N. hombergii >30mm	17.9 ±4.9	18.8 ±4.0	0.08	0.86
N. cirrosa 15-30mm	3.3 ±2.0	3.6 ±1.8	0.26	0.80
N. cirrosa >30mm	0.6±0.6	0	-1.0	0.32
Scoloplos armiger <15mm	0.6±0.4	5.2±2.7	1.68	0.1
S. armiger 15-30mm	2.4±1.5	2.7±1.9	0.14	0.89
S. armiger >30mm	1.5±0.8	3.6±3.6	0.56	0.58
Polydora sp	0	0.6 ±0.4	1.43	0.16
Pygospio elegans	340 ±68	744 ±208	1.84	0.074
Spio martinensis	25.1 ±9.9	20.6 ±6.9	-0.89	0.38
Spiophanes bombyx	8.2±3.9	7.3±5.0	-0.24	0.81

Appendix 2

Worm species, whole study area continued

Invertebrate group, family or species/species size category	Whole study area (N=42)			
	mean density±SE 2006	2007	t value	p value
Magelona mirabilis	2.1 ±2.1	3.61 ±2.6	1.53	0.13
Tharyx sp complex A	588±206	1153±596	1.24	0.22
Capitellids	**64 ±16.1**	**39.5 ±10.5**	**-2.15**	**0.037***
Heteromastus filiformis	0	0.6±0.6	1.0	0.32
Ampherete grubei	0	0.3±0.3	1.0	0.32
Arenicola marina casts	0.48 ±0.2	0.56 ±0.3	0.46	0.65
Lanice conchilega	0	0.61 ±0.61	1.0	0.32
Tubificoides benedii	1570 ±377	1654 ±439	1.33	0.19
Enchytraeidae	0.6±0.4	125±64	2.0	0.053

Appendix 2 contd

Mollusc species, whole study area.

Invertebrate group, family or species/species size category	Whole study area (N=42)			
	mean density±SE 2006	2007	t value	p value
Hydrobia ulvae <3mm	11393 ±19798	14558 ±2822	1.1	0.28
***H. ulvae* 3+mm**	**329 ±124**	**685 ±231**	**2.26**	**0.029***
Retusa obtusa <3mm	3.3±1.9	13.3±12.1	0.97	0.34
R. obtusa 3+mm	4.6±2.4	14.2±7.4	1.54	0.13
***Mytilus edulis* <5mm**	**4.9 ±1.5**	**16.4 ±3.5**	**3.43**	**0.001****
Mytilus edulis 11-15mm	0	0.3 ±0.3	1.0	0.32
Mysella bidentata <5mm	0.9 ±0.7	3.9 ±1.6	1.71	0.095
Cerastoderma edule <5mm	810±377	88±27.2	-1.91	0.063
***C. edule* 5-10mm**	**843±381**	**70.4±38**	**-2.02**	**0.05***
C. edule 11-20mm	7.0 ±2.7	126 ±74	1.61	0.12
C. edule 20-30mm	8.2 ±6.8	1.8 ±1.0	-1.07	0.29
Ensis arcuatus 11-15mm	0	0.3±0.4	1.43	0.16
E. arcuatus 16-20mm	0	0.3±0.4	1.43	0.16
Angulus tenuis <5mm	0	0.3±0.3	1.0	0.32
***Macoma balthica* <5mm**	**60 ±9.9**	**747 ±166**	**4.1**	**0.0001*****
M. balthica 5-10mm	123 ±23	119 ±25	-0.18	0.86
***M. balthica* 11-20mm**	**9.4 ±2.1**	**27.4 ±7.2**	**2.69**	**0.01***
Abra. nitida 6-10mm	0.6±0.6	0.6±0.6	0.01	0.996
***Scrobicularia plana* <5mm**	**20.3 ±4.8**	**8.2 ±2.4**	**-2.52**	**0.016***
S. plana 5-10mm	34.5 ±7.9	21.6 ±5.2	-2.1	0.051
S. plana 11-20mm	25.4 ±12.0	33.6 ±9.7	1.59	0.12
S. plana 21-25mm	3.9±1.4	3.7±1.5	-0.19	0.852
S. plana >30mm	0	0.6±0.4	1.43	0.16

Appendix 2 contd

Crustacean species, whole study area.

Invertebrate group, family or species/species size category	Whole study area (N=42)			
	mean density±SE 2006	2007	t value	p value
Elminius modestus	22.7 ±1.0	4.8 ±4.5	-1.19	0.24
Indeterminate Copepod	0.3 ±0.3	0.3 ±0.3	0	1.0
Urothoe poseidonis <3mm	0.6 ±0.4	0	-1.43	0.16
Urothoe poseidonis 3+mm	0	0		
B. sarsi <3mm	0.6 ±0.4	17.9 ±9.9	1.75	0.087
B. sarsi 3+mm	0.6 ±0.4	5.8 ±2.8	1.86	0.071
Indeterminate *Gammarus*	0.3±0.3	0	-1.0	0.32
Corophium. arenarium <3mm	0.3±0.3	0	-1.0	0.32
C. arenarium 3+mm	0.3±0.3	0	-1.0	0.32
***C. volutator* <3mm**	**1153±467**	**2805±897**	**2.06**	**0.046***
***C. volutator* 3+mm**	**293 ±123**	**999 ±271**	**2.59**	**0.013***
Cyathura carinata	6.1 ±4.9	12.1 ±7.6	1.04	0.31
Tanaids	25.6±17.2	15.1±12.6	-0.63	0.53
Bodotria arenosa	0.3±0.3	0	-1.0	0.32
Pseudocuma longicornis	0.6±0.6	0	-1.0	0.32
Cumaceans	1.2±1.0	10.9±4.5	1.99	0.053
Crangon crangon	7.9 ±1.6	12.5	1.16	0.25
Carcinus maenas	2.4 ±0.9	1.2 ±0.6	-1.67	0.103

Appendix 3
Shorebird numbers in each transect during the winter 2007-08 surveys. Column 1 of each table indicates the transect number or area name. Remaining columns give the numbers of dunlin, redshank, knot, grey plover, bar-tailed godwit, oystercatcher, curlew and shelduck recorded in the first and second counts and mean count for the whole survey. 'OB' refers to outer bank areas.

1st count November - December 2007

Transect	dun1	red1	knot1	grp1	btg1	oyc1	cur1	shel1
51	8	6	411	32	32	143	36	210
52	103	34	345	9	6	37	2	2
53	0	0	49	0	6	37	2	0
54	95	7	79	6	18	206	0	32
55	0	0	110	0	0	0	0	0
56	15	4	0	5	7	62	0	3
57	735	43	11	0	54	27	0	6
58	638	41	124	0	35	41	4	12
59	500	144	183	5	20	0	0	12
60	1296	95	1035	10	8	50	5	11
61	335	0	105	42	4	142	0	67
62	0	2	530	10	0	105	3	362
63	174	0	3600	129	113	0	7	0
64	665	10	1712	23	42	196	3	58
65	81	0	2712	0	76	153	34	0
66	320	6	0	4	84	125	48	0
OB Daseley's	375	6	205	18	24	181	10	0
OB Pandora	27	3	0	0	0	0	0	0

Appendix 3 continued

2nd count December 2007 - January 2008

Transect	dun2	red2	knot2	grp2	btg2	oyc2	cur2	shel2
51	0	3	2343	74	27	49	30	167
52	0	34	190	0	0	0	0	27
53	32	0	150	0	0	0	0	125
54	0	0	10	0	0	152	8	87
55	0	0	10	0	0	0	6	86
56	32	3	20	0	0	21	4	0
57	275	8	0	15	0	51	0	3
58	398	98	0	0	0	46	21	14
59	0	77	0	0	7	8	4	14
60	0	59	0	0	0	0	7	0
61	0	0	0	0	0	0	3	0
62	65	6	0	0	0	15	2	73
63	280	5	0	17	0	0	18	871
64	0	0	400	0	16	1	8	353
65	22	19	3200	4	49	292	44	36
66	18	12	0	57	48	232	27	0
OB Daseley's	43	0	290	4	0	16	5	0
OB Pandora	0	5	65	0	0	17	0	0

Appendix 3 continued

Mean count winter 2007-08

Transect	dun07	red07	knot07	grp07	btg07	oyc07	cur07	shel07
51	4	5	1377	53	30	96	33	189
52	52	34	268	5	3	19	1	15
53	16	0	100	0	3	19	1	63
54	48	4	45	3	9	179	4	60
55	0	0	60	0	0	0	3	43
56	24	4	10	3	4	42	2	2
57	505	26	6	8	27	39	0	5
58	518	70	62	0	18	44	13	13
59	250	111	92	3	14	4	2	13
60	648	77	518	5	4	25	6	6
61	168	0	53	21	2	71	2	34
62	33	4	265	5	0	60	3	218
63	227	3	1800	73	57	0	13	436
64	333	5	1056	12	29	99	6	206
65	52	10	2956	2	63	223	39	18
66	169	9	0	31	66	179	38	0
OB Daseley's	209	3	248	11	12	99	8	0
OB Pandora	14	4	33	0	0	9	0	0