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BIOLOGY
THAMES ESTUARY BENTHIC PROGRAMME

A site by site report on the results of macroinvertebrate surveys undertaken during 1990–91.

NRA

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Summary.

1. Benthic macroinvertebrate samples were taken at 28 sites along the Thames Estuary from Teddington weir to Sea Reach No.2 Buoy in order to use the community structure present to infer the pollution status of the estuary at each point.

2. Samples were collected at quarterly intervals between April 1990 and December 1991 using intertidal, subtidal and kick-sampling techniques. Data from April 1989 to March 1990 were also included for comparison.

3. All macroinvertebrate specimens were removed and identified, with abundance and decalcified wet weight being determined. From these data, diversity, evenness and % composition were calculated.

4. Since the start of the survey, a total of 334 macroinvertebrates has been recorded from the Thames estuary, including 58 polychaete species, 31 amphipods, 28 oligochaetes and 23 bivalves.

5. The maximum number of species recorded at one site in any quarter was 51 at Chapman Buoy during the fourth quarter of 1991. This site has consistently registered the highest diversity. No macrofauna species at all were present in the samples from Beckton during quarter 3.90. This site continues to be the poorest in the estuary.

6. Several sites recorded consistently high abundances, particularly Crossness intertidal, Kew, Allhallows, Gravesend intertidal and West Thurrock intertidal. Generally, intertidal areas demonstrated higher abundances than subtidal sites. The highest total abundance recorded over the reporting period was 27612.5/m^2 at Crossness intertidal in quarter 4.90, due to vast numbers of the oligochaete *Tubifex costatus*. A total abundance of 19540/m^2 was recorded at Shoeburyness East during 4.91 due to high numbers of the snail *Hydrobia ulvae*.

7. Biomass tended to be greatest in the outer estuary intertidal areas due to the presence of large bivalves, polychaetes and crustaceans. During the reporting period, however, the highest biomass was 445.96 gWetWeight/m^2 at West Thurrock intertidal (quarter 2.90) due to a high abundance of large *Nereis (Neanthes) diversicolor*. Other high biomass values included Gravesend intertidal (149.64 in 2.91) when large numbers of *Corophium volutator* were present and during most quarters at Chapman Buoy (maximum 205.04/m^2 in 4.91) which has a generally diverse community of large species. The highest recorded biomass during the whole survey remains at this site (1085.12 in 2.89).

8. Some subtidal sites, especially in the mid-estuary (e.g. Crossness, Purfleet, Gravesend), displayed wide variation in number, composition and abundance. This suggests some instability of the sediment in addition to any other possible influences.

9. Several sites exhibited a dominance (i.e. >50% biomass) of organisms indicative of organic enrichment on more than one occasion, suggesting some influence of such pollution on the site. These were: Kew (3 quarters), Hammersmith Bridge (5), South Bank Centre (3), Greenwich (6), Woolwich intertidal & subtidal (6 & 3), Beckton (7), Crossness intertidal & subtidal (11 & 7), Purfleet intertidal & subtidal (5 & 2) and Gravesend intertidal (5).

10. In addition, several other sites had a numerical dominance (>50% abundance) of organic enrichment species that suggests some influence on the site. These included Allhallows, Grain Flats, Mucking and Teddington. The possible reasons for such results are discussed.

11. The low freshwater flows during the summer of 1991 has a marked deleterious effect on the communities in the estuary, particularly at Teddington. The movement upstream of other estuarine and marine species was also noted, so complimenting results from Teddington low-flow surveys.

12. The community at Mucking deteriorated considerably during the first half of 1991, all species being absent in 3.91. This highlighted the effects of nearby dredging and the site was consequently moved upstream.

13. Details of a possible method of determining the conceivable effect of sewage treatment works on the environment (Potential Impact Indices) are given.

14. Full details of each site, its community structure and possible influences on the site are presented in this report under individual sections, together with a summary of each site.

1. INTRODUCTION

1.1 Aims of Report.

1.1.1 This report details the results of the quarterly macrofaunal surveys undertaken in the Thames Estuary as part of the Thames Estuary Benthic Programme (TEBP). It describes the benthic communities present at a series of 28 sites along the length of the estuary, how these communities have varied with time and gives reasons, where possible, for any variation.

1.1.2 This document provides a continuation of the data presented in Attrill (1990b) and analyzed in Attrill (1991a), though the results from the first year of the TEBP (April 1989-March 1990) are repeated in this present report to allow temporal analysis.

1.1.3 In addition to providing descriptions and analyses of the macrofaunal communities at each site, as each site is considered separately, this report will provide a reference to allow responses to be made to enquiries from consultancies, academics, interested parties, etc. It will also act as an important base module for future analysis in respect to pollution status, community dynamics and subsidiary studies. It will also allow comparison with parallel fish studies at sites along the Thames Estuary.

1.2 Companion volume

1.2.1 In order to prevent any unnecessary text repetition from Attrill (1990b) and to keep this report as concise as possible, a further reference volume has been constructed (Attrill, 1991b). This is a site description report, detailing the physical environment at each site together with possible influences. It is an updated manageable form of descriptions that appeared in Attrill (1990b) and includes maps of each site. This document should be a relevant reference for future technical reports.

2. METHODS.

2.1 Sample Area.

2.1.1 The Thames Estuary as defined for this survey extends from Teddington Weir (the upstream limit of tidal influence) out to Sea Reach No.2 channel marker buoy situated in mid-channel between Haven point on the Essex coast and Warden point on the Isle of Sheppey (Fig. 1). The distance from Teddington to Sea Reach 2 is 108 km.

2.2 Sample Sites.

2.2.1 A total of 22 sites (some with both intertidal and subtidal components) are designated for the purposes of the TEBP. These were originally located to give as full a coverage of the estuary as possible and to coincide with potentially important features (e.g. STW outfalls). Presence of a suitable substrate, ease of access and a water supply for on-site sieving were all factors in site location. Full details of site selection are presented in Attrill (1989), with site descriptions in Attrill (1991b).

2.2.2 Table 1 lists the designated sites (including both intertidal and subtidal sites where appropriate), together with NGR, sample type and distance from London Bridge (the standard reference point).

2.2.3 During sample visits, intertidal sites were located through the use of landmarks, whereas the position of the subtidal sites was recorded using Decca navigation equipment on board the sampling vessel.

2.2.4 The sampling dates for all sites since April 1990 are recorded in Table 2, all sites being visited once per quarter (Quarter 1, Jan-Mar; 2, Apr-Jun; 3, Jul-Sep; 4, Oct-Dec.).

2.3 Sampling method

2.3.1 Three different methods were used to sample the macrofauna depending on the type of site to be sampled.

2.3.2 **Intertidal Sites.**

2.3.2.1 The methodology for sampling the intertidal area has developed since the last report (Attrill, 1990b). These sites are now sampled using a 0.02 m^2 hand-operated Gully grab. Five grab samples are taken and transferred to a FBA strong-meshed net of 1mm mesh size, the sample then being sieved on site utilising the available water supply. The residue is then transferred to either a plastic sample bucket or a polythene bag for return to the laboratory. This process is repeated four times, resulting in four replicates of 0.1 m^2 each.

2.3.2.2 Prior to the implementation of the grab method, samples were obtained by removing the sediment defined within a 0.1 m^2 quadrat. It was felt that the grab method was less susceptible to sample size variation, particularly in softer sediments, so providing a greater degree of accuracy.

2.3.2.3 Intertidal sampling methodology is currently under review by the NRA national marine biology sub-group, with the aim of defining a standard method for implementation by all NRA regions. These methods will be introduced to the Thames Estuary during 1992. As a result there will be a likely change in the intertidal sampling strategy.

2.3.2.4 On-site temperature was taken from a depth of 5 cm using a standard alcohol thermometer.

2.3.3 **Subtidal sites below London Bridge.**

2.3.3.1 The 12 sites falling into this category were sampled using a 0.1 m^2 Day grab from the commercial trawler F.V. Ina-K. The sediment

from the grab was emptied into large holding containers and sieved through a strong-meshed FBA net of 1 mm mesh size, utilising the trawler's on-board water pumping system. The sieve residue was transferred to plastic buckets or polythene bags for return to the laboratory. Four replicate grabs were taken at each site.

2.3.3.2 On-site water temperature was recorded using a standard alcohol thermometer.

2.3.4 **Subtidal sites above London Bridge.**

2.3.4.1 Due to the lack of soft sediment in this part of the estuary, it was not possible to sample the four subtidal sites in this region using the grab method. The technique employed at these sites involved a slight modification of the FBA kick sampling method. The substrate at each site was disturbed using a kicking motion for a duration of 1 minute, the macrofauna displaced being washed into a FBA strong-meshed net of 1 mm mesh size. The residue was transferred to a plastic bucket or polythene bag for transportation to the laboratory. Three replicates were taken, giving a total of three minutes sampling during, equivalent to a standard FBA kick sample.

2.3.4.2 This sampling method is only semi-quantitative, though improved by the division into three replicates, so cannot be directly compared with the quantitative intertidal and subtidal grab methods. As a result, all quantitative data, such as abundance and biomass, have to be expressed in terms of 3 minutes kick rather than m^2. However, as the net width is 255 mm, by restricting the kick to a transect of four metres, the resulting area sampled is approximately 1 m^2.

2.3.4.3 On-site water temperature was recorded using a standard alcohol thermometer.

2.3.4.4 Other available habitats at each site, e.g. boulders, debris, etc., were searched and any additional faunal taxa recorded.

2.3.5 Several other smaller sediment samples for supplementary meiofauna studies and sediment analysis were taken over the reporting period. In each case the sediment was transferred from shore or grab into plastic or glass containers.

2.4 Sample sorting and species identification.

2.4.1 Once transferred to the laboratory, the samples were stored in a refrigerator and sorted as soon as possible. This process keeps organisms alive/fresh facilitating the sorting and identification process.

2.4.2 Each sample was sieved again in the laboratory through both 1 mm and 500 µm sieves to remove any remaining sediment, the residue being transferred to a large, graduated sorting tray. A solution of "instant ocean" was available to maintain marine species. All organisms were removed, counted and identified to species level where possible using the appropriate keys. Difficult or uncertain species (mostly polychaetes) were sent for identification to the British Museum (Natural History). Some problematic freshwater taxa, such as chironomid larvae, ostracods, copepods and Naididae were not routinely specified, though examples were identified by authorities for the purposes of species lists. Decalcified wet weight was recorded for each species.

2.4.3 Small organisms present in large numbers (e.g. tubificids, *Corophium* spp.) were enumerated by counting/weighing a subsample present in a random two of the 10 tray graduations and multiplying by five to give a total value for the sample. A subsample of at least 100 oligochaetes per site were removed for identification, the worms being mounted in polyvinyl lactophenol and placed on a hot plate to clear. The species proportions recorded in the subsample were then related to the total oligochaete figure to achieve abundance and biomass values for each

species.

2.4.4 Examples of each species have been preserved to maintain a species library.

2.5 Analysis.

2.5.1 From the raw data recorded above, several community statistics for the site visit as a whole were calculated.

2.5.2 The number of species present in each of the subsamples was recorded, together with the **total number of species** recorded for the site. From the species number of all subsamples, a **mean species number** was calculated, relating to the average number of species in each subsample. This equates to No.Spp/0.1 m^2 for intertidal and subtidal grab samples and No.Spp/1 minute kick for the four kick samples.

2.5.3 Figures for **mean abundance** and **mean biomass** were recorded for each species. The abundance and biomass values recorded for each species in each subsample were summed (**total abundance** and **total biomass**), with this figure being calculated into the 1 m^2 equivalent thus (example for abundance):

Intertidal and subtidal grabs

$$\text{Abund./m}^2 = \frac{\text{Total Abundance}}{4} \times 10$$

2.5.4 For kick samples, the total abundance and biomass values were used without conversion, relating to abundance and biomass per 3 minute kick.

2.5.5 The total abundance and biomass figures for each species are summed to give total abundance and biomass for the whole sample. This can be related to values/m^2 using the above formula.

2.5.6 The total abundance figures were used to calculated the **diversity** of the community at each site, using the Shannon-Weiner equation with $\log_e$(ln):

Diversity (H'e) = $-\Sigma\ P_i.\ln P_i$

where P_i = the proportion of the total abundance represented by the abundance of the "*i*th" species.

2.5.7 **Evenness** (J) is a function of diversity and reflects the degree of dominance in the community, the lower the evenness, the greater the degree of dominance. It is calculated as a proportion of the diversity that would result from a community made up from equal numbers of each species represented (H_{max}):

H_{max} = ln.Tn, where Tn is the total number of species.

$$J = \frac{H'e}{H_{max}} \qquad J \leq 1.00$$

2.5.8 The species were clumped into their major groups (polychaetes, oligochaetes, bivalves, gastropods, amphipods, others) in order to calculate the **percentage composition (% comp)** of the community. This allows easy observation of the dominance of certain major groups (in terms of both abundance and biomass) and how the general proportional structure of the community varies with time.

2.5.9 **Freshwater scoring systems**

2.5.9.1 The **BMWP score** was calculated for the sites above London Bridge that have largely freshwater communities. This scoring system was devised for the DoE by the Biological Monitoring Working Party for use in freshwater rivers. Each designated taxon is attributed an arbitrary score relating to its apparent tolerance to pollution, the scores being summed to give a value for each site. This system only requires identification to family level and by purely using presence/absence takes no account of variations in

abundance or specific changes within a family. In addition, the taxa list is not exhaustive, many non-scoring organisms recorded in the estuarine samples would not be recognised by the score, despite being indicative of changing conditions. Conversely, some estuarine/marine species score using this system as they fall into families with freshwater representatives (e.g. Gammaridae, Corophiidae).

2.5.9.2 Despite its limitations, especially in tidal regions, the BMWP score does provide a coarse representation of the freshwater invertebrate community present and can be interpreted by non-biologists. It was therefore calculated as a supplementary and comparative statistic.

2.5.9.3 A related score was also calculated, the **Average Score Per Taxon (ASPT)**, indicating any specific removal of the more sensitive high-scoring freshwater families. It is calculated thus:

$$ASPT = \frac{\text{BMWP score}}{n}$$ where n = number of scoring families

2.5.10 **Salinity** data was obtained from the NRA archive, measurements being taken at sites along the estuary on a weekly basis, these data being mid-tide corrected to allow spatial comparison. To illustrate any long-term variations in the salinity regime, the mean quarterly salinity was calculated for each site above Southend using all the available data from that quarter.

3. SITE BY SITE RESULTS AND DISCUSSION.

3.1 Site 1: Teddington.

3.1.1 Community Description.

3.1.1.1 Teddington supports a wide range of freshwater taxa, mainly oligochaetes, amphipods, molluscs and insect larvae. The proportion of each group varies with the season and resulting freshwater flow over Teddington Weir.

3.1.1.2 Tables 3a and 3b present the species recorded at this site since April 1989. Over the last two year, the total number of species recorded has ranged from 13 to 32 (the highest species number so far recorded here) (Fig.2). Interestingly, species number is closely related to the BMWP score at this site (Fig.3), suggesting changes in the environment at Teddington have a similar influence upon the two parameters. Generally, most species are recorded during the second quarter of each year, with the late winter/spring flows allowing the development and maintenance of a diverse freshwater community. Species occurring during these periods range from high scoring (on the BMWP system) caddis flies (*Mystacides longicornis, Athripsodes cinereus*) to non-scoring taxa such as Ostracoda (*Candona* spp.), Cladocera (including *Ilyocryptus sordidus*) and Hydracarina. Despite their non-scoring status, these groups appear to be very sensitive to seasonal changes in flow regime and are generally absent during periods of low-flows (see below).

3.1.1.3 The dominant species at Teddington is *Gammarus zaddachi*, the only estuarine species to be recorded here. The abundance of this amphipod varies dramatically with the season, being absent in 2.90 but recording an abundance of 1790/3 minute kick the following quarter. It is possible that large numbers of *G.zaddachi* have an influence on the rest of the community at Teddington. During sorting, *Gammarus* have often been observed

devouring oligochaetes in the sorting tray. If the abundances of both *G.zaddachi* and total oligochaetes are plotted, a reciprocal pattern is apparent (Fig.4), suggesting that *Gammarus* predation may be a factor in oligochaete distribution, particularly as most of the oligochaete species present would be able to tolerate any reduction in flows. The influence on other species (esp. mayflies) is an unknown quantity, but should not be dismissed.

3.1.1.4 There appears to have been a dramatic change in the distribution of *Gammarus* spp. in the Thames Estuary. Andrews (1977) stated that in September 1976 the increase in salinity at London Bridge due to the drought caused the disappearance of several freshwater species. One of these was *Gammarus pulex* that had been the dominant species down to London Bridge at that time. As a result of the drought, this species had been replaced by *Gammarus zaddachi* at London Bridge, but remained further upstream. Since this time *G.zaddachi* has increased its distribution, replacing *G. pulex* right up to the weir at Teddington. The only time *G. zaddachi* was absent at Teddington was during the high flows of 2.90, when a few individuals of *G. lacustris* and *Crangonyx pseudogracilis* were recorded. Indeed a survey of a site in the freshwater Thames upstream of the weir at Teddington revealed the *Gammarus* species to be *Gammarus zaddachi*. Not only has *G.zaddachi* replaced *G.pulex* in the estuary, it seems to have negotiated the lock/weir at Teddington and replaced *G.pulex* in this part of the freshwater river. This record may be flow dependant; during high freshwater flow *Gammarus zaddachi* may be forced back into the estuary.

3.1.1.5 As a result of the dominant freshwater influence at Teddington, many freshwater species were only recorded at this site: *Aulodrilus pluriseta, Stylodrilus heringianus,* Naididae spp. (*Dero digitata, Stylaria lacustris, Uncinais uncinata*), *Piscicola geomata, Candona* spp., Cladocera (*Ilyocryptus sordidus, Eurycercus lamellatus, Simocephalus retulus*), *Gammarus lacustris, Athripsodes cinereus, Aphelocheirus aestivalis, Baetis* sp., *Ceraclea nigronervosa, Dytiscus* sp., *Hydroptila* sp., *Mystacides*

azurea, M. longicornis, Tinodes waeneri and *Anodonta complanata*.

3.1.1.6 Other species unique to the Thames Estuary have been recorded at Teddington during supplementary surveys (e.g. Teddington low-flow surveys) over the last two years: *Gordius* sp., *Planaria torva, Caenis horaria, Cloeon dipterum, Ephemera danica, Potamonectes depressus, Planorbis carinatus, Lymnaea stagnalis, Theodoxus fluviatilis* and *Sphaerium lacustre*.

3.1.1.7 A further record of note was the presence of a juvenile Chinese Mitten Crab (*Eriocheir sinensis*) under a rock at Teddington on 20.11.90. This boulder was revealed during the periodic lowering of the water level at Teddington, when Richmond lock is non-operational due to maintenance. The crab measured <1 cm carapace width and provides evidence that the species has a resident, breeding, self-maintaining population in the Thames estuary. Large populations of the swan mussel (*Anodonta cygnea*) are present in the mid-channel at Teddington and other sites in the upper estuary. These were periodically revealed when the tide level was lowered.

3.1.1.8 A full species-list of organisms recorded at Teddington and other sites in the Thames Estuary is to be found in Appendix 1. Including 32 chironomid species from Eppy (1989), 110 macroinvertebrate species have so far been recorded at Teddington during the TEBP.

3.1.2 Temporal variation and possible influences.

3.1.2.1 As alluded to in the above section, the most important influence on the fauna at Teddington is the quantity of freshwater entering the estuary over Teddington weir, as the fauna is primarily riparian dependant on the maintenance of the freshwater flow for survival and settlement. The effects of the variation in flow on the whole environment of the upper estuary are discussed in specific reports dealing with low-flows (Attrill, 1990a; Attrill & Ashby-Crane, 1991; Dale, 1992). This report concentrates on the

long-term effects on the macrofauna community.

3.1.2.2 During drought periods, increased abstraction from the freshwater Thames results in much less river water entering the estuary. This situation was apparent during the summers of 1989 and 1990 and the autumn/winter of 1991. A direct consequence of lower flows is an increase in the salinity regime due to the encroachment of estuarine water up the estuary (Figs. 5 & 6). This variation is slight but noticeable, Fig.7 illustrating the influence of the lowered flows (in terms of salinity) on the number of species recorded at Teddington. It can be seen that an increase in salinity was followed by a decrease in the species number of the site during the three low-flow periods described above. Conversely, peaks in species number (89.2, 90.2) followed periods of low salinity. It is not clear whether the increase in salinity is directly causing the decrease in species number. The actual volume of flow may maintain the population by constantly "restocking" the site from upstream, so reducing flow would cut off the supply of new organisms. In addition, other factors such as *Gammarus* predation may play a part, *Gammarus zaddachi* appearing to migrate up the estuary during low-flow periods.

3.1.2.3 The reason for the decline in species number is likely to be a complex combination of these factors, though the major influence of even a small salinity increase cannot be ignored. Under normal flow conditions, the site at Kew has a salinity regime similar to that experienced under drought conditions at Teddington. However, many of the organisms recorded at Teddington are not to be found at Kew, suggesting they are excluded by the relatively higher salinity.

3.1.2.4 The general effect of the increasing salinity is to remove the more "pollution sensitive" species. As a result, the trend for ASPT follows that for species number to a large degree (Fig.8). However, the fit is not as obvious as for BMWP. Several groups that score well on the BMWP system (e.g. Ancylidae, Unionidae, Gammaridae, Corophiidae) are resistant to salinity increases,

either due to specific tolerance or the representation by estuarine species. Conversely, some low scoring species (e.g. *Asellus aquaticus*, Valvatidae, some oligochaetes) seem intolerant to a salinity increase, becoming absent during low-flow conditions. In addition, several species present in the freshwater Thames above the weir (e.g. Physidae, Neritidae) are rarely, if ever, recorded at the estuary site, despite the small spatial separation. This "across the board" removal of species indicates that salinity tolerance is not directly related to general pollution tolerance.

3.1.3 Summary of Site Status.

3.1.3.1 The site at Teddington exhibits the capacity to support a diverse community of freshwater species, including those considered intolerant of pollution. However, the fauna are highly influenced by the quantity of water entering the estuary over the weir. Under low-flow conditions, the community is considerably depleted.

3.2 Site 2: Kew.

3.2.1 Community Description.

3.2.1.1 The community at Kew has a base around a number of freshwater species that are capable of tolerating slight increases in salinity. The peripheral community varies depending on the rate of flow over Teddington weir, though due to the exclusion of many freshwater species that are found at Teddington, the variation from full flow to low flow communities is less dramatic at Kew than it is at Teddington, with the number of species recorded ranging from 12 (low flow) to 21 (high flow) (Fig. 2).

3.2.1.2 Tables 4a and 4b present the species data for all samples taken at Kew since 1989. A few core species (*Gammarus zaddachi*, *Psammoryctides barbatus*, *Sphaerium corneum*, *Tubifex tubifex*) have been recorded on each occasion, regardless of seasonal variation in flow, temperature, etc. Other species (*Ancylus fluviatilis*, *Lymnaea peregra*, *Limnodrilus hoffmeisteri*, *Potamopyrgus jenkinsi*, *Pisidium* spp, *Erpobdella testacea*) have only been absent in a couple of samples. This set of species can be defined as the core community, the remaining species that have been recorded here appear to be more sensitive to any variation.

3.2.1.3 During full flow periods (first two quarters of the year), several fully freshwater species have been recorded in the samples (*Caenis moesta*, Hydracarina sp., *Valvata piscinalis*, *Corophium curvispinum*). Overall, though, the site is dominated by oligochaetes, with 13 species of tubificid being recorded, together with unidentified Enchytraeidae and Naididae spp. Fig.9 illustrates the variation within the composition of the fauna, both in terms of abundance (I/3 min kick) and biomass (gWetWeight/3 min kick). As can be seen, oligochaetes dominated numerically over most of the sample period and also contributed to the total biomass. In quarters 89.4, 90.4 and 91.1, over 50% of the biomass was represented by oligochaetes.

3.2.1.4 As for Teddington, the abundance of oligochaetes was related to the abundance of *Gammarus zaddachi* (Fig.10). In quarters 2.90, 3.90 and 3.91, there were large numbers of these amphipods (up to a vast 7250/3 min kick in 2.90), coinciding with a marked decrease in oligochaete abundance, especially in quarter 3.90. The trend was not so apparent for quarter 2.91, which had both high oligochaete and *Gammarus zaddachi* abundances, but by the following quarter both oligochaete abundance and diversity had decreased markedly.

3.2.1.5 Kew remains the only site where the freshwater snail *Viviparus viviparus* has been recorded, this species appearing periodically on-site in associated Teddington low-flow samples over the last two years. It has not been recorded in a TEBP sample since 3.89. The tropical oligochaete *Branchiura sowerbyi* was recorded frequently during the summer of 1989 at Kew, though it has not been recorded since. The gastropod *Lymnaea auricularia* was recorded during a low-flow sample.

3.2.1.6 A young Chinese Mitten Crab (*Eriocheir sinensis*) was found dead at the low tide mark at Kew during a routine survey in June 1990.

3.2.1.7 Including 22 chironomid species listed by Eppy (1989), a total of 73 species have been recorded at Kew during the TEBP.

3.2.2 Temporal variation and possible influences.

3.2.2.1 As for Teddington, the major influence at Kew appears to be the flow regime over Teddington weir, a decrease in flow resulting in an increase in salinity. Over the last two years, the periods of lowest flow (and thus highest salinity) occurred during the quarters 3.90, 4.90 and 4.91. (Figs. 5 & 6). The lowest salinities were present during the first two quarters of each year. Fig.11 illustrates the relationship between species number and salinity at Kew, indicating that there is a reciprocal relationship as for Teddington - an increase in salinity

resulting in a decrease in species number as the more ephemeral sensitive species are removed. The increases in *Gammarus zaddachi* numbers may be having an additional effect on the species number during the low-flow periods, possibly being a factor in the removal of oligochaete species.

3.2.2.2 Unlike Teddington, Kew has some possible influences additional to the quantity of water entering the estuary from the freshwater river. The periodic dominance of the biomass by oligochaetes (>50%) suggests that this site may be influenced by some degree of organic enrichment. Attrill (1991b) details the inputs to the estuary at this point, but the most influential is likely to be the effluent from Mogden STW which discharges into the estuary three km upstream. Due to the relatively small size of the estuary at this point, Mogden STW has potentially the greatest influence on the estuarine environment of all the works on the tideway (see Appendix 3). Under low-flow conditions, the river at Isleworth (where the discharge enters) can be up to 60% effluent from Mogden, resulting in high coliform levels (Appendix 2). The abundance of oligochaetes at Kew may reflect the effect the STW at Mogden is having on the estuary at this point.

3.2.2.3 There are additional possible inputs of organically enriched water to the Kew area, namely the Brent/GUC, Crane and Duke of Northumberland rivers and the smaller Kew STW ("downstream" of the sample site). All may have local influence, but in terms of volume they seem relatively insignificant compared with Mogden effluent.

3.2.3 Summary of site.

3.2.3.1 The fauna at Kew is based around a set of species able to tolerate the slightly increased salinity regime. Under full flow conditions, these species are supplemented by further freshwater species, which are excluded under low-flow condition. The site appears further influence by some organic enrichment, the most likely source being Mogden STW.

3.3 Site 3: Hammersmith Bridge.

3.3.1 Community Description.

3.3.1.1 Hammersmith Bridge represents the first quantitative intertidal site below Teddington weir, though the overall species list has the possibility of extension from kick samples taken during low-flow surveys. The community is generally one of relatively low abundance comprised mainly of oligochaetes and *Gammarus zaddachi*.

3.3.1.2 Tables 5a and 5b present the species recorded in the samples taken since April 1989, the numbers of species ranging from four to 14 (Fig.12a). Two species (*Gammarus zaddachi* and *Limnodrilus hoffmeisteri*) have been recorded in every sample, the *G.zaddachi* generally being small juveniles living amongst the sand grains. Other species that are found in most samples include *Tubifex tubifex*, *Psammoryctides barbatus* and Chironomidae spp. Over the last year (1991), Sphaeriidae species have become established, with *Sphaerium corneum* the most common species in the 4.91 sample. During high flow spring periods (quarter two of each year), further freshwater species are washed down the estuary and settle out at Hammersmith Bridge. Species recorded only during these periods include *Hydra* sp., the microturbellarian *Phaenocora* sp. and *Caenis moesta*. The number of oligochaete species tends to increase during these periods. As a result, the three highest species numbers have been recorded during 2.89, 2.90 and 2.91.

3.3.1.3 Several truly estuarine species have been recorded at Hammersmith Bridge, including the brown shrimp *Crangon crangon*, *Neomysis integer* and the polychaete *Polydora* sp., all during periods of lower flows. In addition, the amphipod *Corophium lacustre* became resident on rocks beneath the bridge during the summer of 1990 and autumn of 1991, appearing in the intertidal sample of 4.91. These rocks also support core species for this part of the estuary, such as *Ancylus fluviatilis*, *Potamopyrgus jenkinsi* and *Lymnaea peregra*. The isopod *Asellus aquaticus* was found several times during 1989, but has not been recorded since 1.91, even

during the high flow periods.

3.3.1.4 During a low-flow kick sample on 3/12/90, a small crab was observed but avoided capture. Due to the low salinity regime, it was most likely a young *Eriocheir sinensis*.

3.3.1.5 Including species noted during low-flow surveys, 39 species have been recorded at Hammersmith Bridge.

3.3.2 Temporal variation and possible influences.

3.3.2.1 As described above, there is a seasonal peak in species numbers associated with the full-flow spring sample (Fig.12a). In this area of the estuary, this "seeding" of freshwater organisms is likely to be a temporary increase in diversity rather than the norm, the community only being maintained by the above average flows. It seems likely that the "standard" community is around 8 species. However, even at this site the low-flow periods appear to have a detrimental effect, the lowest species numbers (six and four) being recorded during quarter 3.89 and 4.91 - extreme low flow periods. The detailed sections of Figs. 5 and 6 show that there is a much more obvious increase in salinity at this point in the estuary, the full-flow salinity being the same as Kew with a marked difference in the salinity regimes during the low-flow periods. However, the situation at Hammersmith Bridge (and at sites below this point) is complicated by the influx of estuarine species during periods of saline encroachment. These can have the effect of replacing freshwater species in the species number statistic, highlighting the importance of determining the species present. BMWP scores become less relevant at this point - the six-scoring Gammaridae and Corophiidae are represented solely by estuarine species. It is possible, therefore, that an increase in salinity could increase the BMWP score as estuarine species move up the estuary.

3.3.2.2 Against the background of seasonal salinity variation, it is

difficult to determine whether Hammersmith Bridge is exposed to any further influences. Oligochaetes are certainly a major contributor to the total abundance and biomass, but the sand substrate is more restrictive than the mixed substrate at Kew. During several quarters, oligochaetes are numerically dominant, such as the large numbers of *Limnodrilus hoffmeisteri* present in quarter 1.90, though their dominance of the biomass was dependant on the size and abundance of the *Gammarus zaddachi* present. It is possible, therefore, that this site is influenced by some organic enrichment, both from the main river (generally high coliform levels - Appendix 2) and from local storm drains. However, the general instability of the sandy sediment may be preventing larger populations of oligochaetes to develop.

3.3.3 Summary of site.

3.3.3.1 The site at Hammersmith is influenced by variations in flows, with freshwater species temporarily settling during spring. However, many freshwater species disappear during low-flow periods and are replaced by estuarine species due to the saline encroachment. There is some suggestion of organic enrichment affecting the community at this site.

3.4 Site 4: Cadogan Pier.

3.4.1 Community Description.

3.4.1.1 Cadogan Pier supports a community of oligochaetes, salinity-tolerant freshwater species and several upper-estuarine species. The combination of these organisms varies depending to some degree on the freshwater flow, though the total abundance always tends to be high.

3.4.1.2 Tables 6a and 6b present the data from kick samples taken from Cadogan Pier since April 1989, the total number of species present demonstrating a relatively narrow range from nine to 16 (Fig.2). Several species have been recorded in each sample (*Gammarus zaddachi*, *Potamopyrgus jenkinsi*, *Psammoryctides barbatus*, *Tubifex tubifex*), usually in high abundances. Other species (*Limnodrilus claparedeianus*, *Limnodrilus hoffmeisteri*, *Ancylus fluviatilis*, *Corophium lacustre*) are regularly present and can be regarded as core species. However, as several of the larger freshwater species (e.g. *Ancylus fluviatilis*, *Lymnaea peregra*, *Sphaerium corneum*) have not been recorded below Cadogan Pier, this site seems to be a transition point to more estuarine conditions.

3.4.1.3 Several truly estuarine species are regularly recorded at Cadogan Pier (*Crangon crangon*, *Palaemon longirostris*, *Sphaeroma rugicauda*, *Corophium lacustre*), especially during periods of low flow. Compared with sites upstream, there is less of an input of freshwater species during high flow periods. *Caenis moesta* and Hydracarina sp. were recorded during 1.90, but not during the other spring periods that caused increases in the species number at Hammersmith Bridge. As a result of the balance between fresh and estuarine species there tends to be less variation in the species number at Cadogan Pier than at the three sites upstream.

3.4.1.4 The site is characterised by vast numbers of oligochaetes, the numerically dominant species being *Psammoryctides barbatus*. In

this respect the site is similar to Kew, though at Cadogan Pier the numbers of *Gammarus zaddachi* are more stable and the average size of the amphipods tends to be larger. Peak numbers of *G.zaddachi* occurred during 2.91 (2040/3 min kick), which also recorded the lowest number of oligochaetes. At other times, when *Gammarus* numbers were lower, the high abundance of oligochaetes was maintained.

3.4.1.5 Cadogan Pier is the only site where the water boatman (*Sigara* sp.) has been recorded (during low-flow survey).

3.4.1.6 Including 10 chironomid species listed by Eppy (1989), 48 species have been recorded at Cadogan Pier during the TEBP.

3.4.2 Temporal variation and possible influences.

3.4.2.1 The decrease in species number with an increase in salinity is not as apparent at Cadogan Pier as at the previous three sites. Due to the higher salinity (Figs. 5 and 6), more estuarine species are present at this site. These become established during low-flow periods, thus buffering any decrease in species number due to the removal of freshwater species. As a result, the fauna can be said to undergo change rather than depletion.

3.4.2.2 The most obvious change is the presence of *Corophium lacustre*, which forms mud burrows on the surfaces of rocks and pebbles. Under drought conditions, the burrows are obvious on most of the rocks at Cadogan Pier, but the species is "forced back" downstream during high freshwater flows. This species acts as an indicator - other estuarine species (except the ubiquitous *Gammarus zaddachi*) are only found when *C.lacustre* is present. Before the first low-flow period (summer 1989) *Sphaerium corneum* was to be found at Cadogan Pier. It disappeared as salinity increased and has not been recorded since.

3.4.2.3 The vast numbers of oligochaetes suggest some organic enrichment influencing the site, though their percentage of the biomass is depressed by the number of large *Gammarus zaddachi* present (Fig.13). Only for one quarter (1.90) did oligochaetes exceed >50% of the biomass. However, the site is surrounded by storm drains, so the output of these (when operational), together with the quality of the river at this point (generally high coliform levels - Appendix 2) must have some effect on the community. The high abundances of oligochaetes may support this and in turn may be providing a food source for other species (e.g. *Gammarus*).

3.4.3 Summary of Site.

3.4.3.1 Cadogan Pier appears to be a transition zone demarcating the limit for several freshwater species, while under low-flow conditions, several estuarine species are present. Large numbers of oligochaetes suggest organic enrichment, perhaps influenced by the storm drains.

3.5 Site 5: South Bank Centre.

3.5.1 Community Description.

3.5.1.1 The sand and gravel substrate at South Bank Centre supports a generally poor community of mainly oligochaetes, represented in very low abundances. Few strictly freshwater species are to be found here, the majority being saline-tolerant species typical of upper-estuarine conditions.

3.5.1.2 Tables 7a and 7b present the data from the macroinvertebrate samples taken since April 1989, the low number of species ranging from two to seven (Fig.12a). The only species to be recorded in each sample is *Gammarus zaddachi*, usually represented by small juveniles, though *Limnodrilus hoffmeisteri* has only been absent twice. These two species are supplemented by *Potamopyrgus jenkinsi* and *Psammoryctides barbatus*, with other species being recorded only occasionally.

3.5.1.3 Several subtidal boulders at the site provide a substrate for *Corophium lacustre* burrows, particularly during low-flow periods. *C. lacustre* individuals have been recorded in the intertidal sand samples on occasions, presumably originating from these boulder communities. The boulders also provide a habitat for many large *Gammarus zaddachi*, *Sphaeroma rugicauda* and the leech *Erpobdella testacea*. During a preliminary survey of the intertidal area, Psychodidae sp. pupae and *Oulimnius* sp. larvae were recorded, but have not been recorded since.

3.5.1.4 A total of only 19 species have been recorded at South Bank Centre, the lowest total upstream of Woolwich.

3.5.2 Temporal variation and possible influences.

3.5.2.1 The effect of low-flows on the salinity regime becomes more obvious at South Bank Centre (Figs 5 & 6), the range of salinities increasing from a quarterly mean of only 0.08 ‰ in

1.90 (indistinguishable from sites upstream) to 3.32 ‰ six months later. As a result any organisms inhabiting the site have to be able to withstand larger salinity fluctuations, both on a daily and seasonal basis. Freshwater organisms found further upstream (e.g. the similar substrate at Hammersmith Bridge) are therefore excluded, whereas estuarine organisms also have to be able to withstand low salinities. The only species seemingly able to tolerate the salinity range is *Gammarus zaddachi*.

3.5.2.2 Due to the exclusion of many freshwater species, the increases in salinity associated with the low-flow periods have a less dramatic effect. Several oligochaete species (e.g. *Limnodrilus cervix*, *Lumbriculus variegatus*, *Potamothrix hammoniensis*) were only recorded during low salinity quarters. Conversely, and interestingly, *Potamopyrgus jenkinsi* was recorded more often during the high salinity periods (e.g. 3.90, 4.90, 4.91 and the massive influx during 4.89). The snail was originally a brackish species, only invading freshwater systems in the late 19th century (Macan, 1969; Fitter & Manuel, 1986). There are marked morphological differences within the species - snails found above Teddington weir tend to be smooth and dark, while individuals found further down the estuary (e.g. Greenwich) are much lighter and often have a pattern of ridges, keels and frills. The *P.jenkinsi* recorded at South Bank Centre are the "estuarine" type. It is possible, therefore, that this particular population remains intolerant of high freshwater flow.

3.5.2.3 In addition to the salinity fluctuations and the generally harsh, unstable nature of the substrate, other factors may be inhibiting colonization of South Bank Centre. The site is positioned at one of the busiest points in the estuary in terms of river traffic, which may have an effect on the stability of the substrate. In addition, seven storm drains discharge near the site and the shore is scattered with debris (plastics, metal, concrete, etc.).

3.5.2.4 The overall low abundances make community analysis more difficult, due to the exaggerated influence of individuals,

particularly the size of the *Gammarus zaddachi* present. During three quarters, oligochaetes constituted >50 % of the biomass, though the significance of this is unclear.

3.5.3 Summary of site.

3.5.3.1 South Bank Centre appears to present one of the harshest environments for macroinvertebrate colonisation in the Thames Estuary, due to a combination of salinity range, substrate instability, potentially poor water quality and anthropogenic mechanical influences. As a result, the community is one of few species represented in low numbers.

3.6 Site 6: London Bridge.

3.6.1 Community Description.

3.6.1.1 London Bridge supports a subtidal, hard substrate community that is consistently recorded in the mid-upper stretch of the estuary, based around several species naturally occurring under these conditions. However, the exact structure of the community is quite variable, both in terms of species number and abundance.

3.6.1.2 The data from kick samples taken at London Bridge are presented in Tables 8a and 8b, the number of species recorded fluctuating quite widely between two and eleven (Fig.2). As for South Bank Centre, the only species to be constantly recorded was the ubiquitous *Gammarus zaddachi*. However, during the first low-flow summer of 1989, *Corophium lacustre* colonised the boulders and pebbles at the site and has been recorded ever since, forming the basis of the community to be found at London Bridge. *C. lacustre* burrows provide a substrate in themselves, adding an important soft area for colonisation in an otherwise harsh environment. As a result, the quality of communities over the past two years have depended to a large degree on the concentration of *C. lacustre* burrows, modified by the potential impact of *Gammarus zaddachi* numbers.

3.6.1.3 The highest species numbers have occurred during periods of high freshwater flow (e.g. 1.90, 1.91) or periods of high salinity (e.g. 3.90, 4.90, 4.91). Both could be to some degree reliant on *Corophium* burrows - a substrate for colonisation by further oligochaetes during freshwater flows, or for species such as *Polydora* during saline periods. Lowest species numbers occur during the "transition periods" (e.g. 2.90 and originally 3.89, 4.89) when neither community is fully developed or before *Corophium lacustre* has become established. The influence of *Gammarus zaddachi* numbers may be to decrease the oligochaete abundance, as suggested for other sites. The high numbers present during 2.91 and 3.91 coincided with very few oligochaetes,

despite the presence of *Corophium lacustre*.

3.6.1.4 The intertidal region at London Bridge consists almost exclusively of large rocks, bricks, pieces of debris, etc. While this provides a good substrate for the *Corophium lacustre* community below low water, in the intertidal region it is virtually uninhabitable for the species concurrent with the salinity regime. As a result it is practically devoid of life.

3.6.1.5 During the high freshwater flows of 2.89, 1.90 and 1.91 individuals of a few freshwater species (*Caenis moesta*, *Asellus aquaticus*, *Oulimnius* sp.) were recorded. These had been carried downstream by the high flows and it is doubtful whether they would have survived for long.

3.6.1.6 During the TEBP, a total of 23 species have been recorded at London Bridge.

3.6.2 Temporal variation and possible influences.

3.6.2.1 Most of the temporal variation has been described in order to define the community structure. With only an occasional influx of truly freshwater species during high flows, this site is predominately salinity-influenced with freshwater perturbations rather than *vice versa*.

3.6.2.2 Other influences are similar to South Bank Centre, the site being one of high traffic load. In addition, London Bridge is situated on a relatively straight part of the estuary that has been artificially narrowed over the centuries with improvements in the flood defences. As a result, the speed of water movement with the tide here is at its peak, increasing any scouring effect and resultant stresses. The site is also susceptible to periodic deteriorations in water quality, with four storm drains in the near vicinity. However due to influences of substrate, disturbance and *Gammarus* numbers, oligochaete numbers are never great at London Bridge, always representing < 50% of the biomass.

3.6.3 Summary of site.

3.6.3.1 London Bridge presents a harsh environment for colonisation, due to stresses from salinity fluctuations, poor substrate and mechanical and chemical influence. The maintenance of the community is dependant to a large degree on the stable substrate provided by *Corophium lacustre* burrows.

3.7 Site 7: Greenwich.

3.7.1 Community Description.

3.7.1.1 The site at Greenwich presents the first permanent areas of intertidal mud flat available for sampling, although due to their relatively small size the sediment tends to be fairly mobile. As a result the site supports a variable community, both in terms of abundance and species number, generally dominated by often vast numbers of tubificid oligochaetes.

3.7.1.2 Tables 9a and 9b present the quantitative results of the intertidal samples taken at Greenwich since April 1989, the species number varying between one and nine (Fig.12a). The single species was recorded in the first sample (2.89), so as a result only *Limnodrilus hoffmeisteri* has been recorded in all samples, reaching abundances up to 5090/m² (3.91). Other species that have regularly been recorded since 3.89 are *Gammarus zaddachi* and *Potamopyrgus jenkinsi*, together with a *Corophium* species. A high species number (3.89, 3.90) generally correlates with the number of mobile crustacea present in the sample (e.g. *Neomysis integer*, *Crangon crangon*, *Sphaeroma rugicauda*), though the nine species present in 2.91 included five oligochaetes.

3.7.1.3 Subtidally at Greenwich is a *Corophium lacustre* based community similar to that described for London Bridge. However, the *Corophium* were present in vast numbers (>80,000/m²) when surveyed in 1989, and were accompanied by large numbers of *Dreissena polymorpha* in addition to the core species defined for London Bridge. It is likely that many of the more mobile species from this community are occasionally recorded in the adjacent intertidal mud (e.g. 3.89), thus increasing the species number.

3.7.1.4 Greenwich represents the downstream limit for *Erpobdella testacea* and *Asellus aquaticus*, together with the upstream limit for *Monopylephorus rubroniveus*, *Corophium volutator* and *Streblospio shrubsolii*. It was also the only site where a leech species,

tentatively identified as *Bactracobdella paludosa*, was recorded. Two large brown turbellarians were recorded during 3.90, though it has proved impossible to assign a species. A further interesting record was a small (2 cm carapace width) Chinese mitten crab (*Eriocheir sinensis*) caught during a fish trawl near the site on 1.11.90.

3.7.1.5 A total of 25 species have been recorded at Greenwich during the TEBP.

3.7.2 Temporal variation and possible influences.

3.7.2.1 The majority of the species recorded at Greenwich tend to be resilient to salinity changes, though the increasing salinity regime during low flow periods still has some subtle effects. The most notable was the change in *Corophium* species present in the intertidal samples - following the high salinities of 3.90 and 4.90, *Corophium lacustre* was replaced by *Corophium volutator*, despite a subsequent fall in salinity. It would be interesting to see how the increase in salinity affected the massive *Corophium lacustre* population present on the subtidal rocks.

3.7.2.2 The mud at Greenwich has the capacity to support some of the highest abundances of oligochaetes, particularly *Limnodrilus hoffmeisteri*, to be found in the estuary. The presence of the oligochaetes on their own would not necessarily suggest any organic enrichment as, due the relatively low salinity, there are few other sessile species indigenous to this part of the estuary that are capable of colonising the mud areas. However, the large numbers that develop do suggest organic enrichment feeding the community and supporting the high numbers, with oligochaetes representing > 50 % of the biomass in six samples. The mobility of the mud may prevent a stable population recording high oligochaete numbers in each sample.

3.7.2.3 There is no obvious source of organic input to the Greenwich area, the most likely being the main river itself carrying

material from outfalls and storm drains upstream. In addition, and perhaps more influential, would be any effluent brought up from Beckton STW on the incoming tide. NRA studies have shown that water from Beckton at low tide is carried up to Wapping by high tide, well past Greenwich (Appendix 4). However, other possible local inluences include four storm drains pesent in the Greenwich area and the river Ravensbourne. Whatever the source, sewage-associated material such as condoms and toilet paper, have periodically been recorded at the Greenwich site.

3.7.3 Summary of Site.

3.7.3.1 The small mud areas present at Greenwich support a community based around oligochaetes. These have been recorded in large numbers, suggesting organic enrichment is influencing the site. There appears to be an occasional influx of other mobile species, perhaps from the adjacent subtidal community.

3.8 Site 8: Woolwich (Intertidal and subtidal).

3.8.1 Community description - Woolwich Intertidal.

3.8.1.1 The intertidal areas at Woolwich represent the first extensive mud-flats to be sampled. Due to the relatively low and variable salinity, many typical estuarine mud-flat inhabitants are rarely found here, the community generally being dominated by oligochaete species supplemented by more mobile fauna as for Greenwich.

3.8.1.2 Tables 10a and 10b present the data from the intertidal macroinvertebrate samples taken from Woolwich, the total number of species recorded varying from three to 11 (Fig.12a). No species has been recorded in every sample, although *Limnodrilus hoffmeisteri* was only absent in 4.90. This species was usually the numerical dominant, reaching abundances of 825/m² (3.90). All other species have been recorded less regularly, although *Tubifex costatus*, *Potamopyrgus jenkinsi* and *Monopylephorus rubroniveus* are amongst the more commonly occurring species, together with one *Corophium* species. *Gammarus zaddachi* has been recorded less frequently at Woolwich than at all sites upstream of this point, the species becoming less common with the increase in salinity.

3.8.1.3 This site represents the upstream limit for several estuarine species (*Tubificoides benedeni*, *Nereis (Neanthes) diversicolor*, *Nephtys hombergi*), generally being recorded during high salinity/low flow periods (e.g. 3.90). In addition, *Carcinus maenas* has been noted on site, the upstream record for this species.

3.8.1.4 An area of rocks on and below the low-tide level supports a sparse community of *Dreissena polymorpha* and *Balanus improvisus*. Perhaps due to the increasing salinity, *Corophium lacustre* does not seem to be as abundant here as at Greenwich, despite the similar physical conditions.

3.8.1.5 Including species noted on the additional habitats, 26 species have been recorded intertidally at Woolwich. It was the only site in the estuary where a larva of the Ghost midge *Chaoborus* sp. was recorded.

3.8.2 Temporal variation and possible influences - Woolwich Intertidal.

3.8.2.1 As for Greenwich, the variation in species number is to some degree dependant on the number of mobile crustacean species present in the sample - the high species number recorded in 3.91 registering seven crustacean species, five of which were not recorded during the rest of the year. There is little correlation between species number and mean quarterly salinity - the annual fluctuations are similar to the salinity regime experienced on a daily basis. However, during periods of low-flow, the minimum and maximum daily salinities are increased, allowing colonization by species generally distributed further downstream. The most obvious intrusion was *Nephtys hombergi*. Previously to the record during 3.90, the furthest upstream that this species had been recorded was Purfleet. It highlights the apparent mobility of even these infaunal polychaetes. The change in *Corophium* species at this site mirrors the change at Greenwich, *Corophium lacustre* being replaced by *Corophium volutator* at the beginning of 1990.

3.8.2.2 Due to the extreme salinity fluctuations and relatively mobile sediment, stable populations do not persist at Woolwich, making it more difficult to detect any effect from other influences on the community. However, during six quarters, oligochaetes formed > 50 % of the biomass at the site, mainly due to the high numbers of *Limnodrilus hoffmeisteri* present. The fact that this species can proliferate in these unstable conditions suggests that there may be some feed of organic matter onto the site (Brinkhurst, 1971), either from the main river itself or from the three local storm discharges. Effluents from both Beckton and Crossness STW are carried over the site by the incoming tide (Appendix 4), perhaps a major influence on the community structure of the site despite being "downstream".

3.8.3 Community Description - Woolwich subtidal.

3.8.3.1 The subtidal site at Woolwich exhibits a similar range of species to the intertidal site, with oligochaetes generally numerically dominant and supplemented by mobile crustacean species.

3.8.3.2 Tables 10c and 10d present the data for subtidal samples taken at Woolwich, the species number ranging from three to 10 (Fig.14a). As for the intertidal site, no species was omnipresent, although two oligochaete species (*Limnodrilus hoffmeisteri* and *Monopylephorus rubroniveus*) were recorded during all but two quarters. These two species generally accounted for most of the total abundance.

3.8.3.3 The estuarine species *Nereis (Neanthes) diversicolor* and *Tubificoides benedeni* were both recorded subtidally as well as intertidally. In addition, *Gammarus salinus* was definitely recorded during 2.91 - its most upstream record. It is possible this species is present as juveniles, but it is practically impossible to distinguish them from *Gammarus zaddachi* at such a small size.

3.8.3.4 A total of 17 species have so far been recorded at Woolwich subtidal during the TEBP.

3.8.4 Temporal variation and possible influences - Woolwich subtidal.

3.8.4.1 The overall salinity regime at the subtidal site is the same as for the intertidal site. However, only the subtidal site is exposed to the lowest salinities at low tide, thus increasing the possible stresses on the site. The substrate appears relatively unstable, affected by the scouring of the tidal movement, preventing the establishment of stable populations. As a result the site generally records only 3-5 species, with the occasional increase due to the influx of more mobile species.

3.8.4.2 The percentage composition of the biomass is again dependant on the ephemerality of the community, i.e. the influence of large mobile crustacea that happen to be caught in the grab and the current status of the oligochaete population. However, oligochaetes comprised >50% of the biomass during three quarters, reaching total abundances of over $400/m^2$. While this is a comparatively low figure, compared to the overall abundance it suggests the potential for the development of oligochaete numbers, moderated only by the instability of the substrate and variability of the salinity regime. The site would be influenced by the same factors as the intertidal areas, though any effect from the main river would be increased due to the continual "undiluted" exposure to the Thames water at low tide.

3.8.5 Summary of sites.

3.8.5.1 The two sites at Woolwich support similar communities, suggesting similar major influences. The variable physico-chemical regime restricts the fauna, though there is some suggestion of organic enrichment due to the periodic dominance of oligochaete species.

3.9 Site 9: Beckton.

3.9.1 Community description.

3.9.1.1 The subtidal site at Beckton is situated adjacent to the outfall from the sewage treatment works and is the poorest site in the Thames estuary in terms of macroinvertebrate abundance and species number. Generally only oligochaetes were present, with the occasion record of mobile crustacean species.

3.9.1.2 Tables 11a and 11b record the data from each quarter's macroinvertebrate survey, with a species number ranging from 0 to 7 (Fig.14a). The only species present in most samples was *Limnodrilus hoffmeisteri*, usually in low numbers though the species reached an abundance of 1400/m² during 1.90. *L.hoffmeisteri* was the only species in the sample on five occasions, while during 3.90 no macroinvertebrates were present in any of the subsamples. Beckton was the only site to record this rather lamentable statistic. The only other species to be recorded on more than one occasion were *Gammarus zaddachi* (four times), *Corophium volutator* and *Neomysis integer* (both twice). All are relatively mobile species found in large numbers in other parts of the estuary. Other species (e.g. chironomids, Naididae) may be seeded into the mud from the STW, being discharged along with the effluent.

3.9.1.3 Only 10 species have been recorded at Beckton during the TEBP - the lowest total number in the estuary.

3.9.2 Temporal variation and possible influences.

3.9.2.1 As described, the community at Beckton is one of solely *Limnodrilus hoffmeisteri*, occasionally supplemented by mobile crustacea or other oligochaetes. It is interesting to note that peak species numbers occurred during the second quarter of each year, though it is possible that this has more to do with the natural movements and fecundity of the crustacean populations

rather than any seasonal improvements at the site.

3.9.2.2 The site has one primary influence - the outfall from Beckton STW which discharges a potential 730,000 m^2/day of effluent into its own channel just downstream of the site. However, on the incoming tide the outfall plume will be spread over the site area having a direct influence on the area. The effluent is generally of high quality with a relatively low PII despite its large volume (Appendix 3), although there will still be a considerable organic load on the local area. The actual volume of the effluent may be having an effect; the sediment at Beckton is extremely soft and mobile and may be continually being displaced and replaced by the influence of both the outfall and the tide. However, similar soft sediments are also to be found nearby (i.e. Woolwich and Crossness) which support more abundance and diverse communities. This would suggest that what would be a relatively impoverished community due to the difficult physico-chemical conditions is further diminished by the effect of the STW outfall.

3.9.2.3 Due to the dominance of *Limnodrilus hoffmeisteri*, 100% of the biomass is often due to oligochaetes. In total, 6 quarters registered >50% of the biomass represented by oligochaetes, in addition to quarter 3.90 when no species were recorded at all. Generally abundances were low, though 1400/m^2 were recorded during 1.90. The source of any organic enrichment is most likely to be the sewage works, although on occasions when a high quality effluent is discharging, the receiving estuarine water may have a higher load.

3.9.3 Summary of site.

3.9.3.1 Beckton stands out as the poorest site in the Thames estuary, often with only oligochaetes present in low numbers and no macrofauna being present on one occasion. It seems unlikely that proximity of the site to the STW effluent is merely coincidental.

3.10 Site 10: Crossness (Intertidal and subtidal).

3.10.1 Community Description - Crossness intertidal.

3.10.1.1 Crossness intertidal site is situated just upstream of the Crossness STW outfall and supports vast numbers of tubificid oligochaetes, the relatively stable mud in the intertidal area sampled (Attrill, 1991b) allowing the oligochaete population to proliferate and exploit any organic enrichment from the STW discharge.

3.10.1.2 Tables 12a and 12b present the data for macroinvertebrate samples taken since April 1989, the number of species recorded varying within a relatively narrow band of 3-7 species (Fig.12b). The species number is dependant on both the number of oligochaete species present and the appearance of any less frequent species. *Tubifex costatus* has been recorded during each quarter, reaching a density of 27065/m² in 4.90. This is the highest abundance recorded by any species in the Thames estuary during the TEBP. The oligochaete common at previous sites, *Limnodrilus hoffmeisteri*, is also regularly recorded at Crossness. It reached an abundance of over 10,000/m² during 2.90, although this primarily freshwater species becomes less frequently recorded in the estuary below this point. Due to the total dominance of any one oligochaetes species, Crossness intertidal recorded some of the lowest diversity and evenness statistics in the estuary. Among non-oligochaete species, *Nereis (Neanthes) diversicolor* and *Corophium volutator* were often present, though in low numbers compared with oligochaetes.

3.10.1.3 This site is the downstream limit for several oligochaete species (e.g. *Tubifex tubifex*, *Lumbriculus variegatus*), perhaps maintained by the freshwater input from the sewage effluent. It also was the upstream limit for the bivalve *Macoma balthica*, this species present during the relatively low flows of 4.90. As for Beckton, some primarily freshwater taxa (chironomids, oligochaetes) may be washed onto the site from the STW rather

than downstream from the main river.

3.10.1.4 Mainly due to the diversity of oligochaete species, a total of 14 species have so far been recorded at this site during the TEBP.

3.10.2 Temporal variation and possible influences.

3.10.2.1 The influence of seasonal salinity changes becomes less marked the further down the estuary, the only evidence of any influence on the site at Crossness being the appearance of *Macoma balthica* during the high salinity period at the end of 1990.

3.10.2.2 This site is similar to Beckton in being adjacent to a major STW outfall. However, due to the intertidal mid-shore location the sediment is more stable, being exposed to the disruptive tidal movement for a shorter period of time. This enables a stable community to develop, allowing any influences from the outfall to become apparent. The site has consistently the greatest concentration of tubificid oligochaetes in the estuary. As a result it is the only site where oligochaetes formed >50% of the biomass on every sampling occasion, the vast numbers indicating fairly conclusively that the site is highly influenced by organic enrichment. Fig.15 displays the number of times a site has >50% of the biomass represented by oligochaetes and highlights the peak around the Beckton/Crossness area. The STW outfall has one of the highest Potential Impact Indices in the estuary (Appendix 3), so it seems probable that it is the main source of organic material feeding the site.

3.10.2.3 The vast biomass supported by the Crossness mudflats provides a good feeding site for several species of bird, such as Mallard, Teal, gulls, Dunlin and other waders.

3.10.3 Community description - Crossness subtidal.

3.10.3.1 The subtidal site is situated about 100 m downstream, out of the direct physical influence of the outfall but likely to be

affected by its water quality. The site is less stable than the intertidal area and supports a varying community based on oligochaetes in lower abundances than the intertidal site.

3.10.3.2 Tables 12c and 12d present the results from subtidal grabs taken since April 1989, the wide-ranging species number varying from one to 11 (Fig.14a). The core of the community is at least one oligochaete species, usually accompanied by polychaete and crustacean representatives. Due to the apparent instability of the substrate, no species is omnipresent though a core set of species (*Limnodrilus hoffmeisteri*, *Monopylephorus rubroniveus*, *Streblospio shrubsolii*, *Corophium volutator*) are regularly recorded.

3.10.3.3 A total of 20 species have so far been recorded subtidally at Crossness during the TEBP. An interesting record was the presence of several *Physa* sp. individuals during 2.91. This freshwater gastropod has not been recorded in the estuary upstream of this point, but during the same day others were recorded subtidally at West Thurrock.

3.10.4 Temporal variation and possible influences - Crossness subtidal.

3.10.4.1 The site has demonstrated some great variability, particularly quarters 3.89 and 4.89 when the species number went from one to nine. The general range is 5-6 species, superimposed by peaks and troughs, this pattern suggesting a degree of substrate instability. There seems to be a certain patchiness of the fauna at this point, with occasional great variation between subsamples. The drop to one species during 3.89 coincided with a similar disappearance of the fauna at the West Thurrock subtidal site. Both sites are adjacent to busy ship jetties, which may have had and influence (dredging?).

3.10.4.2 Despite the variation, abundances generally remain fairly high (200-600/m^2) allowing some further analysis. Oligochaetes and spionids represented >50% of the biomass on seven occasions,

suggesting that the subtidal site may also be influenced by organic enrichment, presumably from the STW outfalls.

3.10.4.3 The effect of increased salinity is still detectable, with *Nephtys hombergi* and *Nereis (Neanthes) succinea* both being recorded during high salinity periods (4.91 & 4.89). Crossness subtidal is the upstream limit for the latter species.

3.10.5 Summary of sites.

3.10.5.1 The sites at Crossness both show definite signs of organic enrichment, particularly the intertidal area where a stable community including vast numbers of tubificid oligochaetes has developed. Both sites are likely to be highly influenced by the STW outfall, perhaps with a cumulative effect from Beckton upstream. Other non-oligochaete species are frequently recorded, suggesting the deleterious effect of the outfalls is more influential than exclusive. This, however, would change if the overall water quality (e.g DO) of the estuary in the area was to deteriorate and add extra stresses.

3.11 Site 11: Purfleet (Intertidal and subtidal).

3.11.1 Community Description - Purfleet Intertidal.

3.11.1.1 Unlike most intertidal/subtidal pairings, the two purfleet sites are some distance apart (Fig.1, Table 1). The intertidal site is upstream of the large wharf and industrial area with the subtidal site downstream of the Dartford bridge.

3.11.1.2 The intertidal site is a fine mud, with a variable fauna characterised by low abundances of oligochaete and crustacea species.

3.11.1.3 Tables 13a and 13b present data collected from samples taken since April 1989, there being a relatively wide range of species number from two to eleven (Fig.12b). As typifies the variable, unstable sites, no species was found in all samples, although *Tubifex costatus* and *Corophium volutator* were only absent on two occasions. The marine/estuarine oligochaete *Tubificoides benedeni* was regularly recorded at this site, indicating the increasing saline conditions, although several species generally regarded as freshwater (*Psammoryctides barbatus*, *Limnodrilus hoffmeisteri*) manage to survive here.

3.11.1.4 Purfleet intertidal marks the upstream limit for several marine species that are common in the outer estuary, such as *Eteone longa*, *Hydrobia ulvae* and *Caulleriella* sp. It is also the first site where *Carcinus maenas* has been recorded in the quantitative sample. There was a large influx of small *Crangon crangon* into the mud during 2.90, together with five other crustacean species, while quarter 4.91 recorded two freshwater molluscs, *Bithynia tentaculata* and several small *Planorbis* sp. As for the *Physa* sp. at Crossness, their appearance and survival (all were alive) in the mid-estuary is most interesting.

3.11.1.5 Including species discovered on the rocky part of the shore, a total of 28 species have been recorded at Purfleet intertidal. It

remains the only site where the prawn *Palaemonetes varians* has been recorded.

3.11.2 Temporal variation and possible influences - Purfleet intertidal.

3.11.2.1 The variability of the community at Purfleet suggests that this is one of the most unstable intertidal sites in the estuary, with a mobile substrate similar to the subtidal parts of the mid-estuary. This would be a function of the site position in relation to the estuary topography - the channel at this point is straight perhaps increasing the scouring effect. The variability is highlighted by quarters 1.91-3.91 (Table 13b) and can result in the low abundances.

3.11.2.2 Patterns relating to %biomass are more difficult to determine with the low abundances, due to the influence of individual large organisms. However, oligochaete populations have developed up to densities of nearly $400/m^2$, particularly over the winter period, although *Tubifex costatus* has obtained much higher densities both upstream and downstream of Purfleet. The result is that five quarters registered >50% of the biomass represented by oligochaetes (Fig.15), suggesting that the site may have the tail end of any influence from the main sewage works upstream (Appendix 4). The %dominance peak from the Crossness area appears to tail off after this point.

3.11.3 Community description - Purfleet subtidal.

3.11.3.1 The site at Purfleet subtidal appears to have undergone a dramatic change since the end of 1990, perhaps a stabilisation of the sediment. During 1989, the site was extremely poor, supporting basically oligochaetes in low numbers. Since then, a diverse, often high abundance, community has been recorded comprising oligochaetes, polychaetes, crustacea and molluscs.

3.11.3.2 Tables 13c and 13d illustrate the data obtained from samples taken since April 1989, the species number ranging from 2 to 11

(Fig.14b), although five has been the minimum since 1.90. The oligochaete *Tubificoides benedeni* has been recorded in all samples, with *Corophium volutator* in all samples since 1.90. Both species have been recorded in large numbers, 5350/m² for *T.benedeni* and >2300/m² for *C.volutator*. Four spionid polychaete species have been recorded since 1.90, including the upstream limit for *Pygospio elegans*. It is the only site where *Spio filicornis* has been recorded. Purfleet subtidal is also the upstream limit for *Scrobicularia plana* and *Mesopodopsis slabberi*, together with the furthest downstream that *Potamopyrgus jenkinsi* has been recorded.

3.11.3.3 A total of 19 species have been recorded at Purfleet subtidal, although prior to 2.90 only six species had been noted.

3.11.4 Temporal variation and possible influences - Purfleet subtidal.

3.11.4.1 Since 1.90 the site at Purfleet has recorded a comparatively diverse community, with peaks in abundance during the second quarter of each year. There appears to be a decrease in both abundance and species number during the second half of the year. This could be due to any deterioration in water quality over the summer, both in terms of temperature and DO. Many of the species recorded in the diverse community during 2.90 are at or near the limit of their ranges (e.g *Eteone longa*, *Caulleriella* spp., *Scrobicularia plana*). The additional stresses due to poor water quality may be removing the more sensitive species.

3.11.4.2 Despite the existence of a comparatively stable population since 1.90, there appears to be less influence from organic enrichment at the subtidal site, with only two quarters recording a biomass composed of >50% oligochaetes. This may be due to the more distant influence of the major STWs, although the occasional high abundances of *Tubificoides benedeni* suggest there is still a significant input. The %biomass figure is largely modified by the number of *Corophium volutator* and other large species (e.g. *Scrobicularia plana*) present.

3.11.5 Summary of sites.

3.11.5.1 The sites at Purfleet seem to be another transition zone between estuarine and marine influences, with several marine species appearing at the site. Both sites continue to show some influence of organic enrichment, although the subtidal site has a much more diverse fauna than was recorded during 1989.

3.12 Site 12: West Thurrock (Intertidal and Subtidal).

3.12.1 Community description - West Thurrock Intertidal.

3.12.1.1 The apparently highly stable mud-flats at West Thurrock support a high abundance, high biomass community based around four common species. These are supplemented by periodic records of individuals of other species.

3.12.1.2 Tables 14a and 14b present the data obtained from samples taken since April 1989, the comparatively stable community ranging in species number from four to nine, although generally five to seven species are present (Fig.12b). Three species have been recorded in every sample, each recording high abundances: *Nereis (Neanthes) diversicolor* (maximum 4662.5/m²), *Tubifex costatus* (7767.5/m²) and *Corophium volutator* (5420/m²). In addition, *Tubificoides benedeni* has only been absent on one occasion, though this species is present in much lower numbers (max 250/m²). The biomass is dominated by *N.diversicolor*, recording a figure of 760 gWWt/m² in 3.89. This is one of the highest individual species biomass in the Thames Estuary, bettered only by a *Crepidula fornicata* bed sampled at Chapman Buoy.

3.12.1.3 Most of the other species present at the site have been recorded infrequently and in low numbers, although *Macoma balthica* has been a regular constituent of the fauna since 1.90. The remaining species are commonly recorded in the mid-outer estuary, the exceptions being *Corophium insidiosum* (only other record being at Canvey) and a Tipulidae larva. West Thurrock is the lowest site where *Gammarus zaddachi* has been recorded. A large *Molgula manhattensis* was recorded during 2.90. This species is common subtidally, and may possible have been deposited on the intertidal area from the nearby "trash-pit" outfall of the power station.

3.12.1.4 Due to both the high abundance of benthic organisms and the supply of fish being returned to the river from the power station, the site is an important feeding site for many bird species, particularly herons, gulls, waders (including redshank) and shelduck.

3.12.1.5 A total of 15 species have been recorded at West Thurrock intertidal, although many more have been noted from the intake screens of the power station (Appendix 5), including several adult chinese mitten crabs.

3.12.2 Temporal variation and possible influences - West Thurrock Intertidal.

3.12.2.1 West Thurrock intertidal represents one of the most stable communities in the mid estuary, having the basis of the four main species. The only real variation is in the number of supplementary species recorded at any one time, although there have been some changes in the abundances of the core species. *Corophium volutator* numbers are highly volatile, although the population at this site has never totally crashed, unlike other areas (Gravesend intertidal, West Thurrock subtidal). The lowest abundances recorded here were 254/m², the following quarter registering the highest abundance of this species.

3.12.2.2 There has been a more definite pattern of change within the oligochaete population, with a general decrease in abundance of *Tubifex costatus* (Fig.16). This decrease followed the peak abundance in 2.90, the abundance since being measured in hundreds rather than thousands. The reason for the decrease is unclear, although this decimation, together with the biomass dominance of *N.diversicolor*, results in a very low percentage of the biomass being represented by oligochaetes. In addition, oligochaetes never formed >50% of the abundance, despite the large numbers in 2.90.

3.12.3 Community description - West Thurrock Subtidal.

3.12.3.1 In parallel with other such sites in the mid-estuary, the subtidal site at West Thurrock appears to be based on a mobile, unstable mud substrate, resulting in a variable community, both in terms of species composition and abundance. Since a crash in numbers in 3.89, the community has generally been one of low abundance.

3.12.3.2 Tables 14c and 14d present the results from samples taken subtidally since April 1989, the species number varying between

one and eight (Fig.14b), although during 1991 the community was more stable with a range of six to eight species. As described in Attrill (1990b), quarters 2.89 and 3.89 saw the most dramatic change in any population in the Thames Estuary, with an almost total disappearance of a high abundance community based around *Corophium volutator*. The population of 22125/m² in 2.89 remains the highest density of this species recorded, with only 10/m² being recorded the following quarter. The *C.volutator* population has never recovered, the species actually being absent during three quarters.

3.12.3.3 The most frequently occurring species was *Tubificoides benedeni*, which was only absent in 3.89 following the community crash. The only other species that have been recorded in more than half the quarter are *Streblospio shrubsolii* and *Nephtys hombergi*, which has been omnipresent since 4.90. Two *Nereis* species have been recorded here, with the highest abundances of *N.succinea* in the estuary (107.5/m²) being recorded in 4.89.

3.12.3.4 West Thurrock subtidal is the only site where the planktonic copepod *Eurytemora affinis* has been recorded, although this species is likely to be widely distributed in the estuary, and is also the upstream limit of the amphipod *Melita obtusata*, which occurred during the high salinity period of 3.90. The freshwater gastropod *Physa* sp. was recorded during 2.91, the same quarter that it was present at Crossness subtidal.

3.12.3.5 Since April 1989, a total of 19 species have been recorded at West Thurrock subtidal. Several larger additional species have been taken from the intake screens at the adjacent power station (Appendix 5).

3.12.4 Temporal variation and possible influences - West Thurrock subtidal.

3.12.4.1 The major influence affecting the community at the subtidal site appears to be the instability of the sediment, as illustrated by the devastating change between 2.89 and 3.89. However, colonisation by marine species is still to some degree dependant on the freshwater flow. *Nephtys hombergi* was only recorded in 1989 and 1990 during high salinity quarters. It was present in

all quarters in 1991, but most abundant during the relatively high salinity period of 4.91. A similar pattern was also true for *Caulleriella* spp. and *Macoma balthica*.

3.12.4.2 Compared to all four subtidal sites above West Thurrock, this site has a less obvious influence from organic enrichment, perhaps due to the distance from the major STW. At no time did oligochaetes form >50% of the biomass, although they did form >50% of the total abundance on two occasions. However, these two quarters (2.90 and 4.90) had low total abundances - the oligochaetes were not present in large numbers (17.5 and 5/m^2 only).

3.12.5 Summary of site.

3.12.5.1 Due to its position, it would seem that overall West Thurrock is not significantly influenced by organic enrichment from outfalls both upstream and downstream of this point, the intertidal mud-flats providing an example of a "typical" estuarine intertidal community. The subtidal area is more unstable and following a crash in *Corophium volutator* numbers after 2.89 has generally recorded a low abundance community.

3.13 Site 13: Gravesend (Intertidal and Subtidal).

3.13.1 Community Description (Gravesend Intertidal).

3.13.1.1 The intertidal community at Gravesend appears to be generally stable, with a relatively high species number and high total abundance. The fauna are mainly marine, together with several lower-estuary species.

3.13.1.2 Tables 15a and 15b record the results from samples taken at the site since April 1989, the total species number varying between seven and 12 (Fig.12b), although the minimum species number recorded during the last two years is nine. The site has a core of several species, with *Tubificoides benedeni*, *Corophium volutator* and *Nereis (Neanthes) diversicolor* being recorded during all quarters. In addition, *Caulleriella* spp., *Macoma balthica* and *Eteone longa* have rarely been absent, while *Nephtys hombergi* as been present in all quarters since 4.89.

3.13.1.3 Numerically two species co-dominate, *T.benedeni* and *C.volutator*. The oligochaete species is always present in large numbers (>1200/m²), whereas *Corophium* is much more variable. In 2.91 the site registered the highest density for the species (8825/m²), the following quarter only 5/m² were present. There appears to be some pattern to the *C.volutator* numbers, with the annual peaks occurring during the second period of each year (Fig.17). It is unclear what happens to the amphipods, i.e. whether the population migrates or dies off.

3.13.1.4 Gravesend intertidal is the upstream limit for *Arenicola marina* and *Littorina littorea*. It is also the first site below Teddington where *Gammarus zaddachi* has not been recorded.

3.13.1.5 A total of 25 species have been recorded at the Gravesend intertidal site during the TEBP.

3.13.2 Temporal variation and possible influences - Gravesend intertidal.

3.13.2.1 Overall, this site has a relatively stable community beyond the changes in *Corophium volutator* numbers. This has allowed the

development of large populations of tubificids (up to 7160/m²), indicating some organic enrichment. The oligochaetes have formed >50% of the biomass on five occasions - against the general trend for the estuary (Fig.15). Further dominance has been masked by the variations in *Corophium* numbers, the highest *T.benedeni* abundance in 2.90 not resulting in >50% of the biomass due to the presence of 2856 *C.volutator*/m². However, the oligochaetes have formed >50% of the abundance on 9 occasions. The likely source of the enrichment are three local STW, all of which release poor quality effluent into the surrounding area (Appendix 3). Despite their relatively small size, Tilbury and Gravesend have a high observed PII due to this poor quality effluent. It would appear that they are having an effect on the intertidal community at Gravesend.

3.13.2.2 There is little evidence that the variations in salinity are having much of an effect on the fauna at Gravesend. Even though *Littorina littorea* was only recorded during a high-salinity quarter, this pattern is not parallelled by other marine species, such as *Arenicola marina* or the Actinaria sp. In addition, several polychaetes, such as *Nephtys hombergi*, *Caullerietla* spp. and *Eteone longa* were present during the period of extreme high flows (1.90).

3.13.3 Community description - Gravesend subtidal.

3.13.3.1 The subtidal and intertidal sites at Gravesend show the greatest differential of all the paired sites in the mid-estuary, the subtidal site generally being characterised by very low abundances and occasional low species number.

3.13.3.2 Tables 15c and 15d present the data for samples taken subtidally since April 1989, the species number demonstrating a wide range from one to 13 (Fig.14b), though away from these two extremes the range is three to nine. The site followed a very similar pattern to West Thurrock subtidal, with the greatest abundances registered in 2.89 followed by a crash in numbers. The decrease in abundance was not so sudden, however, with a gradual reduction in numbers from 3.89 to 3.90.

3.13.3.3 No one species has been present in all samples, the most frequently recorded being *Tubificoides benedeni* (in low abundances compared with the intertidal area) and *Corophium volutator*. All the remaining species have been recorded in less than half the quarters.

3.13.3.4 The site is the upstream limit for *Tubularia indivisa* and *Sagartia troglodytes*, both recorded in the pre-crash quarter of 2.89, together with large numbers of *Corophium volutator*. *Mytilus edulis* was also recorded during 2.89, the only upstream record being from the West Thurrock power station intake screens. Gravesend is also the only site where the mysid *Schistomysis spiritus* has been recorded in a grab sample.

3.13.3.5 A total of 26 species have been recorded at Gravesend subtidal during the TEBP.

3.13.4 Temporal variation and possible influences - Gravesend subtidal.

3.13.4.1 Despite being only 100m from the intertidal site, the subtidal area is one of high instability and variation. This is likely to be caused by differences in the stability of the sediment, the constant exposure to water movement being enough to keep the substrate mobile and prevent long-term colonisation. As a result, in terms of average species number, it is one of the poorer sites in the estuary, with a single *Nephtys hombergi* being the sole macroinvertebrate present in 3.90.

3.13.4.2 It is more difficult to infer pollution status on top of such instability, although oligochaetes have never represented >50% of the biomass. Due to the low total abundances, they did however form >50% of the abundance on two occasions. The unstable sediment would be preventing the formation of large oligochaete populations, although this is also true for other subtidal sites. It may be the case that the STW effluents from Tilbury and particularly Gravesend would not influence the subtidal site as greatly as the intertidal site. The downstream outfalls would only affect Gravesend sites on the incoming tide, washing over the intertidal site but perhaps not coming into contact with the deeper subtidal area.

3.13.5 Summary of sites.

3.13.5.1 The sites at Gravesend are remarkably different, despite their proximity. The intertidal site has a stable community dominated by oligochaetes, suggesting organic enrichment, perhaps from local STWs. The subtidal site is highly variable, the unstable substrate being the major factor influencing macroinvertebrate distribution.

3.14 Site 14: Mucking.

3.14.1 Community Description.

3.14.1.1 The subtidal site at Mucking exhibited a relatively stable fauna dominated by small annelids. However, the abundance of these annelids decreased during 1990 and in 1991 the site was destroyed by the dredging of an adjacent channel. Relocating the site about 200m upstream resulted in increased species number.

3.14.1.2 Tables 16a and 16b present the results from samples taken since April 1989. Prior to 1991, the species varied little (seven to nine species), although the effect of the dredging and the subsequent relocation resulted in a 1991 species range of five to 13 (Fig.18). Several species have been recorded in all samples, pre- and post-dredging, these being *Tubificoides benedeni*, *Caulleriella* spp., *Nephtys hombergi* and *Macoma balthica*. In addition the small oligochaete *Monopylephorus rubroniveus* was only absent on one occasion. Numerically, *T.benedeni* and *Caulleriella* spp. have been dominant, although a change in numerical dominance occurred between 2.89 and 3.89. *Caulleriella* spp. have been the most numerous in each subsequent quarter.

3.14.1.3 Mucking can be regarded as supporting a basically marine fauna, and is the upstream limit for several species (*Cerastoderma edule*, *Ampharete acutifrons*, *Capitellides giardi*, *Scoloplos armiger*, *Abra alba*, *Ensis* sp., *Diastylis bradyi* and *Melita palmata*). In addition, *Eteone flava* was recorded at the repositioned site, only being present at one other site (Chapman Buoy) and the 4.91 sample contained the only record of *Psammechinus miliaris* in a quantitative sample. This species has been caught in trawls as far upstream as West Thurrock.

3.14.1.4 Since April 1989, a total of 30 species have been recorded at Mucking.

3.14.2 Temporal variation and possible influences.

3.14.2.1 The main obvious variation was caused, as described, by the dredging of a shipping channel about 200m below the site, to

serve an adjacent oil terminal. The dredging started before the 2.91 samples were taken, the effect on the macroinvertebrate community being obvious with a halving of the species number at a previously consistent site, accompanied by a low total abundance. Four of the five species occurred in one of the subsamples, the other three grabs recording very little. The site was revisited in 3.91, but the substrate was a solid clay, the whole top layer of sediment being removed. This was most likely due to a change in water movement with the tide, following the construction of the channel, this new movement into the channel increasing markedly the scouring effect on the locality. As a result, the site was moved upstream, where the samples recorded a good community.

3.14.2.2 There has also been a change since 1989 in the dominance and composition of the small annelid populations. *Tubificoides benedeni* was present in very high numbers (and >50% of the biomass) in 2.89, but was succeeded by the small cirratulid polychaete *Caulleriella* spp. the following quarter, also in high numbers. This worm remained dominant in abundances >1800/m² until 3.90, when there was a crash in numbers to 12.5/m² and has remained at comparatively low abundances since. The reason for the demise is not clear, but cirratulids are generally considered to be a group indicative of some enrichment (Richard Warwick, PML pers. comm.) so may indicate an improvement in local conditions. However, a decrease in *Caulleriella* spp. numbers was also noted at other sites (e.g. Southend intertidal), so the fall in abundance could be a natural cycle.

3.14.2.3 The original high number of oligochaetes and then cirratulids suggest some organic enrichment, although there are few influences on the site apart from the main Thames. Mucking creek enters the estuary just upstream of the site, and Stanford-le-Hope STW enters the creek, which could therefore be a source of any organic matter. As noted above, oligochaetes formed >50% of the biomass on one occasion and >50% abundance twice. However, if *Caulleriella* spp. are included in this "organic enrichment indicator", then the number of quarters with >50% biomass and abundance of these species rises to five and all 11 respectively. No quarter has registered >50% biomass since 2.90 - the last

quarter with large numbers of *Caulleriella* spp.

3.14.3 Summary of site.

3.14.3.1 The Mucking site has undergone change over the last two years, both subtle and dramatic. There has been a decrease in the dominance of organisms that were suggesting organic enrichment and the site was totally destroyed by the effects of nearby dredging in 1991. A new site has been selected away from the influence of the newly dredged channel.

3.15 Site 15: Blythe Sands.

3.15.1 Community description.

3.15.1.1 Blythe Sands is consistently the poorest site in the outer estuary, generally registering few, usually large, species in low abundances compared to neighbouring sites.

3.15.1.2 The data from samples taken at Blythe Sands since April 1989 are presented in Tables 17a and 17b, the generally low species number ranging from three to nine (Fig.19). *Nephtys hombergi* has been recorded during all quarters, with *Macoma balthica*, *Caulleriella* spp., *Tubificoides benedeni* and *Monopylephorus rubroniveus* the only other species present in over half the samples. The highest abundance was recorded in 2.89, due to 382.5/m² *Bathyporeia sarsi*. However, this species has not been recorded since, the most common species generally being either *Caulleriella* spp. or *Nephtys hombergi*, which has been the biomass dominant in all but one quarter.

3.15.1.3 Blythe Sands is the most upstream site for the polychaete *Aricidia minuta*, the anomuran *Porcellana longicornis* and the bivalve *Petricola pholadiformis* as well as the aforementioned *Bathyporeia sarsi*.

3.15.1.4 A total of 24 species have been recorded so far at Blythe Sands, the lowest overall total seaward of West Thurrock.

3.15.2 Temporal variation and possible influences.

3.15.2.1 Unlike most other sites in the outer estuary (except Grain Flats - also on the south side), Blythe has both a poor, variable species complement and a low overall abundance. The species present tend to be relatively large, particularly during the quarters with the lowest species number (e.g. 3.90, 4.91). This would suggest that the muddy sand at this subtidal area may be unstable, preventing small infauna species becoming established, leaving only the larger species such as *Nephtys hombergi*.

3.15.2.2 There may, however, be an extra factor suppressing the community on the south bank of the outer estuary. Many of the subsamples have contained quite large amounts of brown broken down leaf-litter which appears to have a detrimental effect on the faunal community. Initial experiments at Plymouth Marine Laboratory (PML) have indicated that adding such material to a benthic community reduces both diversity and abundance of the meiofauna community (Mike Gee, pers. comm.), either by smothering, reducing the available oxygen by decay or by perhaps releasing inhibitory compounds. It is likely that the material affects the macrofauna, either directly or by removing the meiofaunal food base. The source of the leaf litter so far out in the estuary was recently solved during fish trawls over the site, when large clumps of dead and decaying *Zostera* were caught in the trawls, the material in the grab samples being broken down decaying seagrass.

3.15.3 Summary of site.

3.15.3.1 Blythe sands supports relatively few species in low abundances due in part to a variable, unproductive substrate. The community appears to be further restricted by deposits arising from the decomposition of sea-grass.

3.16 Site 16: Canvey Beach.

3.16.1 Community Description.

3.16.1.1 The sandy-mud at Canvey supports a diverse community of many polychaete, crustacean and mollusc species. The majority of species are comparatively large, there being a low abundance of small annelids present at most other outer estuary intertidal sites.

3.16.1.2 Tables 18a and 18b present the data from samples taken at the site since April 1989, the species number varying quite widely between 9 and 21 (Fig.20). Two species have been recorded in all samples, *Nephtys hombergi* and *Macoma balthica*. *Tubificoides benedeni* was present in all samples up to 2.91, while two other species (*Caulleriella* spp., *Monopylephorus rubroniveus*) have only been absent on a couple of occasions. However, none of these three small species has been recorded in large numbers. These species are supplemented by examples from a wide range of macroinvertebrates recorded at Canvey, including 15 polychaete, 14 crustacean and 12 bivalve species.

3.16.1.3 The community at Canvey was generally numerically dominated by *Nephtys hombergi*, which reached densities of 535/m² in 3.90, the highest abundance of the species in the estuary. The dominance of the biomass depended on the presence of large bivalves (particularly *Mytilus edulis* and *Cerastoderma edule*). When large individuals of these species were absent, *Nephtys hombergi* was the biomass dominant. As a result of the occasional presence of large bivalves, there was a wide range in the total biomass for the site whereas the total abundance was relatively stable, particularly since 3.89 when the range has been only 467.5-785/m².

3.16.1.4 Canvey represents the upstream record for several species, including the polychaetes *Lagis koreni*, *Nephtys caeca*, *Neoamphitrite figulus* and *Nereis longissima*, the crustaceans, *Atylus guttatus*, *Caprella linearis* and *Sphaeroma monodi*, the sea spider *Nymphon rubrum* and the molluscs *Abra alba* and *Crepidula fornicata*. It remains the only side where Gnaithiidae isopods,

the cladoceran *Sarsiella zostericola* and the bivalve *Mactra corallina* have been recorded. In addition, *Corophium insidiosum* and *Websterinereis glauca* have only been recorded at one other site (West Thurrock and Chapman Buoy respectively).

3.16.1.5 Since April 1989, a total of 46 species have been recorded at Canvey, the highest total for any intertidal site in the estuary.

3.16.2 Temporal variation and possible influences.

3.16.2.1 Despite recording the highest total species number, Canvey appears to have a very dynamic community with a few regularly occurring species and many more ephemeral species appearing sporadically. Most of the variation within the community would appear to be natural, dependant on seasonal settlement and recruitment, with many of the less frequently recorded species being represented by small juveniles (e.g. *Ensis* sp., *Mactra corallina*, *Modiolus ?phaseolinus*). The seasonal decrease in species number during the fourth quarter of each year appears to coincide with a disappearance of the species represented by young stages, together with a decline in the number of mobile crustacean species. This could either be due to a natural die-off or a movement of individuals down the shore with the onset of winter, although it is possible that some of the settling species fail to establish due to the general conditions present in the Thames Estuary.

3.16.2.2 There is no evidence that the site is influenced from either organic enrichment or the adjacent petrochemical works. Species that tend to be indicative of organic enrichment (oligochaetes, Cirratulidae, Capitellidae) are present in low abundances, never forming >50% of either the biomass or the abundance. Conversely, several species recorded at the site tend to be indicative of normal, clean conditions (e.g. *Nymphon rubrum*, *Atylus guttatus*, Phyllodocidae spp.), although most of these are only briefly or rarely present.

3.16.3 Summary of site.

3.16.3.1 The mud flats at Canvey support a diverse, dynamic, community formed from a good range of outer estuary species. There is no evidence of any organic enrichment adversely affecting the site, which can be regarded as one of the best sites in the estuary.

3.17 Site 17: Allhallows.

3.17.1 Community description.

3.17.1.1 Allhallows is the only intertidal site to be located on the south bank of the outer estuary and supports a high abundance community. The constituent species consistently record similar abundances, making the community one of the most stable and predictable in the outer estuary.

3.17.1.2 Tables 19a and 19b present the data recorded at Allhallows since April 1989, the species number varying little between 14 and 21 (Fig.20). Due to the inherent stability of the community, many species have been recorded in all samples: *Tubificoides benedeni*, *Caulleriella* spp., *Nephtys hombergi*, a small Capitellidae (*Capitellides giardi*?), *Macoma balthica* and *Scrobicularia plana*. In addition, *Cerastoderma edule*, *Corophium volutator* and *Carcinus maenas* have only been absent on one or two occasions, while *Hydrobia ulvae* has been present in all samples since 4.89. *Littorina littorea* was recorded consistently until 1991, although this species is still very common at the site, together with *Mytilus edulis*.

3.17.1.3 There is a high numerical dominance of small annelids at the site, namely *Tubificoides benedeni* (maximum 8232/m²) and *Caulleriella* spp. (maximum 5250/m²). The variations in the abundance of these two species form the only real fluctuations in the structure of the community. Fig.21 illustrates the variations in the %composition of both the abundance and biomass at the site. The proportions of the biomass remained remarkably stable, the abundance of large polychaetes and molluscs masking any variations due to the small annelids. Allhallows has also recorded the highest densities of the bivalves *Macoma balthica* (764/m²) and *Scrobicularia plana* (214/m²).

3.17.1.4 Allhallows remains the only site where the marine centipede *Strigamia marina*, the bivalve *Mya arenaria* and the isopod *Cyanthura carinata* have been recorded, though the latter has been noted in the creeks around Canvey Island. It is also the only intertidal site to record the burrowing crab *Corystes*

cassivelaunus and the scaleworm *Sthenelais boa*. It is also interesting to note that *Scoloplos armiger*, a polychaete recorded at all other outer estuary site, has not been found at Allhallows.

3.17.1.5 A total of 40 species have so far been recorded at Allhallows since April 1989.

3.17.2 Temporal variation and possible influences.

3.17.2.1 As outlined above, Allhallows as a site exhibits the least variation in community structure in the outer estuary. This would suggest that the extensive mud flats are highly stable, allowing the development and maintenance of the observed community. However, the site also supports some of the highest abundances of small annelids, particularly organisms indicative of organic enrichment such as oligochaetes and cirratulids. In terms of biomass, these species are never dominant due to the numbers of larger constituents of the community, but their contribution to the abundance is highly significant. Fig.15 illustrates the fact, with oligochaetes forming >50% of the abundance on seven occasions. If *Caulleriella* spp. are also included, then all 11 samples would register >50% abundance of organisms indicative of organic enrichment. The only other site to achieve this unenviable statistic was Crossness intertidal. It was also interesting to compare Allhallows with Southend, which demonstrates a similar community. During 1991, the abundance of small annelids fell significantly; at Allhallows they remained numerically dominant.

3.17.2.2 It seems incontrovertible that Allhallows is heavily influenced by organic enrichment, enough to maintain large populations of the small annelids. However, the source of the enrichment is not obvious, as the site has no adjacent outfalls and is situated in an area of sparse population. As a result, there are only two likely sources - the STW outfall at Southend and the main river Thames, though computer models of the Southend outfall suggest the effluent would not be distributed to this part of the estuary and bathing beach bacteriological results (Thomas, 1991, 1992) show very low levels of contamination. It is possible, therefore,

that organic material brought down from further up the Thames is preferentially deposited on the large mudflats on the south bank of the outer estuary, thus feeding the populations of small worms in the sediment.

3.17.3 Summary of site.

3.17.3.1 Allhallows supports a highly productive community, whose constituent species are continually present in similar proportions. However, consistently high abundances of small annelids suggest the site is significantly influenced by organic enrichment, though the source remains unclear.

3.18 Site 18: Chapman Buoy.

3.18.1 Community description.

3.18.1.1 The subtidal site at Chapman Buoy is based upon a heterogeneous substrate resulting in an extremely species rich, diverse community that has recorded the highest species number during every quarter. The community is composed from a wide range of groups, many rarely recorded, if at all, elsewhere in the estuary.

3.18.1.2 Tables 20a and 20b detail the results of samples taken at Chapman Buoy since April 1989. The species number has risen consistently since this date (Fig.22), with a large jump in total species number in the last two samples of 1991 to 51 in 4.91. The mean number of species recorded in each grab sample has, however, remained more constant, the increasing total species number reflecting the high carrying capacity of the environment in terms of species richness. As a result, the species discovery curve (the number of species recorded in each grab that have not been found previously) continues to climb at a remarkably consistent rate (Fig.23), suggesting that further sampling will result in more species being recorded. The site is equally rich in meiofauna (Trett & Feil, 1990, 1991).

3.18.1.3 The site appears to be very patchy, with certain grabs dominated by different, usually large, species such as *Sabella pavonina*, *Sagartia troglodytes* and *Crepidula fornicata*. The additional presence of other large species (e.g. *Asterias rubens*, *Carcinus maenas*, *Pagurus bernhardus*, *Neoamphitrite figulus*) results in a consistently high biomass being recorded for the site, only matched by the dense *Nereis (Neanthes) diversicolor* beds at West Thurrock.

3.18.1.4 Due to the patchiness, few species have been recorded in all quarters, despite the high species number, these being *Tubificoides benedeni* (always in comparatively low numbers), *Sagartia troglodytes*, *?Capitellides giardi* and *Scoloplos armiger*. *Abra alba* and *Glycera convoluta* were only absent in the first quarter (2.89), while *Lepidonotus squamatus*, *Ampharete acutifrons*

and *Carcinus maenas* have also only been absent on one occasion. A major contribution to the species richness at the site are the 38 polychaete species present, by far the highest total in the estuary.

3.18.1.5 Inevitable, Chapman Buoy has recorded species not found elsewhere in the estuary, including *Barnea candida*, *Gibbula umbilicalis*, *Achelia echinata*, *Golfingia* sp. and polychaetes such as *Syllis gracilis*, *Sabella pavonina*, *Mysta picta* and *Anaitides maculata*. Several other species (e.g. *Cancer pagurus*, *Liocarcinus* sp.), recorded as juveniles at Chapman Buoy, have only otherwise been noted as adults in fish trawls.

3.18.1.6 Since April 1989, a total of 98 species has been recorded at Chapman Buoy during the TEBP.

3.18.2 Temporal variation and possible influences.

3.18.2.1 The main variation to be found at Chapman Buoy is related to the patchiness of the heterogenous substrate, i.e. presence of boulders, wood, *Sertularia*, etc. The resulting communities are different, though equally diverse. Generally, the species composition is one of clean conditions, including species of delicate polychaetes, crustacea, sea spiders, echinoderms, etc. It is possible that, due to its depth, the site is not so directly influenced by water from the main river or local discharges as nearby intertidal site, the more stable conditions allowing the development of such a highly interesting and diverse community.

3.18.2.2 As the site shows no indication of any variation due to season or influence from pollution, it is suggested that to prevent unnecessary effort and destruction of the habitat, the site is sampled annually, perhaps during the third quarter.

3.18.3 Summary of site.

3.18.3.1 Chapman Buoy is an excellent site, supporting a highly diverse, species rich subtidal community with many representatives of species that cannot tolerate organic pollution. It suggests that the community present in this part of the estuary is of high conservation importance.

3.19 Site 19: Southend (Intertidal and Subtidal).

3.19.1 Community description - Southend intertidal.

3.19.1.1 The extensive muddy-sand flats at Southend support a relatively high abundance community based around polychaetes and molluscs, with variable numbers of crustacea and oligochaetes. The composition of the community appears to be more variable than the similar site at Allhallows.

3.19.1.2 The data obtained from samples taken at Southend intertidal since April 1989 are presented in Tables 21a and 21b, the species number varying between 12 and 23 (Fig.20), although most samples fall within the range 15-19. As for Allhallows, Southend intertidal has a base community of common intertidal species that have been recorded during each quarter: *Tubificoides benedeni*, *Caulleriella* spp., *Nephtys hombergi*, *Pygospio elegans*, *Cerastoderma edule* and *Macoma balthica*. Other species that have only been absent on one or two occasions include *Corophium arenarium*, *Eteone longa* and *Scoloplos armiger*, which has not, as yet, been recorded from Allhallows.

3.19.1.3 There has been some variation in the numerical dominant at the site, this being *Tubificoides benedeni* in 2.89 and then *Caulleriella* spp. from 3.89-1.91. However, this species has decreased in number, coinciding with a slight increase in the spionid polychaete *Pygospio elegans*, which was dominant in 2.91. The final two quarters were dominated by *Nephtys hombergi*, which was also the biomass dominant during three quarters. As for most of the outer estuary intertidal site, this dominance was dependant on the size of bivalves present in the sample, particularly *Cerastoderma edule*. Certain areas of the flats are dominated by large numbers of *Lanice conchilega* tubes.

3.19.1.4 No species was unique to the site, although the freshwater leech *Theromyzon tessulatum* was present in 4.90. This species invades the nasal cavity of wildfowl, so is likely to have been transported to the site by such means. Southend intertidal remains the only site where small green anemones were found, possibly *Cereus pedunculatus*.

3.19.1.5 Since April 1989, a total of 45 species has been recorded at Southend intertidal.

3.19.2 Temporal variation and possible influences - Southend intertidal.

3.19.2.1 The main changes noted at the site have related to the number and specific composition of the small annelids present. Relatively large numbers of either *Tubificoides benedeni* (up to 1752/m²) or *Capitella* spp. (up to 6082/m²) were recorded until 2.91, both species being indicative of organic enrichment. However, numbers diminished ten-fold in 2.91, this quarter recording peak numbers of another enrichment indicator species *Pygospio elegans* (397.5/m²). The overall effect was to decrease the contribution of the small annelids to the %abundance at the site, where previously they had represented >50%.

3.19.2.2 The reasons for the decrease in small annelid numbers is unclear, although it is possible that the site may have experienced a decreased organic enrichment loading. In addition to the sources outlined for Allhallows, a series of storm drains discharge onto the intertidal area near to the sample site, which may be having a more direct influence on the community.

3.19.2.3 The mudflats at Southend are a site of relatively intensive bait digging. This is a highly disruptive activity and may be responsible for some of the variations in the community. While areas of obvious disturbance are avoided during sampling, any indirect effects on the stability of the substrate or deposition of recently dug material are hard to quantify, but would tend to favour small ephemeral organisms with short life cycles and a tolerance of disturbance.

3.19.3 Community description - Southend subtidal.

3.19.3.1 The subtidal site at Southend is markedly different from the intertidal area, supporting a diverse though variable community of polychaetes and crustaceans supplemented by species from other groups. Despite being at the end of the STW outfall, there is a relatively low abundance of small annelids.

3.19.3.2 Tables 21c and 21d present the results from grab samples taken at the site since April 1989, the total species number widely ranging between 13 and 40 (Fig.19). However, until 1991 the range was 14-22, the last two quarters of 1991 registering 33 and 40 species, with a community similar to that recorded at Chapman Buoy. Few species have been present in all samples, these being *Aricidia minuta*, *Nephtys hombergi* and *Macoma balthica*, although several more have only been absent on one or two occasions and can be included in the core species. These include *Glycera convoluta*, *Scoloplos armiger*, *Tellina fabula* and one *Bathyporeia* sp., usually *B.elegans*.

3.19.3.3 Both abundance and biomass have remained comparatively stable, despite the fluctuations in species composition. The total abundance has remained between 162.5-617.5/m^2, while variations in the biomass have been generally caused by the presence or absence of certain large species, e.g. *Sagartia troglodytes*. The predominant species in terms of abundance has varied over the sample period, with *Aricidia minuta*, *Caprella linearis*, *Nephtys hombergi*, *Pygospio elegans* and *Tellina fabula* all being the most common during one or more quarters. *Nephtys hombergi* has generally been the biomass dominant, only exceeded by *Sagartia troglodytes* (3.90 & 3.91) and *Caprella linearis* (3.89).

3.19.3.4 A total of 28 species of crustacean has been recorded here, the highest total for any site, including Chapman Buoy. Of these, *Atelecyclus rotundus* and *Panoploea minuta* have only been recorded at Southend subtidal. Since April 1989, 72 species have been recorded at the site.

3.19.4 Temporal variation and possible influences - Southend subtidal.

3.19.4.1 As outlined above, the site supports many delicate species, particularly crustaceans, which tend to require relatively clean water conditions. The community present is particularly interesting considering the site is situated at the end of the Southend STW outfall pipe. This works produces a poor quality effluent of only primary treated sewage (Appendix 3), but does not appear to be influencing the site. Oligochaetes have been actually absent on two occasions, and when present only in very

low numbers, as are cirratulids and capitellids. The only small annelids that have been the numerical dominant are *Pygospio elegans* and *Aricidia minuta*, although both are in comparatively low numbers (maximum 85 and 232.5/m² respectively). *P.elegans* is recognised as being indicative of organic enrichment, but the status of *A.minuta* is not certain. However, at no time did any such species approach >50% of either the abundance or the biomass.

3.19.4.2 The outfall pipe discharges the sewage and freshwater through a vertical diffuser system. As the material would be buoyant in seawater and is discharged upwards it is possible that very little settles in the area adjacent to the pipe itself. The plume would be spread over the water surface layers and distributed depending on the tide to settle out over a more general area. It is likely, therefore, that the outfall has more diffuse influence on the surrounding outer estuary area rather than a more classic direct effect on the benthos around the end of the pipe. Material from the outfall may be subtly enriching the communities in the intertidal areas at Allhallows and Southend, as well as subtidal areas further away from the point of discharge (e.g. Sea Reach 2).

3.19.4.3 The subtidal site demonstrated large variations in species number, which is likely to be a function of the patchiness of the substrate in the outer estuary mid-channel. The base substrate is sand, interspersed with patches of stony and shell material similar to that present at Chapman Buoy. When these patches happen to be sampled, the species number increases with the increase in heterogeneity. The anemone *Sagartia troglodytes* is a good indicator of the presence of such patches, this species being attached to shell fragments, etc. The three highest species numbers coincided with the quarters when *S.troglodytes* was recorded in large numbers (3.90, 3.91, 4.91). This heterogeneous "Chapman Buoy" substrate appears to be the most species-rich in the estuary.

3.19.5 Summary of sites.

3.19.5.1 The two sites at Southend support completely different communities. The intertidal area has recorded large numbers of small annelids indicative of organic enrichment, together with species typical of such habitats, although the abundances of the small annelids decreased during the end of 1991. Despite being situated at the end of the STW outfall, the subtidal site demonstrates a community second only to Chapman Buoy in species richness and diversity, with a wide range of crustacea present. It would seem that the design of the Southend outfall results in the effluent bypassing the locality to be distributed over a more general area.

3.20 Site 20: Grain Flats.

3.20.1 Community description.

3.20.1.1 Considering its seaward location, Grain Flats supports a relatively poor, variable macrofauna community based around a few large species.

3.20.1.2 Tables 22a and 22b present the data obtained from samples taken at the site since April 1989, the generally low species number varying between four and 12 (Fig.19). Prior to quarter 2.90, species number had not fallen below nine. Only two species have been recorded in each sample, namely *Macoma balthica* and *Nephtys hombergi*. A few other species have only been occasionally absent, including *Monopylephorus rubroniveus*, *Cerastoderma edule* and *Tubificoides benedeni*.

3.20.1.3 *Nephtys hombergi* tended to be the dominant species in terms of both abundance and biomass. This biomass dominance was dependant on the size of *Cerastoderma edule* present, this species accounting for the largest proportion of the wet weight on four occasions. The only other species to predominate in terms of abundance were *Bathyporeia sarsi* (2.89) and *Monopylephorus rubroniveus* (1.90).

3.20.1.4 Grain Flats remains the only site where three species (the polychaete *Ophelia ?neglecta*, amphipod *Atylus swammerdami* and chaetognath *Sagitta elegans*) were recorded, although *Sagitta* is likely to be common in the plankton. This record is interesting as *S.elegans* is generally associated with oceanic water, the coastal species being *S.setosa*.

3.20.1.5 A total of 32 species have been recorded at Grain Flats during the TEBP.

3.20.2 Temporal variation and possible influences.

3.20.2.1 In common with other subtidal sites in the outer estuary, there appears to be little seasonal variation within the community, the more important factor being the variability of the substrate.

Grain Flats has a lot in common with Blythe Sands, the southerly location, apparently unstable sediment and relatively poor community. Due to its more seaward location, Grain has a larger pool of organisms for potential settlement, the occasional record of such species elevating the status of the site above Grain. However, the basis of the communities are very similar, with *Nephtys hombergi*, *Macoma balthica* and *Monopylephorus rubroniveus* being the important species at both sites.

3.20.2.2 Blythe sands suffered from the deposition of breakdown products from *Zostera* decomposition. This organic material has also been present, although less regularly, in the sediment at Grain, suggesting it may also be influencing the community at this site. Large amounts were present in 3.91, coinciding with the lowest species number and abundance. As for Blythe, the apparent effect was the removal of the smaller infaunal species, this being the only quarter without oligochaetes.

3.20.2.3 There may, however, be other influences affecting the site at Grain. It is positioned on the edge of the Medway estuary, so possibly influenced by either water movement (sediment instability?) or water quality related to this system. In addition, the site is opposite the outfall from Southend, which could conceivably be depositing material in the area. While the biomass was dominated by the few large species, oligochaetes formed >50% of the abundance on two occasions, Grain being the only subtidal site below Mucking to register any such oligochaete dominance.

3.20.3 Summary of site.

3.20.3.1 The site at Grain is poor compared with neighbouring subtidal sites, perhaps due to the comparatively uniform, unstable substrate. The site appears to be influenced by the breakdown material from leaf degradation, as does the other south-shore site Blythe Sands, though there also may be some influence from organic enrichment.

3.21 Site 21: Shoeburyness East.

3.21.1 Community Description.

3.21.1.1 The vast intertidal sandflats at Shoeburyness support a typical, generally stable, community of polychaetes, crustacea and molluscs.

3.21.1.2 The data collected from the site since April 1989 are presented in Tables 23a and 23b. The species number varied between 13 and 20 (Fig.20), although the majority of samples fell in the narrow range of 15-17 species. A definable core community is present at Shoeburyness, with a total of five species (*Nephtys hombergi*, *Scoloplos armiger*, *Cerastoderma edule*, *Corophium arenarium* and *Macoma balthica*) recorded in all samples. Other species (*Hydrobia ulvae*, *Caulleriella* spp., *Pygospio elegans*, *Urothoë poseidonis*, *Eteone longa* plus one *Bathyporeia* sp.) have only been absent once, so can also be regarded as core species within the community. This large species set makes Shoeburyness East one of the most consistent and predictable sites in the estuary.

3.21.1.3 All five species recorded consistently at the site are large species, and this constant presence is reflected in the general stability of the biomass. Despite some abundance variations, there was comparatively little change in the total biomass figure, ranging from 42.16-67.60 gWWT/m². Since 2.90, the predominant species in terms of biomass was generally *Cerastoderma edule*, although the vast numbers of *Hydrobia ulvae* in 4.91 resulted in this species also making the major contribution to the biomass. Prior to 2.90, the polychaete *Scoloplos armiger* was often the dominant species, both in terms of abundance and biomass, although numbers of this species declined during 1990, stabilising at 300-500/m². Since 2.90, *Hydrobia ulvae* has been numerically dominant.

3.21.1.4 Shoeburyness East remains the only site where the nemertean *?Tetrastemma* sp., the amphipod *Bathyporeia pilosa* and the mysid *Praunus flexuosus* have been recorded, although this species is likely to be common in the plankton. In addition, the *Littorina saxatilis* group and *Idotea chelipes* have only been found at this

site.

3.21.1.5 Since April 1989, a total of 39 species have been recorded at the site.

3.21.2 Temporal variation and possible influences.

3.21.2.1 The site at Shoeburyness is remarkably consistent, as described above, and exhibits little temporal variation within the base community structure. Most species show no seasonal pattern in abundance, with the obvious exception of *Hydrobia ulvae*. This small gastropod is generally present on the sand-flats in high numbers, but the abundance increased markedly on two occasions, 4.89 and 4.91, the latter quarter recording a value of nearly 19,000/m². This abundance for a single species has only been exceeded by *Tubifex costatus* in the intertidal mud at Crossness. The peak in *H.ulvae* numbers was not as great during 1990, reaching 4600/m² in 3.90, although it would appear that the species has a seasonal settlement resulting in highest concentrations at the end of the year.

3.21.2.2 Unlike intertidal areas at Southend and Allhallows, the site at Shoeburyness shows little sign of any organic enrichment. Oligochaetes, capitellids, cirratulids and spionids were all present, though always in low numbers compared to similar sites further up the estuary. The spionid *Pygospio elegans* has been recorded in large numbers (up to 100,000/m²) on similar substrates where enrichment is present (Ducrotoy & Sylvand, 1991). The maximum recorded for this species here was only 35/m² (3.91). As a result, their contribution to both biomass and abundance was always small. It would therefore appear that organic material produced in the estuary from a variety of sources is not directly having an effect at this site on the extremes of the estuary.

3.21.3 Summary of site.

3.21.3.1 The site at Shoeburyness East supports one of the most stable, predictable communities in the estuary in terms of species composition and biomass. Low abundances of organisms indicative of organic enrichment suggest the site is not particularly influenced by such material.

3.22 Site 22: Sea Reach No.2 Buoy.

3.22.1 Community Description.

3.22.1.1 The subtidal site at Sea Reach 2 supports a diverse, though variable, community of polychaetes and crustacea supplemented by species from other groups.

3.22.1.2 Tables 24a and 24b present the results from samples taken at the site since April 1989, there being a wide range in total species number from 11 to 29 (Fig.19). There is great variation in the community structure from one sample to the next, with only one species (*Scoloplos armiger*) being recorded in all samples, although there has always been one *Nephtys* species present. The small polychaete *Aricidia minuta* was only absent during 4.90, while there was at least one *Bathyporeia* species in all but one quarter (3.89). The variation at the site is highlighted by the specific changes within two common genera, with four species of both *Nephtys* and *Bathyporeia* being recorded. Three *Nephtys* species were present in 2.90 and 4.91, while all four *Bathyporeia* species were recorded in the sample from 2.90.

3.22.1.3 While demonstrating great variation in species number and composition, the total abundance figures are more stable. The general range was between 237.5-377.5/m^2, although there were three quarters registering higher abundances due to increases in the numbers of *Aricidia minuta* (3.89, 4.89) and *Bathyporeia elegans/Caprella linearis* (3.91). This increase of amphipods was associated with the presence of several *Sertularia* colonies in the sample. Biomass has been more variable, highly influenced by both the presence or absence of large species (e.g. *Pagurus bernhardus, Sagartia troglodytes*) and the abundance of *Nephtys* spp. in the samples.

3.22.1.4 Due to its extreme position, Sea Reach 2 recorded several marine species not found elsewhere in the estuary. These included the sea anemone *Metridium senile*, polychaetes *Anaitides groenlandica, Nephtys longosetosa, Spiophanes bombyx* and *Malacoceros tetracerus*, amphipods *Monoculodes carinatus* and *Pontocrates altamarinus* and a heart-urchin (*?Echinocyamus pusillus*).

Interestingly, the only confirmed *Capitella capitata* in the estuary (a small specimen) was recorded at this site.

3.22.1.5 Since April 1989, a total of 69 species has been recorded at Sea Reach 2 - a figure lower than for the mid-channel sites (Southend, Chapman Buoy) further up the estuary.

3.22.2 Temporal variation and possible influences.

3.22.2.1 Most variation at the site appears to be independent of season, although during 1990 and 1991 the peak species number was recorded during the third quarter. This is most likely due to the appearance of newly settled species in the sample that appear not to survive, or avoid capture by the day grab, beyond this stage.

3.22.2.2 There appears to be definite patchiness in the fauna at Sea Reach, many of the species being sparsely distributed or present in clumps. As a result, they are unevenly recorded in the quarterly samples. In a similar manner to Southend, patchiness in the substrate is also a factor. The substrate is generally a compact sand, with occasional areas containing small shell pieces. However, the distribution of several species, particularly amphipods such as *Caprella linearis* and *Stenothoë marina*, is dependant on the presence of the colonial hydroid *Sertularia* sp., which forms vast "White weed" beds in this part of the estuary.

3.22.2.3 The site at Sea Reach generally exhibits a poorer faunal community than similar mid-channel sites within the estuary boundary (i.e. Chapman Buoy and Southend), with lower species richness and occasional numerical dominance of the small polychaete *Aricidia minuta*. The status of this species is unknown, although it was present in significant numbers during 3.89-1.90. Since this time it has been less abundant, but its decline has coincided with the slight increase in spionid polychaete numbers (Fig.24), particularly *Pygospio elegans*. These are known to be indicative of organic enrichment, but at the site have never reached high abundance (maximum 32.5/m^2).

3.22.2.4 Meiofauna studies at the site (Trett & Feil, 1990, 1991)

suggested the influence of discharged sewage, both in terms of nematode community structure and the presence of "optically active fibres" usually originating from toilet paper. The comparative decrease in macrofauna species, together with the occasional dominance of *A.minuta*, may also be reflecting this influence. The site at Southend subtidal was found to be surprisingly rich, despite its position at the end of the STW outfall and it was suggested that the discharge pattern from the outfall bypassed the site, spreading the effluent over a wider area. It is possible that the effluent from Southend STW discharges onto the water surface and is transported out with the ebb tide to settle in the Sea Reach 2 area, resulting in the observed effects on the macro and meiofaunal communities at the site.

3.22.3 Summary of site.

3.22.3.1 The site at Sea Reach 2 supports a variable, patchy community of marine species. The site is not as rich as similar areas within the estuary, and the occasional presence of large numbers of small polychaetes, together with inferences from meiofauna work, suggest some influence from organic enrichment. This is most likely to originate from the STW outfall at Southend.

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TABLES.

Table 1: Thames Estuary Benthic Programme Sample Sites.

Site	Abbrv.	Site Name	NGR	Type	km from LB
1.	T	Teddington	TQ 168 715	Subtidal kick	-30.5
2.	K	Kew	TQ 191 779	Subtidal kick	-23.6
3.	HB	Hammersmith Bridge	TQ 230 780	Intertidal	-14.8
4.	CP	Cadogan Pier	TQ 274 776	Subtidal kick	- 7.4
5.	SBC	South Bank Centre	TQ 308 803	Intertidal	- 2.3
6.	LB	London Bridge	TQ 327 805	Subtidal kick	- 0.2
7.	GW	Greenwich	TQ 383 780	Intertidal	7.7
8i.	WWi	Woolwich	TQ 427 793	Intertidal	14.5
8s.	WWs	Woolwich	TQ 429 794	Subtidal grab	15.0
9.	BK	Beckton	TQ 456 815	Subtidal grab	18.3
10i.	XNi	Crossness	TQ 492 809	Intertidal	22.5
10s.	XNs	Crossness	TQ 494 809	Subtidal grab	22.7
11i.	Pi	Purfleet	TQ 548 786	Intertidal	30.8
11s.	Ps	Purfleet	TQ 580 761	Subtidal grab	34.7
12i.	WTi	West Thurrock	TQ 592 770	Intertidal	36.0
12s.	WTs	West Thurrock	TQ 593 770	Subtidal grab	36.1
13i.	GVi	Gravesend	TQ 648 745	Intertidal	42.5
13s.	GVs	Gravesend	TQ 649 746	Subtidal grab	42.6
14.	MK	Mucking	TQ 707 808	Subtidal grab	52.4
15.	BS	Blythe Sands	TQ 757 805	Subtidal grab	56.3
16.	CB	Canvey Beach	TQ 800 824	Intertidal	61.1
17.	AH	Allhallows	TQ 838 792	Intertidal	64.5
18.	CHB	Chapman Buoy	TQ 809 813	Subtidal grab	62.5
19i.	SEi	Southend	TQ 888 844	Intertidal	69.5
19s.	SEs	Southend	TQ 901 828	Subtidal grab	71.8
20.	GF	Grain Flats	TQ 877 795	Subtidal grab	69.0
21.	SNE	Shoeburyness East	TQ 949 850	Intertidal	75.2
22.	SR2	Sea Reach No.2 Buoy	TQ 955 810	Subtidal grab	77.6

Table 2.
Sampling Dates for all sites. April 1990 - December 1991

Site	Quar 2/90	Quar 3/90	Quar 4/90	Quar 1/91	Quar 2/91	Quar 3/91	Quar 4/91
1. Teddington	15.05	24.07	03.10	30.01	29.04	12.08	07.11
2. Kew	15.05	24.07	03.10	30.01	29.04	12.08	07.11
3. Hammersmith Bridge	15.05	24.07	03.10	30.01	29.04	12.08	26.11
4. Cadogan Pier	17.05	10.08	06.12	21.02	29.05	29.07	09.12
5. South Bank Centre	13.06	26.07	23.10	19.02	18.04	29.07	26.11
6. London Bridge	17.05	09.08	06.12	21.02	29.05	29.07	26.11
7. Greenwich	13.06	26.07	23.10	19.02	18.04	29.07	26.11
8i. Woolwich intertidal	12.06	25.09	05.12	25.03	17.06	15.08	12.11
8s. Woolwich subtidal	05.06	27.09	01.11	26.02	11.06	17.09	05.11
9. Beckton	05.06	27.09	01.11	26.02	11.06	17.09	05.11
10i. Crossness intertidal	12.06	25.09	05.12	25.03	17.06	15.08	12.11
10s. Crossness subtidal	05.06	27.09	01.11	26.02	11.06	17.09	05.11
11i. Purfleet intertidal	26.06	12.09	11.12	05.03	06.06	10.09	28.11
11s. Purfleet subtidal	05.06	27.09	01.11	26.02	11.06	17.09	05.11
12i. West Thurrock intertidal	26.06	12.09	11.12	05.03	06.06	10.09	28.11
12s. West Thurrock subtidal	05.06	27.09	01.11	26.02	11.06	17.09	05.11
13i. Gravesend intertidal	30.05	29.08	29.10	24.01	03.06	02.09	12.12
13s. Gravesend subtidal	05.06	27.09	01.11	26.02	11.06	17.09	05.11
14. Mucking	01.05	14.08	10.10	05.02	08.05	01.08	14.10
15. Blythe Sands	01.05	14.08	10.10	05.02	08.05	01.08	14.10
16. Canvey Beach	29.06	25.09	25.10	22.01	19.06	12.09	14.11
17. Allhallows	30.05	29.08	29.10	24.01	03.06	02.09	12.12
18. Chapman Buoy	01.05	14.08	10.10	05.02	08.05	01.08	14.10
19i. Southend intertidal	18.06	11.09	27.11	12.03	20.05	19.07	18.11
19s. Southend subtidal	01.05	14.08	10.10	05.02	08.05	01.08	14.10
20. Grain Flats	01.05	14.08	10.10	05.02	08.05	01.08	14.10
21. Shoeburyness East	18.06	11.09	27.11	12.03	20.05	19.07	18.11
22. Sea Reach No.2 Buoy.	01.05	14.08	10.10	05.02	08.05	01.08	14.10

Table 3a.

MACROFAUNA SPECIES RECORDED AT TEDDINGTON (SITE 1). 1989-1990.

Values: Abundance = N.Individuals/3mins. Biomass = g.WetWeight/3mins.
Expressed as Abundance/Biomass.

Species	Quar 2/89	Quar 3/89	Quar 4/89	Quar 1/90	Quar 2/90	Quar 3/90	Quar 4/90
CNIDARIA							
Hydra sp.				1/0.01			
PLATYHELMINTES							
Dendrocoelom lacteum	1/0.01		1/0.03				
Pharnocora sp.				1/0.01	15/0.05		
Polycelis tenuis	3/0.01				1/0.02		
NEMATODA							
Nematoda spp.	2/0.01	1/0.01			5/0.03		
OLIGOCHAETA							
Aulodrilus pluriseta		5/0.01			2/0.01		
Limnodrilus cervix	11/0.04	16/0.05			11/0.02		
Limnodrilus hoffmeisteri	154/0.56	43/0.15		173/0.43	72/0.24	8/0.02	4/0.01
Lumbriculus variegatus	11/0.04	21/0.06		8/0.02	7/0.01	1/0.01	4/0.02
Naididae		3/0.02		81/0.09	87/0.09		
Potamothrix moldaviensis						3/0.01	
Potamothrix hammoniensis	135/0.54	17/0.06					7/0.02
Psammoryctides barbatus	96/0.40	13/0.05	1/0.01	22/0.04	24/0.04	8/0.02	43/0.03
Stylodrilus heringianus							
Tubifex tubifex		14/0.06	3/0.01	14/0.02	11/0.02	1/0.01	1/0.01
HIRUDINEA							
Erpobdella octoculata	1/0.10						
Erpobdella testacea				1/0.03	1/0.11		
Glossiphonia complanata	2/0.10	4/0.14	2/0.11			2/0.02	1/0.01
Helobdella stagnalis	1/0.03	11/0.08	1/0.01	3/0.04	2/0.03	8/0.07	3/0.04
Piscicola geomata	3/0.03						
CRUSTACEA							
Asellus aquaticus	55/0.68	32/0.45		9/0.08	28/0.21		
Candona spp.	20/0.04	23/0.04			6/0.02		
Cladocera spp.		2/0.02			8/0.03		
Copepoda spp.					230/0.19		
Corophium curvispinum	8/0.05	26/0.37		6/0.03	19/0.24	5/0.05	
Crangonyx pseudogracilis					3/0.03		
Gammarus lacustris					2/0.03		
Gammarus zaddachi	1/0.01	390/3.50	1070/22.48	67/2.81		1790/16.83	352/3.31
Ilyocryptus sordidus					64/0.05		
UNIRAMIA							
Anthripsodes cinereus				1/0.02	1/0.02		
Aphelocheirus aestivalis	1/0.01						
Baetis sp.							
Caenis moesta	90/0.89	3/0.02		59/0.08	602/5.97	1/0.01	1/0.01
Ceratopogonidae spp.	2/0.01				3/0.02		
Chironomidae spp.	494/3.15	415/3.33	6/0.07	24/0.21	388/2.86	19/0.08	9/0.04
Dytiscus sp.					12/0.05		
Hydroptila sp.		4/0.03					
Mystacides azurea	4/0.08	4/0.13					
Mystacides longicornis							
Oulimnius tuberculatus	3/0.01		2/0.02		1/0.01		
ACARI							
Hydracarina spp.	22/0.06	30/0.06		2/0.02	91/0.17		
MOLLUSCA							
Ancylus fluviatilis	2/0.07						
Anodonta complanata		4/0.88			1/0.07		
Pisidium spp.	23/0.12	5/0.04	51/0.22	1/0.01	15/0.06	23/0.12	50/0.19
Planorbis sp.					1/0.01		
Potamopyrgus jenkinsi	2/0.02		36/0.10	28/0.17	6/0.04		14/0.05
Sphaerium corneum	9/0.19	6/0.30	1/0.04		2/0.03	11/0.29	8/0.14
TOTALS	**1156/7.26**	**1096/9.46**	**1174/23.10**	**420/4.03**	**1721/10.78**	**1881/17.53**	**497/3.88**
Community Statistics							
Total N.Species	26	24	11	18	32	13	13
Mean N.Species/1 minute kick	19.00	17.33	7.33	12.67	23.30	8.67	8.67
Diversity (H'e)	2.03	1.81	0.42	2.16	2.10	0.31	0.88
Evenness (J)	0.61	0.57	0.18	0.75	0.61	0.12	0.34
Temperature (°C)	22	24	14	9	17	27	16
Mean Quarterly salinity (‰)*	0.09	0.14	0.15	0.08	0.13	0.17	0.20
BMWP Score	94	72	31	48	77	45	36
ASPT	4.70	4.50	3.44	4.36	4.52	4.09	4.00

* Richmond

Table 3b. MACROFAUNA SPECIES RECORDED AT TEDDINGTON (SITE 1), 1991.

Values: Abundance = N.Individuals/3mins. Biomass = g.WetWeight/3mins.
Expressed as Abundance/Biomass.

Species	Quar 1/91	Quar 2/91	Quar 3/91	Quar 4/91
PLATYHELMINTHES				
Dendrocoelom lacteum				2/0.02
Planaria torva				3/0.02
OLIGOCHAETA				
Aulodrilus pluriseta			30/0.11	
Limnodrilus cervix		3/0.01		
Limnodrilus hoffmeisteri	24/0.03	16/0.04	149/0.62	
Lumbriculus variegatus		1/0.02	21/0.08	
Naididae spp.	4/0.03	440/0.62	1/0.01¶	1/0.01
Potamothrix hammoniensis			31/0.13	
Psammoryctides barbatus	107/0.10	48/0.09	137/0.58	10/0.03
Rhyacodrilus coccineus			20/0.07	
Stylodrilus heringianus		1/0.01		
Tubifex tubifex	4/0.02	21/0.04	100/0.40	
HIRUDINEA				
Erpobdella octoculata		1/0.11		
Erpobdella testacea			1/0.01	
Glossiphonia complanata	2/0.02	1/0.02	6/0.05	6/0.12
Helobdella stagnalis	1/0.01	1/0.02	20/0.11	
CRUSTACEA				
Argulus foliaceus			1/0.01	
Asellus aquaticus	5/0.03	5/0.06	4/0.02	
Cladocera spp.		2/0.01		
Copepoda spp.		29/0.03		
Corophium curvispinum	1/0.01			13/0.05
Gammarus zaddachi	16/0.53	9/0.23	395/6.72	796/16.67
Candona spp.	1/0.01		54/0.07	
UNIRAMIA				
Anthripsodes cinereus			3/0.02	1/0.01
Baetis sp.		1/0.01		
Caenis moesta	45/0.05	310/2.62	44/0.21	1/0.01
Ceraclea nigronervosa				1/0.03
Ceratopogonidae spp.		2/0.01		1/0.01
Chironomidae spp.	18/0.10	82/0.48	48/0.10	1/0.01
Mystacides longicornis		1/0.02		
Oulimnius tuberculatus		4/0.02		1/0.01
Tinodes waeneri			1/0.03	
ACARI				
Hydracarina spp.	3/0.02	26/0.04	40/0.06	
MOLLUSCA				
Ancylus fluviatilis				4/0.03
Anodonta complanata			1/2.76	1/0.52
Bithynia tentaculata			2/0.06	4/0.02
Pisidium spp.	17/0.05	19/0.07	2/0.01	13/0.05
Planorbis alba	1/0.01		1/0.01	2/0.01
Potamopyrgus jenkinsi	20/0.04	11/0.04		
Sphaerium corneum	2/0.07	6/0.04	8/0.25	23/0.81
Valvata piscinalis			1/0.01	
TOTALS	**272/1.15**	**1040/4.66**	**1121/12.53**	**884/18.44**
Community Statistics				
Total N.Species	17	24	26	19
Mean N.Species/1 minute kick	12.33	16.33	17.33	10.00
Diversity (H'e)	2.01	1.75	2.22	0.58
Evenness (J)	0.71	0.55	0.68	0.20
Temperature (°C)	5	13	25	12
Mean Quarterly salinity (‰)*	0.12	0.14	0.16	0.24
BMWP Score	40	50	64	74
ASPT	3.64	4.17	4.27	4.63

* Richmond
¶ Dero digitata

Table 9a.

MACROFAUNA SPECIES RECORDED AT KEW (SITE 2). 1989-1990.

Values: Abundance = №.Individuals/3mins. Biomass = g.WetWeight/3mins.
Expressed as Abundance/Biomass.

Species	Quar 2/89	Quar 3/89	Quar 4/89	Quar 1/90	Quar 2/90	Quar 3/90	Quar 4/90
OLIGOCHAETA							
Branchiura sowerbyi		9/0.26					
Enchytraeidae sp.	13/0.07						
Limnodrilus cervix	48/0.19		52/0.15		12/0.03		
Limnodrilus claparedianus					7/0.01		62/0.18
Limnodrilus hoffmeisteri	153/0.69	303/0.90	200/0.59		95/0.28		256/0.75
Limnodrilus udekemianus		73/0.22					
Lumbriculus variegatus				154/0.19			
Naididae spp.		95/0.07		655/0.41			
Potamothrix hammoniensis			208/0.60	31/0.08	26/0.07		
Potamothrix moldaviensis							18/0.05
Psammoryctides barbatus	196/0.97	438/1.33	1899/5.49	398/0.69	71/0.24	6/0.02	1397/4.12
Rhyacodrilus coccineus					3/0.01		40/0.12
Tubifex tubifex	119/0.51	456/1.36	141/0.41	287/0.53	43/0.11	8/0.02	177/0.53
Tubificoides sp.	16/0.08						
HIRUDINEA							
Erpobdella testacea		5/0.12	2/0.07	1/0.05		3/0.09	
Glossiphonia complanata		3/0.12			1/0.01	2/0.02	
Helobdella stagnalis		11/0.10		1/0.01		1/0.01	
CRUSTACEA							
Asellus aquaticus	5/0.11	2/0.03	2/0.01		1/0.01	1/0.02	
Gammarus zaddachi	1090/6.12	293/2.85	235/5.17	138/3.09	7250/49.30	4700/40.89	595/5.17
UNIRAMIA							
Caenis moesta				4/0.03	13/0.12		
Ceratopogonidae sp.	1/0.01						
Chironomidae spp.	16/0.14	20/0.14			28/0.16		
ACARI							
Hydracarina spp.					1/0.01		
MOLLUSCA							
Ancylus fluviatilis	6/0.06	1/0.02		1/0.02		5/0.02	4/0.03
Lymnaea peregra	10/0.19	22/1.32	3/0.40	2/0.15	39/0.13	9/0.11	
Pisidium spp.	14/0.15	17/0.07	2/0.01	5/0.04	1/0.01	1/0.01	4/0.02
Potamopyrgus jenkinsi	6/0.07		3/0.02	7/0.03	5/0.02	1/0.01	51/0.10
Sphaerium corneum	41/1.50	19/1.04	2/0.05	1/0.17	23/0.19	35/0.93	9/0.29
Valvata piscinalis					1/0.05		
Viviparus viviparus		2/0.40					
TOTALS	**1734/11.06**	**1769/10.35**	**2749/12.98**	**1030/5.08**	**7621/50.77**	**4772/42.15**	**2613/11.36**
Community Statistics							
Total №.Species	15	17	12	14	18	12	11
Mean №.Species/1 minute kick	11.67	14.00	7.67	9.67	12.67	6.67	8.67
Diversity (H'e)	1.37	1.95	1.13	1.80	0.36	0.14	1.38
Evenness (J)	0.51	0.67	0.46	0.68	0.12	0.06	0.58
Temperature (°C)	23	22	14	11	19	28	18
Mean Quarterly Salinity (‰)	0.10	0.17	0.18	0.08	0.16	0.24	0.22
BMWP Score	38	39	31	36	49	36	28
ASPT	3.45	3.90	3.44	4.00	3.76	3.60	3.50

Table 4b. MACROFAUNA SPECIES RECORDED AT KEW (SITE 2). 1991.

Values: Abundance = №.Individuals/3mins, Biomass = g.WetWeight/3mins.
Expressed as Abundance/Biomass.

Species	Quar 1/91	Quar 2/91	Quar 3/91	Quar 4/91
OLIGOCHAETA				
Enchytraeidae sp.		1/0.01		
Limnodrilus cervix	16/0.11	47/0.42		
Limnodrilus claparedianus		46/0.42	8/0.02	29/0.09
Limnodrilus hoffmeisteri	88/0.62	530/4.94	24/0.08	43/0.12
Naididae spp.	289/0.38	720/0.65		
Potamothrix ?bavaricus				24/0.07
Potamothrix hammoniensis		428/3.98		90/0.25
Potamothrix moldaviensis	422/2.97	116/1.08		
Psammoryctides barbatus	1397/9.84	212/1.97	93/0.20	358/1.09
Rhyacodrilus coccineus	99/0.70	283/2.65		74/0.21
Tubifex tubifex	153/1.09	147/1.36	57/0.13	30/0.09
HIRUDINEA				
Erpobdella testacea	4/0.38	1/0.09	3/0.05	4/0.25
Glossiphonia complanata				1/0.02
Helobdella stagnalis			1/0.01	
CRUSTACEA				
Asellus aquaticus		1/0.01		
Cladocera sp.	1/0.01			
Corophium curvispinum		1/0.01		
Corophium lacustre	1/0.01			
Gammarus zaddachi	397/9.80	3150/27.08	1490/17.83	596/15.93
UNIRAMIA				
Caenis moesta	4/0.02		1/0.01	
Chironomidae spp.	1/0.01	14/0.06	2/0.01	
ACARI				
Hydracarina spp.	1/0.01			
MOLLUSCA				
Ancylus fluviatilis	3/0.04	5/0.11	8/0.02	7/0.04
Lymnaea auricularia		1/0.91		
Lymnaea peregra		4/0.02	3/0.05	2/0.05
Pisidium spp.	3/0.02	27/0.06		2/0.01
Potamopyrgus jenkinsi	1/0.01	16/0.04	1/0.01	58/0.11
Sphaerium corneum	9/0.76	71/1.54	19/0.31	27/0.30
TOTALS	**2889/26.78**	**5821/47.40**	**1710/18.73**	**1345/18.63**

Community Statistics				
Total №.Species	18	21	13	15
Mean №.Species/1 minute kick	12.00	16.00	8.00	11.00
Diversity (H'e)	1.63	1.64	0.60	1.69
Evenness (J)	0.56	0.54	0.23	0.62
Temperature (°C)	6	13	25	13
Mean Quarterly Salinity (‰)	0.13	0.14	0.21	0.22
BMWP Score	40	36	42	34
ASPT	4.00	3.60	3.82	3.78

Table 5a.

MACROFAUNA SPECIES RECORDED AT HAMMERSMITH BRIDGE (SITE 3). 1989-1990.

Values: Abundance = №.Individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 2/89	Quar 3/89	Quar 4/89	Quar 1/90	Quar 2/90	Quar 3/90	Quar 4/90
HYDROZOA							
Hydra sp.					2/0.02		
PLATYHELMINTHES							
Phaenocora sp.					2/0.02		
OLIGOCHAETA							
Enchytraeidae sp.	10/0.04						
Limnodrilus cervix					18/0.06		
Limnodrilus claparedianus	12/0.04	4/0.02					
Limnodrilus hoffmeisteri	216/0.90	90/0.16	44/0.06	600/2.58	170/0.20	107.5/0.17	47.5/0.09
Limnodrilus udekemianus		14/0.04					
Potamothrix hammoniensis	38/0.18		2/0.01		4/0.02		
Potamothrix moldaviensis			2/0.01		30/0.04	10/0.08	
Psammoryctides barbatus	10/0.04		4/0.02	174/0.56	14/0.04		32.5/0.06
Tubifex costatus						2.5/0.03	
Tubifex ignotus	12/0.04						
Tubifex tubifex	30/0.12	12/0.04	2/0.01	16/0.04	28/0.08		5/0.05
Tubificoides sp.	38/0.14						
HIRUDINEA							
Erpobdella testacea						2.5/0.03	
CRUSTACEA							
Asellus aquaticus	2/0.04		4/0.02	2/0.02			
Crangon crangon						5/0.63	
Gammarus zaddachi	370/1.54	58/0.46	26/0.18	30/0.96	8/0.06	2.5/0.03	5/0.08
Neomysis integer						2.5/0.03	
UNIRAMIA							
Caenis moesta				2/0.02	12/0.06		
Chironomidae spp.	4/0.04	4/0.04	2/0.02	2/0.04	2/0.04		
ACARI							
Hydracarina spp.			2/0.02	2/0.02			
MOLLUSCA							
Lymnaea peregra						2.5/0.05	
Potamopyrgus jenkinsi					2/0.02		
Sphaerium corneum					2/0.02		
TOTALS	**742/3.14**	**182/0.76**	**88/0.35**	**756/4.24**	**294/0.68**	**135/1.07**	**90/0.28**
Community Statistics							
Total №.Species	11	6	9	8	13	8	4
Mean №.Species/0.1 m²	6.00	3.50	3.50	4.25	5.75	3.50	2.50
Diversity (H'e)	1.68	1.31	1.39	0.81	1.50	0.82	1.03
Evenness (J)	0.68	0.67	0.63	0.39	0.58	0.39	0.74
Temperature (°C)	21	22	15	9	18	26	17
Mean Quarterly Salinity (‰)	0.13	0.33	0.45	0.08	0.23	0.94	0.55
BMWP Score	27	24	24	32	42	19	25
ASPT	3.38	3.43	3.43	4.00	3.82	3.80	4.17

Table 5b MACROFAUNA SPECIES RECORDED AT HAMMERSMITH BRIDGE (SITE 3). 1991.

Values: Abundance = №.Individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 1/91	Quar 2/91	Quar 3/91	Quar 4/91
OLIGOCHAETA				
Enchytraeidae sp.		2.5/0.03		
Limnodrilus cervix	10/0.03	10/0.03		
Limnodrilus claparedianus			5/0.03	
Limnodrilus hoffmeisteri	37.5/0.10	92.5/0.15	125/0.23	7.5/0.03
Limnodrilus udekemianus	2.5/0.03			
Naididae spp.	7.5/0.05	2.5/0.03		
Potamothrix hammoniensis		30/0.07		
Potamothrix moldaviensis		10/0.05	5/0.05	2.5/0.03
Psammoryctides barbatus	25/0.05	27.5/0.07	2.5/0.03	
Tubifex tubifex		35/0.10	10/0.03	
POLYCHAETA				
Polydora sp.				2.5/0.03
CRUSTACEA				
Copepoda spp.		5/0.03		
Corophium lacustre				5/0.03
Gammarus zaddachi	17.5/0.20	25/0.10	140/0.80	15/0.13
UNIRAMIA				
Chironomidae spp.	2.5/0.05	2.5/0.03		
MOLLUSCA				
Lymnaea peregra			2.5/0.03	2.5/0.07
Pisidium spp.		17.5/0.10		
Potamopyrgus jenkinsi		50/0.13		2.5/0.03
Sphaerium corneum		5/0.05	25/0.23	27.5/0.33
TOTALS	**102.5/0.50**	**315/0.97**	**315/1.43**	**65/0.68**
Community Statistics				
Total №.Species	7	14	8	8
Mean №.Species/0.1 m²	3.75	8.75	4.25	3.25
Diversity (H'e)	1.61	2.19	1.25	1.65
Evenness (J)	0.83	0.83	0.60	0.79
Temperature (°C)	7	13	26	10
Mean Quarterly Salinity (‰)	0.14	0.18	0.35	0.52
BMWP Score	27	27	22	28
ASPT	3.86	3.38	3.67	4.00

Table 6a.

MACROFAUNA SPECIES RECORDED AT CADOGAN PIER (SITE 4). 1989-1990.

Values: Abundance = N.Individuals/3mins. Biomass = g.WetWeight/3mins.
Expressed as Abundance/Biomass.

Species	Quar 2/89*	Quar 3/89	Quar 4/89	Quar 1/90	Quar 2/90	Quar 3/90	Quar 4/90
OLIGOCHAETA							
Limnodrilus cervix	127.5/0.23				32/0.08		
Limnodrilus claparedianus	115.5/0.21	67/0.18	7/0.01	43/0.44	9/0.02	174/0.47	
Limnodrilus hoffmeisteri	370.5/0.68	118/0.29	7/0.01	187/1.60	80/0.19	522/1.41	85/0.20
Lumbriculus variegatus	115.5/0.21			58/0.66			
Naididae spp.			16/0.03	960/0.11	38/0.05		9/0.02
Potamothrix hammoniensis			16/0.02	87/1.04			64/0.15
Potamothrix moldaviensis			7/0.01	14/0.03			
Psammoryctides barbatus	589.5/1.04	1326/3.31	330/0.57	835/9.95	142/0.41	2607/7.04	1704/4.32
Tubifex costatus	127.5/0.23						
Tubifex tubifex	729/1.28	244/0.62	12/0.02	416/4.42	148/0.34	557/1.50	147/0.37
HIRUDINEA							
Erpobdella testacea	1.5/0.06	2/0.15				1/0.08	1/0.08
CRUSTACEA							
Asellus aquaticus				3/0.02			
Corophium lacustre		1/0.01	1/0.01	4/0.02		7/0.04	51/0.07
Crangon crangon			1/0.93			3/0.12	1/0.14
Crangonyx pseudogracilis				1/0.01			
Gammarus zaddachi	765/6.81	1430/33.37	231/2.05	255/3.77	1570/19.63	555/20.34	421/31.17
Palaemon longirostris						12/0.69	1/0.67
Sphaeroma rugicauda							2/0.03
INSECTA							
Caenis morata				4/0.02			
Chironomidae spp.	3/0.03				12/0.07		1/0.01
ACARI							
Hydracarina spp.				1/0.01			
MOLLUSCA							
Ancylus fluviatilis	4.5/0.14		1/0.01	1/0.02	3/0.02	1/0.01	
Lymnaea peregra	1.5/0.15	13/0.68			31/0.08	2/0.02	
Pisidium spp.		3/0.02					
Potamopyrgus jenkinsi	12/0.18	11/0.07	8/0.03	1/0.01	6/0.03	21/0.06	185/0.20
Sphaerium corneum	9/0.14	17/1.28					
TOTALS	**2971.5/11.39**	**3232/39.98**	**637/3.70**	**2860/22.12**	**2071/20.92**	**4462/31.80**	**2671/37.43**
Community Statistics							
Total N.Species	14	11	12	16	11	12	13
Mean N.Species/1 minute kick	11.00	8.00	6.67	10.67	9.67	10.00	9.00
Diversity (H'e)	1.88	1.24	1.18	1.79	0.97	1.31	1.27
Evenness (J)	0.69	0.50	0.48	0.63	0.40	0.53	0.50
Temperature (°C)	----	27	10	11	21	27	12
Mean Quarterly Salinity (‰)	0.26	1.33	1.36	0.08	0.59	2.38	1.69
BMWP Score	27	31	25	45	21	28	30
ASPT	3.38	3.88	4.17	4.50	3.50	4.00	3.75

* = Based on 2 one-minute kicks.

Table 6b. MACROFAUNA SPECIES RECORDED AT CADOGAN PIER (SITE 4). 1991.

Values: Abundance = №.Individuals/3mins, Biomass = g.WetWeight/3mins.
Expressed as Abundance/Biomass.

Species	Quar 1/91	Quar 2/91	Quar 3/91	Quar 4/91
OLIGOCHAETA				
Limnodrilus cervix			97/0.13	
Limnodrilus claparedianus		4/0.02	8/0.02	19/0.05
Limnodrilus hoffmeisteri	84/0.81		29/0.04	30/0.10
Naididae spp.	410/0.56	36/0.04	1/0.01	1/0.01
Potamothrix bavaricus	26/0.26			
Potamothrix hammoniensis	156/1.45			4/0.01
Psammoryctides barbatus	694/6.76	19/0.03	317/0.57	358/1.78
Tubifex tubifex	390/3.55	2/0.01	97/0.13	45/0.15
HIRUDINEA				
Erpobdella testacea	2/0.22	2/0.19	1/0.01	
Glossiphonia complanata			1/0.01	
CRUSTACEA				
Corophium lacustre	17/0.05	7/0.03	7/0.05	
Gammarus zaddachi	516/23.69	2040/32.03	581/5.88	317/20.17
UNIRAMIA				
Chironomidae spp.		1/0.01		
MOLLUSCA				
Ancylus fluviatilis			2/0.01	1/0.01
Lymnaea peregra	1/0.18	5/0.03	1/0.01	
Potamopyrgus jenkinsi	3/0.02	4/0.03	5/0.02	29/0.05
TOTALS	**2299/37.54**	**2120/32.42**	**1147/6.89**	**804/22.33**

Community Statistics				
Total №.Species	11	10	13	9
Mean №.Species/1 minute kick	8.33	7.00	8.33	6.33
Diversity (H'e)	1.71	0.22	1.34	1.26
Evenness (J)	0.71	0.10	0.52	0.57
Temperature (°C)	6	15	25.5	8
Mean Quarterly Salinity (‰)	0.20	0.45	0.83	1.51
BMWP Score	28	30	31	19
ASPT	4.00	3.75	3.88	3.80

Table 7a. MACROFAUNA SPECIES RECORDED AT SOUTH BANK CENTRE (SITE 5), 1989-1990.

Values: Abundance = №.Individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 2/89	Quar 3/89	Quar 4/89	Quar 1/90	Quar 2/90	Quar 3/90	Quar 4/90
PLATYHELMINTHES							
Turbellaria sp.						2.5/0.08	
OLIGOCHAETA							
Enchytraeidae sp.				18/0.06			
Limnodrilus cervix	8/0.02						
Limnodrilus hoffmeisteri		8/0.04	2/0.02	2/0.02	17.5/0.08	2.5/0.03	5/0.03
Lumbriculus variegatus	20/0.04						
Naididae spp.				2/0.02			
Psammoryctides barbatus	94/0.24	6/0.04		10/0.04			
Tubifex tubifex							2.5/0.03
Tubificoides benedeni					2.5/0.03		
CRUSTACEA							
Corophium lacustre		2/0.02					2.5/0.03
Gammarus zaddachi	4/0.04	2/0.06	4/0.10	18/0.06	85/0.28	25/0.38	
Sphaeroma rugicauda		2/0.02					
UNIRAMIA							
Chironomidae spp.			2/0.02				
MOLLUSCA							
Potamopyrgus jenkinsi			552/3.02			2.5/0.03	20/0.10
TOTALS	**126/0.34**	**20/0.18**	**560/3.16**	**50/0.20**	**105/0.39**	**32.5/0.52**	**30/0.19**
Community Statistics							
Total №.Species	4	5	4	5	3	4	4
Mean №.Species/0.1 m²	2.50	1.75	2.00	2.75	2.25	1.75	1.75
Diversity (H'e)	0.79	1.42	0.08	1.32	0.62	0.80	0.99
Evenness (J)	0.59	0.88	0.06	0.82	0.56	0.58	0.71
Temperature (°C)	10	25	15	8	17	26	14
Mean Quarterly Salinity (‰)	0.44	1.84	2.32	0.08	0.86	3.32	2.34
BMWP Score	10	16	12	7	7	10	16
ASPT	3.33	4.00	3.00	3.50	3.50	3.33	4.00

Table 7b. MACROFAUNA SPECIES RECORDED AT SOUTH BANK CENTRE (SITE 5). 1991.

Values: Abundance = №.Individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 1/91	Quar 2/91	Quar 3/91	Quar 4/91
OLIGOCHAETA				
Enchytraeidae sp.		35/0.07		
Limnodrilus hoffmeisteri	5/0.05	70/0.15		7.5/0.05
Potamothrix hammoniensis		2.5/0.03		
Potamothrix moldaviensis	2.5/0.03			2.5/0.03
Psammoryctides barbatus		10/0.05	5/0.05	
Tubifex tubifex	2.5/0.03	27.5/0.07		
CRUSTACEA				
Corophium lacustre	5/0.05	2.5/0.03		
Gammarus zaddachi	27.5/0.10	92.5/0.25	35/0.20	17.5/0.13
INSECTA				
Chironomidae spp.	2.5/0.03			
MOLLUSCA				
Potamopyrgus jenkinsi	7.5/0.08			5/0.03
TOTALS	**52.5/0.36**	**240/0.65**	**40/0.25**	**32.5/0.24**
Community Statistics				
Total №.Species	7	7	2	4
Mean №.Species/0.1 m²	3.25	4.00	1.50	2.00
Diversity (H'e)	1.47	1.47	0.38	1.16
Evenness (J)	0.76	0.76	0.55	0.84
Temperature (°C)	6	12	24.5	10
Mean Quarterly Salinity (‰)	0.23	0.69	1.24	2.14
BMWP Score	18	16	16	16
ASPT	3.60	4.00	4.00	4.00

Table 8a. MACROFAUNA SPECIES RECORDED AT LONDON BRIDGE (SITE 6), 1989-1990.

Values: Abundance = №.Individuals/3mins, Biomass = g.WetWeight/3mins.
Expressed as Abundance/Biomass.

Species	Quar 2/89	Quar 3/89	Quar 4/89	Quar 1/90	Quar 2/90	Quar 3/90	Quar 4/90
OLIGOCHAETA							
Enchytraeidae sp.	37/0.02			5/0.01			
Limnodrilus hoffmeisteri				5/0.01		6/0.02	
Lumbriculus variegatus	2/0.01						
Naididae spp.	37/0.02			390/0.06	2/0.02		
Potamothrix moldaviensis				5/0.01			
Psammoryctides barbatus	91/0.40			438/4.02		24/0.05	2/0.03
Tubifex tubifex	31/0.08			32/0.06		1/0.01	
POLYCHAETA							
Polydora sp.							2/0.02
HIRUDINEA							
Erpobdella testacea	1/0.29						
CRUSTACEA							
Asellus aquaticus				1/0.01			
Corophium lacustre			2/0.01	42/0.08	1/0.01	136/0.35	39/0.07
Crangon crangon						4/0.07	4/1.36
Gammarus zaddachi	324/3.57	7/0.07	85/2.90	460/6.52	83/1.03	384/15.33	168/6.56
Neomysis integer		6/0.07					
Sphaeroma rugicauda						1/0.01	2/0.02
UNIRAMIA							
Caenis moesta				3/0.02			
Chironomidae spp.	1/0.01						
Oulimnius sp.	1/0.01						
MOLLUSCA							
Potamopyrgus jenkinsi	1/0.02		26/0.05	21/0.11		164/0.44	41/0.08
TOTALS	**491/4.42**	**13/0.14**	**113/2.96**	**1402/10.91**	**86/1.06**	**720/16.26**	**258/8.13**
Community Statistics							
Total №.Species	10	2	3	11	3	8	7
Mean №.Species/1 minute kick	10	1.33	2.33	7.67	2.00	5.33	5.67
Diversity (H'e)	1.02	0.68	0.62	1.41	0.16	1.19	1.00
Evenness (J)	0.44	0.99	0.56	0.59	0.15	0.57	0.51
Temperature (°C)	10	25	8	8	20	23	12
Mean Quarterly Salinity (‰)	0.63	2.43	2.92	0.09	1.29	4.97	2.73
BMWP Score	18	7	15	27	13	16	19
ASPT	3.60	3.50	5.00	4.50	4.33	4.00	3.80

Table 8b. MACROFAUNA SPECIES RECORDED AT LONDON BRIDGE (SITE 6). 1991.

Values: Abundance = №.Individuals/3mins. Biomass = g.WetWeight/3mins.
Expressed as Abundance/Biomass.

Species	Quar 1/91	Quar 2/91	Quar 3/91	Quar 4/91
OLIGOCHAETA				
Enchytraeidae sp.	3/0.02			
Limnodrilus hoffmeisteri			1/0.01	2/0.01
Naididae spp.	19/0.04			
Potamothrix hammoniensis	5/0.02			4/0.01
Potamothrix moldaviensis	1/0.01			
Psammoryctides barbatus	18/0.03	10/0.03		5/0.01
Tubifex tubifex	6/0.01			
POLYCHAETA				
Polydora sp.			2/0.01	4/0.02
CRUSTACEA				
Asellus aquaticus	1/0.02			
Corophium lacustre	35/0.09	16/0.07	80/0.56	100/0.23
Gammarus zaddachi	399/18.76	1530/24.70	1880/27.31	131/4.26
MOLLUSCA				
Potamopyrgus jenkinsi	35/0.07	37/0.09	37/0.49	12/0.03
TOTALS	**522/19.07**	**1593/24.89**	**2000/28.38**	**258/4.57**

Community Statistics				
Total №.Species	10	4	5	7
Mean №.Species/1 minute kick	7.00	3.33	2.75	4.33
Diversity (H'e)	0.95	0.20	0.27	1.10
Evenness (J)	0.41	0.14	0.17	0.57
Temperature (°C)	5	15	24	10
Mean Quarterly Salinity (‰)	0.32	0.95	1.69	3.00
BMWP Score	19	16	16	16
ASPT	3.80	4.00	4.00	4.00

Table 9a.

MACROFAUNA SPECIES RECORDED AT GREENWICH (SITE 7), 1989-1990.

Values: Abundance = №.Individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 2/89	Quar 3/89	Quar 4/89	Quar 1/90	Quar 2/90	Quar 3/90	Quar 4/90
PLATYHELMINTHES							
Turbellaria sp.						5/0.13	
OLIGOCHAETA							
Limnodrilus hoffmeisteri	14/0.02	2/0.02	54/0.10	270/0.26	3577.5/4.30	2065/4.75	485/0.63
Potamothrix hammoniensis					37.5/0.05		
Tubifex costatus		14/0.06		6/0.02			
Tubifex tubifex				62/0.10	272.5/0.33		
HIRUDINEA							
?Bactracobdella paludosa							5/0.08
Erpobdella testacea			2/0.08				
CRUSTACEA							
Asellus aquaticus						5/0.03	
Corophium lacustre		74/0.34	16/0.08	2/0.02			2.5/0.03
Crangon crangon		2/0.02				2.5/0.08	
Gammarus zaddachi		122/1.02	4/0.04	10/0.04	15/0.15	42.5/0.93	
Neomysis integer		16/0.14					
Sphaeroma rugicauda		24/0.16			2.5/0.03	2.5/0.03	
UNIRAMIA							
Chironomidae spp.						5/0.05	
MOLLUSCA							
Dreissena polymorpha		10/0.88					
Potamopyrgus jenkinsi		364/2.64	8/0.06	64/0.36		10/0.08	17.5/0.08
TOTALS	**14/0.02**	**628/5.28**	**84/0.36**	**416/0.82**	**3905/4.86**	**2137.5/6.06**	**510/0.82**
Community Statistics							
Total №.Species	1	9	5	6	5	8	4
Mean №.Species/0.1 m²	1	6	3.25	4.25	3.25	3.75	2.25
Diversity (H'e)	0.00	1.26	1.05	1.05	0.33	0.17	0.24
Evenness (J)	0.00	0.57	0.65	0.54	0.21	0.08	0.17
Temperature (°C)	10.5	24	16	8	17	24	14
Mean Quarterly Salinity (‰)	1.62	4.46	5.70	0.14	1.67	6.82	6.36

Table 9b. MACROFAUNA SPECIES RECORDED AT GREENWICH (SITE 7). 1991.

Values: Abundance = №.Individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 1/91	Quar 2/91	Quar 3/91	Quar 4/91
OLIGOCHAETA				
Limnodrilus hoffmeisteri	80/0.17	212.5/0.30	5090/47.27	380/0.37
Monopylephorus rubroniveus	2.5/0.03	15/0.03		
Naididae spp.		5/0.03		
Tubifex costatus		22.5/0.07	25/0.07	
Tubifex tubifex		10/0.05	25/0.07	
POLYCHAETA				
Polydora sp.	5/0.03			
Streblospio shrubsolii	2.5/0.03			
CRUSTACEA				
Corophium volutator	5/0.03	12.5/0.12	2.5/0.03	
Gammarus zaddachi	5/0.05	30/0.12	7.5/0.05	2.5/0.03
Sphaeroma rugicauda			2.5/0.03	
UNIRAMIA				
Diptera larva		2.5/0.03		
MOLLUSCA				
Potamopyrgus jenkinsi	25/0.10	12.5/0.07	2.5/0.03	155/0.43
TOTALS	**125/0.45**	**322.5/0.82**	**5155/47.55**	**537.5/0.83**
Community Statistics				
Total №.Species	7	9	7	3
Mean №.Species/0.1 m²	3.5	5.75	2.75	2.25
Diversity (H'e)	1.15	1.29	0.08	0.63
Evenness (J)	0.59	0.59	0.04	0.57
Temperature (°C)	5	13	24	10
Mean Quarterly Salinity (‰)	0.56	2.10	3.49	5.46

Table 10a.

MACROFAUNA SPECIES RECORDED AT WOOLWICH INTERTIDAL (SITE 8i). 1989-1990.

Values: Abundance = №.Individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 2/89	Quar 3/89	Quar 4/89	Quar 1/90	Quar 2/90	Quar 3/90	Quar 4/90
NEMATODA							
Nematoda sp.					2.5/0.03		
OLIGOCHAETA							
Enchytraeidae sp.		2/0.01					
Limnodrilus hoffmeisteri	180/0.66	4/0.04	6/0.04	212/0.44	737.5/0.90	825/0.79	
Monopylephorus rubroniveus				46/0.08	12.5/0.08	10/0.08	52.5/0.13
Naididae spp.				8/0.02			
Potamothrix hammoniensis					2.5/0.03		
Tubifex costatus	8/0.04	10/0.01		6/0.02		10/0.03	2.5/0.03
Tubifex tubifex	14/0.04			14/0.02			
POLYCHAETA							
Nephtys hombergii						5/0.05	
Nereis (Neanthes) diversicolor						2.5/0.05	
Polydora sp.				2/0.02			
CRUSTACEA							
Corophium lacustre		12/0.04	4/0.04	10/0.04			
Corophium volutator					10/0.10		2.5/0.03
Crangon crangon					20/0.25		
Gammarus zaddachi		8/0.06		78/2.22	7.5/0.40		5/0.03
Neomysis integer		2/0.04			7.5/0.10		
UNIRAMIA							
Chironimidae spp.			8/0.02				
MOLLUSCA							
Potamopyrgus jenkinsi		46/0.44	136/0.76	8/0.06		5/0.03	2.5/0.03
TOTALS	**202/0.74**	**84/0.64**	**154/0.86**	**384/2.92**	**800/1.89**	**857.5/1.03**	**65/0.25**
Community Statistics							
Total №.Species	3	7	4	9	8	6	5
Mean №.Species/0.1 m²	2.00	3.00	1.75	4.75	4.75	3.00	2.00
Diversity (H'e)	0.54	1.35	0.47	1.36	0.40	0.22	0.76
Evenness (J)	0.39	0.69	0.34	0.62	0.19	0.12	0.45
Temperature (°C)	----	24	12	12	17	18	12
Mean Quarterly Salinity (‰)	4.17	9.15	10.50	0.97	6.11	12.20	11.66

Table 10b. MACROFAUNA SPECIES RECORDED AT WOOLWICH INTERTIDAL (SITE 81), 1991.

Values: Abundance = №.Individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 1/91	Quar 2/91	Quar 3/91	Quar 4/91
OLIGOCHAETA				
Limnodrilus hoffmeisteri	395/0.48	247.5/0.53	117.5/0.20	7.5/0.03
Monopylephorus rubroniveus		40/0.12	15/0.05	
Tubifex costatus	687.5/0.88	5/0.03	7.5/0.05	
Tubifex tubifex	15/0.03			
Tubificoides benedeni		2.5/0.03		
CRUSTACEA				
Corophium lacustre			5/0.03	
Corophium volutator	20/0.15	35/0.20	200/1.15	2.5/0.03
Crangon crangon			5/0.07	
Gammarus zaddachi			32.5/0.25	
Neomysis integer		2.5/0.03	5/0.07	
Palaemon longirostris			5/0.10	
Sphaeroma rugicauda			5/0.07	
UNIRAMIA				
Chaoborus sp.	2.5/0.03			
Chironimidae spp.	2.5/0.03			
Diptera sp.		2.5/0.03		
MOLLUSCA				
Potamopyrgus jenkinsi			10/0.05	15/0.10
TOTALS	**1122.5/1.60**	**335/0.97**	**407.5/2.14**	**25/0.16**
Community Statistics				
Total №.Species	6	7	11	3
Mean №.Species/0.1 m²	3.75	4.00	6.50	1.25
Diversity (H'e)	0.82	0.89	1.47	0.90
Evenness (J)	0.46	0.46	0.61	0.82
Temperature (°C)	11	16	24	11
Mean Quarterly Salinity (‰)	2.76	5.66	6.96	10.46

Table 10c.

MACROFAUNA SPECIES RECORDED AT WOOLWICH SUBTIDAL (SITE 8s), 1989-1990.

Values: Abundance = №.Individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 2/89	Quar 3/89	Quar 4/89	Quar 1/90	Quar 2/90	Quar 3/90	Quar 4/90
OLIGOCHAETA							
Limnodrilus hoffmeisteri	50/0.08		12.5/0.03	300/0.83	420/1.05	10/0.05	
Monopylephorus rubroniveus			25/0.05	97.5/0.18	2.5/0.03	85/0.12	20/0.08
Tubifex costatus						2.5/0.03	
Tubifex tubifex				5/0.03			
Tubificoides benedeni							10/0.05
POLYCHAETA							
Polydora sp.			27.5/0.08	15/0.03			
CRUSTACEA							
Corophium lacustre		40/0.20	2.5/0.03	7.5/0.03		5/0.03	
Corophium volutator						2.5/0.03	
Crangon crangon		10/0.40					
Gammarus zaddachi	5/0.23	10/0.10		7.5/0.15	52.5/0.93	2.5/0.03	
Neomysis integer	2.5/0.03						
MOLLUSCA							
Potamopyrgus jenkinsi		30/0.10		5/0.05		57.5/0.13	7.5/0.03
TOTALS	**57.5/0.34**	**90/0.80**	**67.5/0.19**	**437.5/1.30**	**475/2.01**	**165/0.42**	**37.5/0.16**
Community Statistics							
Total №.Species	3	4	4	7	3	7	3
Mean №.Species/0.1 m²	1.50	2.00	1.50	3.50	2.00	2.75	1.50
Diversity (H'e)	0.46	1.21	1.17	0.86	0.38	1.16	1.01
Evenness (J)	0.42	0.87	0.84	0.44	0.35	0.60	0.92
Temperature (°C)	----	24	13	10	16	18	16
Mean Quarterly Salinity (‰)	4.17	9.15	10.50	0.97	6.11	12.20	11.66

Table 10d. MACROFAUNA SPECIES RECORDED AT WOOLWICH SUBTIDAL (SITE 8s). 1991.

Values: Abundance = №.Individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 1/91	Quar 2/91	Quar 3/91	Quar 4/91
PLATYHELMINTHES				
Turbellaria sp.				7.5/0.17
OLIGOCHAETA				
Limnodrilus hoffmeisteri	20/0.07	122.5/0.28	107.5/0.18	30/0.07
Monopylephorus rubroniveus	107.5/0.25	167.5/0.38	2.5/0.03	37.5/0.05
Psammoryctides barbatus				2.5/0.03
Tubifex costatus		52.5/0.10		
POLYCHAETA				
Nereis (Neanthes) diversicolor		2.5/0.88		
Polydora sp.		2.5/0.03		
Streblospio shrubsolii		5/0.05		
CRUSTACEA				
Corophium volutator	27.5/0.28	45/0.83		
Crangon crangon			2.5/1.88	
Gammarus salinus		25/0.18		
Gammarus zaddachi	2.5/0.03			
Neomysis integer		2.5/0.03		
MOLLUSCA				
Potamopyrgus jenkinsi	2.5/0.03	2.5/0.03		2.5/0.03
TOTALS	**160/0.66**	**427.5/2.79**	**112.5/2.09**	**80/0.36**
Community Statistics				
Total №.Species	5	10	3	5
Mean №.Species/0.1 m²	3.00	4.75	1.50	2.00
Diversity (H'e)	0.96	1.56	0.21	1.16
Evenness (J)	0.60	0.68	0.19	0.72
Temperature (°C)	8	16	20	13
Mean Quarterly Salinity (‰)	2.76	5.66	6.96	10.46

Table 11a.

MACROFAUNA SPECIES RECORDED AT BECKTON (SITE 9). 1989-1990.

Values: Abundance = №.Individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 2/89	Quar 3/89	Quar 4/89	Quar 1/90	Quar 2/90	Quar 3/90	Quar 4/90
OLIGOCHAETA							
Limnodrilus hoffmeisteri	10/0.05	100/0.20	2.5/0.03	1400/4.38	12.5/0.08		10/0.05
Monopylephorus rubroniveus	5/0.03						
Tubifex costatus	5/0.05						
CRUSTACEA							
Corophium volutator	2.5/0.03						
Gammarus zaddachi	67.5/0.80	10/0.20			22.5/0.38		
Neomysis integer	5/0.03				5/0.08		
UNIRAMIA							
Chironomidae spp.	2.5/0.03						
TOTALS	**97.5/1.02**	**110/0.40**	**2.5/0.03**	**1400/4.38**	**40/0.54**	**0/0.00**	**10/0.05**
Community Statistics							
Total №.Species	7	2	1	1	3	0	1
Mean №.Species/0.1 m²	3.00	1.50	0.50	1.00	2.25	0.00	0.50
Diversity (H'e)	1.04	0.31	0.00	0.00	0.94	0.00	0.00
Evenness (J)	0.53	0.45	0.00	0.00	0.85	0.00	0.00
Temperature (°C)	----	23	14	11	17	17	16
Mean Quarterly Salinity (‰)	5.85	11.53	12.10	2.04	6.93	13.58	12.13

Table 11b. MACROFAUNA SPECIES RECORDED AT BECKTON (SITE 9), 1991.

Values: Abundance = №.Individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 1/91	Quar 2/91	Quar 3/91	Quar 4/91
OLIGOCHAETA				
Enchytraeidae sp.	5/0.05			
Limnodrilus hoffmeisteri	2.5/0.03	25/0.10	10/0.05	30/0.07
Naididae spp.		7.5/0.05		
CRUSTACEA				
Corophium volutator		5/0.03		
Gammarus salinus		20/0.25		
Gammarus zaddachi	2.5/0.20			
TOTALS	**10/0.28**	**57.5/0.43**	**10/0.05**	**30/0.07**
Community Statistics				
Total №.Species	3	4	1	1
Mean №.Species/0.1 m²	1.00	2.25	0.50	0.75
Diversity (H'e)	1.04	1.21	0.00	0.00
Evenness (J)	0.95	0.87	0.00	0.00
Temperature (°C)	8	16	20	13
Mean Quarterly Salinity (‰)	4.08	7.57	8.20	11.72

Table 12a.

MACROFAUNA SPECIES RECORDED AT CROSSNESS INTERTIDAL (SITE 10i), 1989-1990.

Values: Abundance = №.Individuals/m², Biomass = g.WetWeight/m². Expressed as Abundance/Biomass.

Species	Quar 2/89	Quar 3/89	Quar 4/89	Quar 1/90	Quar 2/90	Quar 3/90	Quar 4/90
OLIGOCHAETA							
Enchytraeidae sp.	250/0.50		22/0.04	30/0.06			435/0.85
Limnodrilus hoffmeisteri	1588/3.26	530/1.06	34/0.06	384/0.72	10177.5/22.45	2705/7.18	
Limnodrilus udekemianus		58/0.12					
Lumbriculus variegatus				98/0.20			
Naididae spp.					820/0.83	100/0.15	
Tubifex costatus	1110/2.22	758/1.52	2814/6.06	8068/17.12	9897.5/21.73	16170/42.85	27065/53.68
Tubifex tubifex	772/1.54			350/0.66			
Tubificidae sp.			106/0.10				
Tubificoides benedeni				2/0.02			
POLYCHAETA							
Nereis (Neanthes) diversicolor		14/0.28	14/0.90	38/3.72		12.5/0.83	105/16.65
CRUSTACEA							
Corophium volutator		34/0.08	4/0.04		5/0.08		5/0.03
Gammarus zaddachi		2/0.02					
UNIRAMIA							
Chironomidae spp.		4/0.04	6/0.06				
MOLLUSCA							
Macoma balthica							2.5/0.08
TOTALS	**3720/7.52**	**1400/3.12**	**3000/7.26**	**8970/22.50**	**20900/45.09**	**18987.5/51.01**	**27612.5/71.29**
Community Statistics							
Total №.Species	4	7	7	7	4	4	5
Mean №.Species	3.00	4.25	3.75	4.75	3.50	3.75	2.50
Diversity (H'e)	1.32	1.00	0.29	0.46	0.84	0.45	0.12
Evenness (J)	0.82	0.51	0.15	0.24	0.61	0.32	0.07
Temperature (°C)	----	24	14	12	17	18	12
Mean Quarterly Salinity (‰)	7.85	13.38	14.12	2.51	8.83	17.09	14.63

Table 12b. MACROFAUNA SPECIES RECORDED AT CROSSNESS INTERTIDAL (SITE 101), 1991.

Values: Abundance = №.Individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 1/91	Quar 2/91	Quar 3/91*	Quar 4/91
OLIGOCHAETA				
Enchytraeidae sp.	225/0.65			
Limnodrilus hoffmeisteri	390/1.10			55/0.10
Naididae spp.	2.5/0.03	7.5/0.03		85/0.13
Tubifex costatus	3460/10.48	4787.5/19.48	7866.7/25.30	11045/23.70
POLYCHAETA				
Nereis (Neanthes) diversicolor	5/0.30	35/8.45	96.7/15.40	
CRUSTACEA				
Corophium volutator	10/0.15	7.5/0.03	6.7/0.03	
TOTALS	**4092.5/12.71**	**4837.5/27.99**	**7970.1/40.73**	**11185/23.92**
Community Statistics				
Total №.Species	6	4	3	3
Mean №.Species	4.25	2.75	2.33	2.25
Diversity (H'e)	0.55	0.07	0.07	0.08
Evenness (J)	0.31	0.05	0.06	0.07
Temperature (°C)	10	16	28	11
Mean Quarterly Salinity (‰)	4.26	8.29	9.86	13.89

* based on three subsamples only

Table 12c.

MACROFAUNA SPECIES RECORDED AT CROSSNESS SUBTIDAL (SITE 10s), 1989-1990.

Values: Abundance = N°.Individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 2/89	Quar 3/89	Quar 4/89	Quar 1/90	Quar 2/90	Quar 3/90	Quar 4/90
OLIGOCHAETA							
Limnodrilus hoffmeisteri	240/0.75	10/0.10		37.5/0.10	10/0.05		
Monopylephorus rubroniveus	5/0.03		12.5/0.03	497.5/1.22	127.5/0.20	47.5/0.10	220/0.28
Tubifex costatus			67.5/0.08	2.5/0.03		87.5/0.10	
Tubificidae sp.						2.5/0.03	5/0.05
Tubificoides benedeni					7.5/0.03		5/0.03
POLYCHAETA							
Nereis (Neanthes) diversicolor			2.5/1.15			2.5/0.10	
Nereis (Neanthes) succinea			5/0.58				
Polydora sp.			2.5/0.03			7.5/0.03	
Streblospio shrubsolii			5/0.05	2.5/0.03		2.5/0.03	27.5/0.08
CRUSTACEA							
Corophium volutator	37.5/0.30		265/3.00	12.5/0.14	292.5/2.50	70/0.18	2.5/0.03
Crangon crangon	7.5/0.15						
Gammarus zaddachi	2.5/0.03		2.5/0.03	2.5/0.08	7.5/0.05	5/0.03	
Neomysis integer	5/0.08						
MOLLUSCA							
Macoma balthica							2.5/0.05
Potamopyrgus jenkinsi			10/0.05				
TOTALS	**297.5/1.34**	**10/0.10**	**372.5/5.02**	**555/1.59**	**445/2.83**	**225/0.60**	**262.5/0.52**
Community Statistics							
Total N°.Species	6	1	9	6	5	8	6
Mean N°.Species	3.00	0.50	3.00	3.50	3.25	3.00	2.75
Diversity (H'e)	0.70	0.00	0.95	0.51	0.86	1.35	0.61
Evenness (J)	0.39	0.00	0.43	0.28	0.53	0.65	0.34
Temperature (°C)	----	23	14	10	17	18	16
Mean Quarterly Salinity (‰)	7.85	13.38	14.12	2.51	8.83	17.09	14.63

Table 12d. MACROFAUNA SPECIES RECORDED AT CROSSNESS SUBTIDAL (SITE 10s). 1991.

Values: Abundance = №.Individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 1/91	Quar 2/91	Quar 3/91	Quar 4/91
OLIGOCHAETA				
Enchytraeidae sp.	7.5/0.05	670/2.38		
Limnodrilus hoffmeisteri		210/0.75	17.5/0.05	7.5/0.03
Monopylephorus rubroniveus	135/0.18	112.5/0.45	27.5/0.07	457.5/0.30
Naididae spp.		5/0.03		
Tubifex costatus	2.5/0.03	120/0.50		
Tubifex tubifex		312.5/1.10		
Tubificoides benedeni	2.5/0.03			
POLYCHAETA				
Nephtys hombergi				2.5/0.03
Streblospio shrubsolii	10/0.07	12.5/0.05	5/0.03	72.5/0.10
CRUSTACEA				
Corophium volutator	17.5/0.07	47.5/0.23		
UNIRAMIA				
Chironomidae spp.		7.5/0.03		
MOLLUSCA				
Macoma balthica			2.5/0.12	
Physa ?heterostropha		7.5/0.53		
Potamopyrgus jenkinsi	2.5/0.03	2.5/0.03	2.5/0.03	
TOTALS	**177.5/0.46**	**1507.5/6.08**	**55/0.30**	**540/0.46**
Community Statistics				
Total №.Species	7	11	5	4
Mean №.Species	3.50	5.25	2.00	2.50
Diversity (H'e)	0.91	1.59	1.21	0.49
Evenness (J)	0.47	0.66	0.75	0.35
Temperature (°C)	8	16	20	13
Mean Quarterly Salinity (‰)	4.26	8.29	9.86	13.89

Table 13a.

MACROFAUNA SPECIES RECORDED AT PURFLEET INTERTIDAL (SITE 11i). 1989-1990.

Values: Abundance = №.Individuals/m². Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 2/89	Quar 3/89	Quar 4/89	Quar 1/90	Quar 2/90	Quar 3/90	Quar 4/90
OLIGOCHAETA							
Limnodrilus hoffmeisteri				6/0.02	2.5/0.03		
Monopylephorus rubroniveus			4/0.02	48/0.06	7.5/0.03		225/0.28
Psammoryctides barbatus			2/0.02				
Tubifex costatus	56/0.12	16/0.08	6/0.03	44/0.06	20/0.06		5/0.04
Tubificoides benedeni	4/0.04		2/0.01	8/0.06			10/0.04
POLYCHAETA							
Nephtys hombergii						5/0.05	2.5/0.05
Nereis (Neanthes) diversicolor	6/0.40				2.5/0.35		
Polydora sp.							7.5/0.03
Streblopio shrubsolii							5/0.05
CRUSTACEA							
Carcinus maenas					2.5/0.03		
Corophium volutator	120/0.84	2/0.02	2/0.02	4/0.04	47.5/0.60		
Crangon crangon	20/0.18				147.5/5.53		
Gammarus zaddachi					5/0.05		
Neomysis integer	26/0.36				27.5/0.25		
Palaemon longirostris		2/0.06				2.5/0.05	
Palaemonetes varians					2.5/0.93		
UNIRAMIA							
Psychodidae sp.					7.5/0.03		
MOLLUSCA							
Macoma balthica						2.5/0.03	
TOTALS	**232/1.94**	**20/0.16**	**16/0.10**	**110/0.24**	**242.5/7.99**	**10/0.13**	**255/0.49**
Community Statistics							
Total №.Species	6	3	5	5	11	3	6
Mean №.Species/0.1 m²	4.25	1.50	1.50	3.75	5.00	0.75	3.00
Diversity (H'e)	1.30	0.64	1.50	1.20	1.55	1.05	0.52
Evenness (J)	0.72	0.58	0.93	0.75	0.65	0.95	0.29
Temperature (°C)	24	23	10	11	21	23	9
Mean Quarterly Salinity (‰)	11.96	18.15	20.20	6.03	13.79	19.29	15.82

Table 13b. MACROFAUNA SPECIES RECORDED AT PURFLEET INTERTIDAL (SITE 11i), 1991.

Values: Abundance = №.Individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 1/91	Quar 2/91	Quar 3/91	Quar 4/91
OLIGOCHAETA				
Limnodrilus hoffmeisteri	2.5/0.03			
Monopylephorus rubroniveus	320/0.62		50/0.12	7.5/0.07
Naididae spp.	5/0.05			
Psammoryctides barbatus			2.5/0.03	
Tubifex costatus	40/0.10	20/0.07	2.5/0.03	
Tubificoides benedeni	20/0.07		17.5/.10	
POLYCHAETA				
Caulleriella sp.			5/0.05	
Eteone longa			5/0.05	
Nereis (Neanthes) diversicolor	7.5/0.10		10/0.20	
Streblopio shrubsolii	2.5/0.03			
CRUSTACEA				
Corophium lacustre			2.5/0.03	
Corophium volutator	2.5/0.05	90/0.70	2.5/0.03	2.5/0.03
MOLLUSCA				
Bithynia tentaculata				2.5/0.03
Hydrobia ulvae				2.5/0.03
Planorbis sp.				7.5/0.05
TOTALS	**400/1.05**	**110/0.77**	**97.5/0.64**	**22.5/0.23**
Community Statistics				
Total №.Species	8	2	9	5
Mean №.Species/0.1 m²	4.25	1.75	4.50	2.00
Diversity (H'e)	0.78	0.47	1.56	1.46
Evenness (J)	0.38	0.68	0.71	0.91
Temperature (°C)	10	15	20	10
Mean Quarterly Salinity (‰)	11.35	14.05	15.37	19.13

Table 13c.

MACROFAUNA SPECIES RECORDED AT PURFLEET SUBTIDAL (SITE 11s). 1989-1990.

Values: Abundance = №.Individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 2/89	Quar 3/89	Quar 4/89	Quar 1/90	Quar 2/90	Quar 3/90	Quar 4/90
OLIGOCHAETA							
Limnodrilus hoffmeisteri						15/0.03	
Monopylephorus rubroniveus	17.5/0.10	10/0.05	5/0.03	347.5/0.60		12.5/0.05	2.5/0.03
Tubifex costatus					37.5/0.08		
Tubificoides benedeni	40/0.10	10/0.05	20/0.03	480/2.10	947.5/2.57	27.5/0.10	17.5/0.05
POLYCHAETA							
Eteone longa					50/0.28		
Nereis (Neanthes) diversicolor					82.5/3.70		
Polydora sp.					2.5/0.03	7.5/0.03	5/0.03
Scio filicornis					2.5/0.03		
Streblospio shrubsolii				5/0.05		5/0.03	
CRUSTACEA							
Corophium volutator	55/0.38			22.5/0.10	2362.5/26.50	57.5/0.15	17.5/0.10
Gammarus zaddachi		20/0.30			5/0.05		
Mesopodopsis slabberi							2.5/0.03
MOLLUSCA							
Macoma balthica				5/3.88	5/0.03		
Potamopyrgus jenkinsi					2.5/0.03		
Scrobicularia plana					10/1.40		
TOTALS	**112.5/0.58**	**40/0.40**	**25/0.06**	**860/6.73**	**3507.5/34.70**	**125/0.39**	**45/0.24**
Community Statistics							
Total №.Species	3	3	2	5	11	6	5
Mean №.Species/0.1 m²	2.50	1.50	0.50	3.50	5.25	3.00	2.00
Diversity (H'e)	1.01	1.05	0.50	0.85	0.89	1.47	1.30
Evenness (J)	0.93	0.95	0.72	0.53	0.37	0.82	0.81
Temperature (°C)	----	23	14	11	17	17	15
Mean Quarterly Salinity (‰)	11.96	18.15	20.20	6.03	13.79	19.29	15.82

Table 13d. MACROFAUNA SPECIES RECORDED AT PURFLEET SUBTIDAL (SITE 11s). 1991.

Values: Abundance = №.Individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 1/91	Quar 2/91	Quar 3/91	Quar 4/91
OLIGOCHAETA				
Monopylephorus rubroniveus	10/0.05	45/0.12	2.5/0.03	
Tubifex costatus		5/0.03		
Tubificoides benedeni	1297.5/3.57	5350/18.12	15/0.07	37.5/0.13
POLYCHAETA				
Caulleriella sp.	30/0.12	10/0.07		
Eteone longa		7.5/0.07		
Nephtys hombergii	2.5/0.05		2.5/0.03	
Nereis (Neanthes) diversicolor	10/0.53	2.5/0.15		
Polydora sp.				2.5/0.03
Pygospio elegans		55/0.15		7.5/0.03
Spio filicornis	5/0.05			5/0.05
Streblospio shrubsolii	85/0.20	65/0.20		10/0.05
CRUSTACEA				
Corophium volutator	87.5/0.28	767.5/5.62	2.5/0.03	97.5/0.28
MOLLUSCA				
Hydrobia ulvae	7.5/0.05			
Macoma balthica	10/0.60	37.5/0.38	5/0.05	7.5/0.10
Scrobicularia plana	10/2.52	7.5/2.00		
TOTALS	**1555/8.02**	**6332.5/26.91**	**27.5/0.21**	**167.5/0.66**
Community Statistics				
Total №.Species	11	11	5	7
Mean №.Species/0.1 m²	8	6.75	2.00	4.00
Diversity (H'e)	0.73	0.59	1.29	1.26
Evenness (J)	0.30	0.25	0.80	0.65
Temperature (°C)	8	16	19	13
Mean Quarterly Salinity (‰)	11.35	14.05	15.37	19.13

Table 14a.

MACROFAUNA SPECIES RECORDED AT WEST THURROCK INTERTIDAL (SITE 12i). 1989-1990.

Values: Abundance = №.Individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 2/89	Quar 3/89	Quar 4/89	Quar 1/90	Quar 2/90	Quar 3/90	Quar 4/90
OLIGOCHAETA							
Tubifex costatus	3380/6.76	2794/5.60	3128/2.78	1162/1.26	7767.5/14.00	1855/2.42	150/0.20
Tubificoides benedeni	250/0.50	152/0.30	18/0.06	22/0.08	12.5/0.08		7.5/0.05
POLYCHAETA							
Eteone longa					2.5/0.03		
Nephtys hombergii							2.5/0.05
Nereis (Neanthes) diversicolor	2236/402.48	3134/760.78	3470/421.60	2630/317.30	4662.5/415.18	3475/285.85	4250/286.68
Polydora sp.					2.5/0.03		
CRUSTACEA							
Carcinus maenas		2/0.56					
Corophium volutator	1372/10.98	254/1.96	5420/46.06	470/6.70	4425/14.60	357.5/4.08	2550/33.15
Gammarus zaddachi	26/1.12			4/0.26		2.5/0.03	
UNIRAMIA							
Tipulidae sp.				2/0.04			
MOLLUSCA							
Hydrobia ulvae					2.5/0.03		
Macoma balthica				2/0.38	7.5/0.18	20/0.10	10/0.08
Scrobicularia plana						5/2.18	
ASCIDEACEA							
Molgula manhattensis					2.5/1.83		
TOTALS	**7264/421.84**	**6336/769.20**	**12036/470.50**	**4292/326.02**	**16885/445.96**	**5715/294.67**	**6970/320.21**
Community Statistics							
Total №.Species	5	5	4	7	9	6	6
Mean №.Species/0.1 m²	4.50	3.75	3.75	4.50	5.25	4.50	4.50
Diversity (H'e)	1.15	0.94	1.08	0.95	1.13	0.88	0.78
Evenness (J)	0.71	0.58	0.78	0.49	0.51	0.49	0.44
Temperature (°C)	23	27	9	12	23	23	7
Mean Quarterly Salinity (‰)	17.62	20.99	22.76	9.88	16.42	24.57	20.60

Table 14b. MACROFAUNA SPECIES RECORDED AT WEST THURROCK INTERTIDAL (SITE 12i). 1991.

Values: Abundance = №.Individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 1/91	Quar 2/91	Quar 3/91	Quar 4/91
OLIGOCHAETA				
Tubifex costatus	210/0.43	190/0.30	1187.5/1.12	535/0.73
Tubificoides benedeni	10/0.05	2.5/0.03	5/0.03	15/0.07
POLYCHAETA				
Eteone longa				2.5/0.03
Nereis (Neanthes) diversicolor	2140/192.50	2795/264.97	2482.5/270.45	2385/93.18
CRUSTACEA				
Carcinus maenas			5/1.70	
Corophium insidiosum	2.5/0.03			
Corophium volutator	340/4.40	937.5/23.45	1220/7.15	1077.5/7.30
MOLLUSCA				
Hydrobia ulvae				52.5/0.18
Macoma balthica	5/1.30		7.5/0.75	90/0.48
Scrobicularia plana	2.5/0.12			
TOTALS	**2710/198.83**	**3925/288.75**	**4907.5/281.20**	**4157.5/101.96**
Community Statistics				
Total №.Species	7	4	6	7
Mean №.Species/0.1 m²	4.50	3.25	4.00	6.00
Diversity (H'e)	0.69	0.74	1.06	1.10
Evenness (J)	0.35	0.53	0.59	0.57
Temperature (°C).	9	15	19	10
Mean Quarterly Salinity (‰)	13.31	17.70	18.47	20.54

Table 14c.

MACROFAUNA SPECIES RECORDED AT WEST THURROCK SUBTIDAL (SITE 12s). 1989-1990.

Values: Abundance = №.Individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 2/89	Quar 3/89	Quar 4/89	Quar 1/90	Quar 2/90	Quar 3/90	Quar 4/90
OLIGOCHAETA							
Monopylephorus rubroniveus				7.5/0.06	2.5/0.03		
Tubifex costatus	772.5/1.50		162.5/0.20	7.5/0.04			
Tubificoides benedeni	800/1.53		85/0.15	2.5/0.05	12.5/0.05	5/0.05	5/0.05
POLYCHAETA							
Caulleriella sp.			12.5/0.03				
Nephtys hombergii			2.5/0.05			5/0.18	
Nereis (Neanthes) diversicolor	40/1.70			5/0.05			2.5/0.45
Nereis (Neanthes) succinea	10/0.98		107.5/8.93				
Streblospio shrubsolii			100/0.18	7.5/0.03	2.5/0.03		
CRUSTACEA							
Corophium volutator	22125/144.78	10/0.10	362.5/3.35	17.5/0.08	7.5/0.08		
Crangon crangon	2.5/0.08						
Gammarus zaddachi	2.5/0.05			5/0.05	2.5/0.03		
Melita obtusata						2.5/0.03	
MOLLUSCA							
Macoma balthica						2.5/0.03	
ASCIDEACEA							
Molgula manhattensis			12.5/1.20				
TOTALS	**23752.5/150.62**	**10/0.10**	**845/14.09**	**52.5/0.36**	**27.5/0.22**	**17.5/0.32**	**7.5/0.50**
Community Statistics							
Total №.Species	7	1	8	7	5	5	2
Mean №.Species/0.1 m²	5.25	0.50	5.25	3.25	1.75	2.00	0.75
Diversity (H'e)	0.33	0.00	1.56	1.75	1.36	1.51	0.64
Evenness (J)	0.17	0.00	0.75	0.90	0.84	0.94	0.93
Temperature (°C)	----	22	14	11	17	17	15
Mean Quarterly Salinity (‰)	17.62	20.99	22.76	9.88	16.42	24.57	20.60

Table 14d. MACROFAUNA SPECIES RECORDED AT WEST THURROCK SUBTIDAL (SITE 12s). 1991.

Values: Abundance = №.Individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 1/91	Quar 2/91	Quar 3/91	Quar 4/91
OLIGOCHAETA				
Enchytraeidae sp.		15/0.03		
Monopylephorus rubroniveus			2.5/0.03	
Tubifex costatus	5/0.03	17.5/0.07		
Tubificoides benedeni	25/0.10	75/0.23	25/0.07	12.5/0.07
POLYCHAETA				
Caulleriella sp.			27.5/0.10	5/0.05
Nephtys hombergii	2.5/0.05	2.5/0.05	10/0.15	25/0.40
Nereis (Neanthes) diversicolor	12.5/0.58	10/0.70		
Streblospio shrubsolii	5/0.05		7.5/0.03	17.5/0.05
CRUSTACEA				
Corophium volutator	7.5/0.03	190/1.82		2.5/0.03
Eurytemora affinis	2.5/0.03			
Gammarus salinus		5/0.05		
Gammarus zaddachi				2.5/0.03
MOLLUSCA				
Macoma balthica	2.5/0.03		7.5/0.88	2.5/0.03
Physa ?heterostropha		5/0.07		
TOTALS	**62.5/0.90**	**320/3.02**	**80/1.48**	**67.5/0.66**
Community Statistics				
Total №.Species	8	8	6	7
Mean №.Species/0.1 m²	3.25	4.50	2.75	3.25
Diversity (H'e)	1.73	1.23	1.54	1.59
Evenness (J)	0.83	0.59	0.86	0.82
Temperature (°C)	8	16	19	13
Mean Quarterly Salinity (‰)	13.31	17.70	18.47	20.54

Table 15a.

MACROFAUNA SPECIES RECORDED AT GRAVESEND INTERTIDAL (SITE 13i), 1989-1990.

Values: Abundance = №.Individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 2/89	Quar 3/89	Quar 4/89	Quar 1/90	Quar 2/90	Quar 3/90	Quar 4/90
OLIGOCHAETA							
Tubifex costatus	48/0.14						
Tubificoides benedeni	1680/5.26	4710/14.16	3900/11.72	1374/4.30	7160/32.22	6467.5/18.78	6400/24.95
POLYCHAETA							
Arenicola marina	2/0.12				2/0.02		
Caulleriella sp.		24/0.14	54/0.12	70/0.32	48/0.18	30/0.13	367.5/0.60
Eteone longa	10/0.16	28/0.24	8/0.88	2/0.02	4/0.04	40/0.13	12.5/0.18
Nephtys hombergii			12/0.22	8/0.34	2/0.16	90/1.23	72.5/3.25
Nereis (Neanthes) diversicolor	36/1.66	136/3.16	34/1.48	6/1.00	24/2.04	50/3.88	25/1.78
Nereis (Neanthes) succinea				12/0.20			
Polydora sp.				20/0.06			
Streblospio shrubsolii				10/0.06			
HIRUDINEA							
Glossiphonia ?heteroclita							2.5/0.03
CRUSTACEA							
Carcinus maenas	2/1.06				2/0.02		
Corophium volutator	4756/47.50	1312/10.08	34/0.06	1110/9.00	2856/31.88	722.5/6.50	705/8.08
Gammarus salinus					2/0.02		
Neomysis integer		100/1.00					
MOLLUSCA							
Littorina littorea						5/0.50	
Macoma balthica	2/1.61	18/1.68	16/1.92		4/0.18	20/0.98	17.5/0.10
Scrobicularia plana		2/2.06				2.5/0.08	2.5/0.03
TOTALS	**6536/6.51**	**6330/32.52**	**4058/15.60**	**2612/15.30**	**10104/66.76**	**7427.5/32.21**	**7605/39.15**

Community Statistics

Total №.Species	8	8	7	9	10	9	9
Mean №.Species/0.1 m²	4.75	7.00	6.75	6.00	5.50	7.00	6.75
Diversity (H'e)	0.69	0.76	0.23	0.90	0.68	0.51	0.61
Evenness (J)	0.33	0.37	0.12	0.41	0.30	0.23	0.28
Temperature (°C)	19	21	13	8	11	29	14
Mean Quarterly Salinity (‰)	20.62	22.87	24.59	12.61	16.51	26.81	21.94

Table 15b. MACROFAUNA SPECIES RECORDED AT GRAVESEND INTERTIDAL (SITE 13i). 1991.

Values: Abundance = №.Individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 1/91	Quar 2/91	Quar 3/91	Quar 4/91
ANTHOZOA				
Actinaria sp.			5/0.05	
OLIGOCHAETA				
?Clitellio arenarius				2.5/0.03
Monopylephorus rubroniveus	10/0.10			
Tubifex costatus		2.5/0.03		
Tubificoides benedeni	2825/10.68	4850/14.55	1285/3.88	1282.5/3.88
POLYCHAETA				
Arenicola marina	2.5/0.03	10/0.55	2.5/0.07	
Caulleriella sp.	267.5/2.78	75/0.25	237.5/0.72	475/2.35
Eteone longa		2.5/0.03		5/0.05
Nephtys hombergii	42.5/2.35	22.5/1.00	35/0.53	52.5/2.52
Nereis (Neanthes) diversicolor	5/0.28	32.5/2.65	20/0.80	2.5/0.55
Pygospio elegans		5/0.05		
Streblospio shrubsolii	42.5/0.13			2.5/0.03
CRUSTACEA				
Corophium volutator	25/0.10	8825/128.83	5/0.05	2.5/0.03
Crangon crangon			5/0.05	
Gammarus salinus		2.5/0.03		
Palaemon longirostris			2.5/0.28	
MOLLUSCA				
Hydrobia ulvae	5/0.05			2.5/0.03
Macoma balthica	15/0.10	5/1.62	10/0.93	17.5/0.12
Scrobicularia-plana		2.5/0.05	2.5/0.03	2.5/0.03
TOTALS	**3240/16.60**	**13835/149.64**	**1610/7.39**	**1847.5/9.62**
Community Statistics				
Total №.Species	10	12	11	11
Mean №.Species/0.1 m²	8.00	7.75	6.50	6.00
Diversity (H'e)	0.56	0.72	0.72	0.82
Evenness (J)	0.24	0.29	0.30	0.34
Temperature (°C)	8	13	23	7
Mean Quarterly Salinity (‰)	16.99	19.36	20.26	23.17

Table 15c. MACROFAUNA SPECIES RECORDED AT GRAVESEND SUBTIDAL (SITE 13s), 1989-1990.

Values: Abundance = N.Individuals/m². Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 2/89	Quar 3/89	Quar 4/89	Quar 1/90	Quar 2/90	Quar 3/90	Quar 4/90
HYDROZOA							
Tubularia indivisa	2.5/0.23						2.5/0.05
ANTHOZOA							
Sagartia troglodytes	2.5/0.10						
OLIGOCHAETA							
Monopylephorus rubroniveus			15/0.03	10/0.05			
Psammoryctides barbatus		10/0.02					
Tubifex costatus	12.5/0.03						
Tubificoides benedeni	47.5/0.10	70/0.18	45/0.08	55/0.08	2.5/0.03		5/0.05
POLYCHAETA							
Caulleriella sp.	2.5/0.05		5/0.05				
Eteone longa	2.5/0.03						
Nephtys hombergii			10/0.18			2.5/0.05	
Nereis (Neanthes) diversicolor	22.5/1.98	40/1.00					
Nereis (Neanthes) succinea			2.5/0.15	2.5/0.05			
Polydora sp.					12.5/0.08		
Streblospio shrubsolii	765/2.03		42.5/0.13	12.5/0.05	2.5/0.03		5/0.03
CRUSTACEA							
Corophium volutator	4597.5/36.83	360/2.90	32.5/0.25	5/0.05	2.5/0.03		
Crangon crangon	5/0.15						
Gammarus salinus	2.5/0.08	10/0.20	15/0.03				
Mesopodopsis slabberi							5/0.05
Neomysis integer			2.5/0.03				
Schistomysis spiritus							2.5/0.03
UNIRAMIA							
Psychodidae sp.					2.5/0.03		
MOLLUSCA							
Macoma balthica		10/0.20					2.5/0.03
Mytilus edulis	7.5/0.55						
ASCIDIACEA							
Molgula manhattensis	12.5/10.43			2.5/0.05			
TOTALS	5482.5/52.51	500/4.50	170/0.90	87.5/0.33	22.5/0.20	2.5/0.05	32.5/0.44
Community Statistics							
Total N.Species	13	6	9	6	5	1	7
Mean N.Species/0.1 m²	6.75	4.00	4.25	2.25	1.50	0.25	3.25
Diversity (H'e)	0.58	0.96	1.79	1.18	1.29	0.00	1.80
Evenness (J)	0.22	0.54	0.81	0.66	0.80	0.00	0.93
Temperature (°C)	----	22	14	11	16	17	15
Mean Quarterly Salinity (‰)	20.62	22.87	24.59	12.61	16.51	26.81	21.94

Table 15d. MACROFAUNA SPECIES RECORDED AT GRAVESEND SUBTIDAL (SITE 13s), 1991.

Values: Abundance = №.Individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 1/91	Quar 2/91	Quar 3/91	Quar 4/91
OLIGOCHAETA				
Tubificoides benedeni	7.5/0.05		5/0.05	27.5/0.07
POLYCHAETA				
Caulleriella sp.				35/0.10
Nephtys hombergii			7.5/0.05	47.5/1.07
Pygospio elegans				2.5/0.03
Streblospio shrubsolii	2.5/0.03			15/0.05
CRUSTACEA				
Corophium volutator		2.5/0.03	2.5/0.03	25/0.07
Gammarus salinus	2.5/0.12			
Schistomysis spiritus		5/0.07	2.5/0.03	
Siriella armata		2.5/0.25		
MOLLUSCA				
Hydrobia ulvae				2.5/0.03
Macoma balthica			2.5/0.03	
TOTALS	**12.5/0.20**	**10/0.35**	**20/0.19**	**155/1.42**
Community Statistics				
Total №.Species	3	3	5	7
Mean №.Species/0.1 m²	1.00	0.75	1.5	3.75
Diversity (H'e)	0.95	1.04	1.50	1.66
Evenness (J)	0.86	0.95	0.93	0.85
Temperature (°C)	8	16	19	13
Mean Quarterly Salinity (‰)	16.99	19.36	20.26	23.17

Table 16a.

MACROFAUNA SPECIES RECORDED AT MUCKING (SITE 14), 1989-1990.

Values: Abundance = №.Individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 2/89	Quar 3/89	Quar 4/89	Quar 1/90	Quar 2/90	Quar 3/90	Quar 4/90
OLIGOCHAETA							
Monopylephorus rubroniveus	30/0.10	10/0.03	5/0.05	10/0.08	32.5/0.10		10/0.05
Psammorydides barbatus			30/0.10				
Tubificoides benedeni	8732.5/24.40	700/2.80	17.5/0.10	85/0.18	102.5/0.35	12.5/0.08	130/0.43
POLYCHAETA							
Ampharete acutifrons		12.5/0.30					
Arenicola marina		22.5/7.13	2.5/0.70		2.5/4.35		
Capitellides giardii	30/0.10	5/0.08		7.5/0.15	2.5/0.05		
Caulleriella sp.	565/1.55	3750/16.25	3325/5.00	4962.5/11.90	1837.5/5.70	12.5/0.03	152.5/0.20
Nephtys hombergii	2.5/0.50	52.5/1.45	37.5/2.18	17.5/1.63	12.5/1.65	65/1.65	27.5/1.08
Nereis (Neanthes) diversicolor	5/0.20						
Nereis (Neanthes) succinea				2.5/0.03			
Polydora sp.							5/0.03
Scoloplos armiger		2.5/0.05					
CRUSTACEA							
Corophium lacustre			7.5/0.08				
Corophium volutator	15/0.35			85/0.53			
Diastylis bradyi			2.5/0.03				
Melita palmata							5/0.03
Neomysis integer						2.5/0.03	
MOLLUSCA							
Cerastoderma edule						2.5/0.03	
Macoma balthica	55/5.10	35/4.25	2.5/0.13	5/0.08	2.5/0.03	15/0.20	10/0.10
TOTALS	**9435/32.30**	**4590/32.34**	**3400/8.27**	**5175/14.58**	**1992.5/12.23**	**140/2.12**	**340/1.92**
Community Statistics							
Total №.Species	8	9	8	8	7	7	7
Mean №.Species/0.1 m²	3.50	6.00	5.00	5.75	4.50	4.00	4.25
Diversity (H'e)	0.34	0.59	0.15	0.24	0.35	1.50	1.25
Evenness (J)	0.16	0.27	0.07	0.12	0.18	0.77	0.64
Temperature (°C)	12	20	15	8	16	20	16
Mean Quarterly Salinity (‰)	27.62	29.49	31.41	20.73	26.44	30.55	30.15

Table 16b. MACROFAUNA SPECIES RECORDED AT MUCKING (SITE 14). 1991.

Values: Abundance = №.Individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 1/91	Quar 2/91	Quar 3/91*	Quar 4/91
OLIGOCHAETA				
Monopylephorus rubroniveus	672.5/0.70	10/0.05	62.5/0.10	15/0.07
Tubificoides benedeni	2.5/0.03	5/0.03	85/0.25	27.5/0.10
POLYCHAETA				
Ampharete acutifrons			15/0.38	
Caulleriella sp.	472.5/1.15	52.5/0.10	1280/1.85	367.5/0.90
Eteone flava	2.5/0.07			
Eteone longa	2.5/0.03		15/0.12	
Nephtys hombergii	120/6.78	2.5/0.12	127.5/4.80	210/4.62
Nereis (Neanthes) succinea	2.5/0.05			
Pygospio elegans			147.5/0.30	17.5/0.07
Scoloplos armiger			12.5/0.10	5/0.03
CRUSTACEA				
Carcinus maenas			2.5/0.03	
Corophium volutator	2.5/0.03		5/0.12	
Diastylis bradyi				2.5/0.03
Mesopodopsis slabberi				2.5/0.03
Ostracoda sp.				5/0.05
UNIRAMIA				
Psychodidae sp.	2.5/0.03			
MOLLUSCA				
Abra ?alba			12.5/0.40	
Ensis sp. (?arcuatus)			5/0.18	
Hydrobia ulvae				7.5/0.03
Macoma balthica	27.5/0.20	2.5/0.15	35/2.42	7.5/0.10
ECHINODERMATA				
Psammechinus miliaris				2.5/0.03
TOTALS	**1307.5/9.07**	**72.5/0.45**	**1805/11.05**	**670/6.06**
Community Statistics				
Total №.Species	10	5	13	12
Mean №.Species/0.1 m²	5.25	1.75	9.50	7.00
Diversity (H'e)	1.08	0.92	1.16	1.24
Evenness (J)	0.47	0.57	0.45	0.50
Temperature (°C)	4.5	11	23	16
Mean Quarterly Salinity (‰)	25.96	26.31	27.80	29.69

* = site moved slightly upstream - original site destroyed by nearby dredging.

Table 17a.

MACROFAUNA SPECIES RECORDED AT BLYTHE SANDS (SITE 15). 1989-1990.

Values: Abundance = №.Individuals/m². Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 2/89	Quar 3/89	Quar 4/89	Quar 1/90	Quar 2/90	Quar 3/90	Quar 4/90
ANTHOZOA							
Sagartia troglodytes			15/1.40				
OLIGOCHAETA							
Monopylephorus rubroniveus			2.5/0.03	2.5/0.03	12.5/0.10		
Tubificoides benedeni	20/0.10	7.5/0.06	5/0.05	10/0.05	2.5/0.03		
POLYCHAETA							
Ampharete acutifrons			2.5/0.25				
Aricidia minuta					5/0.03		
Capitellides giardi					12.5/0.13		
Caulleriella sp.			197.5/0.23	100/0.18	132.5/0.28	10/0.05	5/0.05
Eteone longa			2.5/0.03				
Nephtys hombergii	27.5/1.18	5/0.08	20/1.00	27.5/1.95	17.5/1.10	55/1.18	30/0.65
Nereis (Neanthes) succinea		5/0.05					
Pygospio elegans		10/0.05					
Scoloplos armiger	5/0.13				2.5/0.03		2.5/0.03
CRUSTACEA							
Bathyporeia garsi	382.5/1.25						
Corophium volutator		2.5/0.03		2.5/0.03			
Gammarus salinus			2.5/0.03				
Neomysis integer							2.5/0.03
Porcellana longicornis			2.5/0.10				
MOLLUSCA							
Macoma balthica	5/0.38	5/0.13		2.5/0.08	12.5/0.08	7.5/0.28	2.5/0.03
Petricola pholadiformis		12.5/0.38		2.5/0.10			
TOTALS	**440/3.04**	**47.5/0.78**	**250/3.12**	**147.5/2.42**	**197.5/3.10**	**72.5/1.51**	**42.5/0.79**
Community Statistics							
Total №.Species	5	7	9	7	8	3	5
Mean №.Species/0.1 m²	3.75	3.00	3.25	3.25	5.50	2.25	2.25
Diversity (H'e)	0.53	1.90	0.89	1.03	1.18	0.72	0.97
Evenness (J)	0.33	0.91	0.40	0.53	0.57	0.65	0.60
Temperature (°C)	12	20	15	8	15	20	16
Mean Quarterly Salinity (‰)	27.62	29.49	31.41	20.73	26.44	30.55	21.79

Table 17b. MACROFAUNA SPECIES RECORDED AT BLYTHE SANDS (SITE 15), 1991.

Values: Abundance = N°.Individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 1/91	Quar 2/91	Quar 3/91	Quar 4/91
OLIGOCHAETA				
Monopylephorus rubroniveus	62.5/0.15	47.5/0.10	15/0.03	
Tubificoides benedeni	2.5/0.03		5/0.05	
POLYCHAETA				
Ampharete acutifrons		2.5/0.03		
Arenicola marina			2.5/1.72	
Caulleriella sp.	35/0.18	52.5/0.20	2.5/0.03	
Eteone longa	7.5/0.15	2.5/0.18		
Nephtys hombergii	97.5/4.12	22.5/1.18	60/2.70	32.5/1.33
Scoloplos armiger			2.5/0.23	
CRUSTACEA				
Corophium volutator	2.5/0.03			
Crangon crangon	2.5/3.30			
Diastylis bradyi				2.5/0.03
Mesopodopsis slabberi				2.5/0.03
MOLLUSCA				
Cerastoderma edule			2.5/1.25	
Macoma balthica	10/0.38	12.5/0.33	5/0.05	
TOTALS	**220/8.34**	**140/2.02**	**95/6.06**	**37.5/1.39**

Community Statistics

Total N°.Species	8	6	8	3
Mean N°.Species/0.1 m²	4.75	4.25	3.25	1.50
Diversity (H'e)	1.42	1.39	1.27	0.49
Evenness (J)	0.68	0.78	0.61	0.45
Temperature (°C)	4.5	11	23	16
Mean Quarterly Salinity (‰)	25.96	26.31	27.80	29.69

Table 10a.

[redacted]OFAUNAL SPECIES RECORDED AT [redacted]EY B[redacted] (SITE 16), 1989-1990.

Values: Abundance = №.Individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 2/89	Quar 3/89	Quar 4/89	Quar 1/90	Quar 2/90	Quar 3/90	Quar 4/90
OLIGOCHAETA							
Monopylephorus rubroniveus	2/0.02		66/0.10	150/0.14		42.5/0.10	65/0.13
Tubificoides benedeni	24/0.04	12/0.08	2/0.02	36/0.08	2.5/0.03	7.5/0.03	12.5/0.08
POLYCHAETA							
Ampharete acutifrons				2/0.02			
Capitellides giardi	6/0.02				10/0.05		
Caulleriella sp.	4/0.02		244/0.46	108/0.18	7.5/0.08	37.5/0.13	42.5/0.18
Eteone longa	2/0.02						2.5/0.05
Lagis koreni		2/0.16			5/0.05		
Nephtys caeca		2/0.02					
Nephtys hombergii	82/1.72	166/2.52	302/5.78	162/3.46	137.5/2.58	535/10.48	425/9.40
Nereis (Neanthes) diversicolor	4/0.42	4/0.02	2/0.02				
Nereis longissima				2/0.38	2.5/0.58		
Nereis (Neanthes) succinea					2.5/0.10	2.5/0.40	
Pygospio elegans			4/0.12	4/0.04		25/0.10	37.5/0.18
Scoloplos armiger	46/0.54				5/0.05	2.5/0.03	
CRUSTACEA							
Atylus guttatus					2.5/0.03		
Caprella linearis					2.5/0.03		
Carcinus maenas		8/1.24			25/1.55		2.5/0.28
Corophium volutator			2/0.02			7.5/0.05	
Crangon crangon		8/0.22			17.5/2.95		
Gammarus locusta		10/0.04			12.5/0.18		
Gammarus salinus					5/0.03		
Gnathiidae (?Paragnathia)				2/0.02			
Palaemon longirostris		4/0.24	2/0.96				
Pinnotheres pisum						2.5/0.13	
Porcellana longicornis					17.5/0.10		
Sarsiella zostericola					2.5/0.03		
MOLLUSCA							
Abra alba					5/0.13		2.5/0.20
Cerastoderma edule		10/32.13		4/6.51	10/0.08		
Crepidula fornicata		14/0.30				47.5/9.55	
Ensis sp. (?arcuatus)					7.5/0.15		
Hydrobia ulvae				6/0.02			22.5/0.10
Littorina littorea						2.5/1.28	
Macoma balthica	6/0.12	16/0.52	6/0.20	22/0.18	180/0.43	52.5/0.18	40/0.23
Mactra corallina						2.5/0.08	
Mytilus edulis		6/27.86		2/12.51		5/24.90	
Scrobicularia plana			2/0.20	4/0.26	7.5/0.03	12.5/0.13	
TOTALS	**178/2.96**	**262/65.35**	**632/7.88**	**504/23.80**	**467.5/9.24**	**785/47.57**	**652.5/10.83**
Community Statistics							
Total №.Species	9	13	10	13	21	15	10
Mean №.Species/0.1 m²	6.50	7.50	5.25	7.25	10.50	7.25	7.50
Diversity (H'e)	1.50	1.45	1.12	1.60	1.96	1.30	1.27
Evenness (J)	0.65	0.57	0.49	0.63	0.64	0.48	0.55
Temperature (°C)	8	24	10	8	25	16	17
Mean Quarterly Salinity (‰)	29.09	32.09	32.95	25.96	29.21	32.34	----

Table 18b. MACROFAUNA SPECIES RECORDED AT CANVEY BEACH (SITE 16). 1991.

Values: Abundance = №.Individuals/m². Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 1/91	Quar 2/91	Quar 3/91	Quar 4/91
ANTHOZOA				
Sagartia troglodytes	2.5/1.03		2.5/0.03	
OLIGOCHAETA				
Monopylephorus rubroniveus	10/0.03	20/0.05	12.5/0.07	110/0.10
Tubifex costatus			5/0.05	
Tubificoides benedeni	5/0.05		2.5/0.03	
POLYCHAETA				
Ampharete acutifrons		15/0.18		
Capitellides giardi	2.5/0.03	10/0.05	5/0.03	
Caulleriella sp.	5/0.03		20/0.07	12.5/0.05
?Chaetozone setosa				10/0.07
Eteone longa		12.5/0.38		
Eulalia bilineata		2.5/0.03		
Nephtys caeca		32.5/0.23		
Nephtys hombergii	300/7.08	247.5/13.03	385/8.45	482.5/9.53
Pygospio elegans	10/0.08	15/0.12	10/0.10	42.5/0.15
Scoloplos armiger	10/0.05	22.5/0.38	7.5/0.10	2.5/0.03
Websternereis glauca		2.5/0.03		
HIRUDINEA				
Glossiphoniidae sp.				2.5/0.03
CRUSTACEA				
Atylus guttatus		2.5/0.03	2.5/0.03	
Carcinus maenas	2.5/0.25	2.5/3.02	5/0.15	
Corophium insidiosum	5/0.05			
Crangon crangon		15/1.12	2.5/0.10	
Gammarus salinus	2.5/0.03		2.5/0.03	
Palaemon longirostris			2.5/0.20	
Sphaeroma monodi			2.5/0.03	
PYCNOGONIDA				
Nymphon rubrum	5/0.05			
MOLLUSCA				
Abra alba	87.5/0.33	70/0.48	2.5/0.07	
Abra sp.(?nitida)				2.5/0.10
Cerastoderma edule	2.5/14.55	5/0.05		2.5/0.03
Crepidula fornicata	27.5/7.90		2.5/0.03	
Ensis sp.		5/0.25		
Hydrobia ulvae		7.5/0.05	27.5/0.07	
Macoma balthica	47.5/0.23	132.5/1.33	22.5/0.30	40/0.33
Modiolus ?phaseolinus	2.5/0.03			
Mytilus edulis	7.5/40.85			
Scrobicularia plana	5/0.18			
TOTALS	**540/72.83**	**627.5/20.88**	**522.5/9.94**	**715/10.45**
Community Statistics				
Total №.Species	19	19	19	11
Mean №.Species/0.1 m²	8.75	12.50	8.50	6.50
Diversity (H'e)	1.63	2.01	1.21	1.14
Evenness (J)	0.55	0.68	0.41	.48
Temperature (°C)	7	16	18	10
Mean Quarterly Salinity (‰)	27.36	28.34	30.24	31.61

Table 19a.

MACROFAUNA SPECIES RECORDED AT ALLHALLOWS (SITE 17). 1989-1990.

Values: Abundance = N.individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 2/89	Quar 3/89*	Quar 4/89	Quar 1/90	Quar 2/90	Quar 3/90	Quar 4/90
ANTHOZOA							
Sagartia troglodytes		5.3/1.36					
OLIGOCHAETA							
Monopylephorus rubroniveus	168/0.50						
Naididae spp.							
Tubificoides benedeni	4796/14.40	3413.3/9.89	1534/3.68	3200/9.26	8232/14.80	2847.5/9.55	2760/6.10
POLYCHAETA							
Ampharete acutifrons	162/3.82	24/0.69	2/0.14		40/0.86	2.5/0.15	
Arenicola marina	78/4.38	45.3/4.53	6/0.46	4/0.12			
Capitellides giardi	36/0.62	29.3/0.13	42/0.38	18/0.08	28/0.12	52.5/0.18	10/0.08
Caulleriella sp.	1418/5.66	1496/8.27	4824/20.26	1022/3.56	652/1.88	925/2.18	4632.5/5.58
Eteone longa	6/0.08	16/0.11		20/0.16	8/0.04		
Lanice conchilega			2/0.02			2.5/0.10	
Lepidonotus squamatus					2/0.02		
Nereis (Neanthes) diversicolor	62/1.64	93.3/3.44	40/1.34		10/0.10		
Nereis (Neanthes) succinea							2.5/0.68
Nephtys hombergii	58/13.92	66.7/7.17	112/9.24	82/7.58	92/15.66	347.5/15.13	277.5/10.30
Pygospio elegans				4/0.02	68/0.32	12.5/0.08	
Sthenelais boa						2.5/0.53	
HIRUDINEA							
Erpobdellidae sp.						2.5/0.03	
Helobdella stagnalis							2.5/0.03
CRUSTACEA							
Carcinus maenas	8/3.44	32/3.04	4/0.24		4/5.88	7.5/1.28	2.5/0.43
Corophium volutator	32/0.38	5.3/0.05	4/0.06	8/0.04	32/0.12	2.5/0.03	2.5/0.03
Corystes cassivelaunus					4/0.06		
Crangon crangon	2/0.10	8/0.77	14/1.46		2/0.02		2.5/0.20
Cyanthura carinata		2.7/0.03			4/0.04		
Gammarus salinus		2.7/0.03	2/0.02				
Melita palmata					4/0.04		2.5/0.03
Palaemon elegans				2/0.42			
Palaemon longirostris						2.5/0.08	
DIPTERA							
Chironomidae sp.							5/0.05
CHILOPODA							
Strigamia maritima							2.5/0.05
MOLLUSCA							
Cerastoderma edule	6/8.07		2/0.92		38/26.56	5/6.30	15/18.68
Hydrobia ulvae				48/0.08	60/0.16	170/0.20	167.5/0.25
Littorina littorea	34/11.30	2.7/0.97	8/5.10	2/1.09	12/2.04	10/2.60	5/1.75
Macoma balthica	124/16.19	226.7/47.13	138/28.58	174/14.09	764/16.26	292.5/11.50	60/11.65
Mya arenaria	2/0.96						
Mytilus edulis	20/43.66	5.3/7.35	24/38.99	4/7.68	4/9.52		
Scrobicularia plana	42/2.12	32/5.52	8/2.41	10/0.79	214/2.84	45/2.23	35/5.90
TOTALS	7054/130.24	5506.6/100.48	6766/113.30	4598/44.97	10274/97.34	4730/52.15	7985/61.79
Community Statistics							
Total N.Species	18	18	17	14	21	17	17
Mean N.Species/0.1 m²	13.00	13.00	10.25	9.25	14.50	10.50	9.25
Diversity (H'e)	1.14	1.13	0.90	0.93	0.87	1.31	1.05
Evenness (J)	0.39	0.39	0.32	0.35	0.29	0.46	0.37
Temperature (°C)	17	23	14	8	16	29	12
Mean Quarterly Salinity (‰)	29.09	32.09	32.95	25.96			

* = based on 3 subsamples only

Table 19b. MACROFAUNA SPECIES RECORDED AT ALLHALLOWS (SITE 17), 1991.

Values: Abundance = №.Individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 1/91	Quar 2/91	Quar 3/91	Quar 4/91
OLIGOCHAETA				
Naididae spp.	10/0.05			
Tubificoides benedeni	2875/7.78	1962.5/10.18	1450/4.35	1875/3.85
POLYCHAETA				
Amphicte acutifrons		75/0.85	10/0.28	
Anaitides mucosa			2.5/0.03	2.5/0.03
Arenicola marina			2.5/0.05	
?Capitellides giardi	67.5/0.20	57.5/0.25	52.5/0.25	37.5/0.12
Caulleriella sp.	5250/11.75	455/0.88	172.5/0.40	1050/2.63
Eteone longa	2.5/0.03	12.5/0.07		27.5/0.20
Lanice conchilega			2.5/0.05	
Nereis (Neanthes) diversicolor		2.5/0.03		2.5/0.05
Nephtys hombergii	160/8.23	130/11.15	412.5/12.40	150/6.60
Pygospio elegans		20/0.10	35/0.12	45/0.15
CRUSTACEA				
Carcinus maenas		5/1.85	5/0.25	2.5/0.75
Corophium volutator	5/0.03	5/0.18	7.5/0.10	
Crangon crangon	2.5/0.15		7.5/0.45	
Gammarus salinus	5/0.03			
Melita palmata		2.5/0.07		2.5/0.03
Neomysis integer			2.5/0.03	
MOLLUSCA				
Abra alba			2.5/0.05	
Abra ?nitida				2.5/0.05
Cerastoderma edule	12.5/5.98	37.5/43.67	12.5/13.75	7.5/4.33
Hydrobia ulvae	255/0.25	17.5/0.05	75/0.18	1062.5/1.10
Littorina littorea			2.5/1.00	
Macoma balthica	90/8.10	167.5/9.98	385/17.00	325/13.78
Mytilus edulis	2.5/2.35			
Retusa obtusa			2.5/0.03	
Scrobicularia plana	20/1.13	12.5/2.52	52.5/4.30	12.5/0.62
TOTALS	**8757.5/46.06**	**2962.5/81.83**	**2695/55.07**	**4605/34.28**
Community Statistics				
Total №.Species	14	15	20	15
Mean №.Species/0.1 m²	9.25	10.75	12.50	10.50
Diversity (H'e)	1.02	1.23	1.52	1.50
Evenness (J)	0.39	0.45	0.51	0.55
Temperature (°C)	6	15	24	6
Mean Quarterly Salinity (‰)	27.36	28.34	30.24	31.61

Table 20a.

MACROFAUNA SPECIES RECORDED AT CHAPMAN BUOY (SITE 18). 1989-1990.

Values: Abundance = №.Individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 2/89	Quar 3/89	Quar 4/89*	Quar 1/90	Quar 2/90	Quar 3/90	Quar 4/90
ANTHOZOA							
Sagartia troglodytes	5/2.10	120/61.98	313.3/98.90	362.5/114.90	242.5/61.93	195/77.20	222.5/54.53
OLIGOCHAETA							
Monopylephorus rubroniveus	7.5/0.08					12.5/0.08	7.5/0.05
Tubificoides benedeni	22.5/0.08	20/0.08	30/0.07	32.5/0.10	7.5/0.05	150/0.33	40/0.13
POLYCHAETA							
Ampharete acutifrons	240/3.23	92.5/5.45	13.3/2.40	5/0.45	15/0.43	7.5/0.35	12.5/0.51
Anaitides maculata		17.5/0.10				5/0.05	2.5/0.03
Anaitides mucosa		20/0.15	10/0.10			12.5/0.20	5/0.08
Aricidia minuta			75/0.13 ->	12.5/0.03 ->			
Autolytus sp.					2.5/0.03		2.5/0.03
?Capitellides giardi	5/0.05	40/0.10	6.7/0.07	5/0.20	52.5/0.25	242.5/0.60	115/0.25
Caulleriella sp.		2.5/0.03	110/0.27	60/0.13		5/0.05	5/0.03
Eteone longa	10/0.08	5/0.05	3.3/0.03	5/0.05			
Eulalia bilineata	97.5/2.38				12.5/0.10		27.5/0.13
Gattyana cirrhosa			10/1.37	27.5/4.85			2.5/0.08
Glycera convoluta		2.5/0.13	80/2.33	85/1.55	65/0.73	90/1.53	92.5/0.83
Lagis koreni		47.5/0.70	23.3/4.27			17.5/1.37	
Lanice conchilega		40/0.58	6.7/1.13			65/6.23	22.5/1.43
Lepidonotus squamatus		22.5/0.15	6.7/0.37	15/0.23	10/0.38	15/1.73	12.5/0.15
Mysta picta	2.5/0.08	2.5/0.08	3.3/0.13	2.5/0.03			2.5/0.03
Neoamphitrite figulus	32.5/2.01		13.3/7.30				
Nereis (Neanthes) diversicolor	67.5/2.95						
Nereis longissima	2.5/0.03	92.5/2.55	13.3/1.53	7.5/1.88	20/0.55	15/4.90	
Nereis (Neanthes) succinea			6.7/0.67				
Nephtys caeca		45/1.10	6.7/5.13		12.5/1.78	15/1.05	15/1.20
Nephtys hombergii	90/2.80	2.5/0.03					
Notomastus latericeus			3.3/0.07		10/0.53		5/0.08
Ophelia ?neglecta							5/0.13
Pholoë synophthalmica	12.5/1.83			5/0.93			5/0.10
Pomatoceros triqueter				5/0.10	7.5/0.05	7.5/0.05	
Pygospio elegans	5/0.05				85/0.40		2.5/0.03
Sabella pavonina			30/53.20	42.5/90.20	2.5/0.28	265/58.38	5/1.95
Sabellaria spinulosa		15/0.25			2.5/0.03	2.5/0.03	17.5/0.40
Scoloplos armiger	115/1.70	120/2.25	23.3/0.83	17.5/0.33	42.5/1.03	12.5/0.10	25/0.60
Sthenelais boa			10/0.43	7.5/0.95	2.5/0.03		10/0.18
Websternereis glauca				5/0.05		2.5/0.03	

Table 20a. cont...

Species	Quar 2/89	Quar 3/89	Quar 4/89*	Quar 1/90	Quar 2/90	Quar 3/90	Quar 4/90
HIRUDINEA							
?Oceanobdella blennii						2.5/0.03	
SIPUNCULOIDEA							
Golfingia ?margaritaceum			3.3/0.80				
CRUSTACEA							
Atylus guttatus	5/0.05					15/0.08	2.5/0.03
Bathyporeia elegans				2.5/0.03			
Cancer pagurus						2.5/0.15	
Carcinus maenas	15/69.40		30/71.33	10/0.68	7.5/3.33	10/11.25	10/0.58
Corophium arenarium		2.5/0.03	3.3/0.03			2.5/0.03	
Crangon crangon		2.5/0.20					2.5/2.10
Gammarus salinus			6.7/0.07				
Macropodia rostrata						5/0.35	
Neomysis integer						2.5/0.03	
Pagurus bernhardus				2.5/0.40			
Porcellana longicornis	10/0.50						
PYCNOGONIDA							
Nymphon rubrum						2.5/0.03	7.5/0.10
Pycnogonum littorale	7.5/0.60	2.5/0.20			2.5/0.03		
MOLLUSCA							
Abra alba		15/0.63	10/0.40	22.5/1.65	12.5/0.45	2.5/0.30	7.5/0.30
Cerastoderma edule	30/75.08						
Crepidula fornicata	1127.5/822.80	72.5/144.60		7.5/10.20		10/1.73	5/0.13
Gibbula umbilicalis							5/0.30
Lepidopleurus asellus	2.5/0.08						
Macoma balthica		5/0.05		5/0.05	5/0.08		
Mytilus edulis	37.5/95.40				2.5/15.35		
Nucula turgida	5/0.79		3.3/0.07	5/0.75	2.5/0.03	2.5/0.05	
Onchidoriidae sp.						2.5/0.35	2.5/0.43
Petricola pholadiformis		7.5/0.25				20/2.68	
Tellina fabula	37.5/0.80						
ECHINODERMATA							
Amphipholis squamata					2.5/0.05	2.5/0.08	
Ophiura ophiura							5/0.10
TOTALS	**1992.5/1085.12**	**815/221.72**	**779.8/253.30**	**820/230.82**	**645/96.80**	**1220/171.40**	**717.5/67.11**
Community Statistics							
Total №.Species	25	25	27	25	26	33	35
Mean №.Species/0.1 m²	17.75	15.50	17.67	15.50	15.25	18.25	19.00
Diversity (H'e)	1.87	2.71	2.33	2.16	2.42	2.34	2.49
Evenness (J)	0.57	0.82	0.69	0.66	0.73	0.67	0.70
Temperature (°C)	12	20	15	8	15	20	16
Mean Quarterly Salinity (‰)	29.09	32.09	32.96	25.96	29.21	32.33	31.06

* = based on 3 subsamples only.

Table 20b. MACROFAUNA SPECIES RECORDED AT CHAPMAN BUOY (SITE 18), 1991.

Values: Abundance = N°.Individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 1/91	Quar 2/91	Quar 3/91	Quar 4/91
HYDROZOA				
Tubularia indivisa		17.5/0.28		
ANTHOZOA				
Sagartia troglodytes	320/53.50	240/64.90	225/58.45	227.5/67.93
OLIGOCHAETA				
Monopylephorus rubroniveus	10/0.03	17.5/0.07	7.5/0.05	2.5/0.03
Psammoryctides barbatus	2.5/0.03			
Tubificoides benedeni	42.5/0.10	5/0.03	2.5/0.03	37.5/0.13
Tubificoides pseudogaster		2.5/0.03		
POLYCHAETA				
Ampharete acutifrons		65/0.72	37.5/1.72	12.5/0.68
Anaitides mucosa			5/0.10	35/0.25
?Antinoella finmarchia			10/0.35	
Aphrodite aculeata				2.5/37.05
Aricidia ?minuta		2.5/0.03		2.5/0.03
Autolytus sp.	5/0.05	37.5/0.12	7.5/0.05	
?Capitellides giardi	40/0.23	32.5/0.10	42.5/0.20	182.5/0.35
Caulleriella sp.	15/0.08			
Chaetozone setosa	2.5/0.03			7.5/0.15
Eteone flava	2.5/0.05			
Eteone longa	5/0.05	2.5/0.03	2.5/0.03	5/0.05
Eulalia bilineata	5/0.05	5/0.03	15/0.12	5/0.05
Eumida sanguinea	5/0.05			7.5/0.03
Gattyana cirrhosa			40/2.17	10/0.10
Glycera convoluta	47.5/0.33	70/0.55	35/0.60	87.5/1.45
Harmathoë sp.				2.5/0.03
Lagis koreni				2.5/1.12
Lanice conchilega			247.5/7.28	37.5/1.25
Lepidonotus squamatus	15/1.28	22.5/0.50	5/0.07	7.5/0.07
Myxta picta	7.5/0.05	2.5/0.03		
Neoamphitrite figulus	2.5/0.10	2.5/2.10	7.5/10.72	7.5/6.42
Nephtys caeca	5/0.53	10/1.65	27.5/0.70	17.5/0.45
Nephtys hombergii				15/1.28
Nereis longissima	2.5/0.18	7.5/0.83		5/2.13
Notomastus latericeus		2.5/0.05	10/0.35	32.5/2.73
Pholoë ?minuta				2.5/0.03
Pholoë synophthalmica	20/0.15	27.5/0.20	12.5/0.12	12.5/0.07
Pomatoceros triqueter	22.5/0.13	2.5/0.03	7.5/0.15	2.5/0.03
Pygospio elegans	7.5/0.08			
Sabella pavonina	2.5/0.20	5/1.18		52.5/36.25
Sabellaria spinulosa		37.5/0.33	47.5/0.80	227.5/2.88
Scoloplos armiger	2.5/0.03	20/0.23	45/0.45	65/1.73
Sthenelais boa	12.5/0.80		5/0.10	
Syllidae sp.1		10/0.05		2.5/0.03
Syllis gracilis		5/0.05		5/0.03
HIRUDINEA				
Erpobdellidae sp.			2.5/0.05	
UNIRAMIA				
Chironomidae sp.		2.5/0.03		
CRUSTACEA				
Atylus guttatus			7.5/0.15	10/0.13
Bodotria scorpioides		2.5/0.03	2.5/0.03	
Caprella linearis		7.5/0.05	192.5/1.07	7.5/0.05
Carcinus maenas	15/43.78	5/81.08	2.5/0.10	7.5/0.95
Chaetogammarus ?stoerensis				5/0.03
Corophium acherusicum	2.5/0.03		2.5/0.03	
Corophium arenarium			5/0.05	
Crangon crangon			2.5/1.05	
Gammarus salinus	2.5/0.03		5/0.05	
Hippolyte variana			2.5/0.05	

Table 20b. cont.

Species	Quar 1/91	Quar 2/91	Quar 3/91	Quar 4/91
CRUSTACEA cont.				
Hyas arenarius			5/0.45	
Liocarcinus sp.			5/0.05	
Macropodia rostrata			5/0.28	
Palaemon serratus			5/2.17	
Pagurus ?pubescens			2.5/0.07	
Porcellana longicornis			5/0.12	
Sphaeroma monodi				5/0.15
Stenothoë marina			7.5/0.05	7.5/0.07
PYCNOGONIDA				
Achelia echinata			5/0.05	2.5/0.03
Nymphon rubrum	2.5/0.03	82.5/0.28	50/0.25	7.5/0.05
Pycnogonum littorale	5/0.55	2.5/0.28		5/0.68
MOLLUSCA				
Abra alba	7.5/0.28	22.5/1.25	2.5/0.28	25/0.13
Barnea candida		90/4.92		22.5/5.38
Crepidula fornicata	2.5/0.08		2.5/0.53	10/7.08
Donax vittatus			2.5/0.03	
Gibbula umbilicalis	2.5/0.25	5/0.53	5/1.47	5/0.63
Macoma balthica		2.5/0.03		
Modiolus ?phaseolinus	2.5/0.03			
Moerella pygmaea				10/0.05
Mysella bidentata	2.5/0.05			5/0.03
Mytilus edulis				2.5/11.15
Nucula turgida			2.5/0.05	2.5/0.13
Petricola pholadiformis	117.5/2.78	17.5/0.45	2.5/0.15	2.5/1.40
ECHINODERMATA				
Amphipholis squamata				22.5/0.37
Asterias rubens			5/37.62	2.5/11.57
TOTALS	**765/106.00**	**892.5/163.05**	**1182.5/130.86**	**1301.5/205.04**

Community Statistics				
Total N.Species	35	36	48	51
Mean N.Species/0.1 m²	17.50	18.50	25.50	25.25
Diversity (H'e)	2.29	2.73	2.73	2.92
Evenness (J)	0.64	0.76	0.70	0.74
Temperature (°C)	4	10	22	16
Mean Quarterly Salinity (‰)	27.36	28.34	30.24	31.61

Table 21a.

MACROFAUNA SPECIES RECORDED AT SOUTHEND INTERTIDAL (SITE 19i), 1989-1990.

Values: Abundance = N.Individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 2/89*	Quar 3/89	Quar 4/89	Quar 1/90	Quar 2/90	Quar 3/90	Quar 4/90
ANTHOZOA							
Cereus pedunculatus		2/0.24					
NEMERTEA							
Nemertea sp.					2.5/0.05		
OLIGOCHAETA							
Monopylephorus rubroniveus				4/0.04	45/0.13	37.5/0.08	145/0.23
Tubificoides benedeni	1752/1.72	10/0.06	14/0.06	1428/3.24	195/0.40	5/0.03	2.5/0.03
Tubificoides pseudogaster	60/0.08						
POLYCHAETA							
Amphicteis gunneri	112/0.40	14/0.60			7.5/0.10		
Anaitides mucosa			6/0.08		5/0.05		10/0.10
Arenicola marina				10/3.64			
Capitellides giardi			46/0.18	140/1.02	25/0.18		10/0.10
Caulleriella sp.	16/64	1770/7.14	4850/19.40	6082/7.18	960/1.68	325/0.45	3110/9.63
Eulalia bilineata			14/0.16				2.5/0.03
Eteone longa	8/0.04	8/0.10	8/0.06	8/0.22			25/0.23
Lanice conchilega		4/0.04	8/0.64		10/0.48	2.5/0.05	
Lepidonotus squamatus					2.5/0.03		
Nephtys hombergii	116/9.68	70/6.16	146/11.10	40/11.98	145/17.90	242.5/11.88	262.5/16.10
Neoamphitrite figulus					2.5/0.03		
Nereis (Neanthes) diversicolor	12/2.36	16/0.08		48/1.30	2.5/2.53	42.5/0.88	7.5/0.05
Nereis (Neanthes) succinea			10/0.12				
Pygospio elegans	76/0.12	6/0.06	4/0.04	14/0.08	65/0.28	37.5/0.10	52.5/0.15
Scoloplos armiger	4/0.04	120/1.62	14/0.14	2/0.04	2.5/0.05	2.5/0.03	2.5/0.03
RHYNCHOCOELA							
Theromyzon tessulatum							2.5/0.05
CRUSTACEA							
Carcinus maenas		12/0.28	8/0.20		2.5/0.03	5/0.05	2.5/0.68
Corophium arenarium	36/0.44	26/0.24	18/0.08		10/0.08	15/0.05	10/0.05
Crangon crangon		14/0.24	4/0.18		7.5/0.68	7.5/0.60	
Gammarus locusta					20/0.13		2.5/0.03
Melita palmata			16/0.04		2.5/0.03		
Microprotopus maculatus			4/0.02				
Neomysis integer						2.5/0.05	
Urothoe poseidonia			2/0.02				
MOLLUSCA							
Cerastoderma edule	12/0.84	2/0.40	12/23.21	4/4.74	27.5/27.45	7.5/16.43	72.5/65.48
Crepidula fornicata			2/0.14				
Hydrobia ulvae			2/0.02	2/0.02		7.5/0.05	22.5/0.08
Littorina littorea		2/0.90	2/0.64			2.5/0.63	
Macoma balthica	68/6.55	246/6.88	42/7.22	72/3.24	25/0.53	30/0.40	37.5/1.20
Nucula turgida				6/0.06		2.5/0.03	
Scrobicularia plana			2/0.04	38/1.36			
Tellina fabula							2.5/0.05
TOTALS	2320/20.07	2322/25.22	5234/63.79	7898/38.16	1565/52.82	775/31.79	3782.5/94.30
Community Statistics							
Total N.Species	12	16	23	15	21	17	19
Mean N.Species/0.1 m²	12.00	11.00	13.25	11.50	12.00	9.75	12.00
Diversity (H'e)	1.06	0.83	0.49	0.79	1.50	1.73	0.85
Evenness (J)	0.43	0.29	0.16	0.29	0.49	0.61	0.29
Temperature (°C)	8	23	11	11	20	24	8

* = 2 subsamples only

Table 21b. MACROFAUNA SPECIES RECORDED AT SOUTHEND INTERTIDAL (SITE 191). 1991.

Values: Abundance = №.Individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 1/91	Quar 2/91	Quar 3/91	Quar 4/91
OLIGOCHAETA				
Monopylephorus rubroniveus	130/0.20	200/0.30	25/0.07	92.5/0.10
Tubificoides benedeni	27.5/0.10	22.5/0.10	7.5/0.05	10/0.07
Tubificoides pseudogaster		10/0.05		
POLYCHAETA				
Amphicte agilis	10/0.10	67.5/1.02	5/0.10	
Anaitides mucosa				7.5/0.10
Arenicola marina	12.5/0.12			
Capitellides giardi	15/0.20	5/0.05	2.5/0.03	
Caulleriella sp.	1475/3.28	142.5/0.25	85/0.23	187.5/0.20
Chaetozone setosa				42.5/0.13
Eteone longa	25/0.30	130/0.78	15/0.07	110/0.93
Nephtys hombergii	210/8.40	107.5/9.83	142.5/7.85	262.5/10.80
Nereis (Neanthes) diversicolor	20/0.25			2.5/0.03
Pygospio elegans	32.5/0.15	397.5/2.30	87.5/0.20	115/0.25
Scoloplos armiger	5/0.05			12.5/0.38
CRUSTACEA				
Carcinus maenas	2.5/8.88		5/0.05	5/0.27
Corophium arenarium	7.5/0.05	12.5/0.10	15/0.10	10/0.05
Crangon crangon		2.5/0.03	20/0.28	
Cumopsis goodsiri				7.5/0.03
Gammarus locusta	2.5/0.07			
Gammarus salinus		2.5/0.03	2.5/0.03	
Sphaeroma monodi			5/0.03	
MOLLUSCA				
Cerastoderma edule	47.5/0.55	22.5/4.48	10/15.43	60/27.45
Ensis sp.				2.5/0.20
Hydrobia ulvae		12.5/0.05		50/0.10
Macoma balthica	52.5/0.85	87.5/1.18	37.5/0.15	52.5/0.55
Scrobicularia plana	5/0.07	7.5/0.07		
Unidentified sp. (?Gari sp.)				2.5/0.03
TOTALS	**2080/23.52**	**1230/20.62**	**465/24.67**	**1032.5/41.67**

Community Statistics

Total №.Species	17	16	15	18
Mean №.Species/0.1 m²	14.00	11.75	9.50	12.75
Diversity (H'e)	1.21	2.07	2.06	2.24
Evenness (J)	0.43	0.75	0.76	0.77
Temperature (°C)	10	14	18	11

Table 21c.

MACROFAUNA SPECIES RECORDED AT SOUTHEND SUBTIDAL (SITE 191), 1989-1990.

Values: Abundance = N.Individuals/m². Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 2/89	Quar 1/89*	Quar 4/89	Quar 1/90	Quar 2/90	Quar 3/90	Quar 4/90
ANTHOZOA							
Sagartia troglodytes			20/0.93		5/2.38	35/4.90	
NEMERTEA							
Cephalothrix rufifrons		3.3/0.07					
Lineus sp.						2.5/0.05	
OLIGOCHAETA							
Monopylephorus rubroniveus	2.5/0.03	3.3/0.03		12.5/0.05			2.5/0.03
Tubificoides benedeni				2.5/0.03	2.5/0.03	2.5/0.03	
POLYCHAETA							
Aricidia minuta	232.5/0.13	36.7/0.10	87.5/0.18	85/0.10	50/0.13	17.5/0.10	35/0.10
Capitellides giardi		33.3/0.17	2.5/0.03		2.5/0.03		
Caulleriella sp.	7.5/0.05		12.5/0.13	10/0.05	5/0.05		2.5/0.03
Chaetozone setosa						2.5/0.03	2.5/0.03
Eteone longa		10/0.07			7.5/0.10	10/0.08	10/0.10
Glycera convoluta	2.5/0.03	10/0.07	20/0.38	7.5/0.45	10/0.13	2.5/0.03	
Magelona mirabilis			5/0.08	5/0.05	5/0.05	20/0.10	10/0.08
Malacoceros fuliginosus			2.5/0.05				
Neoamphitrite figulus	2.5/0.03		2.5/0.35			2.5/0.10	
Nephtys hombergii	57.5/4.93	86.7/1.63	37.5/4.60	50/12.18	32.5/6.75	172.5/4.43	65/4.00
Pomatoceros triqueter					2.5/0.03		
Pygospio elegans		3.3/0.03	22.5/0.23	40/0.23		42.5/0.15	85/0.68
Scoloplos armiger	37.5/0.73		5/0.18	30/0.28	2.5/0.05	5/0.10	10/0.05
SIPUNCULOIDEA							
?Golfingia sp.						5/0.13	
CRUSTACEA							
Atylus falcatus							2.5/0.03
Atylus guttatus		16.7/0.10				2.5/0.03	
Bathyporeia elegans	27.5/0.10	6.7/0.07	15/0.13	22.5/0.08		7.5/0.03	5/0.05
Bathyporeia guilliamsoniana				2.5/0.03			
Caprella linearis	22.5/0.13	256.7/2.07					
Carcinus maenas			3.3/0.03				
Crangon crangon		6.7/0.17	2.5/0.03				
Diastylis bradyi		13.3/0.30	12.5/0.10		5/0.05	2.5/0.03	2.5/0.03
Gammaridae sp.						2.5/0.03	
Melita obtusata			2.5/0.03				
Microprotopus maculatus	2.5/0.03						
Pagurus bernhardus			2.5/0.03				2.5/1.11
Periculoides longimanus	15/0.10	26.7/0.10			2.5/0.03		5/0.03
Sphaeroma monodi						2.5/0.03	
Stenothoë marina	5/0.03	40/0.10					
PYCNOGONIDA							
Nymphon rubrum		3.3/0.07				5/0.08	2.5/0.03
MOLLUSCA							
Abra alba				2.5/0.05	7.5/0.08		2.5/0.30
Cerastoderma edule		3.3/0.07					
Macoma balthica	2.5/0.08	10/0.23	7.5/0.23	12.5/0.15	20/0.85	17.5/0.23	10/0.23
Modiolus ?phaseolinus						2.5/0.08	
Retusa obtusa				5/0.05			
Tellina fabula	12.5/1.68	6.7/0.07	7.5/0.28	27.5/2.35	12.5/0.45	27.5/0.33	27.5/0.33
TOTALS	**430/8.08**	**580/5.55**	**267.5/7.97**	**315/16.13**	**180/11.22**	**390/11.10**	**282.5/7.24**
Community Statistics							
Total N.Species	14	20	18	15	17	22	18
Mean N.Species/0.1 m²	8.25	11.00	9.75	9.50	8.50	11.00	9.25
Diversity (H'e)	1.67	2.13	2.30	2.20	2.26	2.05	2.12
Evenness (J)	0.62	0.69	0.78	0.81	0.80	0.66	0.73
Temperature (°C)	12	20	15	8	15	19	16

* = based on 3 subsamples only

Table 21d. MACROFAUNA SPECIES RECORDED AT SOUTHEND SUBTIDAL (SITE 19s). 1991.

Values: Abundance = N.Individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 1/91	Quar 2/91	Quar 3/91	Quar 4/91
ANTHOZOA				
Sagartia troglodytes			65/8.82	22.5/2.33
OLIGOCHAETA				
Oligochaete sp.				5/0.03
Tubificoides benedeni		2.5/0.03	2.5/0.03	
POLYCHAETA				
Anaitides mucosa			7.5/0.03	2.5/0.03
Aricidia minuta	15/0.08	22.5/0.10	10/0.05	5/0.03
Autolytus ?prolifera			22.5/0.12	
Chaetozone setosa				2.5/0.03
Eteone longa	2.5/0.03			
Eulalia bilineata			10/0.05	15/0.10
Eumida sanguinea				2.5/0.03
Glycera convoluta			5/0.62	15/0.17
Lanice conchilega			17.5/0.18	
Magelona mirabilis	7.5/0.10			2.5/0.03
Malacoceros fuliginosus		5/0.05		7.5/0.03
Nephtys caeca				2.5/0.15
Nephtys hombergii	42.5/5.03	72.5/6.58	140/3.67	57.5/4.90
Pholoë synophthalmica				2.5/0.03
Pygospio elegans	37.5/0.25	7.5/0.05		5/0.05
Sabellaria spinulosa			2.5/0.07	
Scoloplos armiger		12.5/0.10	12.5/0.07	30/0.17
Syllidae sp.			7.5/0.03	10/0.05
Syllis sp.				7.5/0.05
HIRUDINEA				
Helobdella stagnalis	2.5/0.03			
?Oceanobdella blennii		2.5/0.03	2.5/0.03	
CRUSTACEA				
Atelecyclus rotundus				2.5/0.05
Atylus falcatus	2.5/0.03		2.5/0.03	
Atylus guttatus			15/0.10	2.5/0.03
Bathyporeia elegans		12.5/0.03	10/0.03	
Bathyporeia pelagica	15/0.05			
Bathyporeia sarsi			2.5/0.03	2.5/0.03
Bodotria scorpioides				2.5/0.03
Caprella linearis			125/0.85	7.5/0.03
Carcinus maenas			2.5/0.03	2.5/0.23
Copepoda sp.		2.5/0.03		
Corophium acherusicum				2.5/0.03
Diastylis bradyi		12.5/0.12	20/0.15	7.5/0.03
Hippolyte varians			2.5/0.03	2.5/0.03
Hyas arenarius			5/0.30	2.5/0.05
Idotea linearis			2.5/0.03	
Macropodia rostrata			5/0.12	10/0.45
Melita palmata				2.5/0.03
Melita obtusata	2.5/0.03		5/0.07	
Panoplosa minuta				2.5/0.03
Pagurus bernhardus				2.5/0.60
Periculoides longimanus	2.5/0.03		40/0.10	5/0.05
Pseudoruma longicornis		7.5/0.05		
Stenothoë marina			7.5/0.05	5/0.03
Urothoë poseidonis		2.5/0.03		
PYCNOGONIDA				
Nymphon rubrum			12.5/0.07	7.5/0.05
Pycnogonum litterale			2.5/0.30	
MOLLUSCA				
Abra alba		30/0.48	35/2.90	17.5/0.55
Cerastoderma edule	2.5/0.03			
Gastropoda sp.				2.5/0.05
Hydrobia ulvae			2.5/0.03	
Macoma balthica	20/0.43	2.5/0.03	7.5/0.12	5/0.05
Modiolus ?phaseolinus				5/0.03
Tellina fabula	10/0.13	40/3.85	7.5/0.53	105/1.73
ECHINODERMATA				
Amphipholis squamata				2.5/0.05
TOTALS	**162.5/6.25**	**235/11.56**	**617.5/19.64**	**389/12.46**
Community Statistics				
Total N.Species	13	15	33	40
Mean N.Species/0.1 m²	7.00	8.25	16.00	15.00
Diversity (H'e)	2.04	2.16	2.65	2.86
Evenness (J)	0.80	0.80	0.76	0.78
Temperature (°C)	4	10	22	16

Table 22a.

MACROFAUNA SPECIES RECORDED AT GRAIN FLATS (SITE 20), 1989-1990.

Values: Abundance = №.Individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 2/89	Quar 3/89	Quar 4/89	Quar 1/90	Quar 2/90	Quar 3/90	Quar 4/90
ANTHOZOA							
Sagartia troglodytes			2.5/0.55				
OLIGOCHAETA							
Monopylephorus rubroniveus	12.5/0.03	7.5/0.03	2.5/0.03	747.5/0.53	45/0.10	20/0.08	47.5/0.13
Tubificoides benedeni	32.5/0.10	5/0.03	5/0.03	42.5/0.13	2.5/0.03	2.5/0.03	
Tubificoides pseudogaster	15/0.03						
POLYCHAETA							
Anaitides mucosa			5/0.05				
Aricidia minuta				2.5/0.03			
Capitellides giardi					2.5/0.03		
Caulleriella sp.			45/0.10	105/0.25		2.5/0.03	5/0.03
Eteone longa		2.5/0.03					
Goniada maculata						7.5/0.50	
Nephtys caeca		12.5/0.13					
Nephtys hombergii	25/0.68	55/2.03	137.5/5.85	190/7.53	30/1.38	247.5/7.03	150/3.90
Pygospio elegans				5/0.05			
Scoloplos armiger	15/0.13	7.5/0.08		5/0.03			
CRUSTACEA							
Atylus swammerdami							2.5/0.03
Bathyporeia sarsi	35/0.15						
Crangon crangon		2.5/0.88					
Diastylis bradyi	2.5/0.03					2.5/0.03	
Neomysis integer			20/0.08				
MOLLUSCA							
Cerastoderma edule				2.5/0.03	2.5/3.38	12.5/18.43	5/0.30
Hydrobia ulvae			2.5/0.03	7.5/0.05			
Macoma balthica	10/0.23	27.5/0.95	2.5/0.43	67.5/0.41	5/0.13	35/0.48	7.5/0.10
Nucula turgida				10/0.08		7.5/0.18	2.5/0.03
Petricola pholadiformis		2.5/0.05					
Retusa obtusa				7.5/0.05			
CHAETOGNATHA							
Sagitta elegans	2.5/0.05						
ECHINODERMATA							
Ophiura ophiura						2.5/0.05	
TOTALS	**150/1.51**	**122.5/4.21**	**222.5/7.15**	**1192.5/9.73**	**87.5/5.05**	**340/26.84**	**220/4.52**
Community Statistics							
Total №.Species	9	9	9	12	6	10	7
Mean №.Species/0.1 m²	5.25	4.50	4.25	8.00	3.75	5.50	3.50
Diversity (H'e)	1.76	1.63	1.11	1.23	1.16	1.06	0.95
Evenness (J)	0.77	0.74	0.50	0.50	0.65	0.46	0.49
Temperature (°C)	12	20	15	8	15	19	16

Table 22b. MACROFAUNA SPECIES RECORDED AT GRAIN FLATS (SITE 20). 1991.

Values: Abundance = №.Individuals/m², -Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 1/91	Quar 2/91	Quar 3/91	Quar 4/91
OLIGOCHAETA				
Monopylephorus rubroniveus	20/0.07	127.5/0.23		12.5/0.03
Tubificoides benedeni		5/0.03		
POLYCHAETA				
Caulleriella sp.	10/0.05	10/0.05		
Eteone longa	2.5/0.03	2.5/0.05		
Glycera convoluta				2.5/0.05
Lanice conchilega				2.5/0.05
Nephtys hombergii	265/5.75	157.5/6.40	32.5/0.72	215/1.42
Ophelia ?neglecta	2.5/0.03			
Pygospio elegans	2.5/0.03			
Scoloplos armiger	5/0.07	2.5/0.03		
CRUSTACEA				
Diastylis bradyi				5/0.05
Gammarus salinus			2.5/0.03	
MOLLUSCA				
Abra alba		25/0.20		
Cerastoderma edule	7.5/10.60	5/5.85	2.5/7.05	2.5/5.33
Macoma balthica	87.5/0.90	55/0.45	12.5/0.35	25/0.65
Petricola pholadiformis		2.5/0.03		
ECHINODERMATA				
Ophiura ophiura	10/0.13			
TOTALS	**412.5/17.66**	**392.5/13.32**	**50/8.15**	**265/7.58**
Community Statistics				
Total №.Species	10	10	4	7
Mean №.Species/0.1 m²	6.00	6.00	2.25	3.50
Diversity (H'e)	1.16	1.48	0.93	0.74
Evenness (J)	0.50	0.64	0.67	0.38
Temperature (°C)	4	10	22	16
Mean Quarterly Salinity (‰)				

Table 23a.

MACROFAUNA SPECIES RECORDED AT SHOEBURYNESS EAST (SITE 21), 1989-1990.

Values: Abundance = №.Individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 2/89	Quar 3/89	Quar 4/89	Quar 1/90	Quar 2/90	Quar 3/90	Quar 4/90
NEMERTEA							
Cephalothrix rufifrons		4/0.10					
Nemertea sp.(?Lineus sp.)					5/0.08		
?Tetrastemma sp.		2/0.02					
OLIGOCHAETA							
Tubificoides benedeni	32/0.02	4/0.04	2/0.02	4/0.04	2.5/0.03	7.5/0.05	
Tubificoides pseudogaster							2.5/0.03
POLYCHAETA							
Anaitides mucosa		4/0.06	44/1.80		2.5/0.03	7.5/0.23	15/0.35
Arenicola marina		2/0.12					
Capitellides giardi	4/0.02	2/0.02					
Caulleriella sp.	4/0.02		12/0.06	20/0.10	12.5/0.10	10/0.08	15/0.08
Eteone longa	22/0.28	28/0.16	6/0.06	8/0.08	7.5/0.03	2.5/0.03	2.5/0.03
Glycera convoluta	8/0.32	4/0.38	44/1.34	22/1.42	7.5/0.68	10/0.18	
Nephtys ?cirrosa							2.5/0.13
Nephtys hombergii	10/0.76	4/0.94	18/1.68	16/0.68	35/13.88	110/5.23	40/1.48
Nereis (Neanthes) diversicolor	6/0.42	12/0.24					
Pygospio elegans	20/0.04	8/0.04	4/0.02	10/0.10	2.5/0.03	7.5/0.05	
Scoloplos armiger	604/17.62	3460/44.62	1746/18.64	1400/18.90	720/11.85	345/6.33	297.5/7.60
CRUSTACEA							
Bathyporeia pelagica				2/0.02	110/0.40	27.5/0.10	25/0.10
Bathyporeia pilosa				2/0.02			
Bathyporeia sarsi	132/0.66	6/0.04	12/0.06	14/0.08			12.5/0.05
Carcinus maenas		4/0.10			12.5/0.10	5/2.68	
Corophium arenarium	8/0.12	68/0.26	96/0.20	124/0.40	95/0.33	40/0.13	47.5/0.15
Crangon crangon		2/0.14	10/0.20		17.5/1.43	12.5/0.68	2.5/0.05
Cumopsis goodsiri				2/0.02			2.5/0.03
Gammarus locusta					7.5/0.08		
Melita obtusata	4/0.02						
Praunus flexuosus					2.5/0.03		
Urothoë poseidonis	10/0.20	2/0.02	6/0.04	36/0.18	12.5/0.10	2.5/0.03	
MOLLUSCA							
Cerastoderma edule	16/19.15	12/6.04	34/5.57	82/13.20	140/14.75	95/18.43	137.5/27.38
Hydrobia ulvae		486/0.54	11830/7.57	222/0.86	995/1.25	4612.5/9.68	2000/4.20
Macoma balthica	60/19.04	136/13.68	128/13.08	52/6.52	62.5/7.10	62.5/11.20	72.5/15.75
Nucula turgida						2.5/0.03	
Retusa obtusa							5/0.05
Tellina fabula					2.5/0.03		
TOTALS	**933/58.69**	**4250/67.60**	**13992/50.34**	**2016/42.16**	**2252.5/52.36**	**5360/55.14**	**2680/57.46**
Community Statistics							
Total №.Species	15	20	15	16	20	17	16
Mean №.Species/0.1 m²	13.00	12.00	11.75	13.00	12.25	11.00	10.25
Diversity (H'e)	1.31	0.79	0.60	1.20	1.57	0.67	0.99
Evenness (J)	0.49	0.26	0.22	0.43	0.52	0.24	0.36
Temperature (°C)	8	23	12	11	18	21	8

Table 23b. MACROFAUNA SPECIES RECORDED AT SHOEBURYNESS EAST (SITE 21), 1991.

Values: Abundance = №.Individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 1/91	Quar 2/91	Quar 3/91	Quar 4/91
OLIGOCHAETA				
Psammoryctides barbatus		2.5/0.03		
Tubificoides pseudogaster		2.5/0.03		
Tubificoides benedeni	7.5/0.05			
POLYCHAETA				
Arenicola marina	2.5/0.03			
Anaitides mucosa				10/0.13
Caulleriella sp.	17.5/0.10	2.5/0.03	2.5/0.03	5/0.03
Chaetozone setosa		2.5/0.03		
Eteone longa	2.5/0.03	2.5/0.05		5/0.03
Glycera convoluta	2.5/0.07			2.5/0.03
Nephtys hombergii	52.5/3.18	30/2.60	45/6.92	22.5/1.55
Pygospio elegans	2.5/0.03	32.5/0.15	35/0.15	15/0.10
Scoloplos armiger	347.5/10.12	315/10.72	535/10.15	227.5/4.75
HIRUDINEA				
Helobdella stagnalis			2.5/0.05	
CRUSTACEA				
Bathyporeia sarsi	125/0.30	245/0.68	542.5/2.38	150/0.95
Carcinus maenas			2.5/0.03	
Corophium arenarium	127.5/0.43	57.5/0.58	45/0.20	12.5/0.07
Crangon crangon				10/0.30
Cumopsis goodsiri	5/0.05	12.5/0.10		
Urothoë poseidonis	5/0.05	50/0.45	20/0.07	2.5/0.03
UNIRAMIA				
Chironomidae spp.			5/0.05	
MOLLUSCA				
Cerastoderma edule	90/38.62	37.5/20.58	50/17.45	72.5/17.82
Hydrobia ulvae	635/0.88	572.5/2.25	970/1.42	18912.5/26.23
Littorina littorea	2.5/1.02			
Macoma balthica	55/9.93	37.5/5.40	55/9.95	77.5/8.68
Mysella bidentata				5/0.05
Nucula turgida	2.5/0.03			
Retusa obtusa	2.5/0.03			10/0.07
TOTALS	**1485/64.95**	**1405/43.70**	**2310/48.85**	**19540/60.81**

Community Statistics				
Total №.Species	18	15	13	16
Mean №.Species/0.1 m²	11.00	12.00	9.25	11.25
Diversity (H'e)	1.73	1.72	1.51	0.20
Evenness (J)	0.60	0.64	0.59	0.07
Temperature (°C)	12	13	18	11

Table 24a.

MACROFAUNA SPECIES RECORDED AT SEA REACH №.2 BUOY (SITE 22), 1989-1990.

Values: Abundance = №.Individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 2/89	Quar 3/89	Quar 4/89	Quar 1/90	Quar 2/90	Quar 3/90	Quar 4/90
ANTHOZOA							
Metridium senile	5/3.53						
Sagartia troglodytes		2.5/3.85					2.5/0.93
NEMERTEA							
Cephalothrix rufifrons	2.5/0.05	2.5/0.13					
Nemertea sp.		2.5/0.05					
OLIGOCHAETA							
?Branchiura sowerbyi		10/0.08					
Monopylephorus rubroniveus						5/0.05	
Tubificoides benedeni							2.5/0.03
POLYCHAETA							
Anaitides groenlandica			2.5/1.00				
Anaitides mucosa	7.5/0.08						
Aphrodita aculeata						5/0.03	
Aricidia minuta	20/0.08	735/0.98	575/0.65	140/0.18	107.5/0.23	75/0.15	
Capitella capitata		2.5/0.03					
Caulleriella sp.	7.5/0.10			2.5/0.03			
Chaetozone setosa				2.5/0.03			
Eteone longa	5/0.10			2.5/0.03		7.5/0.08	
Eulalia bilineata							5/0.05
Glycera convoluta		2.5/0.08	5/0.08	5/0.10			
Goniada maculata	2.5/0.08				5/0.23	5/0.23	
Lagis koreni		20/0.18				2.5/0.03	
Lanice conchilega		2.5/0.03					
Magelona mirabilis		45/0.55	7.5/0.30	7.5/0.05	5/0.03		2.5/0.03
Malacoceros fuliginosus	5/0.05			12.5/0.05			10/0.05
Myxta picta							2.5/0.25
Nephtys caeca	42/2.78	25/3.68	85/11.65	75/6.23	27.5/4.10	77.5/4.33	75/2.70
Nephtys cirrosa					5/0.13		
Nephtys hombergii		32.5/0.33			5/0.23		
Nereis (Neanthes) succinea	2.5/0.45						
Pygospio elegans			12.5/0.53	32.5/0.13	7.5/0.05	22.5/0.10	32.5/0.10
Scoloplos armiger	42.5/0.24	127.5/2.03	95/2.48	22.5/0.35	27.5/0.43	27.5/0.30	12.5/0.08

Table 24a. cont...

Species	Quar 2/89	Quar 3/89	Quar 4/89	Quar 1/90	Quar 2/90	Quar 3/90	Quar 4/90
HIRUDINEA							
?Oceanobdella blennii						2.5/0.03	
CRUSTACEA							
Atylus falcatus		15/0.08		2.5/0.03	7.5/0.05		5/0.05
Bathyporeia elegans				67.5/0.15	7.5/0.05		
Bathyporeia guilliamsoniana					2.5/0.03	2.5/0.03	
Bathyporeia pelagica					32.5/0.10	22.5/0.08	65/0.18
Bathyporeia sarsi	5/0.05		22.5/0.13	2.5/0.03			
Corystes cassivelaunus						2.5/1.08	
Crangon crangon						2.5/0.30	
Diastylis bradyi		2.5/0.03			5/0.05	7.5/0.05	
Melita obtusata	5/0.03						
Melita palmata							12.5/0.08
Microprotopus maculatus	82.5/0.17						
Neomysis integer							2.5/0.03
Pagurus bernhardus	5/15.98						
Periculoides longimanus	2.5/0.03						
Pontocrates altamarinus							2.5/0.03
Sphaeroma monodi	17.5/0.38						
Urothoë poseidonis	17.5/0.10						
PYCNOGONIDA							
Nymphon rubrum						2.5/0.03	5/0.13
MOLLUSCA							
Abra alba	2.5/0.73	25/4.93			12.5/0.08	2.5/0.03	
Cerastoderma edule			2.5/0.65			2.5/0.03	
Donax vittatus		2.5/0.38	2.5/0.90				
Ensis sp.(?arcuatus)						2.5/0.05	
Macoma balthica		7.5/1.03		2.5/2.20	2.5/0.28	10/0.60	
Nucula turgida		2.5/0.13			10/0.18	12.5/0.25	10/0.53
Tellina fabula	2.5/0.05		12.5/1.73		5/0.38	10/0.60	
ECHINODERMATA							
Ophiura ophiura	2.5/0.38					2.5/0.03	5/0.10
TOTALS	**287.5/25.80**	**1065/18.58**	**822.5/20.10**	**377.5/9.71**	**275/6.63**	**312.5/8.29**	**252.5/5.35**
Community Statistics							
Total №.Species	21	19	11	14	17	23	17
Mean №.Species/0.1 m²	9.75	10.50	7.25	7.50	9.50	11.25	7.75
Diversity (H'e)	2.22	1.23	1.08	1.77	2.14	2.42	2.05
Evenness (J)	0.76	0.42	0.45	0.67	0.76	0.77	0.72
Temperature (°C)	12	19	15	8	15	19	16

Table 24b. MACROFAUNA SPECIES RECORDED AT SEA REACH No.2 BUOY (SITE 22), 1991.

Values: Abundance = №.Individuals/m², Biomass = g.WetWeight/m².
Expressed as Abundance/Biomass.

Species	Quar 1/91	Quar 2/91	Quar 3/91	Quar 4/91
POLYCHAETA				
Aricidia minuta	25/0.07	30/0.10	7.5/0.05	7.5/0.07
Autolytus sp. (?prolifera)			30/0.07	
Caullerielia sp.	2.5/0.03	2.5/0.03		
Chaetozone setosa				2.5/0.03
Eulalia bilineata			2.5/0.03	
Glycera convoluta			2.5/0.07	
Goniada maculata	5/0.55			2.5/0.03
Lagis koreni				2.5/0.03
Lanice conchilega			12.5/0.07	
Magelona mirabilis	2.5/0.03	5/0.07		5/0.05
Malacoceros fuliginosus			5/0.03	
Malacoceros tetracerus	2.5/0.03			
Nephtys caeca	62.5/3.25	22.5/3.93	90/3.23	
Nephtys cirrosa		2.5/0.12		17.5/0.53
Nephtys hombergii		10/0.35		5/0.70
Nephtys longosetosa				2.5/0.33
Pygospio elegans	17.5/0.10	30/0.33	17.5/0.07	
Scoloplos armiger	12.5/0.05	27.5/0.43	22.5/0.23	12.5/0.18
Spiophanes bombyx				5/0.05
HIRUDINEA				
Piscicolidae sp.			7.5/0.05	
CRUSTACEA				
Atylus falcatus	10/0.05		17.5/0.12	10/0.07
Atylus guttatus			40/0.12	
Bathyporeia elegans		70/0.25	250/0.78	155/0.28
Bathyporeia guilliamsoniana	2.5/0.03		10/0.05	5/0.05
Bathyporeia pelagica	102.5/0.20			
Caprella linearis			165/0.48	
Corystes cassivelaunus			2.5/0.43	
Crangon crangon			2.5/0.05	
Diastylis bradyi		2.5/0.05	17.5/0.23	
Idotea linearis			2.5/0.05	
Melita obtusata		2.5/0.03		
Microprotopus maculatus		5/0.03		
Monoculodes carinatus			7.5/0.05	
Pagurus bernhardus			2.5/0.05	
Periculoides longimanus		2.5/0.03		
Porcellana longicornis			2.5/0.03	
Pseudocuma longicornis		2.5/0.03		
Stenothoë marina			17.5/0.05	
PYCNOGONIDA				
Nymphon rubrum			17.5/0.23	
MOLLUSCA				
Abra alba	2.5/0.03		15/1.50	
Abra nitida		5/0.15		
Donax vittatus			2.5/0.48	
Macoma balthica	2.5/0.28	2.5/0.10	2.5/0.03	
Moerella pygmaea		2.5/0.03		
Nucula turgida	10/0.13	10/0.07	2.5/0.03	2.5/0.03
Tellina fabula	5/0.50	2.5/0.03		2.5/0.03
ECHINODERMATA				
?Echinocyamus pusillus			2.5/0.07	2.5/0.43
TOTALS	**265/5.36**	**237.5/6.16**	**777.5/8.73**	**240/2.81**
Community Statistics				
Total №.Species	15	19	29	16
Mean №.Species/0.1 m²	7.75	8.50	11.75	8.00
Diversity (H'e)	1.88	2.30	2.32	1.52
Evenness (J)	0.70	0.78	0.69	0.55
Temperature (°C)	4	10	22	16

FIGURES.

Figure 1.

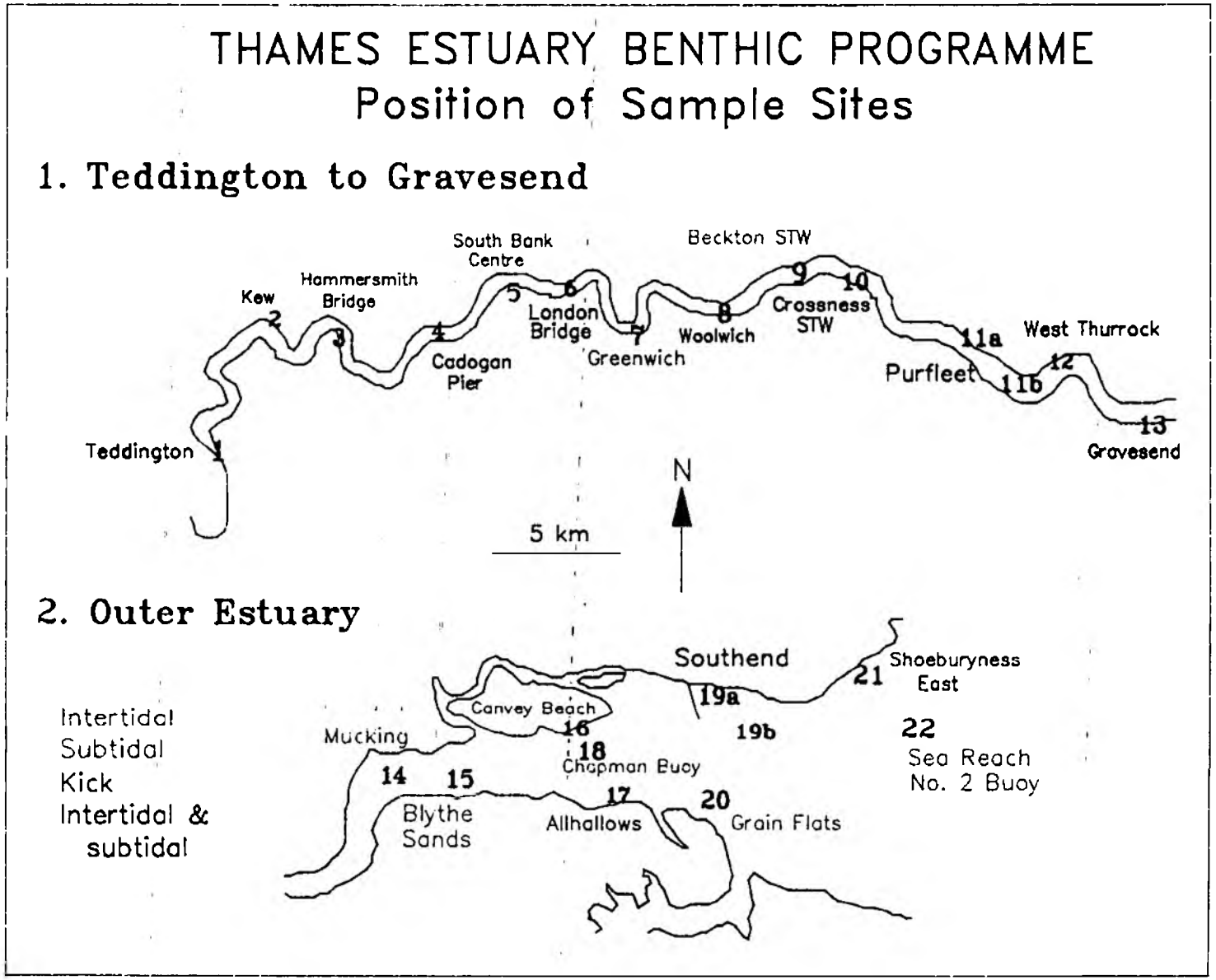

THAMES ESTUARY BENTHIC PROGRAMME
Position of Sample Sites
1. Teddington to Gravesend
Teddington
Kew
Hammersmith Bridge
Cadogan Pier
South Bank Centre
London Bridge
Greenwich
Woolwich
Beckton STW
Crossness STW
Purfleet
West Thurrock
Gravesend
1
2
3
4
5
6
7
8
9
10
11a
11b
12
13
N
5 km
2. Outer Estuary
Intertidal
Subtidal
Kick
Intertidal &
subtidal
Mucking
Canvey Beach
Southend
Shoeburyness East
Chapman Buoy
Blythe Sands
Allhallows
Grain Flats
Sea Reach No. 2 Buoy
14
15
16
17
18
19a
19b
20
21
22

Fig.2

THAMES ESTUARY BENTHIC PROGRAMME

Species number 1989-91

Upper estuary kick sample sites

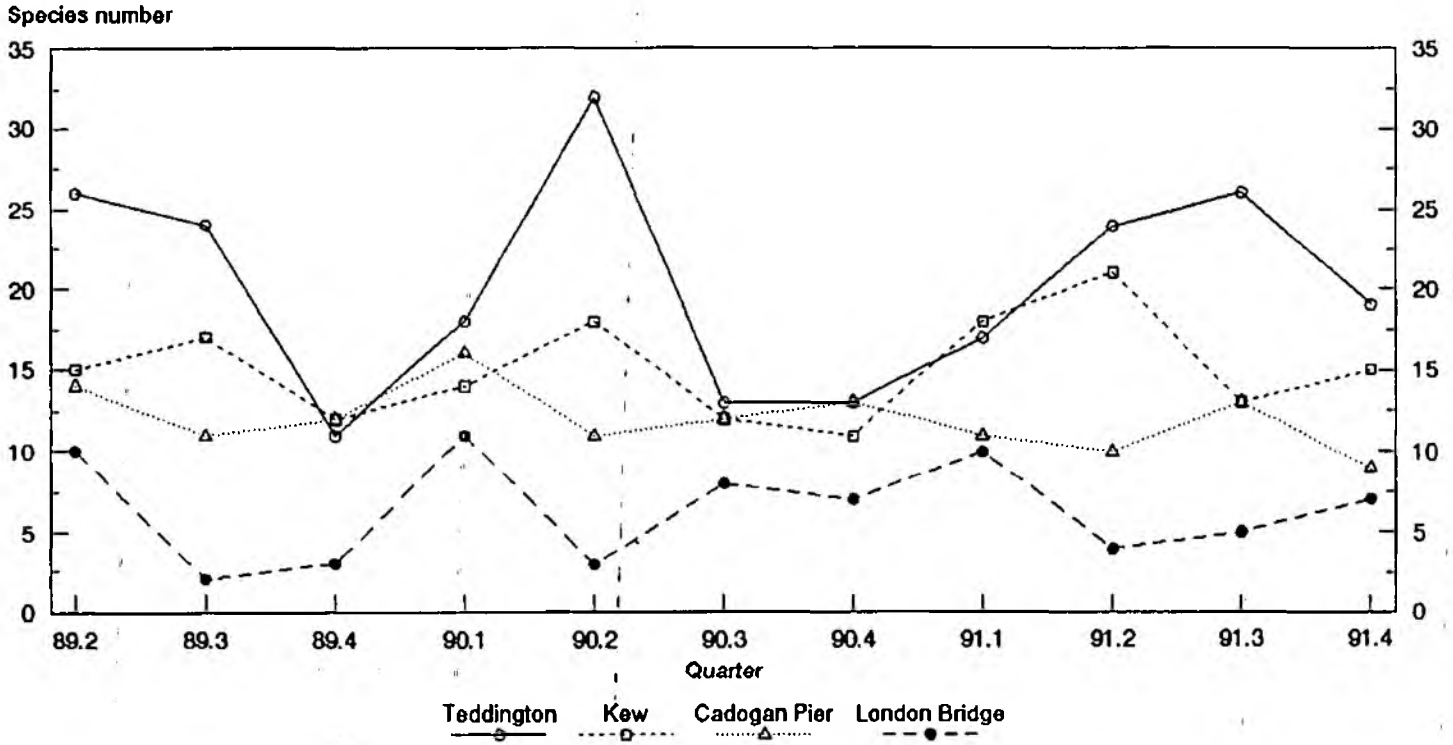


Fig.3

THAMES ESTUARY BENTHIC PROGRAMME

SITE 1: TEDDINGTON

TOTAL SPECIES NUMBER and BMWP SCORE

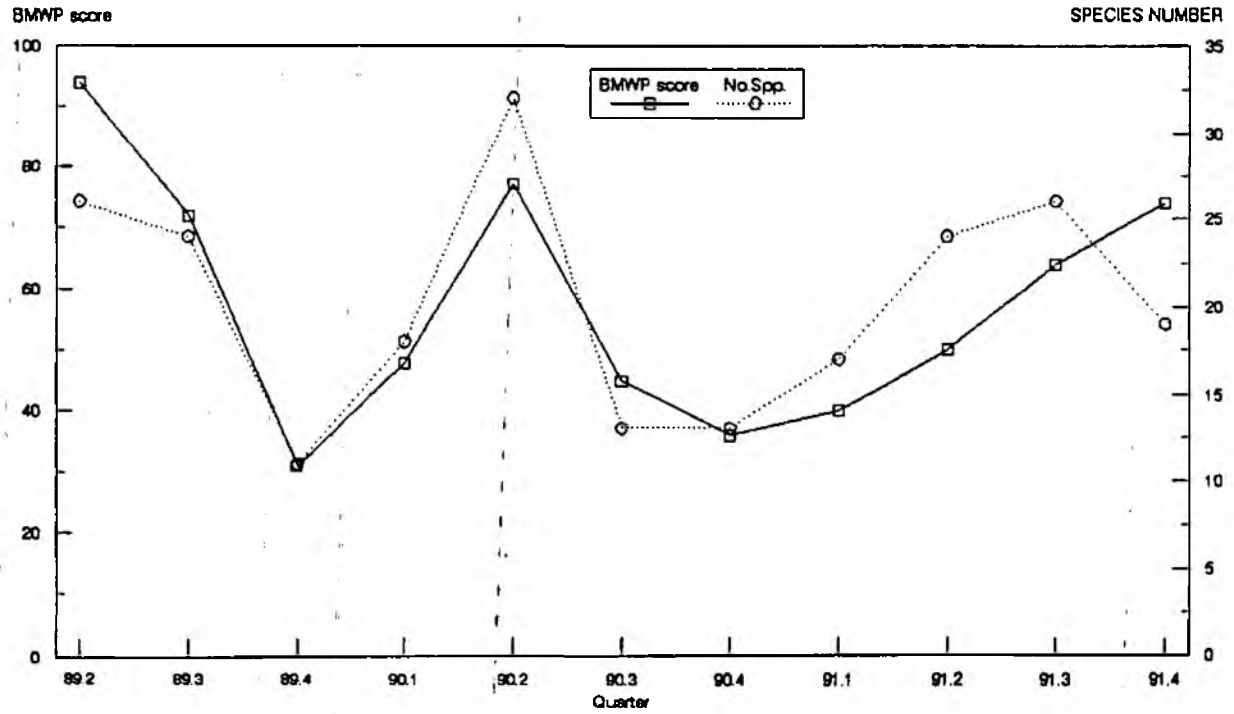


Fig.4

THAMES ESTUARY BENTHIC PROGRAMME

SITE 1: TEDDINGTON

Number of amphipods and oligochaetes

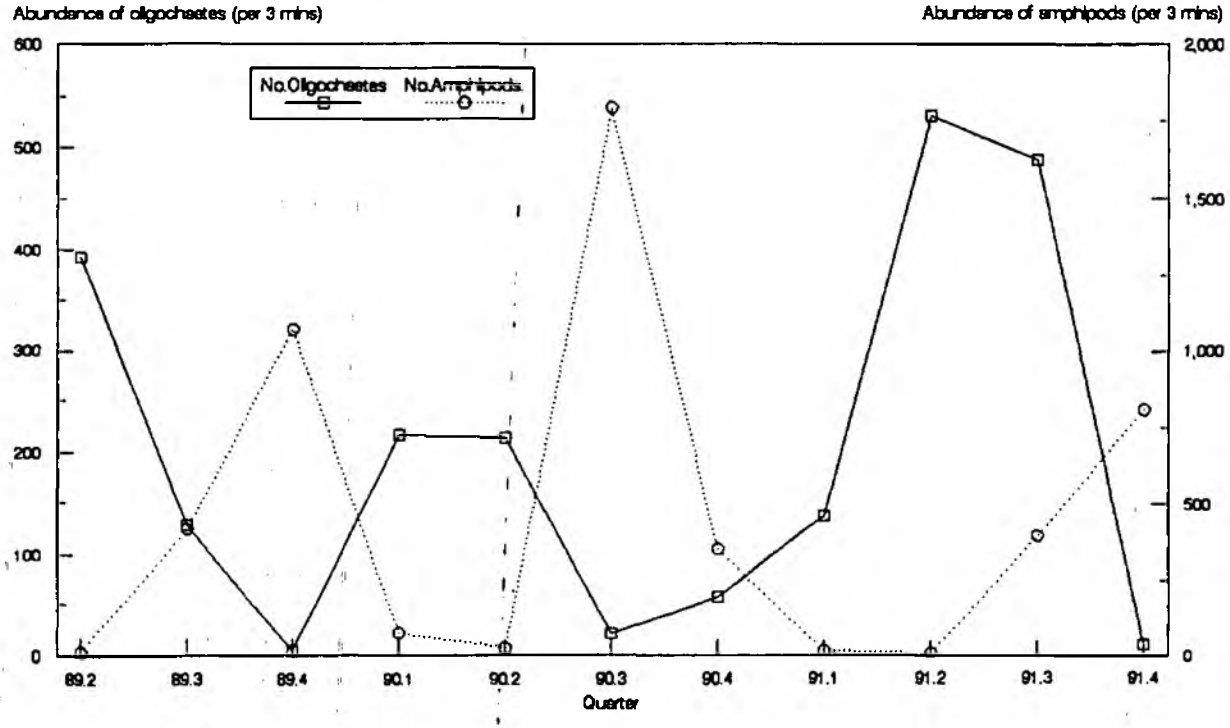


Fig.5

THAMES ESTUARY BENTHIC PROGRAMME

SALINITY PROFILES (MEAN QUARTERLY SALINITY)
ALL SITES TEDDINGTON-CHAPMAN BUOY, 1990

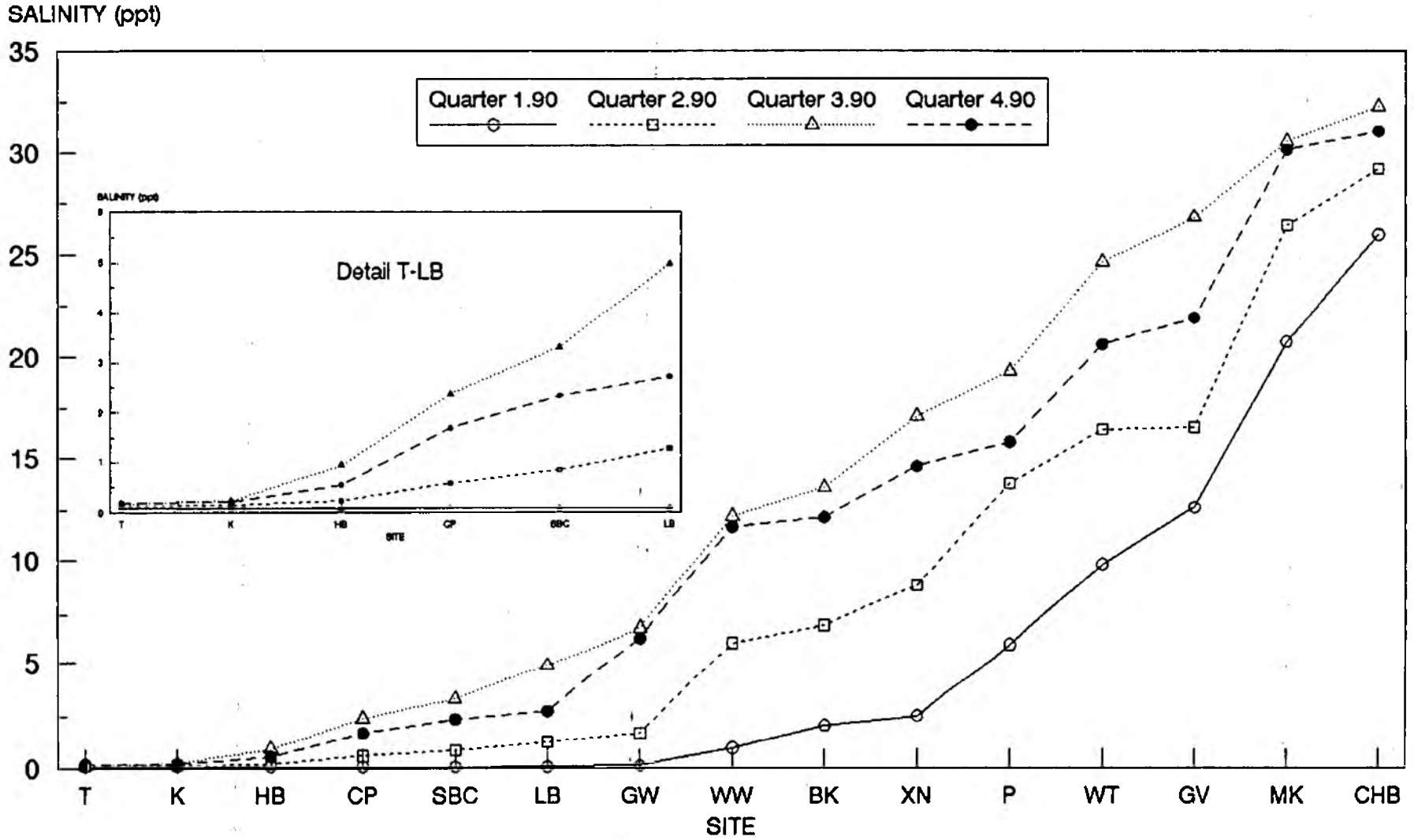


Fig.6

THAMES ESTUARY BENTHIC PROGRAMME

SALINITY PROFILES (MEAN QUARTERLY SALINITIES)

ALL SITES TEDDINGTON-CHAPMAN BUOY, 1991

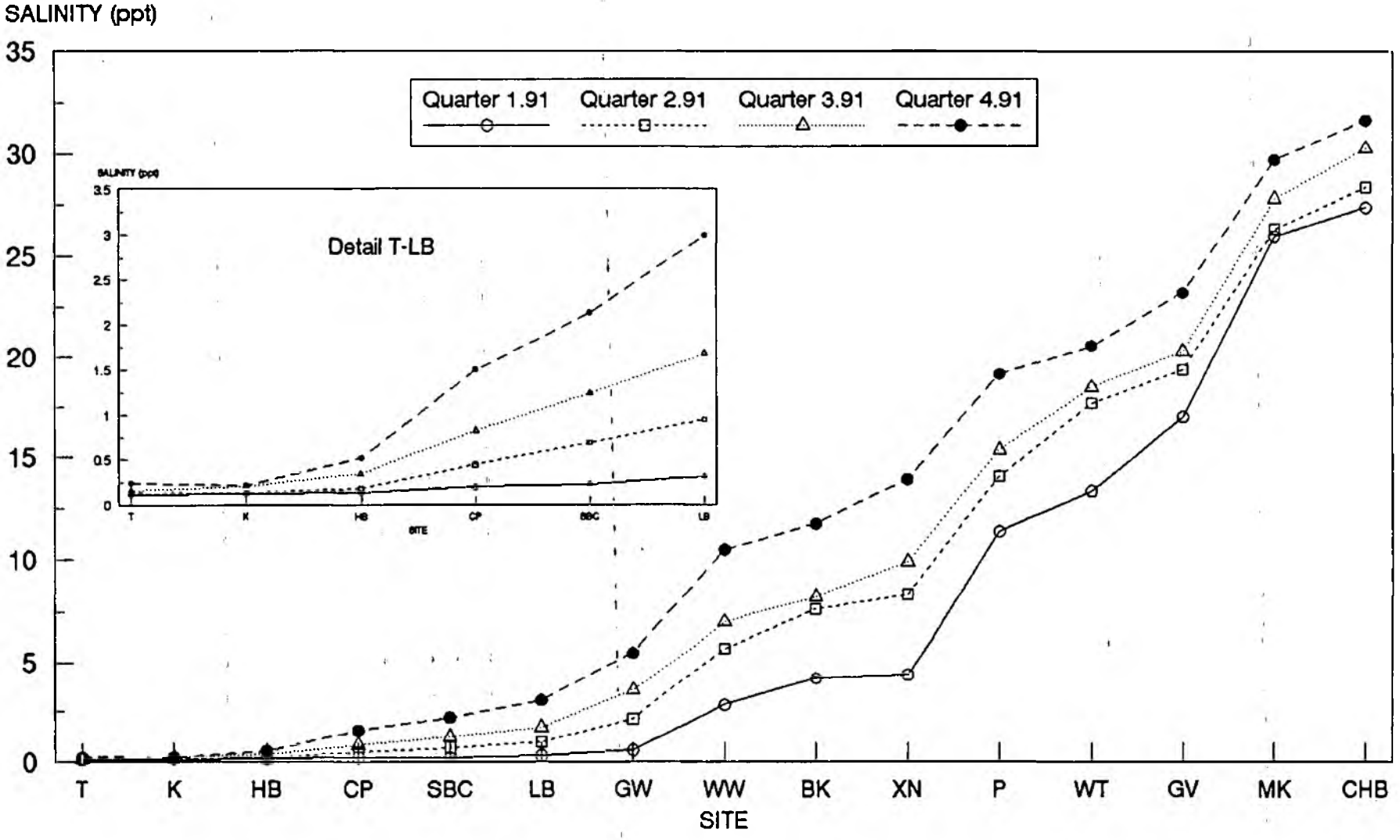


Fig.7

THAMES ESTUARY BENTHIC PROGRAMME

SITE 1: TEDDINGTON

Variation in species No. with salinity

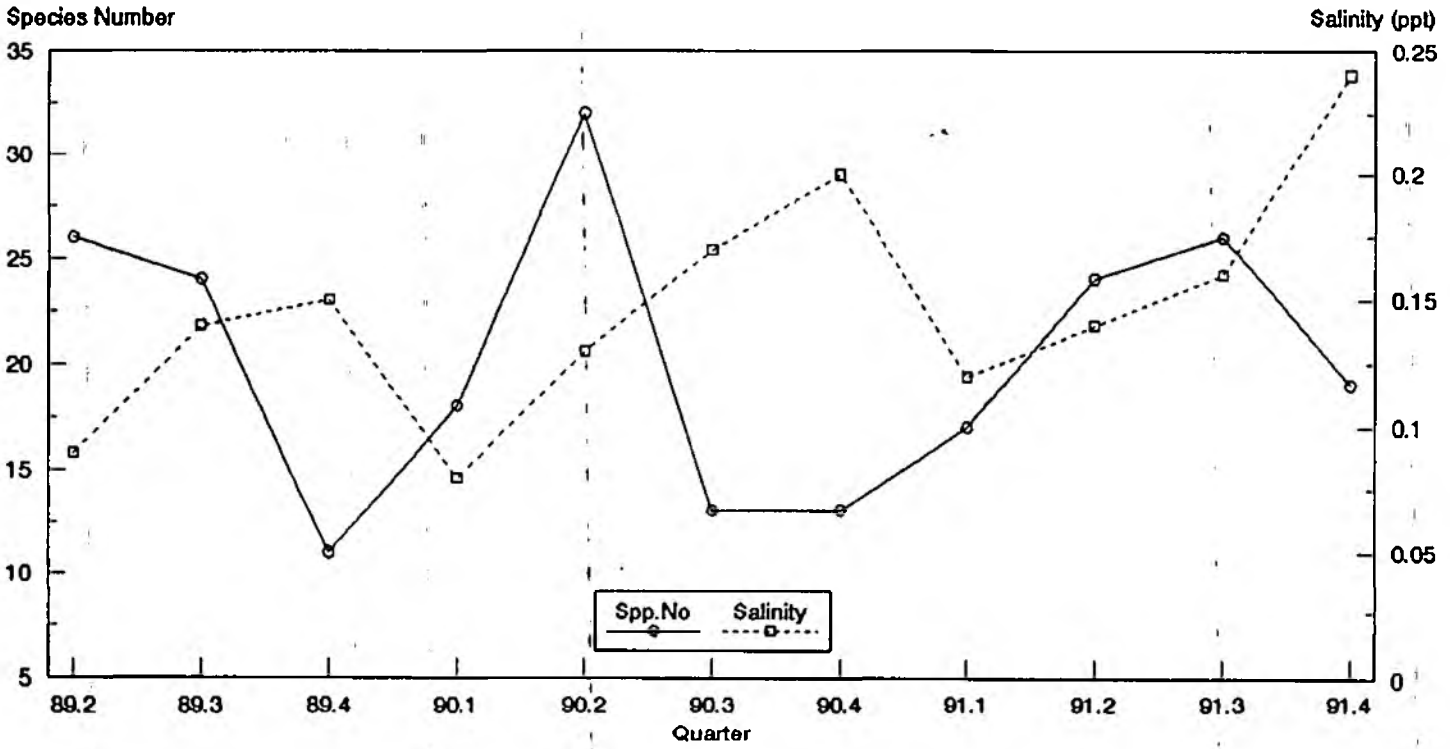


Fig.8

THAMES ESTUARY BENTHIC PROGRAMME

SITE 1: TEDDINGTON

Species number related to ASPT

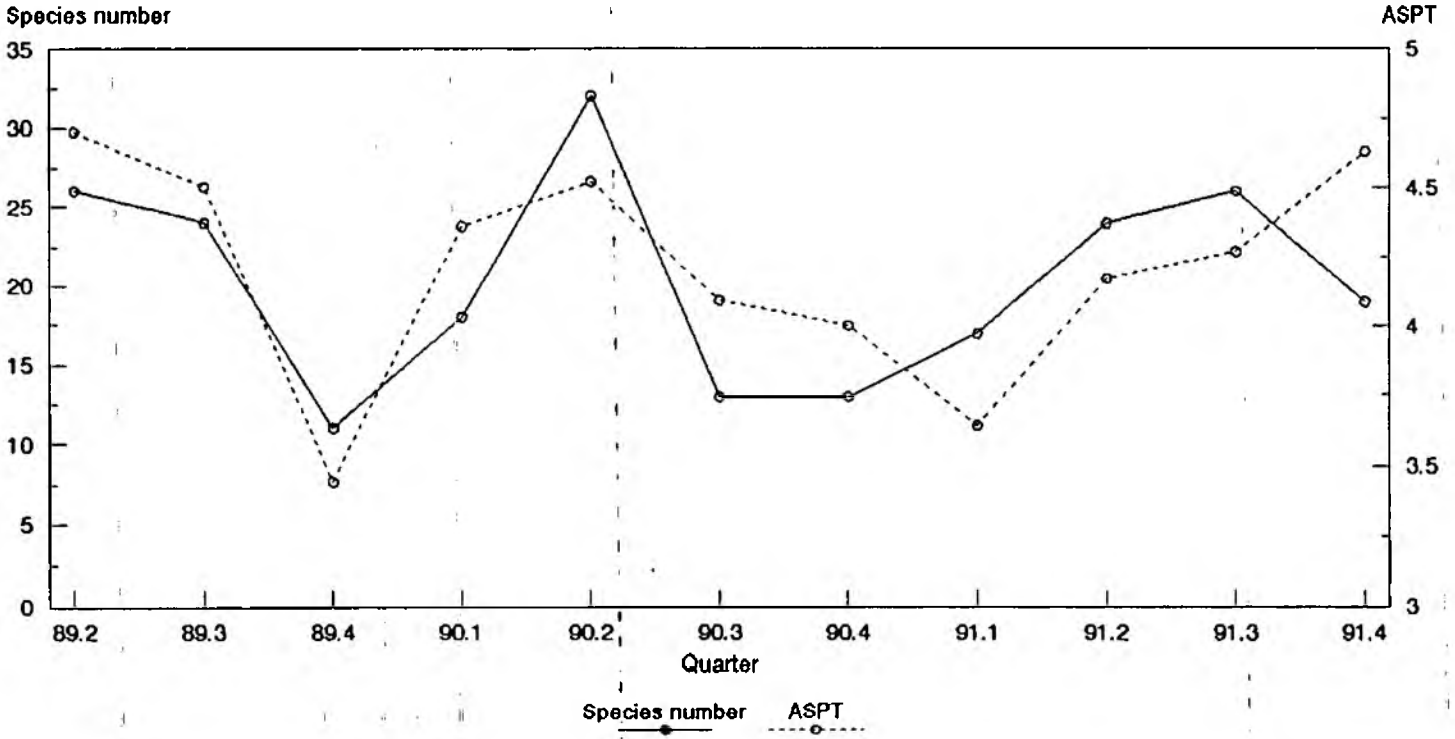
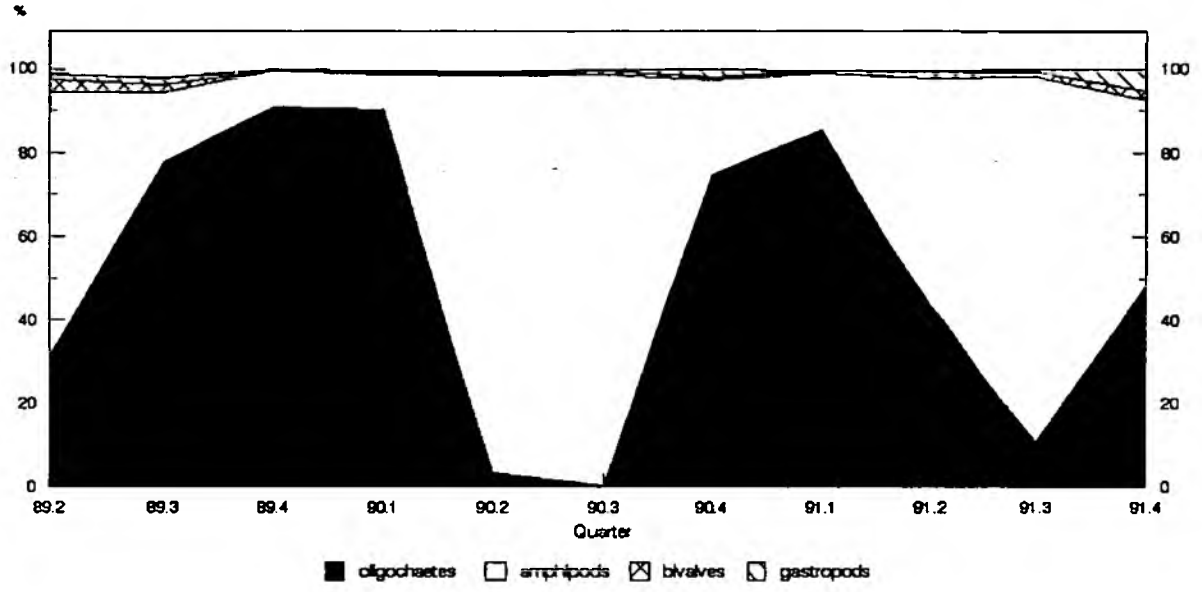


Fig.9 **THAMES ESTUARY BENTHIC PROGRAMME**

SITE 2: KEW

Composition of the fauna-% of abundance



Composition of the fauna-% of biomass

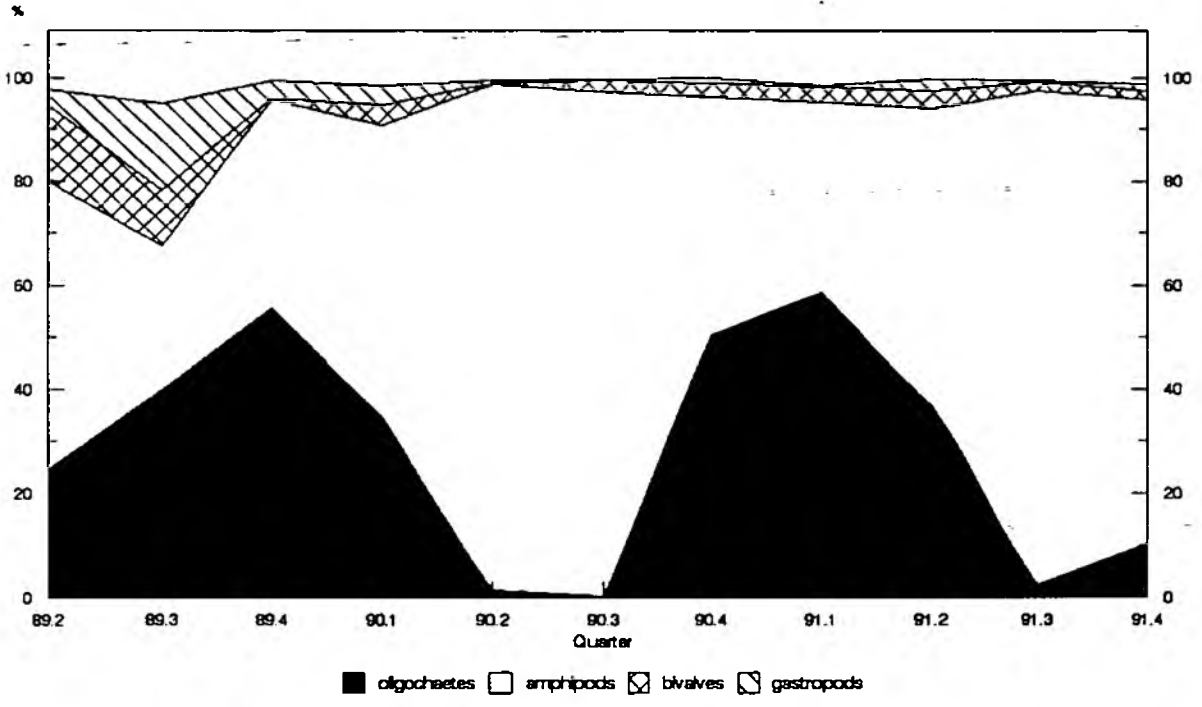


Fig.10

THAMES ESTUARY BENTHIC PROGRAMME

SITE 2: KEW

Number of amphipods and oligochaetes

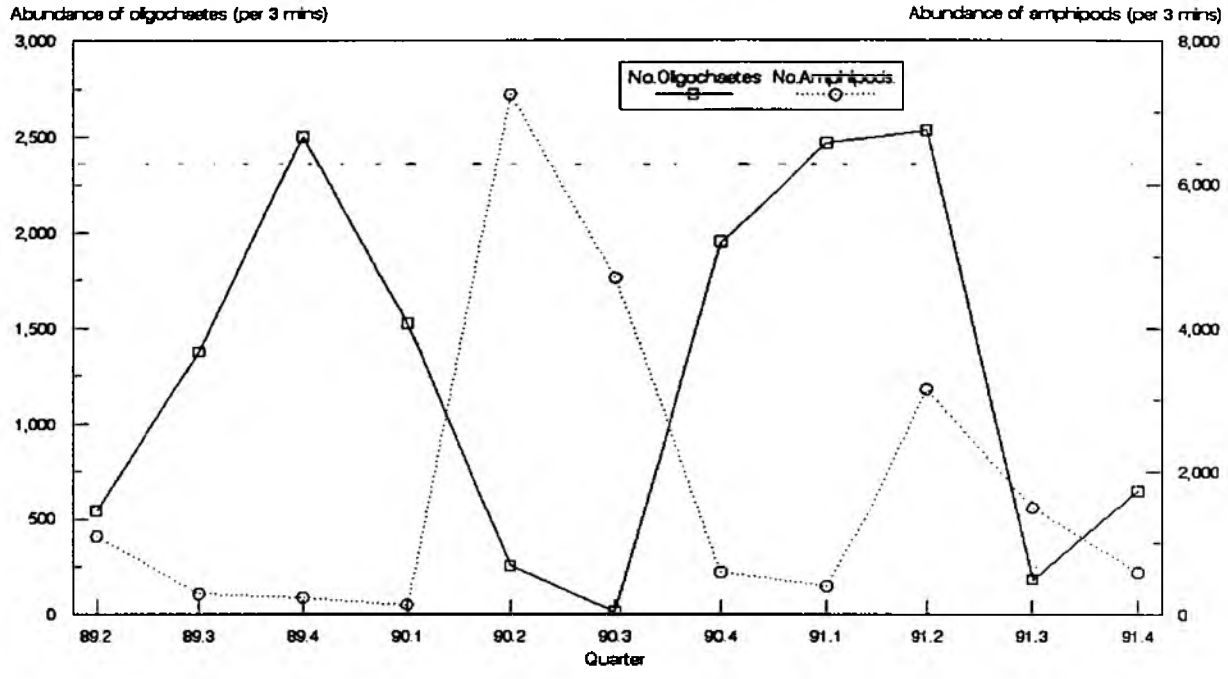


Fig.11

THAMES ESTUARY BENTHIC PROGRAMME

SITE 2: KEW

Variation in species No. with salinity

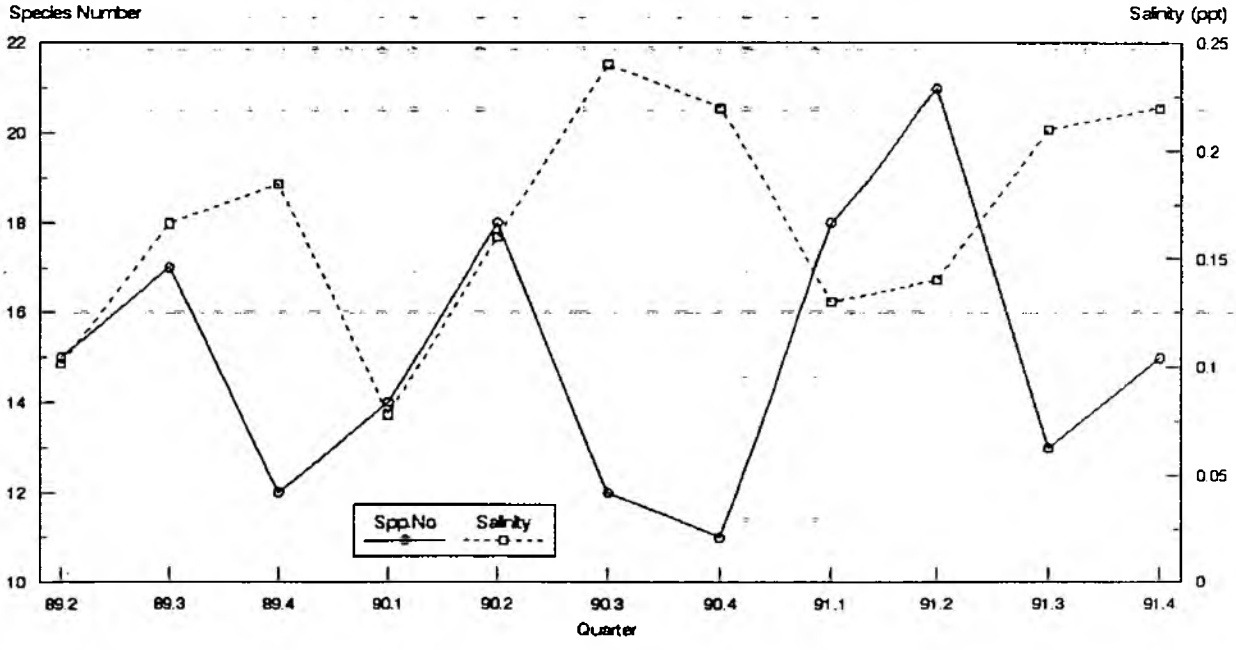


Fig.12a

THAMES ESTUARY BENTHIC PROGRAMME

Species number 1989-91

a. Intertidal sites Hammersmith to Woolwich

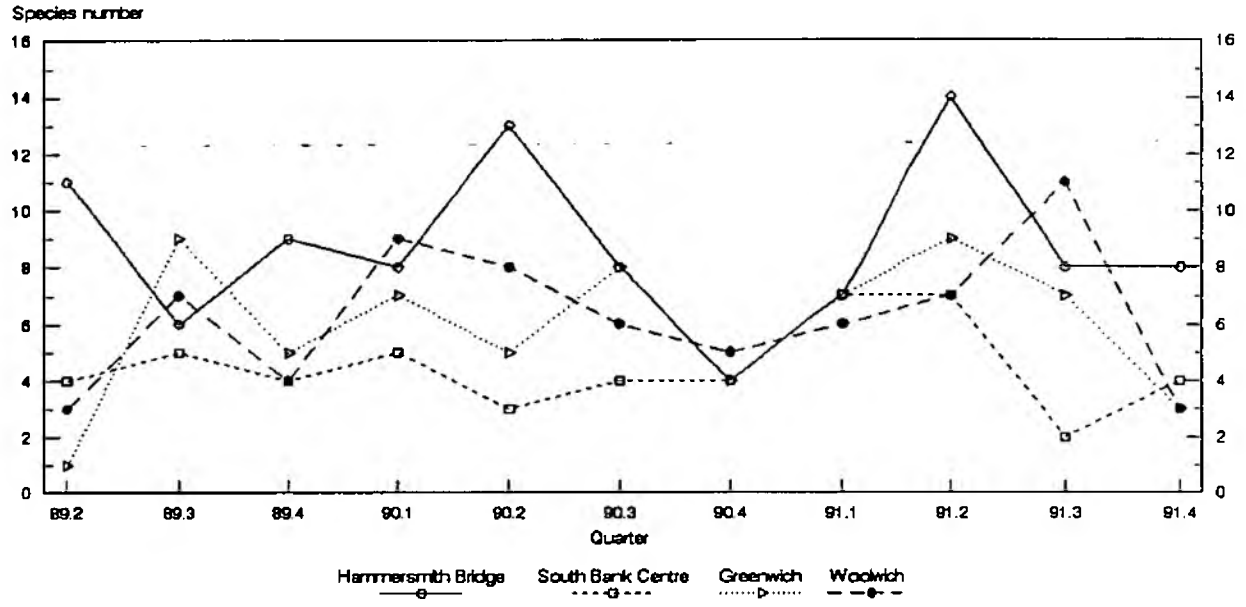


Fig.12b

THAMES ESTUARY BENTHIC PROGRAMME

Species number 1989-91

b. Intertidal sites Crossness to Gravesend

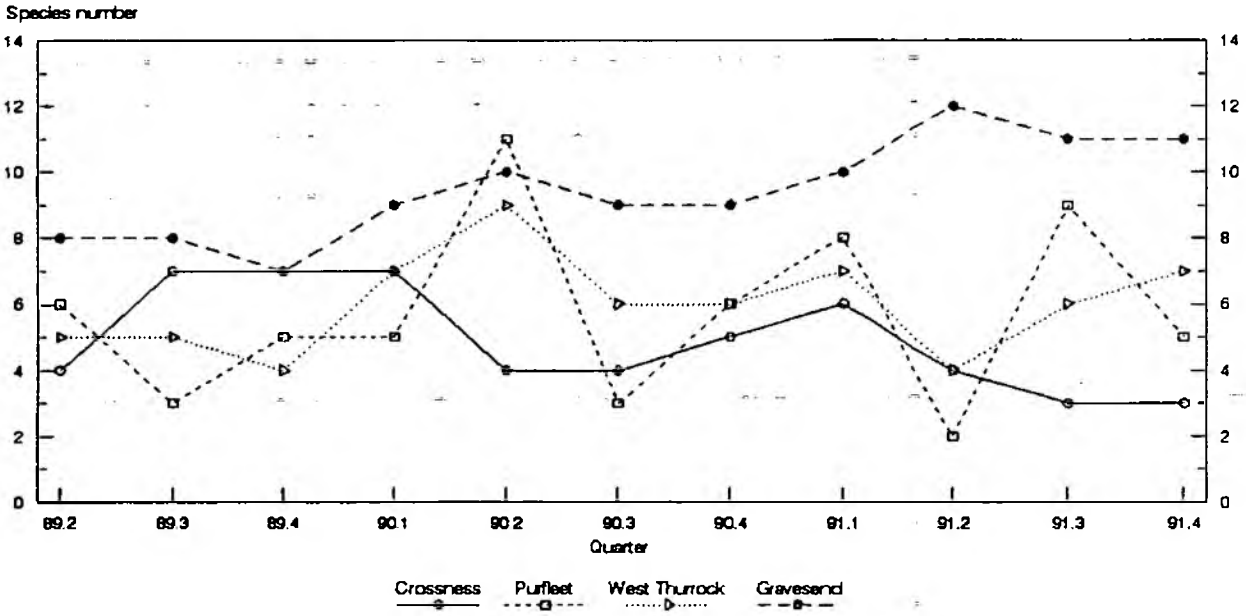
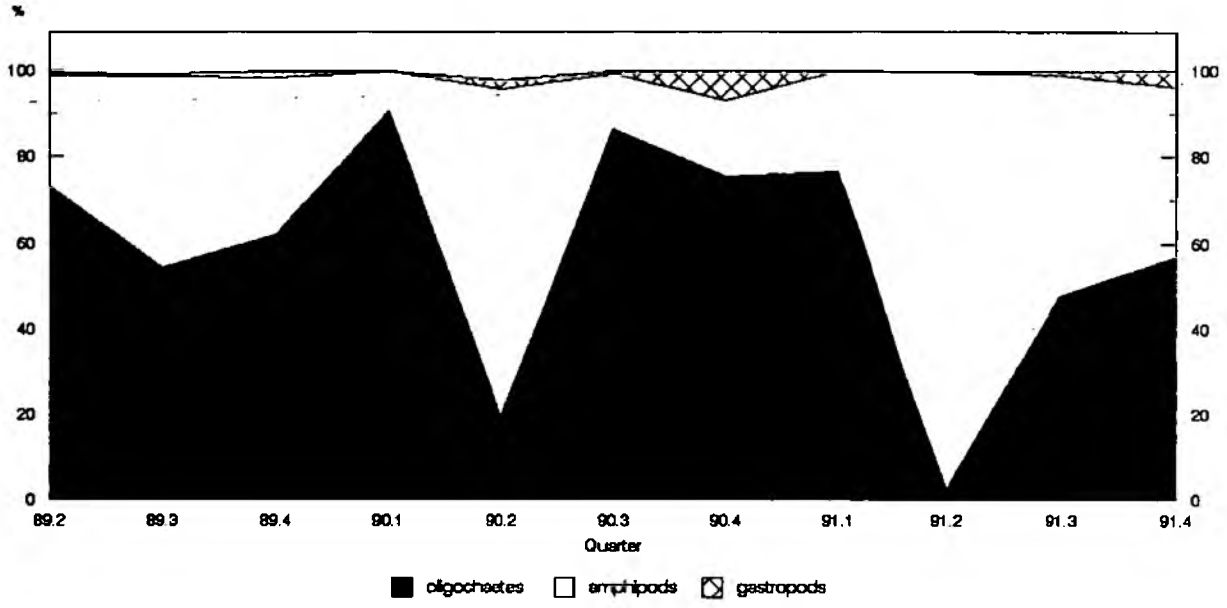


Fig.13

THAMES ESTUARY BENTHIC PROGRAMME

SITE 4: CADOGAN PIER

Composition of the fauna-% of abundance



Composition of the fauna-% of biomass

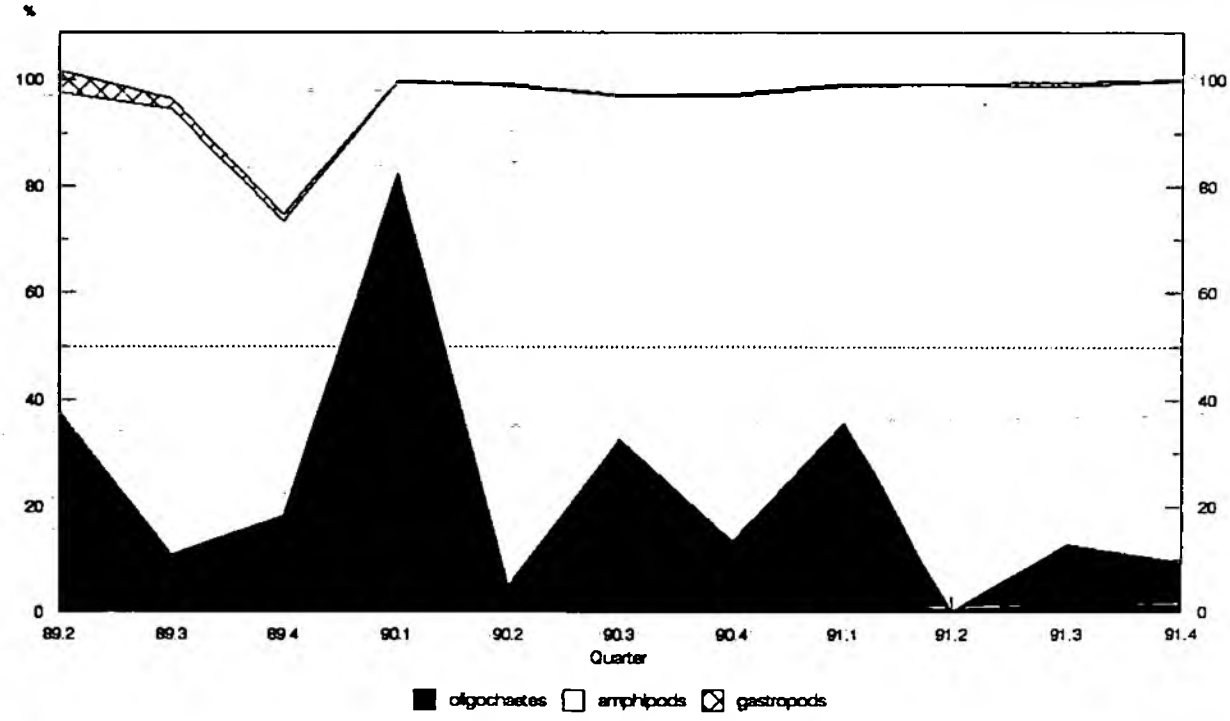
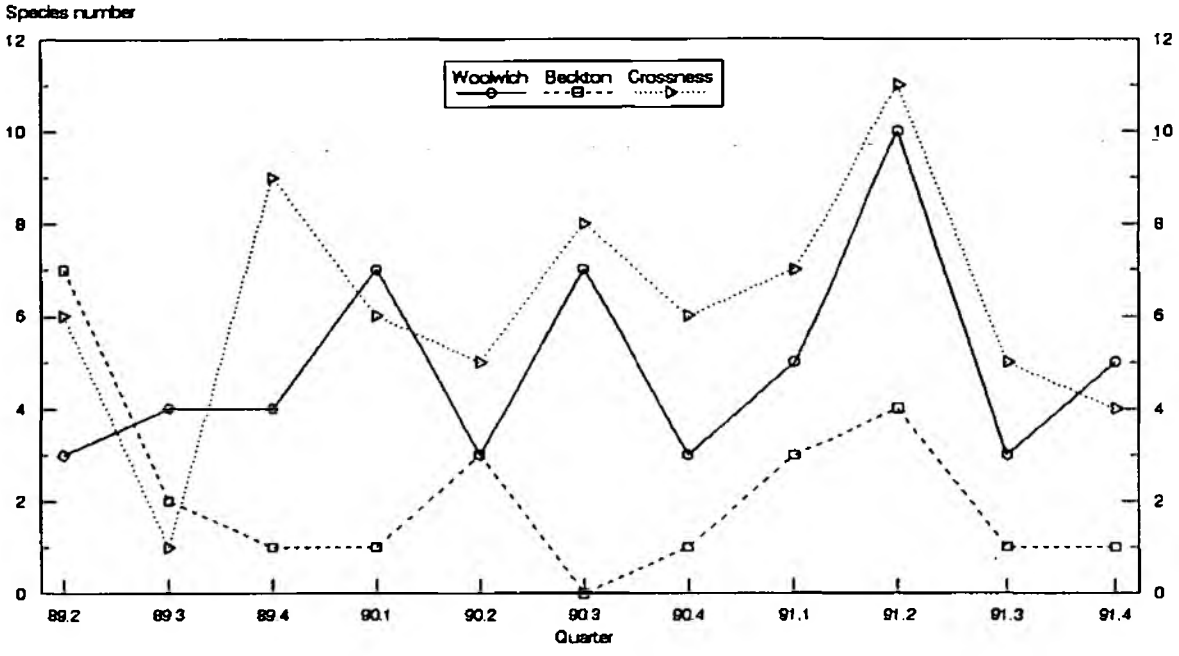


Fig.14 **THAMES ESTUARY BENTHIC PROGRAMME**

Species number 1989-91

a. subtidal sites Woolwich to Crossness



b. subtidal sites Purfleet to Gravesend

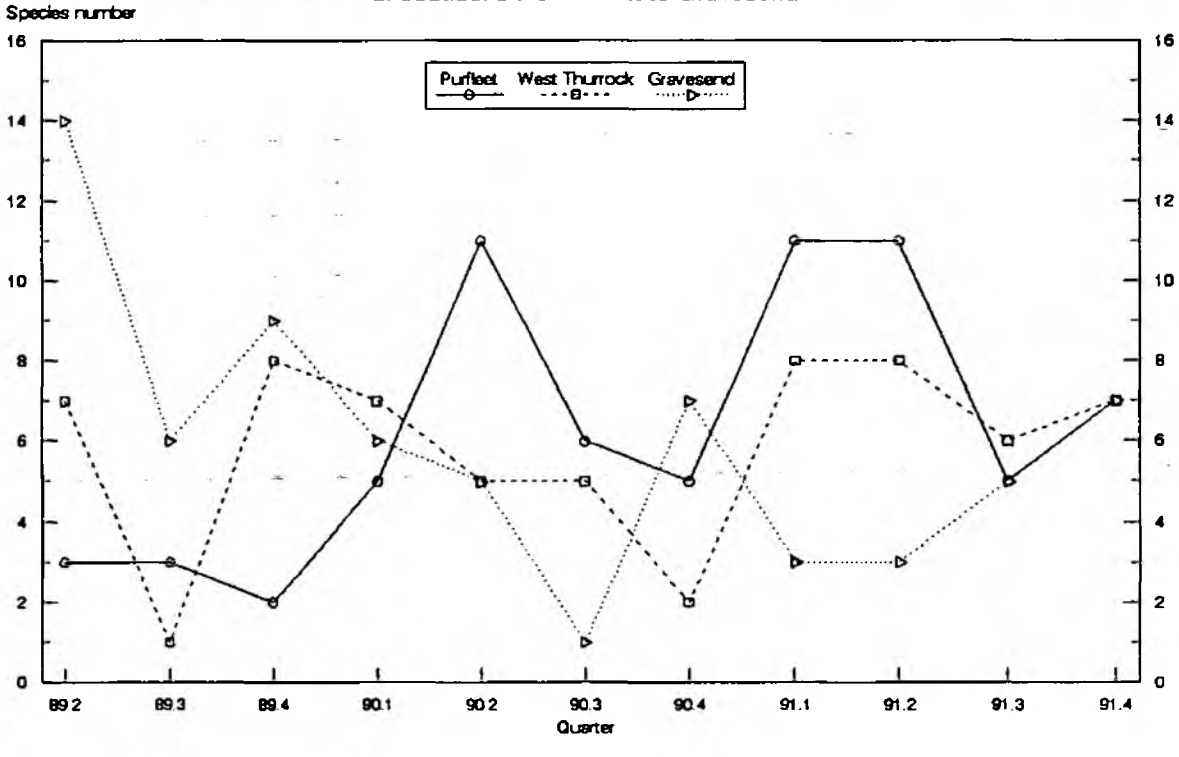
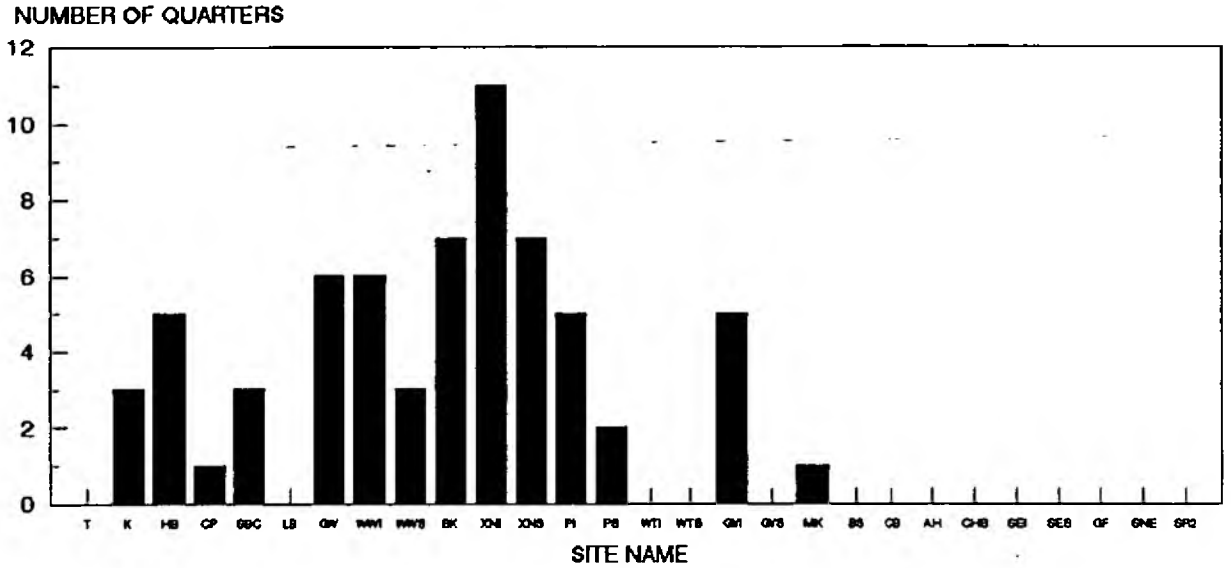


Fig.15 **THAMES ESTUARY BENTHIC PROGRAMME**

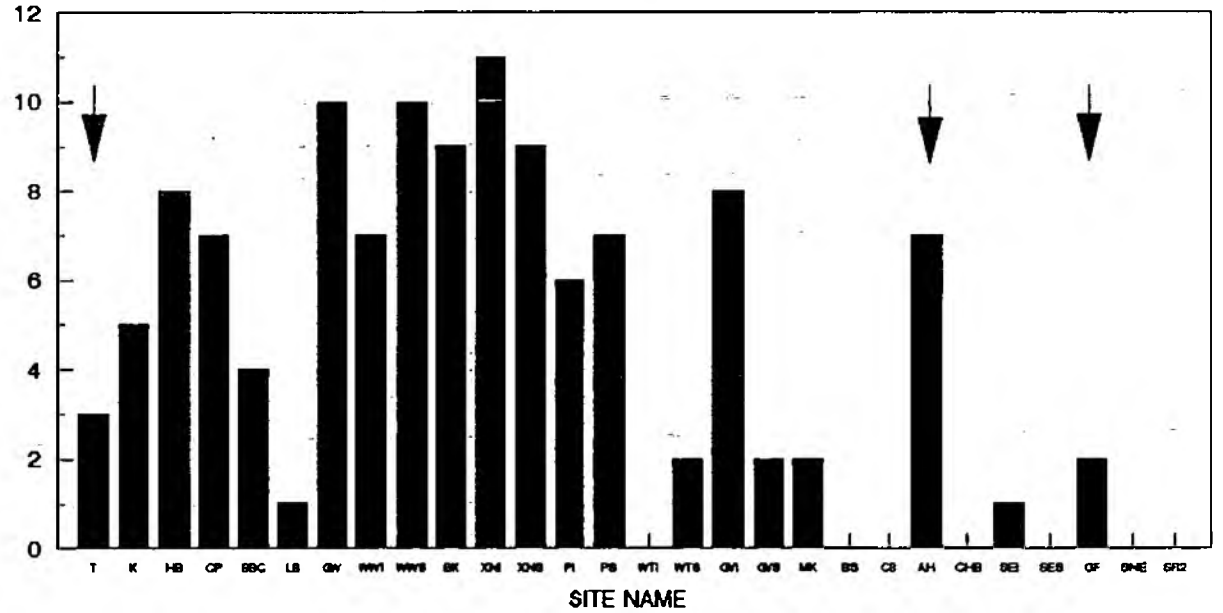
DOMINANCE OF OLIGOCHAETES

>50% Biomass



The number of quarters where oligochaetes represented >50% of the total biomass, indicating possible organic enrichment

>50% Abundance



Large numbers of oligochaetes may be masked by the presence of large species, but may also be indicating a degree of organic enrichment

Some examples arrowed

Fig.16

THAMES ESTUARY BENTHIC PROGRAMME

WEST THURROCK INTERTIDAL
CHANGES IN ABUNDANCE OF MAJOR SPECIES

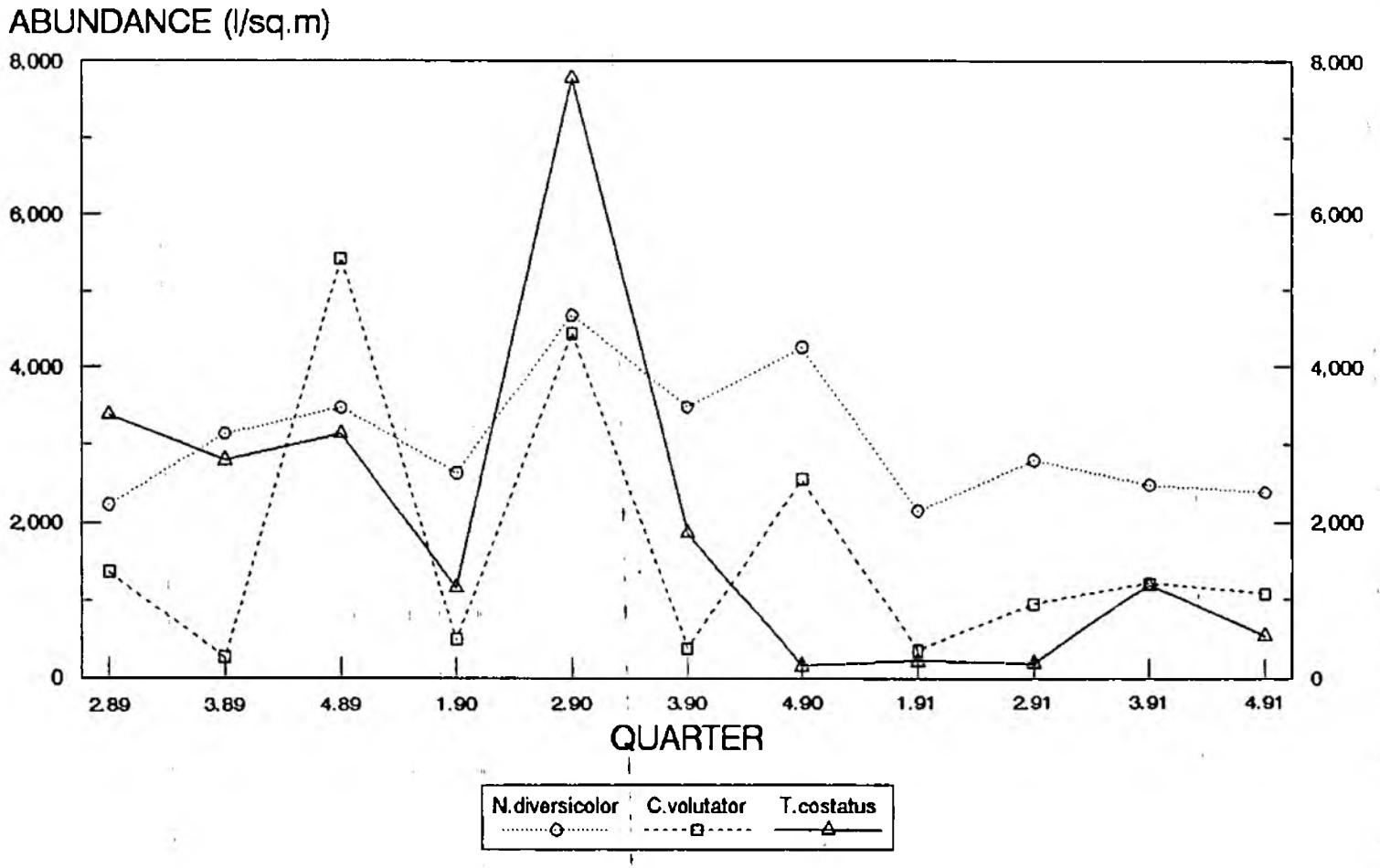


Fig.17

THAMES ESTUARY BENTHIC PROGRAMME

SITE 13I: GRAVESEND INTERTIDAL

Abundance of C.volutator and T.benedeni

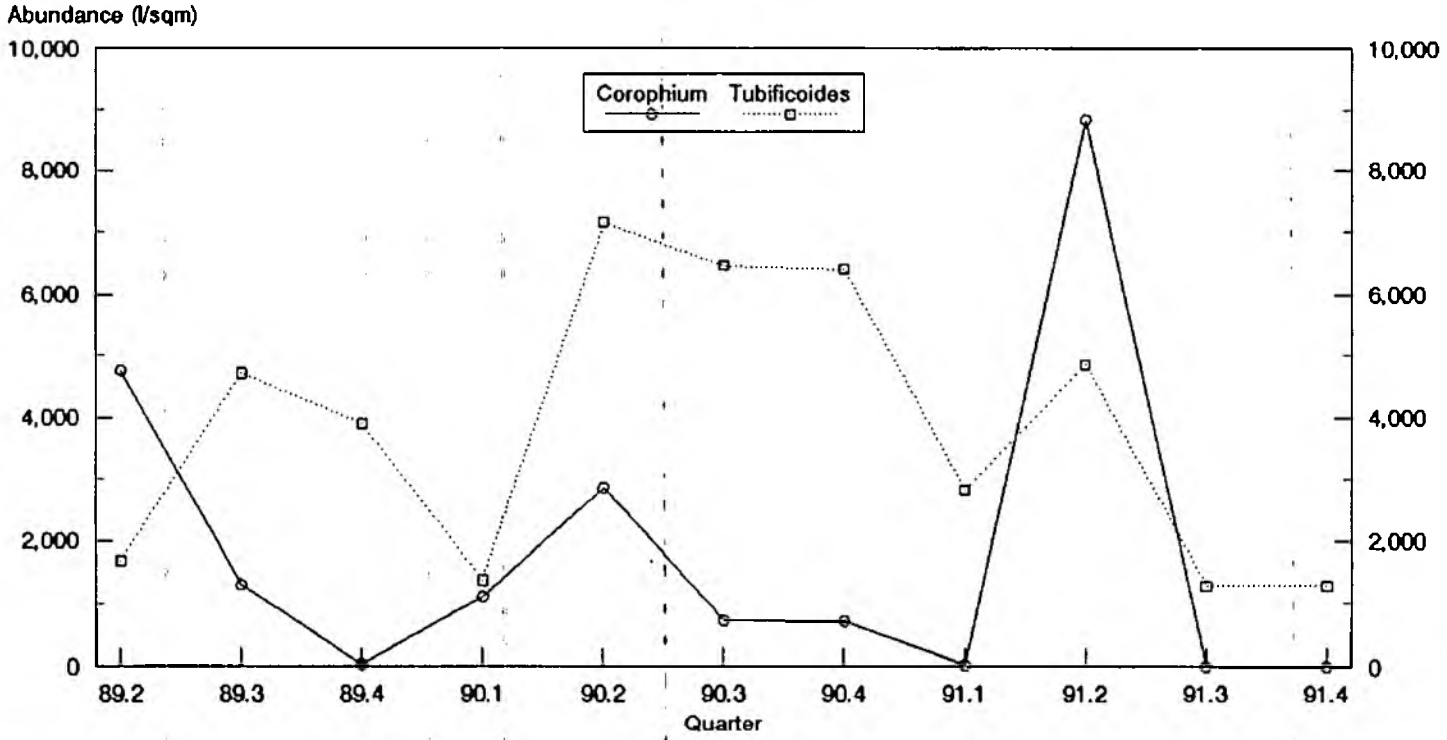


Fig.18 **THAMES ESTUARY BENTHIC PROGRAMME**

SITE 14: MUCKING

Species Richness

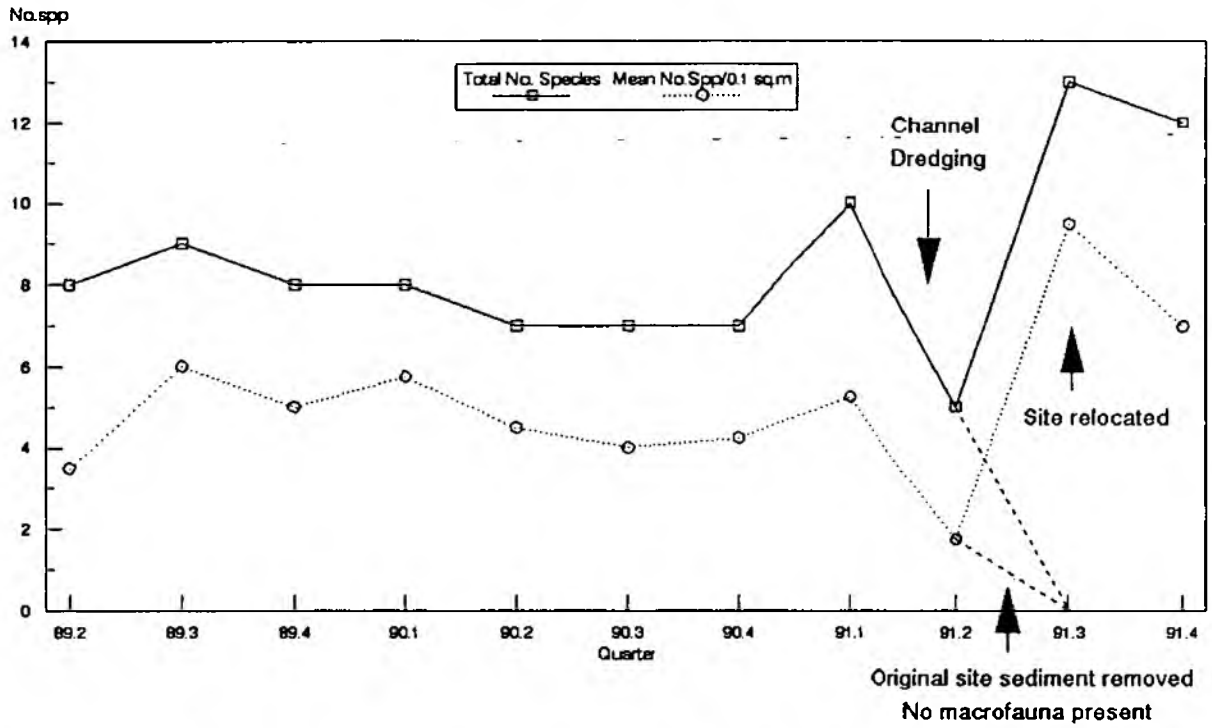


Fig.19 **THAMES ESTUARY BENTHIC PROGRAMME**

Species number 1989-91

Subtidal sites Blythe Sands, Southend, Grain and Sea Reach 2.

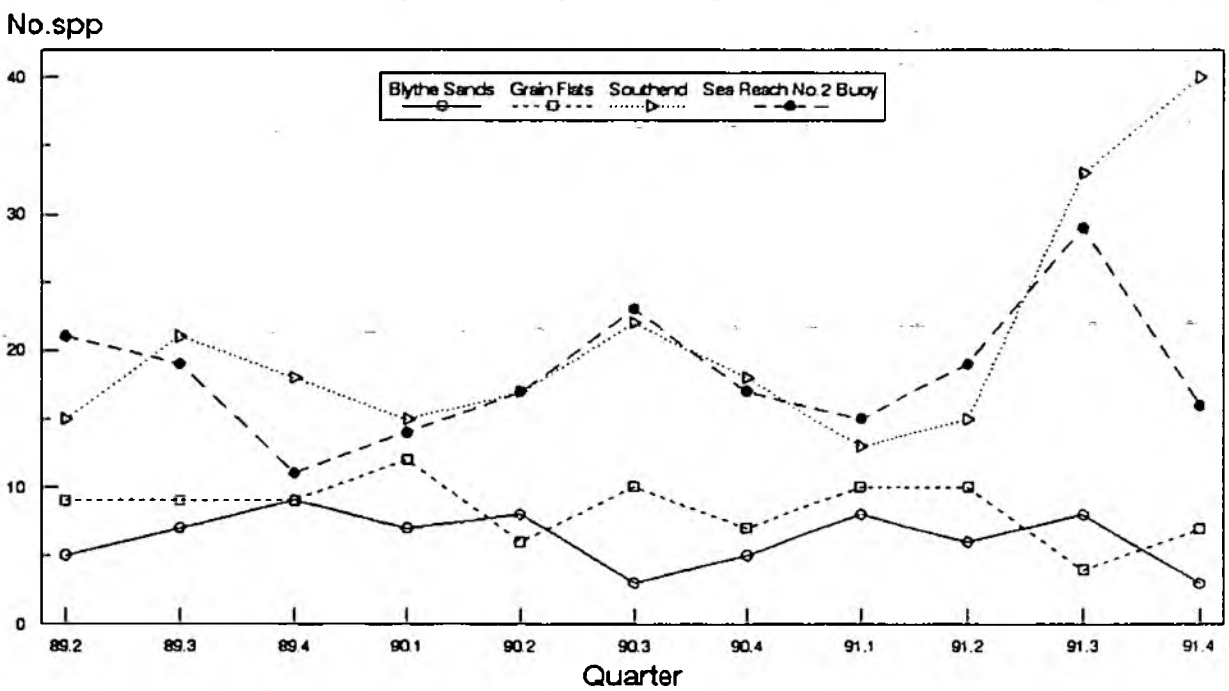


Fig.20

THAMES ESTUARY BENTHIC PROGRAMME

Species number 1989-91

Intertidal sites Canvey to Shoeburyness East

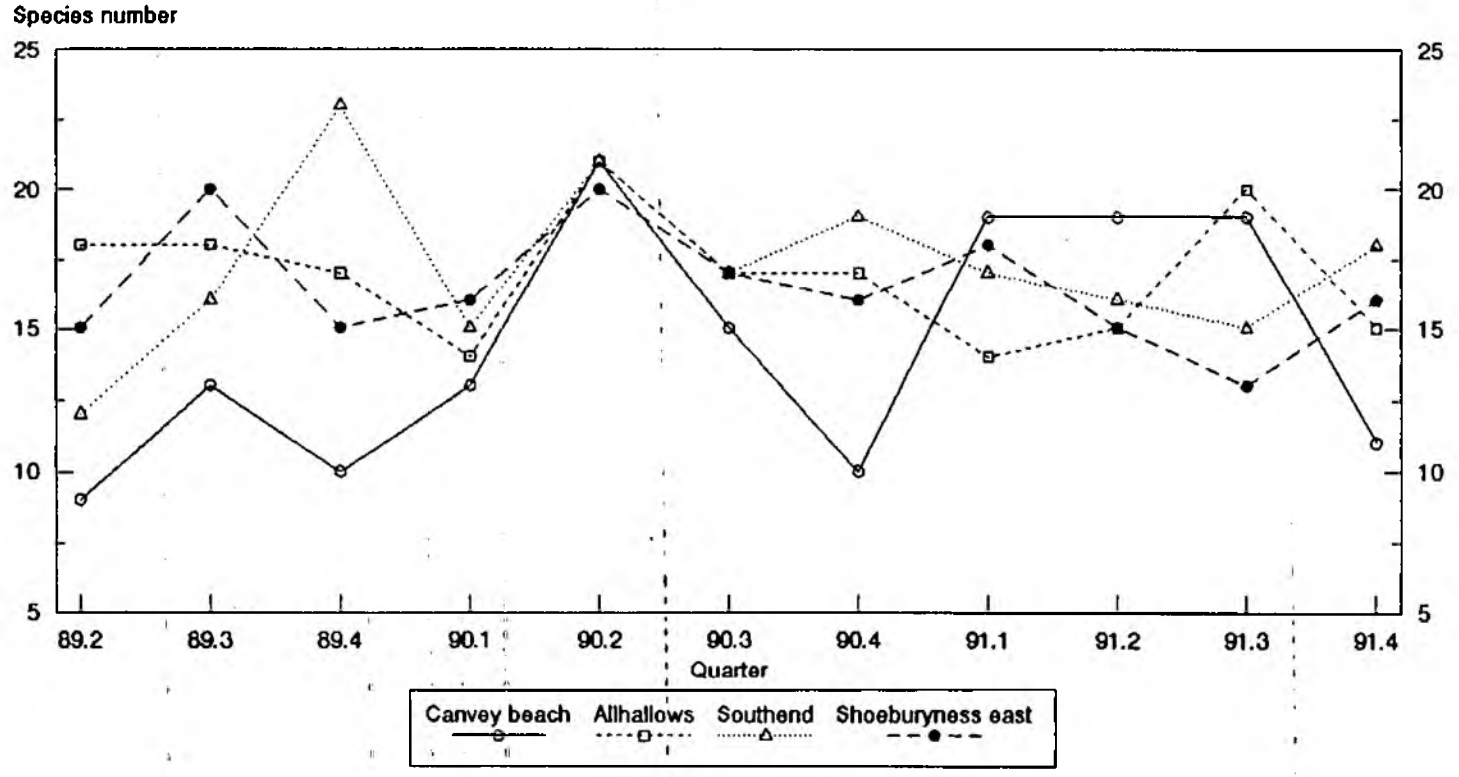
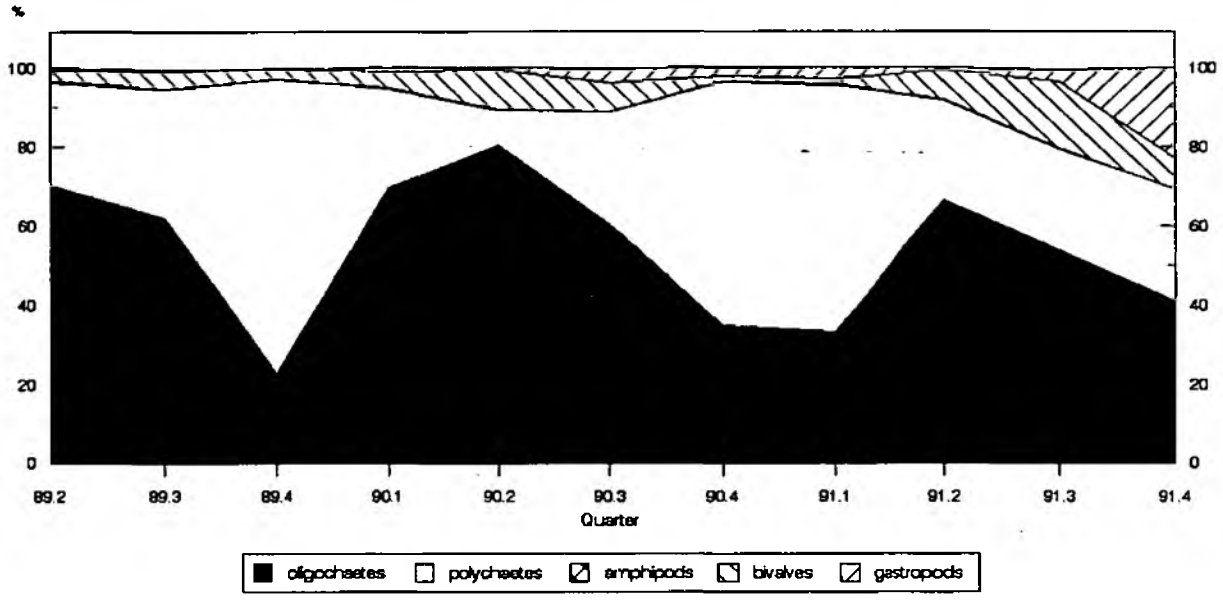


Fig.21

THAMES ESTUARY BENTHIC PROGRAMME

SITE 17: ALLHALLOWS

a). Composition of the fauna-% of abundance



b). Composition of the fauna-% of biomass

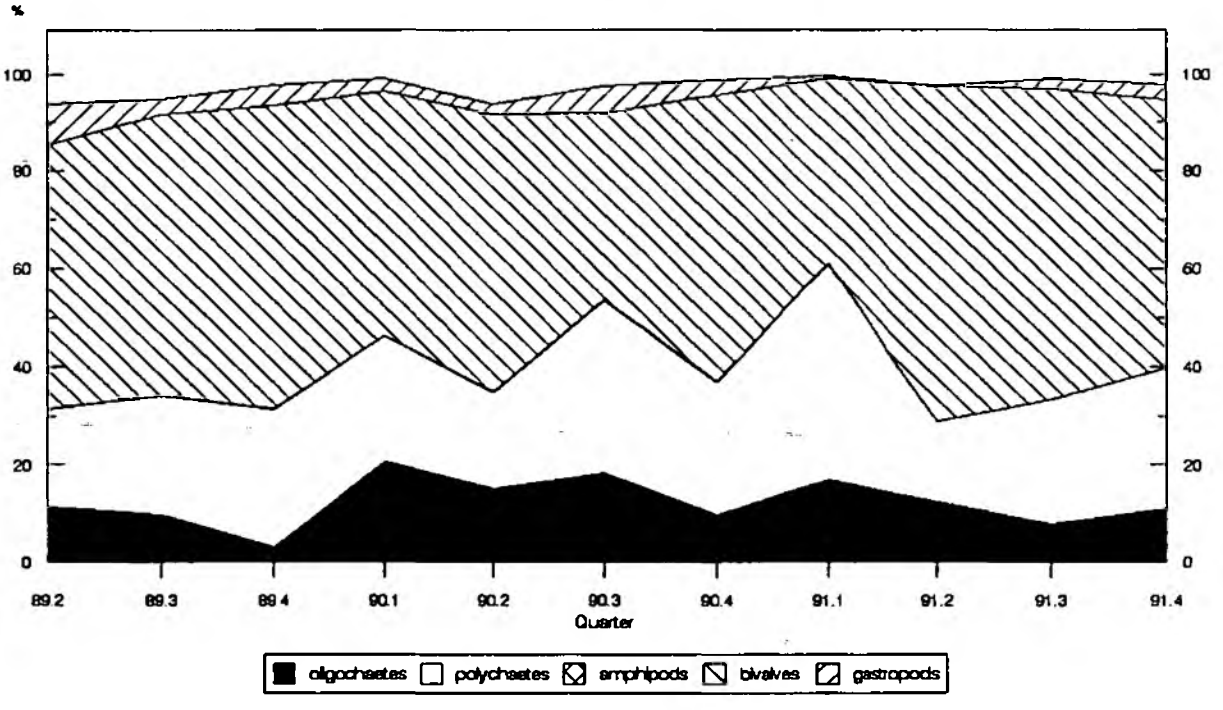


Fig.22. **THAMES ESTUARY BENTHIC PROGRAMME**

Species number 1989-91

Site 18: Chapman Buoy

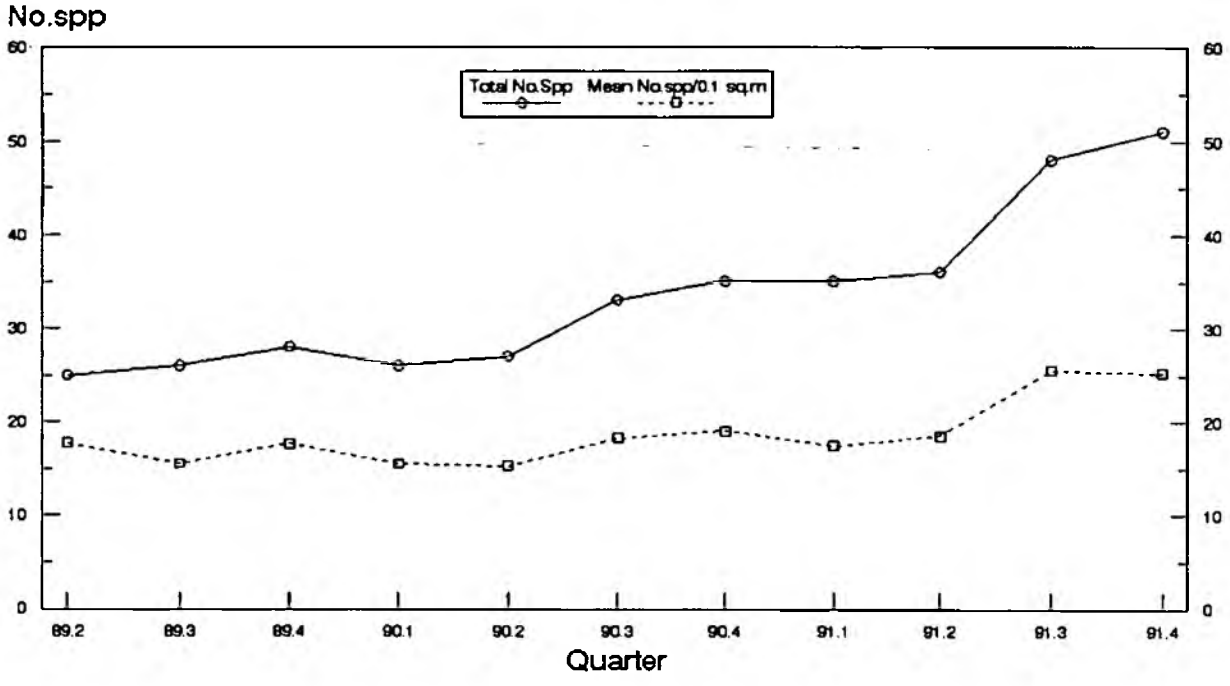


Fig.23 **THAMES ESTUARY BENTHIC PROGRAMME**

SITE 18: CHAPMAN BUOY

Species discovery curve

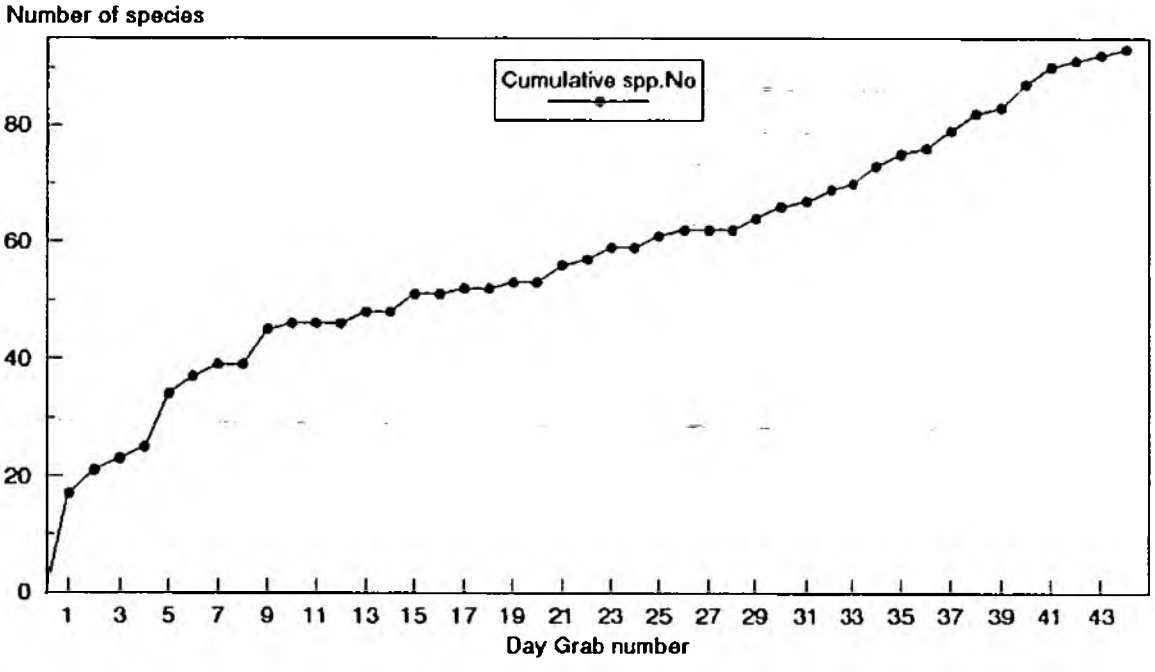
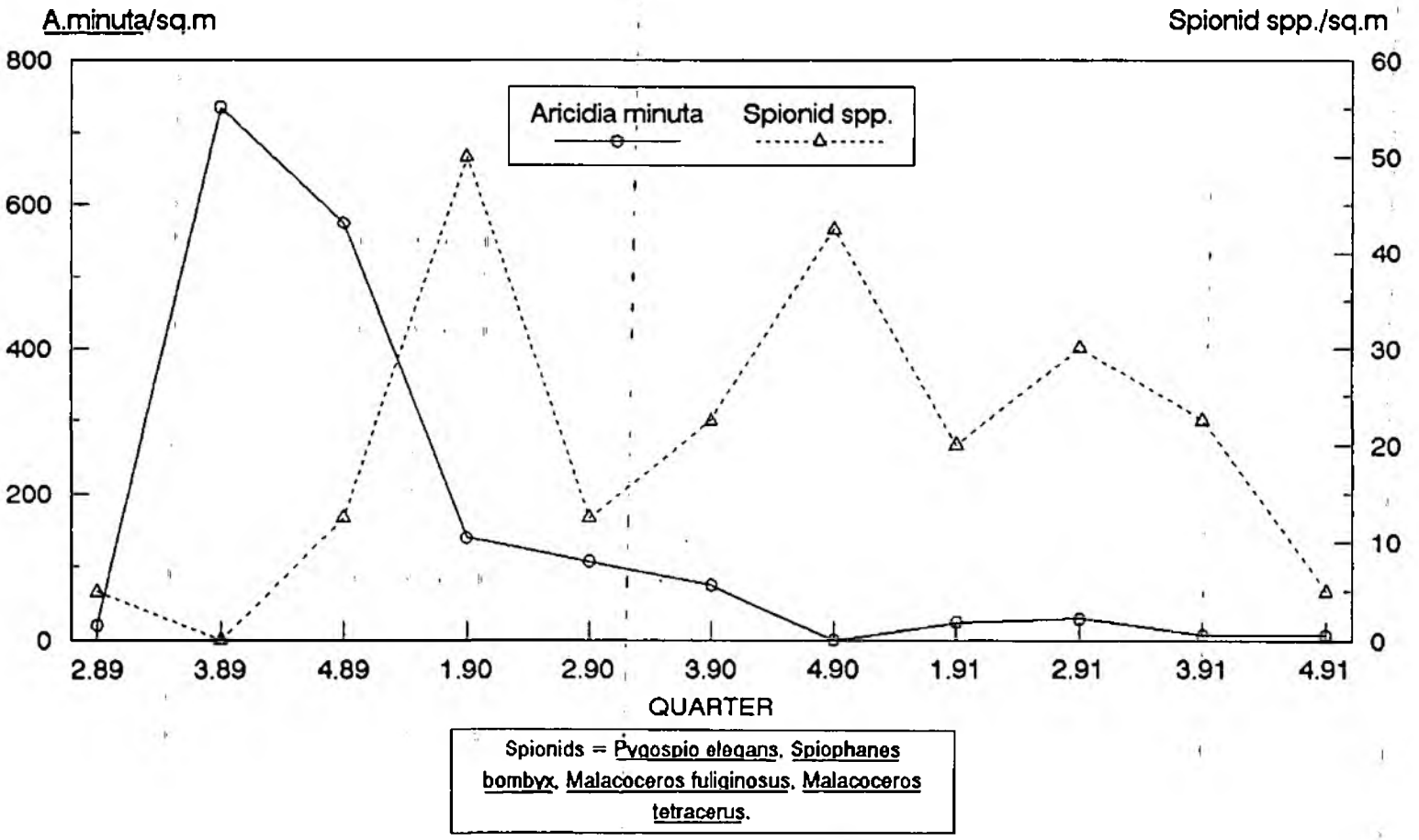


Fig.24.

THAMES ESTUARY BENTHIC PROGRAMME

SITE 22: SEA REACH No.2 BUOY

Abundance of small polychaete species



Spionids = Pygospio elegans, Spiophanes bombyx, Malacoceros fuliginosus, Malacoceros tetracerus.

APPENDICES.

Appendix 1.

LIST OF INVERTEBRATE SPECIES FOUND IN THE THAMES ESTUARY DURING TEBP SINCE 1/4/89

Key: T=Teddington, IW=Isleworth (Teddington low-flow sample site only), K=Kew, HB=Hammersmith Bridge, CP=Cadogan Pier, SBC=South Bank Centre, LB=London Bridge, GW=Greenwich, WW=Woolwich, BK=Beckton, XN=Crossness, P=Purfleet, WT=West Thurrock (incl. power station intake), GV=Gravesend, MK=Mucking, BS=Blythe Sands, CB=Canvey Beach, AH=Allhallows, CHB=Chapman Buoy, SE=Southend, GF=Grain Flats, SNE=Shoeburyness East, SR2=Sea Reach No.2 Buoy, WTT=Trawl at West Thurrock, OET=Trawl in outer estuary.

Species.	Group.	Sites recorded
Freshwater sponge	sponge	T K HB CP
Athecata hydroid	hydroid	GV
Cordylophora ?lacustris	hydroid	CP SBC LB GW
Hydra sp.	hydroid	T HB
Sertularia cupressina	hydroid	CHB SE OET
Sertularia sp.	hydroid	OET
Tubularia indivisa	hydroid	GV OET
Aurelia aurita	jellyfish	CB WT
Actiniaria sp.	sea anemone	OET
?Cereus pedunculatus	sea anemone	SE
Metridium senile	sea anemone	SR2 OET
Sagartia ?elegans	sea anemone	OET
Sagartia troglodytes	sea anemone	GV BS CB AH CHB SE GF SR2
Tealia felina	sea anemone	OET
Pleurobrachia pileus	ctenophore	WT GV OET
Phaenocora sp.	rhabdocoel	T HB
Dendrocoelum lacteum	flatworm	T K HB
Planaria torva	flatworm	T
Polycelis tenuis	flatworm	T K HB
Turbellaria spp.	flatworm	GW SE SNE
Nematoda spp.	nematodes	T WW
Cephalothrix rufifrons	nemertean	SE SNE SR2
Lineus sp.	nemertean	SE
Nemertea sp.A	nemertean	SR2
Tetrastemma sp?	nemertean	SNE
Gordius sp.	nematomorpha	T
Aulodrilus pluriseta	oligochaete	T
Branchiura sowerbyi	oligochaete	K SR2?
Clitellio arenarius?	oligochaete	XN
Eiseniella tetraedra	oligochaete	K XN
Enchytraeidae spp.	oligochaete	K HB SBC LB WW BK XN
Limnodrilus cervix	oligochaete	T K HB CP SBC
Limnodrilus hoffmeisteri	oligochaete	T-LB GW WW BK XN SE ?GF
Limnodrilus claparedeianus	oligochaete	K HB CP
Limnodrilus udekemianus	oligochaete	K HB XN
Lumbriculus variegatus	oligochaete	T K CP SBC LB XN
Lumbriculidae(*Trichodrilus?*)	oligochaete	K
Monopylephorus rubroniveus	oligochaete	GW-GV MK BS CB SE GF SNE
Naididae	oligochaete	T K HB CP SBC LB GW BK XN P
Dero digitata	oligochaete	T
Nais elinguis	oligochaete	K CP WW
Stylaria lacustris	oligochaete	T
Uncinais uncinata	oligochaete	T
Potamothrix bavaricus	oligochaete	CP
Potamothrix hammoniensis	oligochaete	T K HB CP SBC LB GW WW
Potamothrix moldaviensis	oligochaete	K HB CP SBC LB
Psammoryctides barbatus	oligochaete	T-CP SBC LB GW P GV CHB SNE
Rhyacodrilus coccineus	oligochaete	T K
Stylodrilus heringianus	oligochaete	T

Tubifex tubifex	oligochaete	T K HB CP SBC LB GW WW XN
Tubifex ?ignotus	oligochaete	HB
Tubifex costatus	oligochaete	T-LB GW WW XN P WT GV CB
Tubificoides benedeni	oligochaete	WW XN-BS CB AH CHB SE GF SNE
Tubificoides pseudogaster	oligochaete	SNE
Tubificoides sp.	oligochaete	K HB
Ampharete acutifrons	polychaete	MK BS CB AH CHB SE SNE
Anaitides groenlandica	polychaete	SR2
Anaitides maculata	polychaete	CHB
Anaitides mucosa	polychaete	CHB SE GF SNE
Aphrodite aculeata	polychaete	CHB SR2 OET
Arenicola marina	polychaete	GV MK AH SE SNE
Aricidia ?minuta	polychaete	BS CHB GF SE SR2
Autolytus prolifera	polychaete	SR2
Capitella capitata	polychaete	SR2
?Capitellides giardi	polychaete	MK BS CB AH CHB SE GF SNE
Caulleriella sp.	polychaete	WT-BS CB AH CHB SE GF SNE SR2
C.caput-esocis	polychaete	AH SE
C.zetlandica	polychaete	AH SE
Chaetozone setosa	polychaete	CHB SNE SR2
Eteone longa	polychaete	P-BS CB AH CHB SE GF SNE SR2
Eteone flava	polychaete	MK CHB
Eulalia bilineata	polychaete	CB CHB SE
Eumida sanguinea	polychaete	CHB SE
Gattayana cirrhosa	polychaete	CHB OET
Glycera convoluta	polychaete	CHB SE GF SNE SR2
Goniada maculata	polychaete	GF SR2
Harmathoë sp.	polychaete	CHB
Lagis koreni	polychaete	CB CHB SR2
Lanice conchilega	polychaete	CB AH CHB SE GF SNE SR2
Lepidonotus squamatus	polychaete	AH CHB SE
Magelona mirabilis	polychaete	SE SR2
Malacoceros fuliginosus	polychaete	SE SR2
Malacoceros tetracerus	polychaete	SR2
Mysta picta	polychaete	CHB
Neoamphitrite figulus	polychaete	CB SE CHB
Nephtys caeca	polychaete	CHB SE SR2
Nephtys cirrosa	polychaete	SNE SR2
Nephtys hombergii	polychaete	WW P WT GV-AH SE GF SNE SR2
Nephtys longosetosa	polychaete	SR2
Nereis longissima	polychaete	CB CHB OET
Nereis (Neanthes) diversicolor	polychaete	WW XN-GV MK CB CHB SE GF SNE
Nereis (Neanthes) succinea	polychaete	XN WT GV MK CB CHB
Nereis (Neanthes) virens	polychaete	OET
Notomastus latericeus	polychaete	CHB
Ophelia ?neglecta	polychaete	GF
Pholoë ?minuta	polychaete	CHB
Pholoë synophthalmica	polychaete	CHB SE
Polydora ?ciliata	polychaete	HB LB GW WW XN P WT GV
Pomatoceros triqueter	polychaete	CHB SE
Pygospio elegans	polychaete	P GV MK BS CB AH SE GF SNE SR2
Sabella pavonina	polychaete	CHB
Sabellaria spinulosa	polychaete	CHB SE
Scoloplos armiger	polychaete	MK BS CB CHB SE GF SNE SR2
Spio filicornis	polychaete	P
Spiophanes bombyx	polychaete	SR2
Sthenelais boa	polychaete	AH CHB
Streblospio shrubsolii	polychaete	GW WW XN P WT GV
Syllis gracilis	polychaete	CHB
Syllis sp.	polychaete	SE
Syllidae sp.	polychaete	CHB, SE
Tharyx marioni	polychaete	SE
Websterinereis glauca	polychaete	CB CHB
?Batracobdella paludosa	leech	GW

Erpobdella octoculata	leech	T K
Erpobdella testacea	leech	T K HB CP SBC LB GW
Glossiphonia complanata	leech	T K HB CP
Glossiphonia ?heteroclita	leech	GV
Helobdella stagnalis	leech	T K AH SE
?Oceanobdella blennii	leech	CHB SR2
Piscicola geometra	leech	T
Theromyzon tessulatum	leech	T HB SE
Golfingia ?margaritaceum	sipunculid	CHB
Pedicellina sp.	entoproct	CB
Encrusting bryozoan spp.	bryozoan	GV CB AH CHB SE SNE SR2 OET
Flustra foliacea	bryozoan	OET
Freshwater bryozoan	bryozoan	T K HB CP
Balanus improvisus	barnacle	WW XN P CHB
Elminius modestus	barnacle	GV CB AH CHB SE SNE SR2
Semibalanus balanoides	barnacle	CB AH
Cladocerans	cladoceran	T K CB
Eurycercus lamellatus	cladoceran	T
Ilyocryptus sordidus	cladoceran	T
Sarsiella zostericola	cladoceran	CB
Simocephalus retulus	cladoceran	T
Candona spp.	ostracods	T
Copepoda spp.	copepods	T HB WT
Eurytemora affinis	copepod	WT
Argulus foliaceus	fish louse	T
Bodotria scorpioides	cumacean	CHB SE
Cumopsis goodsiri	cumacean	SE SNE
Diastylis bradyi	cumacean	MK BS SE GF SR2
Pseudocuma longicornis	cumacean	SE SR2
Asellus aquaticus	isopod	T K HB CP LB GW
Cyanthura carinata	isopod	AH
Gnathiidae (*Paragnathia*?)	isopod	CB
Idotea chelipes	isopod	SNE
Idotea granulosa	isopod	CB
Idotea linearis	isopod	SE SR2 OET
Jaera albifrons	isopod	P AH
Ligia oceanica	isopod	WT AH
Sphaeroma rugicauda	isopod	CP SBC GW WW P
Sphaeroma monodi	isopod	CB CHB SE SR2
Atylus falcatus	amphipod	SE SR2
Atylus guttatus	amphipod	CB CHB SE SR2
Atylus swammerdami	amphipod	GF
Bathyporeia elegans	amphipod	CHB SE SR2
Bathyporeia guilliamsoniana	amphipod	SE SR2
Bathyporeia pelagica	amphipod	SNE SR2
Bathyporeia pilosa	amphipod	SNE
Bathyporeia sarsi	amphipod	BS GF SNE SR2
Caprella linearis	amphipod	CB CHB SE SR2
Chaetogammarus ?stoerensis	amphipod	CHB
Corophium acherusicum	amphipod	CHB SE
Corophium arenarium	amphipod	CHB SE SNE
Corophium curvispinum	amphipod	T K
Corophium insidiosum	amphipod	WT CB
Corophium lacustre	amphipod	K HB CP SBC LB GW WW MK
Corophium volutator	amphipod	All sites GW-MK CB AH CHB SE
Crangonyx pseudogracilis	amphipod	T CP
Gammarus lacustris	amphipod	T
Gammarus locusta	amphipod	CB SE SNE
Gammarus salinus	amphipod	WW BK XN WT GV BS CB AH GF
Gammarus zaddachi	amphipod	T-LB GW WW BK XN P WT
Melita obtusata	amphipod	WT SNE SR2
Melita palmata	amphipod	MK AH SE
Microprotopus maculatus	amphipod	SE SR2
Monoculodes carinatus	amphipod	SR2

Orchestia gammarella	amphipod	AH
Panopleoa minuta	amphipod	SE
Periculodes longimanus	amphipod	SE SR2
Pontocrates altamarinus	amphipod	SR2
Stenothoe marina	amphipod	CHB SE SR2
Urothoe poseidonis	amphipod	SE SNE SR2
Mesopodopsis slabberi	mysid	P GV MK BS
Neomysis integer	mysid	K HB LB GW WW BK XN-GV GF
Praunus flexuosus	mysid	SNE
Schistomysis spiritus	mysid	GV
Siriella armata	mysid	WT GV
Crangon crangon	natant	HB CP GW WW XN-GV CB-CHB GF SNE WTT OET
Hippolyte varians	natant	CHB SE OET
Palaemon elegans	natant	AH SNE
Palaemon longirostris	natant	CP WW P WT GV CB WTT
Palaemon serratus	natant	WT CHB
Palaemonetes varians	natant	P
Pandalus montagui	natant	WT OET
Processa nouveli holthuisi	natant	WT
Pagurus bernhardus	anomuran	CHB SE SR2 OET
Pagurus ?pubescens	anomuran	CHB
Porcellana longicornis	anomuran	BS CB CHB
Homarus gammarus	macruran	OET
Atelecyclus rotundus	brachyuran	SE
Cancer pagurus	brachyuran	GW CHB OET
Carcinus maenas	brachyuran	WW P-MK CB-SE SNE WTT OET
Corystes cassivelaunus	brachyuran	AH SR2
Eriocheir sinensis	brachyuran	T K HB GW XN WT
Hyas arenarius	brachyuran	CHB SE OET
Liocarcinus puber	brachyuran	OET
Liocarcinus depurator	brachyuran	OET
Liocarcinus holsatus	brachyuran	WT OET
Macropodia rostrata	brachyuran	WT CHB SE OET
Pinotheres pisum	brachyuran	CB
Ceratopogonidae spp.	dipteran	T K
Chironomid spp.	dipteran	T-LB GW WW BK XN AH CHB SNE
Acricotopus sp.	chironomid	T K
Brillia longiforca	chironomid	SBC
Bryophaenocladius sp.	chironomid	T K CP
Chironomus sp.	chironomid	T K CP AH
Conchapelopia melanops	chironomid	T K
Cricotopus bicinctus	chironomid	T K
Cricotopus sp.	chironomid	T K CP
Cricotopus sylvestris	chironomid	T
Cryptochironomus sp.	chironomid	T
Demeijerea sp.	chironomid	T
Dicrotendipes sp.	chironomid	T K
Glyptotendipes sp.	chironomid	T K
Harnischia sp.	chironomid	T K
Limnophyes sp.	chironomid	T K CP
Metriocnemus sp.	chironomid	CP
Micropsectra atrofasciata	chironomid	T K
Micropsectra sp.	chironomid	K
Microtendipes sp.	chironomid	K
Nanocladius sp.	chironimid	T K
Orthocladius sp.	chironomid	T
Parachironomus sp.	chironomid	T K CP
Paratendipes sp.	chironomid	T
Paratrichocladius sp.	chironomid	T K CP
Phaenopsectra sp.	chironomid	T K
Polypedilum sp.1	chironomid	T
Polypedilum sp.2	chironomid	T K
Procladius sp.	chironomid	T

Psectrocladius sp.	chironomid	T K
Pseudosmittia sp.	chironomid	T K CP
Rheocricotopus sp.	chironomid	T
Rheopelopia sp.	chironomid	T
Rheotanytarsus sp.	chironomid	T
Smittia sp.	chironomid	CP
Synorthocladius sp.	chironomid	T K
Thalassosmittia sp.	chironomid	T K LB CP
Thienemannimyia sp.	chironomid	T K
Xenochironomus sp.	chironomid	T K
Chaoborus sp.	dipteran	WW
Erioptera sp.	dipteran	SNE
Psychodidae sp.	dipteran	SBC LB P GV
Tipulidae sp.	dipteran	WT
Ischnura elegans	damsel fly	T K CP
Athripsodes cinereus	caddis	T
Ceraclea nigronervosa	caddis	T
Hydroptila sp.	caddis	T
Mystacides azurea	caddis	T
Mystacides longicornis	caddis	T
Tinodes waeneri	caddis	T
Baetis sp.	mayfly	T
Caenis horaria	mayfly	T
Caenis moesta	mayfly	T K HB CP LB
Cloeon dipterum	mayfly	T
Ephemera danica	mayfly	T
Potamonectes depressus	beetle	T
Haliplus sp.	beetle	T
Oulimnius sp.	beetle	T SBC LB
Oulimnius tuberculatus	beetle	T
Aphelocheirus aestivalis	water bug	T
Sigara sp.	water bug	CP
Strigamia maritima	centipede	AH
Hydracarina spp.	water mite	T K HB CP
Limnesidae	hydracarina	T K HB
Mideopsidae	hydracarina	CP
Achelia echinata	sea spider	CHB
Nymphon rubrum	sea spider	CB CHB SE SR2
Pycnogonum littorale	sea spider	CHB SE
Lepidopleurus asellus	chiton	CB AH CHB
Acroloxus lacustris	gastropod	IW
Ancylus fluviatilis	gastropod	T K HB CP
Bithynia tentaculata	gastropod	T K CP P
Buccinum undatum	gastropod	OET
Crepidula fornicata	gastropod	CB CHB SE OET
Gibbula umbilicalis	gastropod	CHB
Hydrobia ulvae	gastropod	P WT MK CB AH GF SE SNE
Littorina littorea	gastropod	CB AH SNE
Littorina saxatilis	gastropod	SNE
Lymnaea auricularia	gastropod	K
Lymnaea peregra	gastropod	T K HB CP
Lymnaea stagnalis	gastropod	T
Physa ?heterostropha	gastropod	XN WT
Planorbis alba	gastropod	T K P
Planorbis carinatus	gastropod	T
Potamopyrgus jenkinsi	gastropod	T K CP SBC LB GW WW XN P
Theodoxus fluviatilis	gastropod	T
Valvata piscinalis	gastropod	T K
Viviparus viviparus	gastropod	K
Acanthodoris pilosa	opistobranch	OET
Onchidoriidae sp.	opistobranch	CHB OET
Retusa obtusa	opistobranch	SE GF SNE
Abra alba	bivalve	CB CHB SE SR2
Abra ?nitida	bivalve	SR2

Anodonta complanata	bivalve	T
Anodonta cygnea	bivalve	T K CP
Barnea candida	bivalve	CHB
Cerastoderma edule	bivalve	MK BS CB AH CHB SE GF SNE SR2
Donax vittatus	bivalve	CHB SR2
Dreissena polymorpha	bivalve	T CP GW
Ensis ?arcuatus	bivalve	MK CB SE SR2
Macoma balthica	bivalve	All sites XN-SR2
Mactra corallina	bivalve	CB
Modiolus ?phaseolinus	bivalve	CB CHB SE
Moerella pygmaea	bivalve	CHB SR2
Mya arenaria	bivalve	AH
Mysella bidentata	bivalve	CHB SNE
Mytilus edulis	bivalve	WT GV CB AH CHB SE SNE
Nucula turgida	bivalve	CHB SE GF SNE SR2
Petricola pholadiformis	bivalve	BS CHB GF
Pisidium spp.	bivalve	T K HB CP
Scrobicularia plana	bivalve	P WT GV CB AH CHB SE
Sphaerium corneum	bivalve	T K HB CP
Sphaerium lacustre	bivalve	T
Tellina fabula	bivalve	CHB SE SNE SR2
Alloteuthis subulata	cephalopod	WT
Sepia officianalis	cephalopod	WT
Sepiola atlantica	cephalopod	WT
Echinocardium cordatum	heart-urchin	OET
?Echinocyamus pusillus	pea-urchin	SR2
Psammechinus miliaris	sea urchin	MK WTT OET
Asterias rubens	starfish	CB CHB WTT OET
Ophiura ophiura	brittle star	CHB GF SR2 OET
Amphipholis squamata	brittle star	CHB SE GF
Sagitta elegans	chaetognath	GF
Molgula manhattensis	sea squirt	WT GV

Appendix 2.
Coliform levels recorded in the upper Thames Estuary during Teddington low-flow surveys 1989-90.

Data from Attrill (1990) and Attrill & Ashby-Crane (1991).

a. 1989

Site	*Escherichia coli* Maximum	*Escherichia coli* Mean	*Escherichia coli* Minimum	Total Coliforms Maximum	Total Coliforms Mean	Total Coliforms Minimum
u/sT¶	5,100	1,574	270	103,000	37,600	1,100
T	45,000	6,007	400	250,000	36,933	2,000
IW†	>150,000	41,130	3,800	800,000	301,867	49,000
K	50,000	20,967	3,500	310,000	131,600	41,000
HB	60,000	15,320	3,900	280,000	127,467	30,000
CP	58,000	11,140	1,000	630,000	119,933	19,000

b. 1990

Site	*Escherichia coli* Maximum	*Escherichia coli* Mean	*Escherichia coli* Minimum	Total Coliforms Maximum	Total Coliforms Mean	Total Coliforms Minimum
u/sT¶	3,500	1,212	250	53,000	18,807	3,000
T	15,000	2,607	300	40,000	19,222	3,000
IW†	>150,000	23,722	2,200	>1,500,000	317,500	19,000
K	98,000	20,017	1,600	1,030,000	195,889	24,000
HB	29,000	9,181	1,800	430,000	80,188	13,000
CP	40,000	7,011	900	380,000	81,167	7,000

¶ = upstream Teddington weir site, NGR: TQ 170713.
† = Isleworth site, NGR: TQ 169761.

Appendix 3.
Potential Impact Indices (PIIs) for Major Thames Estuary STW.

The PII is derived by relating the volume discharging from each STW to the amount of water in the estuary (or river, canal, etc.) at the receiving point. Estuary width (at high tide) is used as a basic measurement of the receiving water. Due to the cubic relationship, using the receiving water *volume* would increase the disparity between upper and outer estuary STW impacts, though calculation of this value is complicated due to a necessary knowledge of the estuarine bed topography. Similarly, using low-tide estuary width would also increase the PII, though this value is harder to measure due to variations in tidal level between spring and neap tides. Mean high tide width can be measured from OS maps.

The PII is calculated by dividing the estuary width into the potential discharge, the higher the index, the greater the potential influence of the outfall on the receiving water and its environment.

STW Name	Potential discharge (m^3/d)	Estuary Width (m)	Potential Impact Index
Mogden	420,000	100	4,200
Kew	65,500	130	504
Beckton	730,000	770	948
Crossness	982,000	840	1,169
Long Reach	165,600	810	204
Northfleet	9,300	730	13
Tilbury	32,000	1170	27
Gravesend	12,700	1540	8
Southend	36,650	8000	5

The above table illustrates the **potential** impact of each STW on the receiving water at that point. Obviously, the **actual** impact would depend on the quality of the effluent, highlighting the requirement for high quality effluent at sites with a high PII. A deterioration in the effluent from Mogden is likely to have a much greater effect on the estuarine environment than a similar decline in the quality of a low PII works.

An indication of the actual impact can be obtained by relating the volume of effluent, the receiving estuary width and the recorded quality of the effluent. One measure of the quality is the concentration of *Escherichia coli* faecal bacteria in the effluent, though in theory any potential pollutant can be used, particularly if the impact of a specific contaminant (e.g. Cd) is of interest. If this figure is multiplied by the PII, the resulting value gives an estimation of the actual impact (or "observed PII").

The *E.coli* concentrations used in the following table were obtained from an NRA survey of all Thames Estuary STW discharges undertaken in March 1991 and are used only as an example. Obviously, the mean of a series of samples would have to be taken to give a significant *E.coli* concentration for each STW.

STW name	Recorded *E.coli* concentration (/100ml)	Observed PII ($\times 10^6$)
Mogden	30,000	126.00
Kew	10,000	5.04
Beckton	6,000	5.69
Crossness	56,000	65.50
Long Reach	56,000	11.42
Northfleet	530,000	6.89
Tilbury	>1,500,000	>40.50
Gravesend	>1,500,000	>12.00
Southend	>1,500,000	>7.50

Due to the relatively high quality of Beckton's effluent it has a low observed PII, whereas a much smaller works with an extremely poor effluent, such as Tilbury, has a higher value. Mogden remains the STW with the highest PII - if it had an effluent with the same quality as Beckton, the value would drop from 126 to 25.2. Due to storm overflow, Mogden has periodic discharges of very poor quality (similar to Tilbury). During these periods the PII would be much higher (>6300), highlighting the influence this works has on the environment of the upper estuary.

The PII gives a general indication of the effect of a STW. Outer estuary works have a generally low PII due to the receiving volume, though they may be having a greater local effect on the area around the outfall.

Appendix 4.
Spatial Influence of Thames Estuary major STW.

The following table illustrates the movement of water up and down the estuary over a tidal cycle and therefore which sites may be influenced by the effluents from the major sewage treatment works.

Example: **Position at high tide -** water outside Beckton STW at low tide would move up to Wapping (between London Bridge & Greenwich) by high tide.

Position at low tide - water outside Beckton STW at high tide would move down to Greenhithe (between Purfleet & West Thurrock) by low tide

Sites affected refers to the TEBP sites that the spread of effluent passes over and thus may be influencing.

STW	Position at high tide	Position at low tide	Sites affected
Mogden	Richmond	Putney	K HB
Kew	Richmond	Cadogan	K HB CP
Beckton	Wapping	Greenhithe	GW WW BK XN P WT
Crossness	Victoria Dock	Greenhithe	WW BK XN P WT
Long Reach	Beckton	Gravesend	BK XN P WT GV
Northfleet	Purfleet	Mucking	P WT GV MK
Tilbury	Purfleet	Mucking	P WT GV MK
Gravesend	Purfleet	Mucking	P WT GV MK
Southend*	Mucking	Sea Reach 2	MK BS CB CHB AH SE GF SNE SR2

* The influence of Southend STW on the sites listed will be dependant on local water movement within the outer estuary. This table just defines the area of possible influence due to tidal movement.

The effect of each STW will be dependant on the discharge volume, size of receiving water and effluent quality (see PIIs, Appendix 3).

Appendix 5
List of invertebrate species recorded from the intake screens of West Thurrock Power Station.

CNIDARIA
- *Aurelia aurita*

CTENOPHORA
- *Pleurobrachia pileus*

POLYCHAETA
- *Nereis (Neanthes) diversicolor*
- *Nereis (Neanthes) succinea*

CRUSTACEA
- *Carcinus maenas*
- *Corophium volutator*
- *Crangon crangon*
- *Eriocheir sinensis*
- *Gammarus salinus*
- *Gammarus zaddachi*
- *Ligia oceanica*
- *Liocarcinus holsatus*
- *Macropodia rostrata*
- *Neomysis integer*
- *Palaemon longirostris*
- *Palaemon serratus*
- *Pandalus montagui*
- *Processa nouveli holthuisi*
- *Sirtella armata*

MOLLUSCA
- *Alloteuthis subulata*
- *Mytilus edulis*
- *Sepia officianalis*
- *Sepiola atlantica*

ASCIDIACEA
- *Molgula manhattensis*