ENVIRONMENT AGENCY

HUMBER ESTUARY

FLOOD DEFENCE STRATEGY

PAULL HOLME STRAYS

ENVIRONMENTAL MONITORING REPORT 2005

Version No 1.0
March 2005

Environment Agency
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Environment Agency

Paull Holme Strays

Environmental Monitoring Report 2005

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Environment Agency

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Contents Amendment Record

This report has been issued and amended as follows:

Issue	Revision	Description	Date	Signed
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Acknowledgements for volunteers

The Environment Agency wish to thank all the volunteers who have been involved with monitoring the site, for all the time, effort and enthusiasm they have given. The information they have collected has provided a fantastically in-depth look at what is living in and what has been using the site over the last year, and one which we would not have without their help. Particular thanks go to Mr Roy Lyon and Mr Ian Biggin from Hull Valley Wildlife Group and Mr Alan Marshall from East Yorkshire Botany Club who have not only collected a large amount of data themselves but have also collated the information they and their co-volunteers collected.

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NOTE: ALL REFERENCES IN THIS DOCUMENT CAN BE FOUND IN FULL IN APPENDICES A, B, C, AND E.

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Technical Summary

Paull Holme Strays (PHS) above, is the site of the first major managed realignment scheme on the Humber. Created by the Environment Agency as part of a flood risk management scheme, the site provides approximately 80ha of new intertidal habitat (hereafter referred to as 'the inside') and is fronted by the extensive Paull Holme Sands mudflat (hereafter referred to as 'the outside'). The site is adjacent to the Humber Estuary Special Protection Area (SPA), Ramsar Site and possible Special Area of Conservation (pSAC). These designations form part of the Natura 2000 network of 'European Sites' and illustrate the international importance of the estuary for, amongst other things, intertidal habitats and the wildfowl and waders they support.

Since the old tidal embankment was breached on 5th September 2003 initial observations have indicated that the site has been rapidly changing in response to twice daily tidal inundations and associated sediment re-distribution. A general plan of the PHS site showing the location of the breaches on the original embankment and the new embankment is shown in Figure 1. In order to monitor the observed changes, a 5-year monitoring programme began in late 2003 to monitor the accretion and erosion at this site and to assess the development of intertidal habitat and associated assemblages especially benthic invertebrates, birds and vegetation. Initial first year results are presented in this report.

The main objectives of the PHS managed realignment project were to:

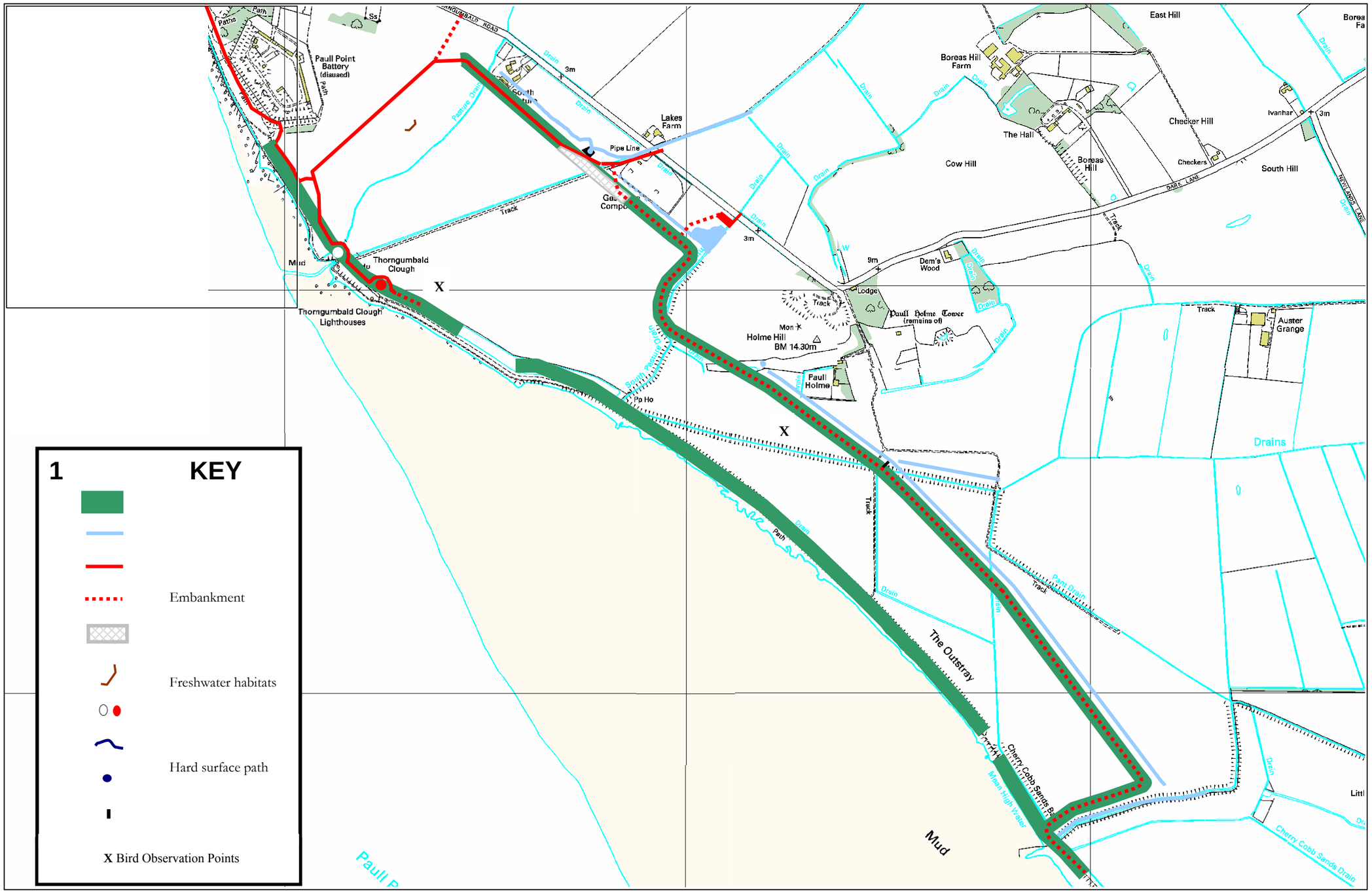
- provide cost effective flood risk management for the area;
- create intertidal habitat to compensate for that lost through implementation of this and other flood defence schemes in the middle estuary;
- address additional habitat losses arising from coastal squeeze and identified in the Coastal Habitat Management Plan (CHaMP). These losses occur when, in response to rising sea levels, intertidal habitats are prevented from migrating inland by tidal defences.

The scope of this PHS environmental monitoring project includes:

- Implementation of environmental monitoring (e.g. accretion/erosion, benthic invertebrates, salt marsh vegetation and bird use) over the site (both inside and outside where appropriate) as agreed in the Environmental Action Plan (EAP) and planning consent;
- Provision of an annual environmental monitoring report, incorporating the results of the above studies with those generated through monitoring undertaken by voluntary groups;

The results of the first year of monitoring are extremely encouraging as regards the rate of habitat development and bird usage as well as with respect to the targets set out in the EAP. However, it is important at this

Figure 1 A general plan of the Paull Holme Strays Site



early stage of the project (year 1) to emphasise the fact that most results obtained thus far are to act as a *baseline* for subsequent years. Therefore, much of the data on rates of, and absolute values for, accretion and erosion at PHS gathered in the 12 months or so following breaching of the original defences may or may not reflect trends for the foreseeable future. Similarly data on how (and at what rate) benthic invertebrates, birds, insects and other fauna and flora may have become established in the newly created environment need to be interpreted carefully; importantly, any assumptions made at this stage can only be speculative.

It was initially anticipated that the PHS site would ultimately create approximately 45ha of mudflat and 35ha of salt marsh. However the success of this scheme in developing such habitats will depend, amongst other things, on the ability of its soil and sediments to withstand the erosive action of waves and tidal currents, while allowing sediment accretion to occur.

The results of the monitoring may be usefully considered in the light of this basic time line for the development of the site and its land use:

- Pre September 2001 – Site largely in arable use, the land being bare between plantings typically of oilseed and cereals. There was also some rough grassland, hedgerows and some well-vegetated brackish water pools (old borrow pits) present.
- September 2001 to September 2003 – Site under various stages of construction with large areas of disturbed or bare ground, ephemeral pools (especially during winter flooding) with ex-arable areas reverting to rank vegetation.
- Post September 2003 – Breaches created and site subject to tidal inundation creating large areas of new open water (where new borrow pits were flooded) and encouraging development of mudflat and salt marsh areas.

The following is a summary of the results of the monitoring undertaken during the period December 2003 to October 2004.

1. Accretion and erosion

The initial survey undertaken between December 2003 and April 2004 shows greatest accretion at stations towards the north-western end of the PHS site, near the main breach. Total accretion recorded here averaged ca. 100 mm with highest daily rates as high as 1.6 mm d^{-1}. By contrast, at the south-eastern stations, total accretion was less than 10mm. The overall accretion and erosion data recorded at the 28 stations is considered to be representative of the realignment site, especially in its western part.

The formal monitoring programme was started in May 2004 and results between then and October 2004 are discussed in this report. Surveys were undertaken at a total of 60 stations (37 inside the site, 3 by the breaches and 20 on the outside).

Overall, patterns of deposition followed those of the initial survey with the greatest amount of accretion recorded in the lower-lying north-western sector of the site, which is continuing to act as a sediment trap. At elevations lower than 2.3m ODN, most sites in the north-western basin accumulated more than 20mm sediment, and up to 86mm at one station, with deposition higher here than at equivalent elevations on the outside of the site. Sedimentation has also been far greater in the north-western sector than in the higher south-eastern strip, where all sites but one are over 2.7m ODN and average accretion at this elevation and above was between 0 (at the highest sites) and 9mm, except for one station showing evidence of erosion (-6mm). Sedimentation on the salt marsh sites outside, above the *Spartina* (Common Cord-grass) zone at approximately 2.7m-3.6m ODN was between 1.7-5.3mm. The relationship between accretion (inside the site) and elevation was evident even from this first year of monitoring.

The PHS realignment area is crossed by subterranean Transco gas pipes and it is important that these pipelines remain securely buried under the sediment of the site. Specific monitoring posts have been set up to monitor sediment deposition/loss in this area. Results show no cause for concern regarding loss of material over the pipelines as monitoring showed that between July and October sediment had generally accreted

in this area, except in the immediate vicinity of some posts, due to local scouring around their bases.

2. Salt marsh vegetation

At least 15 salt marsh and salt tolerant species were recorded on the site where land will be suitable for salt marsh colonisation, albeit at low density and very patchily. Species found included Common Salt marsh-grass, Common Cord-grass, Sea-spurrey (2 species), Sea Aster, Common Glasswort, Sea Couch, Common Couch, Creeping Bent, Sea-purslane, Scurvy-grass, Spear-leaved Orache, Red Fescue, Sea Plantain, Sea Arrow-grass, and also Common Reed. Of interest, Slender Hare's-ear was recorded in the old embankment: this is very rare in Yorkshire and nationally scarce and ways should be sought to ensure that this species is not lost.

Colonisation by salt marsh plants is sparse (certainly in comparison with that shown at the Frieston managed realignment site, Lincolnshire, after the first year) but cover and species diversity are comparable with that observed at the Tollesbury site, Essex. Salt marsh development at PHS may be limited by seed and propagule dispersal into the site, this is likely to be less of a constraint at Frieston.

Although sparsely distributed, about a dozen halophyte species were observed at the Paull site, and in time salt marsh is expected to develop at the appropriate elevations. To what extent vegetation establishes around the edges of the low-lying mudflat will depend upon seed and/or tiller fragments reaching the appropriate zones and other conditions such as drainage being suitable to sustain vegetation.

3. Benthic invertebrates

As observed in similar schemes elsewhere, the invertebrate communities in the inside of PHS are impoverished in comparison to those found on the outside, i.e. the well established mudflats. In particular, species diversity and total community abundance and biomass were lower on the inside and the community here was dominated by opportunistic oligochaete species. Initial results appear to suggest that the highest rate of colonisation may be taking place at those sites which experience the most frequent tidal inundation. Although

community distribution patterns did not initially clearly correspond to sites of maximum or minimum accretion, as reported by Boyes and Mazik (2004) (see below), these trends will need to be further assessed in the coming years. Of interest, two terrestrial species were found inside; these are not considered to be part of the estuarine community which is developing across the site but it will be of interest in the future to note their decline as the estuarine mudflat and associated communities develop.

4. Ornithology

Pre-breach and Construction Monitoring

Prior to construction, the majority of land inside the site was under arable use and used as a roosting site by Golden Plover and Lapwing in autumn, when un-vegetated. Areas of grassland along the banks and a series of small wetland areas (originally borrow pits) supported a small population of breeding waterfowl (predominantly Mallard). When construction started the area of 'bare' ground increased, as well as ephemeral wetland, thereby increasing the potential usage by roosting waders such as Golden Plover, and waterfowl associated with wetlands, including breeding Avocet, and feeding Mallard and Teal.

Prior to breaching construction activity appeared to cause little disturbance to the bird populations using the mudflats outside the site, although a small feeding exclusion zone was noted on the existing mudflat immediately around the breach site whilst work was ongoing here.

Post-breaching of the site (September 2003)

Post breaching there has been increased use by wildfowl, with Shelduck, Teal and Mallard using the area, as well as some wader activity, although this was relatively low compared to the more established intertidal sites outside. This pattern is to be expected as the site develops, with some species of estuarine wildfowl having a more catholic diet than most waders, and thus moving into such transitional habitats more readily. As the invertebrate fauna of the site develops, it is expected that the potential for wader feeding will increase. Notably, despite the breach, the site continued to support breeding Avocet, the

topography of parts of the realignment area being suitable for the requirements of the species.

The monitoring has seen some interaction between populations using the site and the adjacent mudflat complex at Saltend. It appears that some of the Saltend wildfowl population have moved into the site with birds taking advantage of the newly created, but suitable, feeding conditions.

Interactions by waders have also been seen between Saltend and Paull, with some species feeding on Saltend moving to PHS to roost whilst species such as Dunlin and Redshank move between the areas. This has been most notable with Black-tailed Godwit, which has recently established a roost on the site.

Volunteer Bird survey

Results from monitoring by the Hull Valley Wildlife group from January 2003 to October 2004 have revealed that the site is well frequented by a wide range of birds including passerines, breeding waders, and over-wintering wildfowl. It also indicates national importance due to the presence of Avocet and the numbers of Black-tailed Godwit and Golden Plover.

5. Terrestrial and freshwater vegetation

In summary the key points arising from the surveys carried out by the East Yorkshire Botany Club (EYBC) are:

- Terrestrial habitats are, as expected, being colonized by opportunist, hardy species similar to the ones planted by the Environment Agency. One record of note is the presence of Corn Parsley (*Petroselinum segetum*), a locally frequent coastal species restricted to the south and east of England. Many species present are ubiquitous on waste and derelict land, for example False-oat Grass, Cock's-foot and Creeping Thistle
- Salt marsh species (also recorded in the CEH surveys) observed included Glasswort (a primary coloniser of bare mudflats), Sea Aster and Sea-purslane typical of mid-level saltmarsh, and Sea Mayweed, Sea Plantain and Hairy Buttercup normally associated

with higher level marsh and coastal grasslands. Other species observed that are typical of maritime grasslands include, Sea-spurrey and Grass-leaved Orache.

6. Freshwater macro-invertebrates

Realignment of the flood defences between Paull and Thorngumbald resulted in the loss of a large borrow pit behind the original embankment which supported a rich assemblage of aquatic macro-invertebrates including some rare coastal species. New aquatic habitats were provided in the form of extensive dykes and a pond behind the new embankments and in July 2003 vegetation was transferred from the borrow pit to the new water bodies in an attempt to translocate some of the invertebrates.

Results indicate that the new water bodies already support a wide range of freshwater macro-invertebrates including: several scarce water beetles (some being opportunistic colonists of new ponds and others being specialists of coastal/brackish water habitats); caddis flies; damselflies and dragonflies; molluscs and leeches; amphipods and isopods; and fish and amphibians.

7. Water voles

Water voles were shown to inhabit the old borrow pit and ditch system prior to construction of the PHS scheme. Subsequent survey of the new soke dykes and pond at PHS indicates that water voles are already colonising these new habitats. Over time, as the vegetation cover develops and the water voles have additional breeding seasons, they are expected to colonise the whole stretch of freshwater habitat at PHS.

8. Student reports

Two MSc projects have been undertaken at PHS and these are summarised in this report. The titles of the projects were as follows:

1. Habitat mapping and development at the Paull Holme Strays Managed Realignment site on the Humber Estuary. Paul Robertson (2004) as part of MSc in Estuarine and Coastal Science and Management at the University of Hull.

1. The infaunal and hyperbenthic faunal colonisation of a managed realignment site. Jennifer Adamson (2004) as part of MSc in Estuarine and Coastal Science and Management at the University of Hull.

9. Discussion – Summary

Initial results suggest that since the PHS site was breached in September 2003 the area has accreted significantly. Highest rates of accretion are in the north-west part of the site inside the main breach, but future monitoring will highlight the longer term trends that will determine habitat development. Ornithological monitoring indicates that the site is already a valuable resource, especially for wildfowl which are less specialised in their feeding requirements, and future surveys are expected to show changes in bird presence/distribution as better feeding habitat develops. Salt marsh plants are starting to colonise the higher parts of the site and benthic invertebrate communities are developing, although at present they largely comprise opportunistic species.

In overview it is considered that the site has developed largely as expected over the first year of tidal influence, and the monitoring programme implemented appears to be providing appropriate data against which to judge achievement of the ecological targets set in the Environmental Action Plan for the scheme.

1 INTRODUCTION AND PROJECT DESCRIPTION

1.1 OVERVIEW AND GEOGRAPHICAL SETTING

1.1.1 Throughout the early 1990's considerable work was carried out on behalf of the National Rivers Authority (predecessor to the Environment Agency) to assess tidal defence needs in the Humber Estuary. Whilst a long term flood risk management strategy was being developed as the Humber Estuary Shoreline Management Plan (HESMP) the investigations also showed that urgent flood defence improvements were required at a number of locations, including the Thorngumbald Clough to Little Humber section on the north bank of the estuary to the east of Hull. Subsequent investigations, consultations and design development led to the submission of a Planning Application in August 2000 for a scheme comprising managed realignment of the defence and including creation of a new retired embankment and breach of the existing bank. This was expected to result in the creation of approximately 80ha of new intertidal habitat.

1.1.2 A number of mitigation, monitoring, management and enhancement measures were identified within the Environmental Statement (ES), which was published in August 2000 to accompany the planning application for the Thorngumbald (Paull Holme Strays) Scheme. A detailed Environmental Action Plan (EAP) was compiled to provide details of how these requirements (including a number of planning conditions) would be addressed and implemented during the detailed design, construction and post construction phases of the project. An Environmental Steering Group (ESG) was set up to ensure the continued involvement of key consultees throughout the design, construction and operational phases of the scheme.

1.1.3 The scheme is now completed and the existing bank was breached and the site first flooded in early September 2003.

1.2 PURPOSE OF THIS REPORT

1.2.1 Since the PHS site was breached on the 5th September 2003, it has been rapidly changing as a result of twice daily tidal inundations and changes

in sediment distribution. In order to monitor such change, a five year programme of environmental monitoring at the Paull Holme Strays 'realignment site' was established (inside and outside the realignment area where appropriate) to meet the requirements of the Planning Conditions, EAP) and where possible the wider aspirations of the ESG. This programme comprises the following:

- Development of a basis for monitoring over the site (inside and outside of realignment area where appropriate);
- Incorporation of additional monitoring by volunteer groups and others
- Collation of additional information not covered by specific monitoring contracts (e.g. tide and surge, meteorological information etc);
- Collation of all monitoring results on an annual basis and production of an annual summary report to be circulated widely.

This Report is the first annual summary report of environmental monitoring carried out at the site up until October 2004.

1.3 USE OF PAULL HOLME STRAYS AS 'COMPENSATORY HABITAT'

1.3.1 The Paull Holme Strays (Thorngumbald) scheme is within and/or adjacent to the Humber Flats Marshes and adjacent to the Humber Estuary Special Protection Area (SPA), Ramsar Site and possible Special Area of Conservation (pSAC). The proposed works were deemed to have the potential for 'likely significant effect on the European Sites' and consequently an 'appropriate assessment' was carried out under the Conservation (Natural Habitats & c) Regulations 1994 (SI No. 2716) (the Habitats Regulations). The 'competent authority' (East Riding of Yorkshire Council) decided that the works had potential for an 'adverse effect on the integrity of the European Site', but it was demonstrated that the scheme should go ahead for reasons of 'overriding public interest' and that there were no less damaging alternatives available. In fact, in the longer term, the scheme is likely to provide nature conservation benefits through the creation of new intertidal habitat. Through this habitat creation the scheme also provided 'compensation' for habitat losses at urgent tidal defence works being carried out elsewhere in the estuary.

1.3.2 The requirement for formal 'compensation' under the Habitats Regulations for adverse effects on the European Site, at UW1 (Thorngumbald) (the Paull Holme Strays scheme) and UW15-17 (SCM Jetty to East of Oldfleet drain), was formally agreed with Defra and a number of consultees. It was also agreed that the habitat created at UW1 would be used to address the direct losses associated with another Environment Agency scheme at Barton Haven. Although there is no requirement for formal 'compensation' at this location, the Environment Agency is providing 'replacement' habitat as part of its wider 'no net habitat loss' approach to the delivery of tidal defences in the Estuary.

1.4 PAULL HOLME STRAYS ENVIRONMENTAL ACTION PLAN

1.4.1 A formal Environmental Action Plan (EAP) was developed for the PHS project and was agreed with the Planning Authority and other key consultees as part of the planning permission for the scheme. The EAP described the habitat creation and other mitigation measures identified in

the Environmental Statement, outlined the monitoring programme and identified targets for habitat creation and species usage.

1.4.2 Details of the environmental targets for the site are provided in Appendix I. In summary the quantitative targets set were:

- Habitat creation to compensate for direct scheme losses at PHS and at Immingham (a scheme known as Urgent Works 15 to 17) = 2.43ha, of which 1.53ha should be mudflat and 0.9ha salt marsh
- Habitat creation to compensate for coastal squeeze losses at PHS and Immingham = 10.58ha, of which 5.58ha should be mudflat and 5ha salt marsh
- Habitat creation to compensate for direct scheme losses at Barton Haven = 0.03ha mudflat.

The qualitative targets set were:

(a) **Mudflat** -The mudflat created must support an invertebrate assemblage of similar species, population abundance and biomass to reference sites in the middle estuary (see table in Appendix I).

(b) **Salt marsh –** The developing salt marsh habitat should support a range of species which are representative of the middle and lower salt marsh communities in the area (see tables in Appendix I). Upper salt marsh should be retained on the remnant floodbank.

(c) **Birds**

- At least 30 feeding wintering waterbirds : Redshank, Dunlin, Shelduck and Curlew must be present; and
- At least 12 roosting wintering waterbirds: Golden Plover must be present.

These targets were based on the bird populations on the Humber remaining stable over the review period. As such, it might be necessary to calibrate bird counts in relation to the overall bird populations on the estuary for different species.

1.5 THE MONITORING PROGRAMME

1.5.1 The following is a brief outline of the specific monitoring studies which are being undertaken as part of the project.

Accretion & Erosion Monitoring

1.5.2 The accretion and erosion monitoring is being carried out by the Centre for Ecology and Hydrology (CEH) and the full methodology is in Appendix A. Their approach comprises a number of transects across the site (see Figure 4) to cover existing intertidal habitats seaward of the old embankment and 'new' intertidal habitats landward of this (see plan in Appendix A). Each transect has several sampling sites at which buried expanded metal plates or pairs of parallel posts were deployed at each sampling site to measure accretion/erosion twice annually. Results are included in the annual report.

1.5.3 As a result of changes in site topography noticed soon after breaching, the Institute for Estuarine and Coastal Studies (IECS) undertook an interim study to assess the extent (magnitude) of these changes between December 2003 and March 2004 (when CEH took over). To ensure continuity, the methodology used was approved by all concerned and the results of this initial survey (described in full in Appendix A) are part of the overall long term accretion/erosion monitoring programme.

1.5.4 In brief, the aims of this programme are:

- To monitor sedimentation (accretion and/or erosion) at established sites twice annually (Spring and Autumn)
- To monitor the height of the 34 posts above the gas pipelines annually
- To monitor sedimentation at three sites in the Humber (Kilnsea, Skeffling and Welwick) annually. This monitoring is undertaken in order to provide an overall context with regard to natural fluctuations in the Humber.

Salt marsh Vegetation

1.5.5 The intertidal vegetation monitoring is being carried out by the Centre for Ecology and Hydrology (CEH) and the full methodology is in Appendix A. Briefly, the approach uses the same transects and sampling sites as for the accretion and erosion monitoring described above and comprises permanent quadrats of different sizes to survey the vegetation, ensuring they are representative of each area but also allow the identification of fine scale changes. As vegetation is established within the realignment area, one of the smaller quadrats ($1m^2$) at each location divided into 100 cells is used to record more detailed information on colonisation, establishment and spread of salt marsh vegetation at different elevations. All quadrats are photographed.

Benthic Invertebrate Monitoring

1.5.6 The benthic invertebrate monitoring is being undertaken by the Institute of Estuarine and Coastal Studies (IECS) of the University of Hull and the full methodology is in Appendix B. The approach comprises annual sampling at 25 (of the 28) locations on previously described transects to represent existing and 'new' intertidal habitats; a number of replicate core samples will be tested for invertebrate analysis and one for organic carbon and particle size analysis (if needed) at each location; samples will be analysed for species composition and abundance, wet weight biomass, mean lengths of large invertebrates, and organic content.

Ornithological Monitoring

1.5.7 The ornithological monitoring is being undertaken by the Institute of Estuarine and Coastal Studies (IECS) of the University of Hull and a full methodology is reproduced in Appendix C. IECS have been using this approach to monitor bird activity at the site, pre- and during construction, since December 2001. Pre–breach monitoring using a single count point methodology allowed good views of the fronting mudflats and the majority of the retreat area, whilst minimising the potential for counter disturbance. An important prerequisite of the pre-breach programme aims was to assess the level of impact to the avifauna from the construction programme. Subsequent to breaching a two point count approach was used and care taken to minimise disturbance to the avifauna of the area.

Counts were conducted over a half tide cycle, either high to low or low to high water.

1.5.8 Observations of usage and behaviour (and behaviour change, e.g. disturbance) were also recorded. Quarterly summary reports and an annual report of all results in an overall project context have been produced.

Volunteer and other surveys

1.5.9 A programme of additional monitoring was organised by the RSPB, EN and the Environment Agency to gain information about the wider biodiversity of the site. This was mainly carried out by volunteers and comprised monitoring of marginal vegetation and invertebrates in the new soke dyke and new pond, amphibians, water voles, Odonata and Lepidoptera, terrestrial vegetation and additional bird monitoring of the whole site (complementing IECS studies). This monitoring was undertaken in specific sectors at the PHS site as indicated in the relevant map in Appendix D. With the exception of the results from Freshwater Invertebrates and Other Data Collection (see below) results from this additional monitoring are described in Appendix D.

(a) Terrestrial and freshwater vegetation

(i) Vegetation data for the terrestrial and freshwater habitats was collected by the East Yorkshire Botany Club. Monitoring was undertaken on two dates through the summer 2004, 12th June and 14th August, to ensure that a good range of species would be captured.

(ii) Data was collected by the group sweeping each sector, noting all species seen. Although not easily repeatable, this method allows a wide range of species to be identified, without being limited to the area within a quadrat. The data was collected on a sector by sector basis and was collated on recording sheets, noting species and location.

(b) Breeding Bird surveys

(i) Breeding bird surveys were carried out by Hull Valley Wildlife Group, using a modified BTO Breeding Bird Survey methodology. Each sector equated to the BBS 1km transect, and

the crest of the new defence was used as the walking line. Three BBS surveys were carried out, a preliminary visit and early visit in April 2004, and a late visit in May 2004. Results were collected on modified BBS recording sheets.

(c) General surveys: HVWG and others

(i) A number of general walkover surveys were undertaken throughout the year. The information collected on these surveys was segregated into sectors and species and location within sector noted on recording sheets. All species seen, of interest to the surveyor, were noted.

(ii) Results of all voluntary monitoring is contained in individual reports contained within the Appendices.

(d) Freshwater invertebrates

(i) Realignment of the Humber bank between Paull and Thorgumbald resulted in loss of a large borrow pit behind the original embankment which supported a variety of aquatic macro-invertebrates including rare coastal invertebrates. New aquatic habitats were provided in the form of extensive dykes and a pond behind the new embankments with vegetation and invertebrates transferred from the borrow pit to the new water bodies in an attempt to establish communities. A survey of aquatic macro-invertebrates was undertaken by Martin Hammond in April 2004, to evaluate both effectiveness of translocation and the overall fauna; the results are included in Appendix E.

(e) Other Data Collection

(i) Other items of data and monitoring included: Water vole monitoring (Environment Agency (EA)); Photo monitoring and general site information (EA); Tide and Surge data (EA); and rainfall data (EA)

(ii) These items of information have been included in the Annual Report as Appendix F (Water Vole), Appendix G (Photographic record) and Appendix H (Meteorological and Tide Data).

2 SUMMARY OF MONITORING RESULTS

2.1 INTRODUCTION

2.1.1 In order to maximise the potential functional gain and understanding of habitat creation schemes a consistent approach is required. Standard monitoring methods were therefore employed to measure the rates of accretion/erosion at the realignment site, and a full methodology can be found in the CEH and IECS monitoring reports (Appendices A and B). Importantly, it was paramount to use methods which ensured the selected sites were representative of the area as a whole and the techniques adequate for the type of investigation undertaken. The project ensured that most sites and transects selected for the accretion and erosion monitoring were also used to assess the extent of establishment of benthic invertebrates, vegetation and other ecological parameters. This would guarantee a global perspective of the changes taking place at the newly created site (and intertidal habitats) at PHS. The results of such monitoring will not only enable the evaluation of current objectives but will inform the design and management of habitat creation schemes in the future.

2.1.2 The transects on the site were continued seawards to the fronting salt marsh and mudflat and 2 transects with sampling sites were set up south of the realignment. These are being monitored to determine their vegetation communities and to check that there are no adverse effects of the realignment on the adjacent salt marsh.

2.1.3 Statistical analysis was undertaken using standard software including SPSS version 11 and a range of well known robust tests (both parametric and non-parametric). Whereas analyses carried out on this initial data set are considered preliminary with the aim of showing general patterns, as the study progresses more detailed statistical analysis might be appropriate.

2.1.4 The results of the monitoring may be usefully considered in the light of this basic time line for the development of the site and its land use:

- Pre September 2001 – Site largely in arable use, the land being bare between plantings typically of oilseed and cereals. There was also some rough grassland, hedgerows and some well-vegetated brackish water pools (old borrow pits) present.
- September 2001 to September 2003 – Site under various stages of construction with large areas of disturbed or bare ground, ephemeral pools (especially during winter flooding) with ex-arable areas reverting to rank vegetation.
- Post September 2003 – Breaches created and site subject to tidal inundation creating large areas of new open water (where new borrow pits were flooded) and encouraging development of mudflat and salt marsh areas.

2.1.5 Preliminary results from the monitoring undertaken thus far are presented in the following sections.

2.2 ACCRETION AND EROSION

Interim period
December 2003 – April 2004 (IECS)

2.2.1 Figure 2 shows the position of sampling stations for the interim monitoring programme.

2.2.2 Mean (and standard error) total (cumulative) accretion/erosion recorded at each station at two weekly intervals (Dec 2003 to April 2004; 7 readings) is shown in Figure 3.

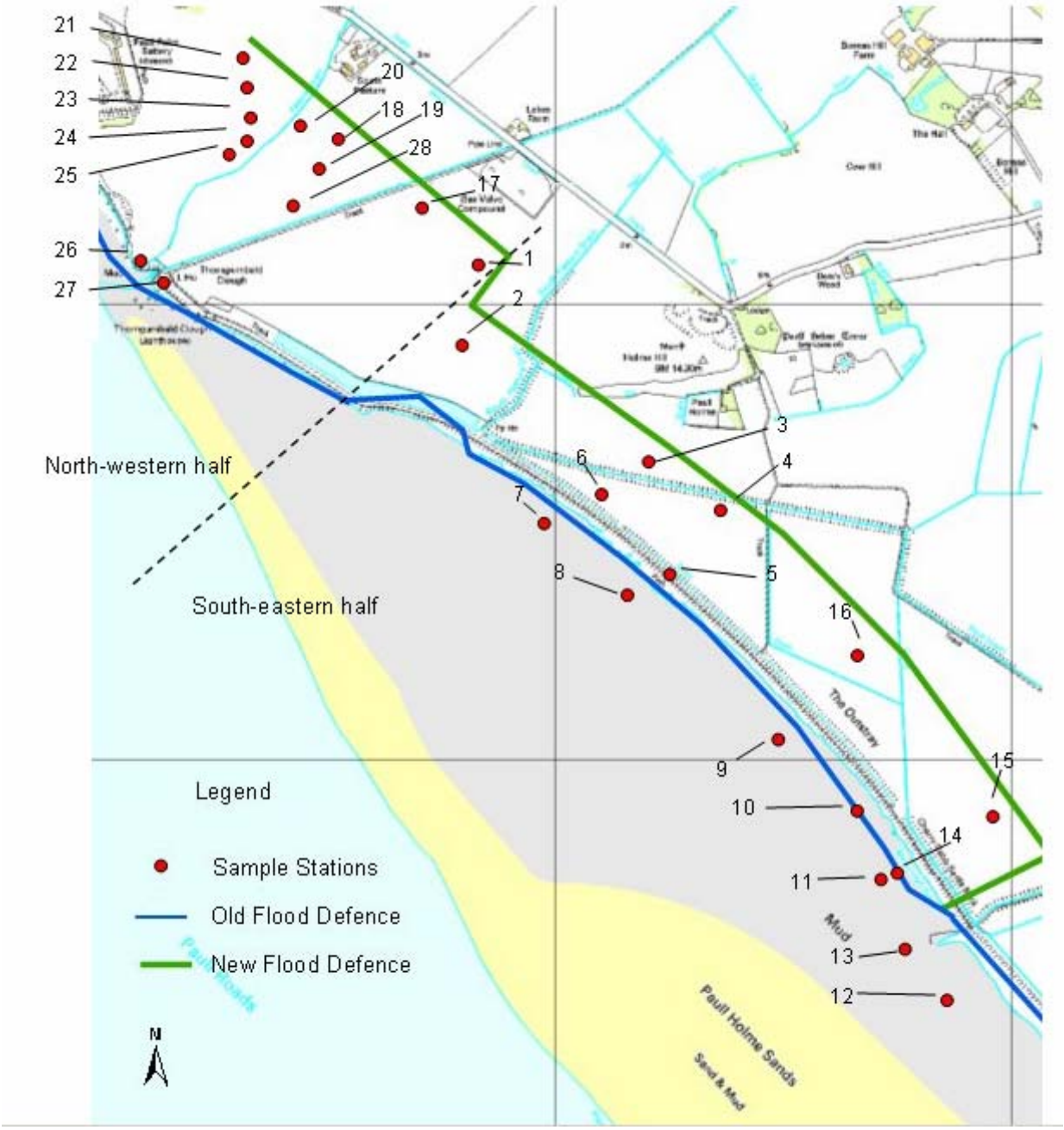


Figure 2 Position of the interim sampling stations for accretion/erosion monitoring.

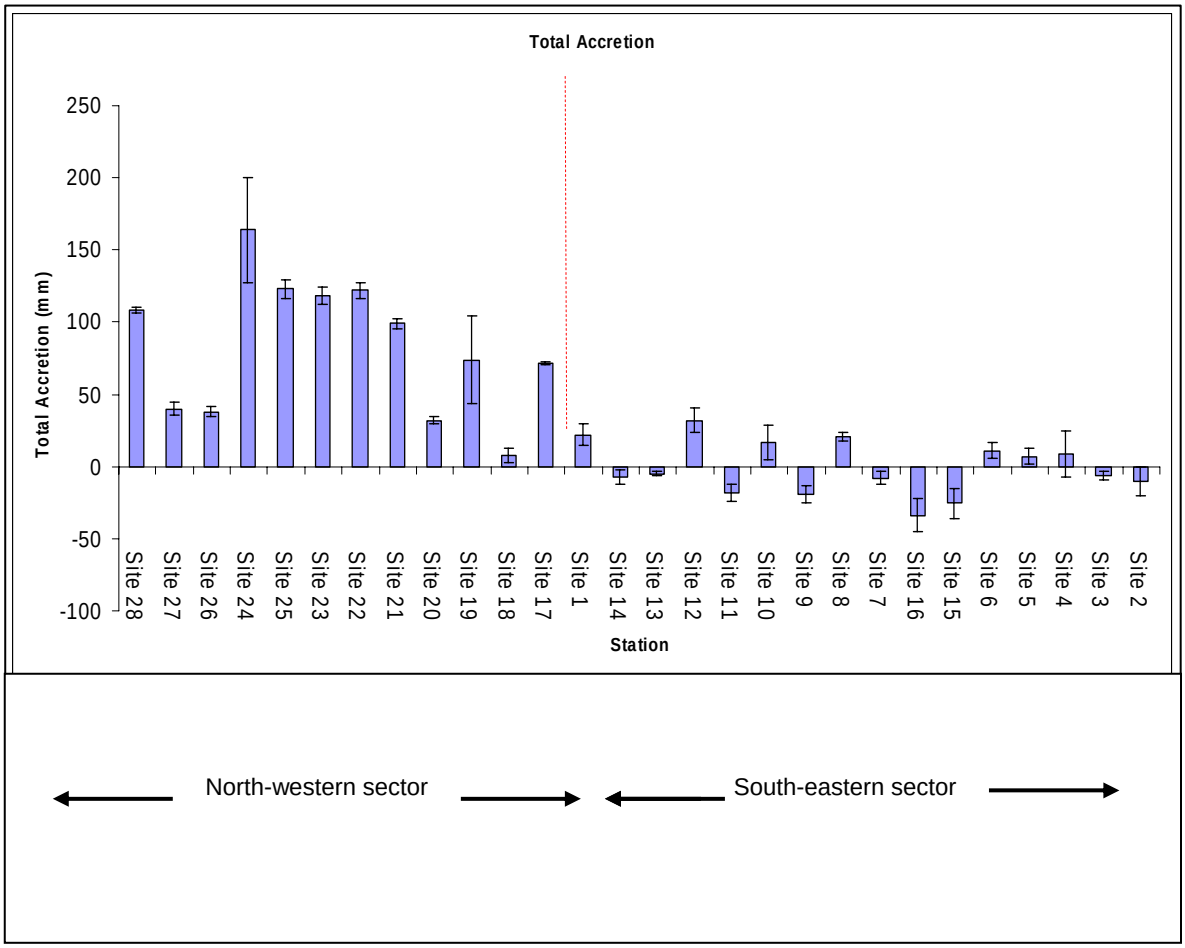


Figure 3 Cumulative accretion/erosion (mean ±SE) at the 28 stations; 7 readings.

2.2.3 A general trend of high levels of accretion to the north-west of the site and lower levels of accretion or erosion to the south-eastern side was observed. More generally, three distinct groups of stations have been identified.

2.2.4 The first one includes stations 2,3,5,6,7,8,9,11,13,15 and 16, all of which show signs of slight erosion or very slight accretion (-25 to 16 mm) and are all situated within the south-eastern half of PHS. The six 'control' stations (7 to 9, 11 and 13; outside of the site) are also included within this group with the exception of number 12. These have all showed variability in sediment height with the general trend being one of erosion.

2.2.5 The second group is where higher levels of accretion (9 – 40 mm) were recorded: stations 1, 4, 10, 12, 20, 26 and 27; these are dispersed across the inside and represent pockets of accretion.

2.2.6 The third group is where the highest levels of accretion within the four-month monitoring period occurred, i.e. at stations towards the north-western side of the PHS, close to the breach in the old sea wall (stations 17 to 28). Of these, only two show variability in the measurements (20 and 25). Mean levels of accretion at the upper shore stations (17, 19 and 21) ranged from 71 – 99 mm, whilst levels of 108 –164 mm were recorded at stations 22 to 25 and number 28 on the mid shore. The station with the highest accretion is number 24 (164 mm or 1.6 mm per day), with neighbouring stations also experiencing high rates of accretion. These are located to the north-west of Pasture Drain in the top north-western corner of the site (e.g. station 24), suggesting that the water ponding in this area at high tide is depositing high loads of sediment. Stations 18 and 20 on the upper shore although accreting, are doing so at a slower rate due to their higher elevation on the mudflat.

Long Term Monitoring

May 2004 – October 2004 (CEH)

2.2.7 Figure 4 shows the locations of sampling stations for the long term monitoring of accretion/erosion.

2.2.8 Sites are labelled with the transect number followed by the number of the sampling station along that transect (from landwards to seawards), so for example, Site 4.5 is at sampling station 5 on Transect 4.

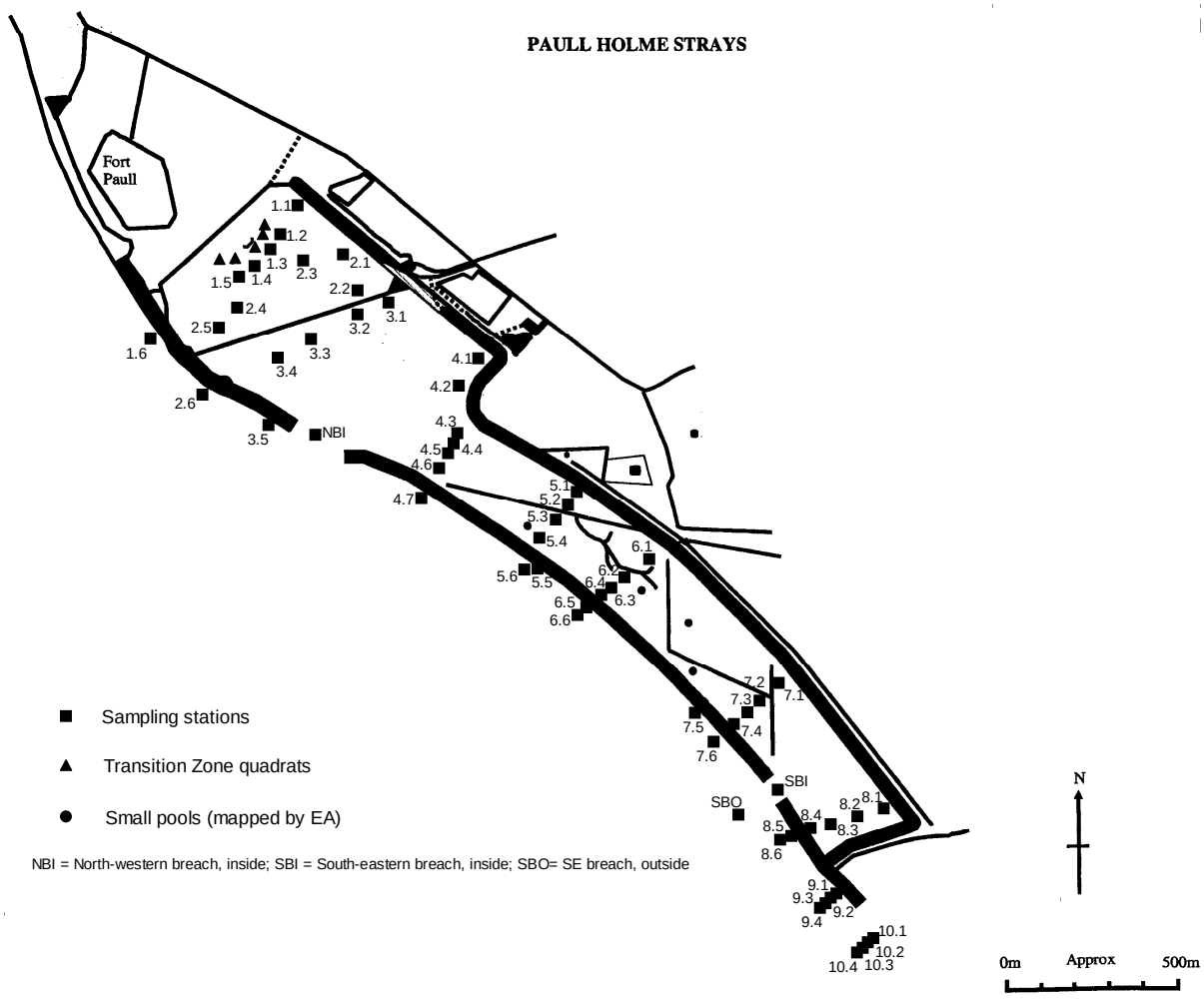


Figure 4. Sampling stations for long term monitoring of accretion/erosion (CEH).

2.2.9 Accretion (or erosion) in the 4 ½ months between May and the end of September/early October at each of the monitoring sites is shown graphically in Figure 5. As expected, the greatest amount of accretion was in the lower-lying north-western basin (mudflat), particularly Transects 2 and 3, where up to 86 mm deposition was recorded at the lowest elevation (1.93m at Site 2.3). Photographs of all the sites are included in the full report (Appendix A)

2.2.10 Transect 1 on the NW edge of the mudflat is at a higher elevation than Transect 2 and 3. Most of the sites on Transect 1 showed accretion except for a small loss of sediment (just 3.5mm) at 1.2. Unfortunately the canes at Site 1.1 were destroyed by bikers. Accretion at the remaining three sites on Transect 1 ranged from about 7mm up to about 15mm at the lowest (Site 1.5). Accretion on Transect 4 varied between 8 and 35mm. The south-eastern narrower section of the site (Transects 5-8) received far less sediment deposition, with generally little or no accretion at the highest parts of the site, notably Transect 6 and half of Transect 7, and less than 9mm elsewhere except for the lowest site (Site 5.2) which had built up by an average of 21mm.

2.2.11 The lack of sedimentation on much of Transect 6 was evident by the considerable remains of dead terrestrial vegetation still on the surface. Similarly, no net deposition had occurred on Site 7.4 (a negative value of ≈0.3mm) and dead vegetation was still visible on the dry hard surface. Less than 1mm of accretion was measured at Site 7.1, with approximately 4 to 5 mm at Sites 7.2 and 7.3. Site 8.1, at the back of the site by the new defence bank, had lost an average of 6mm of sediment. The remainder of the sites on Transect 8 had accreted over 3mm at the highest site up to about 9mm at the lowest.

2.2.12 Outside the realignment site, the upper two salt marsh sites on transects 9 and 10 at elevations between 2.7m and 3.6m above ODN accumulated 2-5mm of sediment. The lower *Spartina* zones (2.1-2.2m ODN) on transects 9 and 10 accumulated 16mm and 23mm of sediment respectively.

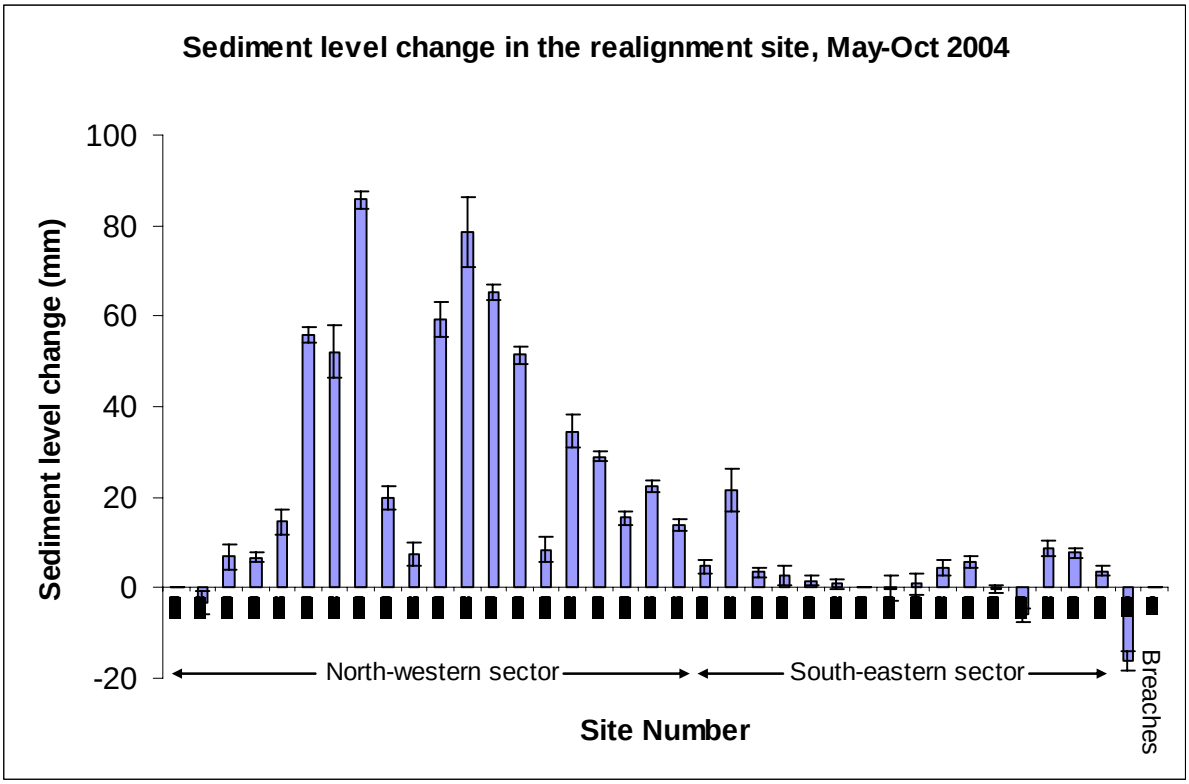


Fig. 5. Sediment level change (Accretion/erosion) at the monitoring stations inside the realignment site, May to October 2004

2.3 SALT MARSH VEGETATION

2.3.1 Vegetation colonisation of the tidally influenced areas of the site has been patchy. At least 15 salt marsh and salt tolerant species are present on the site where land will be suitable for salt marsh colonisation, although at low density and very patchy this year. Species found included: Salt Marsh grass (a target species, ts, identified in the EAP), Cord Grass (ts), Sea Spurrey (ts) (2 species), Sea Aster (ts), Glasswort (ts), Sea Couch, Common Couch, Creeping Bent (ts), Sea Purslane (ts), Scurvy Grass (ts), Spear-leaved Orache, Red Fescue (ts), Sea Plantain (ts), Sea Arrow grass (ts), and also Common Reed**.**

2.3.2 There is little vegetation in the north-western part apart from a few sprigs of *Spartina* (another target species), as most is low-lying mudflat, although quite a good cover of vegetation has established near the tidal

limit on the north-western perimeter. This was almost exclusively *Atriplex prostata* (Spear-leaved Orache). The overall (general) pattern of vegetation in the south-eastern strip can be summarised as follows: predominantly vegetation remaining at the highest elevations in the middle which have experienced little or no sedimentation (overwhelmingly *Elytrigia repens*, Common Couch), and typical salt marsh halophytes mainly at the south–eastern end.

2.3.3 The pattern of predominantly salt–tolerant glycophytes at the north-western end of the narrow south-eastern strip, terrestrial vegetation at the highest elevations in the middle, and halophytic species at the south-eastern end of the narrow strip can be seen clearly in Figure 6.

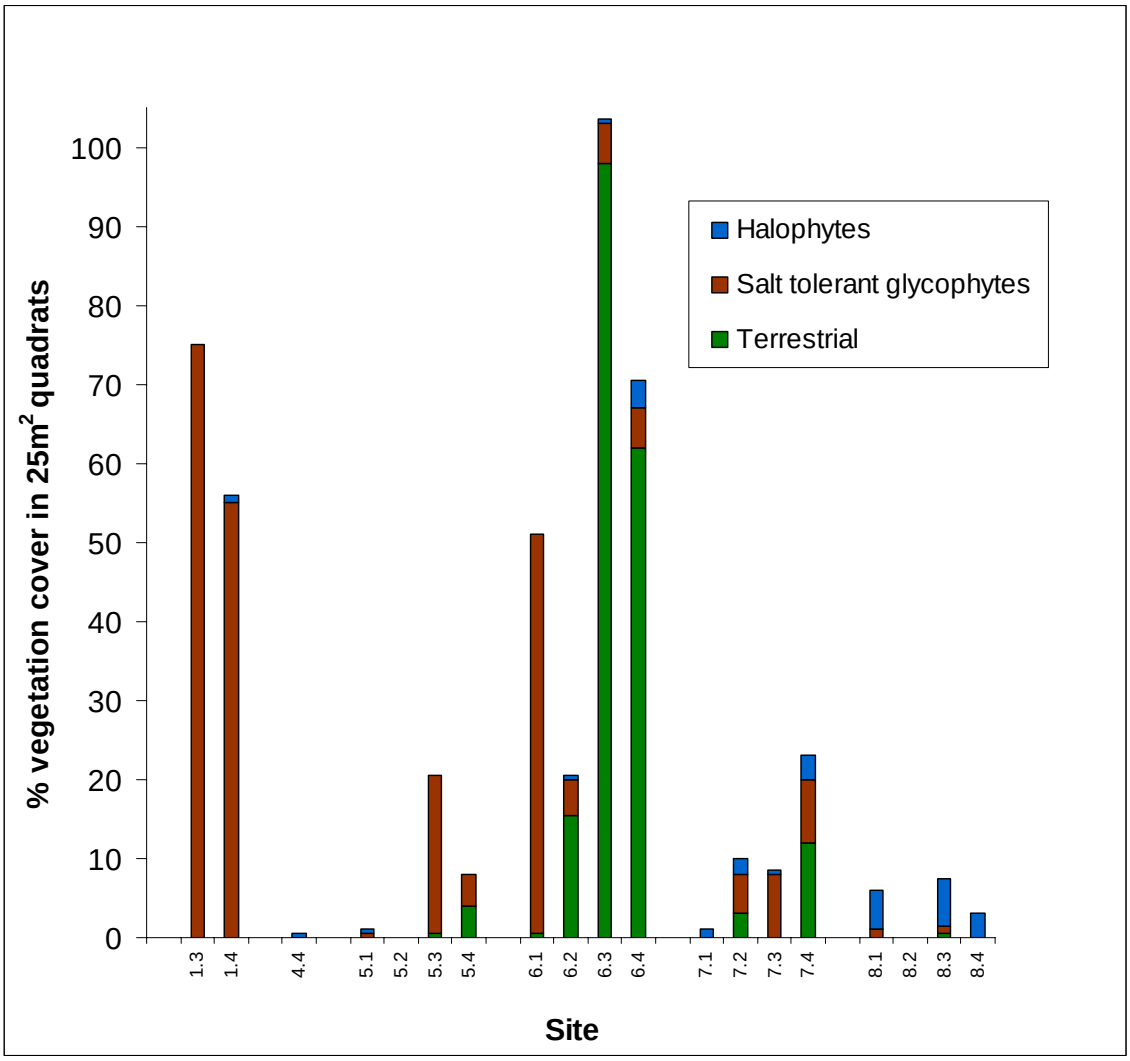


Fig. 6 Vegetation Cover in the 25m^2 Quadrats in the Realignment Site, July 2004.

2.4 BENTHIC INVERTEBRATES

2.4.1 A total of 20 marine/estuarine species were recorded across the entire survey area (inside and outside). The community as a whole was dominated by opportunistic species (particularly close to the breaches) such as oligochaete worms and nematodes which accounted for 69% of the organisms of the community. One species of polychaete and 3 of bivalves accounted for >95% of the total biomass. Many of these are considered target species for the PHS site and in particular *Tubificoides*

benedii, Macoma balthica, Hediste diversicolor, and *Pygospio elegans (*Source: ABP research report).

2.4.2 Whereas there were in some cases statistically significant differences for abundance, biomass and number of species among all of 25 sites, there were no clear and readily interpretable spatial patterns of abundance, biomass, species diversity or species distribution, particularly among stations inside. Despite the lack of spatial patterns however, the highest abundance and diversity values were generally recorded at sites on the outside.

2.4.3 There were however differences both between the inside and outside of the site and between the sampling stations within these two areas; this is typical of a middle estuary situation (IECS: pers. comm.).

2.4.4 Hence, inside, the stations with the greatest abundance and community biomass were situated in the upper shore area opposite the north-western breach. Other areas of relatively high abundance and biomass were situated in the mid shore area to the west of the north-western breach and along the transect to the east of the south-eastern breach. Similarly, the maximum number of species was found at these sites. Interestingly, *P. litoralis,* an opportunistic species and early coloniser associated with disturbed or newly formed habitats, was recorded in high numbers.

2.4.5 On the outside, there was a fairly clear pattern of reduction in biomass, species diversity and, to a lesser extent, abundance in a high to low shore direction.

2.4.6 The species composition of the communities within each area was also found to be different. Although both communities were dominated by oligochaetes in terms of abundance, enchytraeid worms were dominant outside the managed realignment site whereas *P. litoralis*, an opportunistic species, was dominant inside.

2.4.7 Of interest, two terrestrial species were recorded, *Collembolla* sp. and *Diptera* sp. It is not certain if these taxa are the remnants of the previous pre-breach habitat (which will decrease further over time) or just 'accidental' species introduced from adjacent terrestrial habitats e.g. from run-off. In any event such taxa are not considered to be part of the estuarine community which is developing across the site and it is

expected that numbers will decline as the estuarine mudflat and associated communities develop.

2.4.8 Size frequency distribution indicated that the majority of organisms were in the <5mm class, both inside and outside of the site. The frequency of organisms in the larger size classes was higher on the outside. In addition, beds of *Hediste spp* were larger in size and in greater in numbers inside than outside.

2.4.9 Generally, sediments became increasingly coarse (increasing sand content) towards mean low water on the outside of the site. In contrast the finer sediments with higher silt content were largely found in the upper shore areas and the north-western side of the inside. There were significant differences between sites inside and outside.

2.4.10 Levels of organic carbon were significantly higher inside (9.2%) than outside (5.7%); similar values (5.5%) were recorded at the adjacent site of Saltend (Allen, 2000).

2.5 ORNITHOLOGY

Pre-breach and Construction Monitoring

2.5.1 Prior to construction, the majority of land inside the site was under arable use and used as roosting site by Golden Plover and Lapwing in autumn, when in an un-vegetated state. Areas of grassland along the banks and a series of small wetland areas (originally borrow pits) supported a small population of breeding waterfowl (predominantly Mallard). When construction started the area of 'bare' ground increased, as well as ephemeral wetland, thereby increasing the potential usage by roosting waders such as Golden Plover, and waterfowl associated with wetlands, including breeding Avocet, and feeding Mallard and Teal.

2.5.2 Overall, the middle estuary appears to have developed as a stronghold for Mallard, to some extent offsetting the significant regional decline over the last 10 years. Additionally, results from the surveys indicated an increase in the status of ducks, primarily Mallard and Teal, inside the site. Generally, the level of usage for several species was greater than in 2002, this being largely due to the increase in the area of bare ground and

an increase in the extent of ephemeral wetland within the realignment site.

2.5.3 Prior to breaching, the overall construction activity appeared to cause little disturbance to the bird populations using the mudflats outside the site. A small feeding exclusion zone was noted on the existing mudflat immediately around the breach and other localised works, but in general the low level of prolonged construction activity caused no visible significant impact to the bird populations outside the site (Foulholme Sands).

Post-breaching of the site (September 2003)

2.5.4 *Winter*: Inside the site itself birds were found to be using the south-eastern area, which was not previously considered important for feeding or roosting. Maximum densities were recorded in areas which do not drain fully at low water (and where no invertebrate sampling was undertaken). In contrast, large numbers of waders as well as Shelduck were again observed feeding on the established mudflats outside the site, with this differential usage between the areas indicating that as yet, the inter-tidal invertebrate community within the site had not yet become sufficiently established to be able to support a substantial feeding assemblage of avifauna. Specifically, counts on the realignment area showed dominance by Shelduck, Teal and Mallard (especially foraging birds); 15,000 Golden Plover roosting along the Drain (~ 20-30% of Humber population) and roosting flocks of Redshank and Dunlin on the old flood bank. Dunlin and Curlew, wader and wildfowl usage was comparable to the previous year.

2.5.5 *Spring/Summer/Autumn:* Wader numbers both inside the site and on the surrounding mudflats were lower than in 2003. Counts over the spring to early summer of 2004 did not record migratory Dunlin, Ringed Plover, Redshank, Black-tailed Godwit and Curlew on the mudflat this also being reflected by the absence of large roosting flocks inside the site. However, this may have been an artefact of survey timing rather than an actual absence of migratory flocks from the area during passage, such movements often occurring over the period of only a week, and therefore easily missed by the once a month survey frequency. By contrast, 262

Shelduck were recorded on the mudflat and 635 birds on the realignment area in June.

2.5.6 Inside the PHS site, the wader assemblage was similar to that of surrounding mudflats, but feeding activity was mostly undertaken on the outside. However, large numbers of Shelduck were foraging within the area in the late spring with greater numbers using the realignment site than the existing mudflat over the tidal cycle in the June survey.

Volunteer bird survey results

2.5.7 A species count survey from January 2003 to October 2004 inclusive was undertaken by Hull Valley Wildlife Group on a volunteer basis. What follows is a brief description of the results generated. The aim of this survey was also to try and integrate some of the findings with those of the formal monitoring undertaken by the IECS as well as contribute to the general discussion on the preliminary outcomes of the managed realignment project at PHS.

2.5.8 The figures collected during the two year cycle recorded 126 species in total; three species in particular though namely Avocet (*Recurvirostra avosetta*), Black-tailed Godwit (*Limosa limosa*) and Golden Plover (*Pluvialis apricaria*) are present during the winter in numbers above the UK Importance Threshold. The threshold numbers for these species are as follows:

- Avocet – UK Threshold Number – 10
- Black-tailed Godwit – UK Threshold Number – 70
- Golden Plover – UK Threshold Number - 2500

This makes the site nationally important for these species.

Figures 7 to 11 show the monthly total bird counts as well as monthly totals for a selected bird species as recorded by IECS. The full data is included in Appendix D.

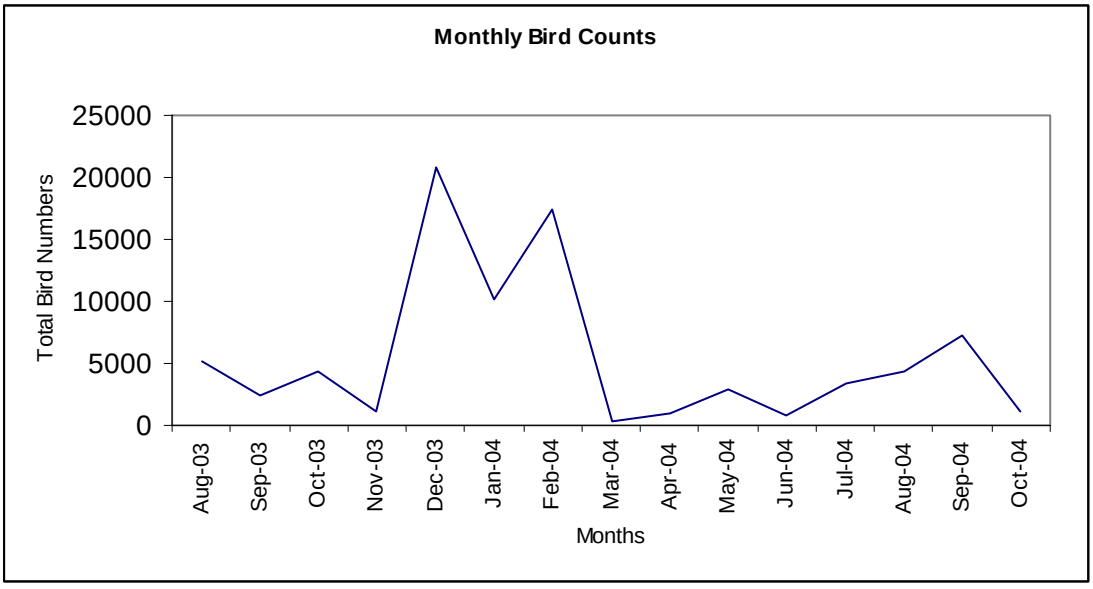


Figure 7. Total Monthly Bird Counts

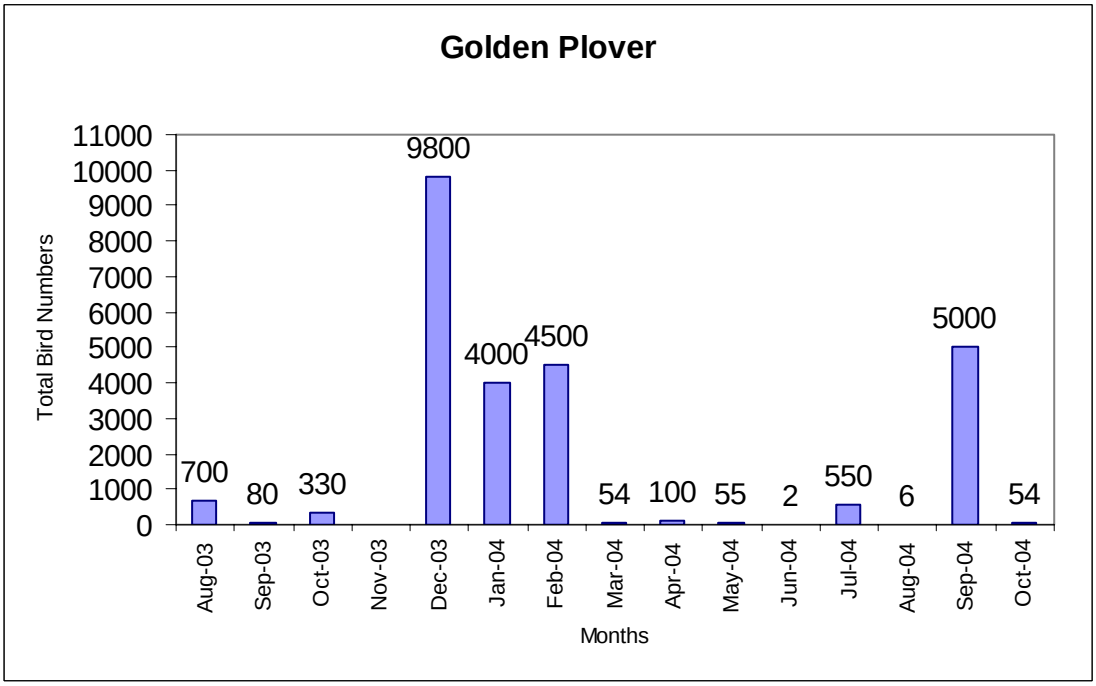


Figure 8. Total Golden Plover Counts per Month

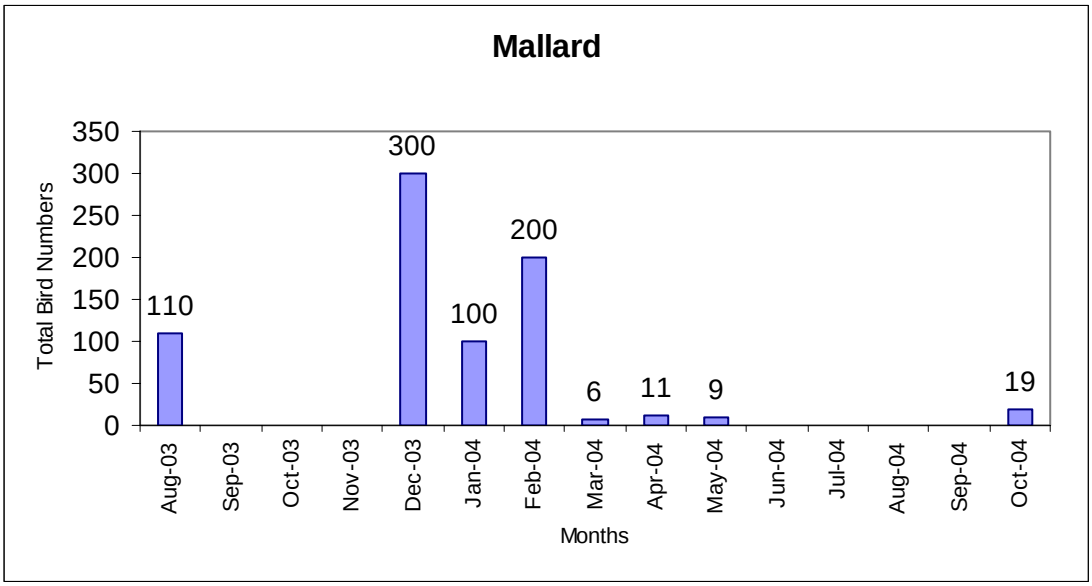


Figure 9. Total Mallard Counts per Month

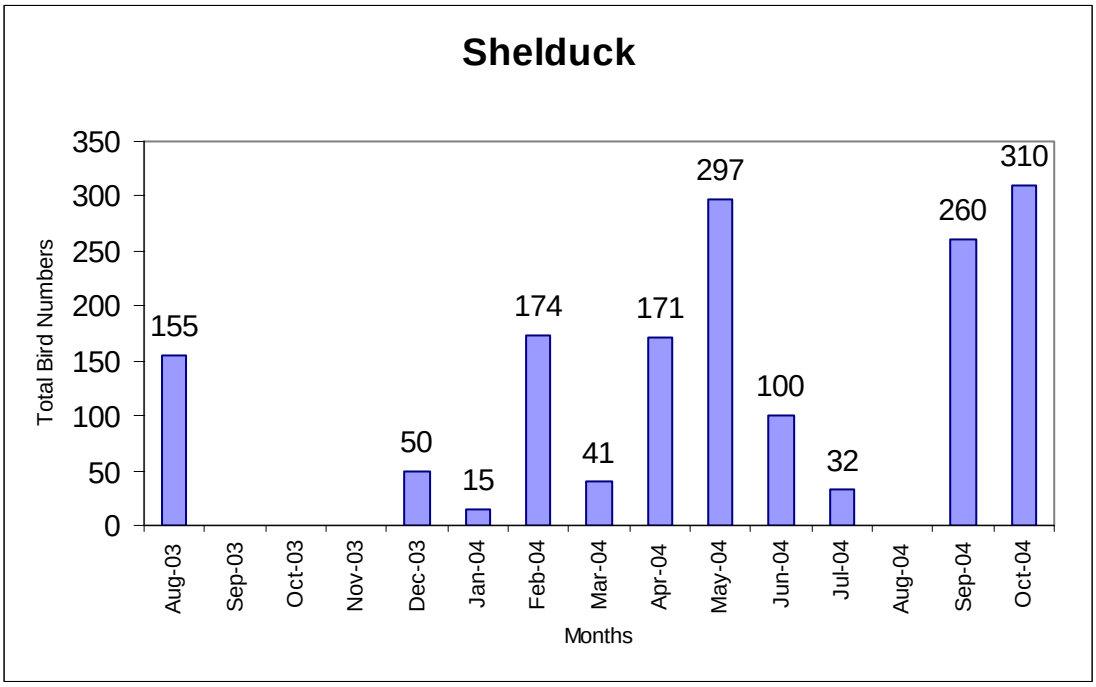


Figure 10. Total Shelduck Counts per Month

2.6 VOLUNTARY AND OTHER MONITORING

2.6.1 The voluntary monitoring made use of sectors as opposed to transects (used to monitor accretion/erosion and vegetation) since there was a need to split the site into a small number of large sampling size blocks (sectors) rather than survey lines. A Sector Map showing the number and size of the sectors used and all voluntary monitoring results are included in Appendix D.

EYBC East Yorkshire Botany Club

2.6.2 The terrestrial and freshwater vegetation monitoring was undertaken by a team of botanists from the EYBC.

- A total of 137 species was recorded across the site.
- The area has been colonized by opportunist species typical of this habitat.

- A species of note here is Corn Parsley (*Petroselinum segetum*) a locally frequent coastal species typically restricted to the south and east of England only; this was recorded in sector E.
- Yellow Oat-grass and Smooth Meadow-grass have not taken at all.
- Section G appears to be the most vegetated sector.
- In general, the planting by the Environment Agency has been successful with the majority of species present in most areas.
- A sub-species of the grass soft brome was recorded (*Bromus hordeaceus ssp longipedicilatus*).

A full list of plants is included in Appendix *D*.

Mosses

2.6.3 A range of mosses was recorded in sector F including *Pleurocarpous*, *Cleistocarpous acrocarpous* and *Acrocarpous*; none of these is considered scarce in this region.

Terrestrial Invertebrates

2.6.4 A number of common Lepidoptera, Coleoptera, Syrphidae, Hymenoptera and Odonata have been recorded on site.

2.6.5 Species recorded are typical of this type of site and none is notable or protected.

Water voles

2.6.6 Six sections were surveyed and the full results can be found in Appendix G.

2.6.7 Numerous direct sightings of water voles and related signs such as latrines, droppings, feeding remains, burrows and pathways indicate their presence.

2.6.8 Water voles were not recorded on un-vegetated sections.

Freshwater invertebrates (Mr Martin Hammond)

2.6.9 General:

The new water bodies support several scarce water beetles. These include opportunistic colonists of raw ponds such as *Hygrotus nigrolineatus* and *Scarodytes halensis* as well as specialists of coastal/brackish water habitats including *Haliplus apicalis, Agabus conspersus* and *Enochrus bicolor*. Some of these species may be of ephemeral occurrence but others will hopefully have established resident populations. None of the specialist brackish water Corixid bugs were found but these had not been present in the former borrow pit. Caddis flies were represented by two larval taxa, one of which is typical of ion-rich waters. The brackish water amphipod *Gammarus zaddachi* is abundant. Most other aquatic invertebrates were ubiquitous freshwater or wide tolerance species.

2.6.10 Of eight Nationally Scarce water beetles recorded from the former borrow pit, three were found in the new habitats (*Haliplus apicalis, Agabus conspersus* and *Dytiscus circumflexus*). All these species were believed to have been translocated, although it cannot be assumed that they have not established unassisted.

2.6.11 Interestingly, the weevil *Lictodactylis leucogaster* was not found despite having been translocated in large numbers and its food plant (spiked water-milfoil) being well-established and vigorous.

2.6.12 Diversity of beetles: A total of 38 water beetle taxa were recorded which is considered diverse for a site with poorly developed vegetation structure. Of the four sites investigated, site SP3 had by far the greatest diversity of species where 29 taxa were observed. Water bugs: a total of 16 species were recorded but none of the true brackish water species were observed. Caddis flies: Only two or three species were recorded.

2.6.13 A number of species of damselfly and dragonfly were recorded. Only one species of mollusc and one species of leech were observed.

2.6.14 Several species of crustaceans were recorded including amphipods and one species of isopod. Fish and amphibians were also recorded.

Rainfall and Tide and Surge data

2.6.15 There is a substantial amount of data covering rainfall and tides at areas in or near the PHS site; this is included as raw data in the Annual Report in Appendix H.

2.6.16 Rainfall: At present it is sufficient to say that in the course of July and August 2004 at Winstead and Great Culvert (two sites equidistant from PHS) there was an unusually high amount of rain for this time of the year. In particular on the 7th and 22nd July and the 8th, 9th and 10th August, the two sites recorded as much as 32 mm in a single 24 hr period.

2.6.17 Tides: The tides recorded were not unusual but records may become useful in the future monitoring period (2005-2008).

3 SUMMARY AND DISCUSSION

3.1 SEDIMENTATION

3.1.1 The loss of saltmash and mudflat in the Humber estuary due to the forecast future sea level rise is identified in the Humber Estuary SMP where the creation of replacement areas is highlighted as a priority.

3.1.2 The overall objective of this project indicates that the PHS site (80 hectares) should create 45ha of mudflat and 35ha of salt marsh. The success of the inside of the managed realignment site in developing such habitats will depend, amongst other things, on the ability of soil and sediments here to withstand the erosive action of waves and tidal currents, while allowing sediment accretion to occur.

3.1.3 As outlined in the results section, the north-western end of the Paull Holme Strays site has been found to be primarily depositional and would appear therefore to be meeting the aims of the site for creating mudflat habitat. Tidal waters on both spring and neap tides for instance have been shown to cover the whole of the north-western end of the site, with water moving up through Pasture Drain and Thorngumbald Drain and draining fast at low tide (Helen Richardson, Environment Agency pers. comm.).

3.1.4 Quantitative results from this investigation also indicate that in the first 4 month survey period (December 2003 to March 2004), stations 22 to 25 in the north-western end of the PHS site recorded average total accretion of ~100mm with station 24 having the highest average accretion rate (1.6 mm d^{-1}).

3.1.5 Measurements of sedimentation inside and outside during the second 4 month interval between May and October show that, according to expectations, the greatest amount of deposition has been in the lower-lying north-western sector of the realignment, which is continuing to trap a lot of sediment. Here, the sites on the mud at elevations lower than approximately 2.3m above ODN have received between 8 and 86mm of sediment, with most capturing over 20mm. Sediment deposition is also far greater in the north-western sector than it is at equivalent elevations on the fronting mudflat. Out on the mudflat between 2.1 and 2.3m ODN,

all sites except one accreted between just 1.7mm and 5.3mm of new sediment.

3.1.6 Several mm of sediment can be deposited on a big single tide in the Humber (Brown 1998), but much of it may be re-suspended and carried out on the ebb. Re-suspension is presumably much reduced in the sheltered conditions of the realignment site so it behaves as a settling tank.

3.1.7 Generally, sedimentation on the north-western mudflat area of the site is far greater than on the higher south-eastern sector (Transects 5-8), where between zero and 21mm was deposited, with one site at the back, near the south-east corner, losing 6mm. The difference between accretion in the south-eastern part and on the adjacent and fronting salt marsh at equivalent elevations is less marked than the mudflat comparisons. All sites except for one on Transects 5 to 8 are above 2.7m ODN, and at or above this elevation accretion was between approximately -6mm and +9mm (the 21mm accretion was recorded at the one site below 2.7m, on Transect 5). Salt marsh sites above the *Spartina* zone range from about 2.7m to 3.6m above ODN and increases in surface level between 1.7 and 5.3mm were measured.

3.1.8 It will take a series of measurements over time before we are able to establish good representative rates of accretion above the noise of temporal and spatial variability, however, even with just this first interval of accretion measurements a surprisingly good relationship with elevation was apparent for the realignment site.

3.1.9 This year's measurements of the 34 posts over the gas pipeline showed sediment accretion in almost all cases, except for some scouring immediately around the base of some of the posts. There appears to be no cause for concern so far about erosion of the sediments over the pipeline, particularly in view of the 51mm-79mm of accretion between May and October measured at monitoring sites close by, along Transect 3.

3.2 VEGETATION

3.2.1 The highest areas along Transect 6 (Site 6.3) appear to have received little tidal inundation, if any, and are covered with the widespread weedy grass, Common Couch. The remainder of the site has experienced varying degrees of tidal inundation and amounts of new sediment cover, depending upon the elevation. Most of the pre-breach cover of terrestrial vegetation has been removed (where there has been tidal inundation), but remains visible on parts of the site where the sediment deposition is still only a thin layer. The most common species colonising the bare inundated areas at higher elevations, particularly around 3m above ODN on Transect 1, has been the ground-spreading, salt-tolerant, Spear-leaved Orache.

3.2.2 About a dozen typical salt marsh species were found on the realignment site, but only some of these were found in the permanent quadrats: Common Salt marsh-grass, Sea Aster, Common Cord-grass, Greater and Lesser Sea-spurreys, Glasswort, Grass-leaved Orache, Red Fescue, and Sea Couch. None were recorded at more than 3% cover and most were less than 1% in the few quadrats in which they were found.

3.2.3 When compared with the elevations of the salt marsh sites on the adjacent marsh at Transects 9 and 10, and the cliffed salt marsh just outside the site, the monitoring sites along transects 5 to 8 inside are at elevations suitable for development of middle to upper salt marsh, as are sites 1.2 to 1.4. on Transect 1. Sites along the transects in the narrow south-eastern sector of the site are all higher than the elevation of the pioneer *Spartina spp* marsh just south of the site, as is the south-eastern breach (approximately 2.7m above ODN). More detailed surveys, which are planned for next year, would verify this, but it would appear that most of the south-eastern sector of the site will be too high for pioneer marsh to persist.

3.2.4 The other sites on Transect 1 (1.1 and 1.5.) are currently at elevations similar to low / pioneer *Spartina anglica* marsh on adjacent salt marsh, as are Sites 4.4 to 4.7 on Transect 4 and the two most seaward sites on Transect 2 (2.4 and 2.5). If propagule supply, dewatering and drainage are sufficient for plant colonisation and establishment here, some areas around the perimeter of the mudflat basin in the north-western sector could develop into low marsh zones.

3.2.5 Colonisation of the Paull Holme Site by typical salt marsh species of adjacent salt marshes has been very sparse during the year following the breach, certainly compared with the first year of vegetation colonisation of the Wash Banks realignment site at Frieston (personal observation), which was quite densely covered, particularly with the annual pioneer species *Salicornia spp*. (Glasswort) and *Suaeda maritima* (Annual Seablite). However, other realignment sites have also exhibited low cover of vegetation in the early years; for example, vegetation density in the first year after the breach at Tollesbury, Essex, was very low, and limited to two annual pioneer species: Glasswort and Seablite. More salt marsh species have been found in the first year at PHS than in the first year at Tollesbury.

3.2.6 The reasons for relatively lower colonisation than at Wash Banks are largely speculative at this stage, but the main one may be seed limitation. Hence, although these species occur in the salt marshes on the north bank of the Humber Estuary, there are no extensive stands such as those found on the west coast of the Wash adjacent to the Frieston realignment site. Probably the nearest location of extensive *Salicornia* is on the south side of the mouth of the Humber, south of Cleethorpes (Humberston Fitties and further south). Additionally, there are fewer opportunities for propagules to disperse into the south-eastern sector of the site (fewer tidal incursions) owing to its higher elevation and the corresponding higher elevation of the breach. However, the north-western breach and sector floods far more frequently and yet there have been very few seedlings or plantlets established at potentially suitable elevations.

3.2.7 Of interest, the plant *Bupleurum tenuissimum* (Slender Hare's-ear) was found growing on the old sea wall, on the edge of the footpath where the ground has been kept open by trampling. It is rare in Yorkshire and this population would appear to be the most northerly record for the species in Great Britain. However, as the old embankment patch is no longer used due to the creation of the breaches and the plant has an uncertain future at this site.

3.3 BENTHIC INVERTEBRATES

3.3.1 This project has highlighted that the integrity of intertidal mudflat communities is of primary importance in fulfilling the relevant conservation designations highlighted in the EAP, particularly with

regard to avifaunal usage of the site and its dependency on infaunal invertebrate abundance and diversity. Hence, given the importance of benthic invertebrates as prey for a variety of waders, wildfowl and other aquatic consumers (e.g. crabs and fish), this project recognises the importance of ascertaining their distribution and value to the local ecosystem.

3.3.2 Results from the benthic invertebrate survey have indicated that the faunal communities present across the entire survey area can be considered typical of a middle estuarine area, being composed of large numbers of relatively small organisms and low numbers of species. The dominant fauna (both inside and outside) comprised oligochaete worms (principally enchytraeidae) and nematodes accounting for almost 70% of the total organisms recorded. Previous findings on the intertidal communities within this part of the estuary were broadly consistent to those of the present study in terms of species composition and abundances (Allen & Elliott, 1999; Mortimer *et al*., 1999; Allen, 2000; Mazik & Elliott, 2000; Widdows *et al.*, 2000; Mazik, 2004). Notwithstanding this level of dominance by a few organisms, these taxa may not necessarily be present purely because they are opportunistic. As indicated above they are typical of mid estuary mudflats and are likely to be present in high numbers even when the area has matured. In addition, such communities are most likely to be strongly related to sediment type and elevation. A sandier substrate for instance is likely to have greater numbers of the larger macro-invertebrates, so any future changes in sediment composition (and topography) will need to be assessed alongside faunal data.

3.3.3 Moreover, investigations undertaken by CEFAS and IECS have shown that benthic organisms do recolonise de-faunated sediments both through vertical and horizontal migration. These studies however concentrated on anthropogenic sediment accretion typically providing greater levels of accretion than those currently occurring at Paull Holme Strays. (Bolam & Whomersley, 2003; Bolam & Whomersley, in press). Furthermore, a study undertaken on the Tees estuary looked at the colonisation of a recreated intertidal area (size: 9 ha) by estuarine/marine invertebrates and their bird predators from April 1993 to August 1997 (Evans *et al.*, 1998). Data from the site, flooded in September 1993, suggested that colonisation would have been more rapid if the enclosure had been flooded in the spring, thus gaining from the summer recruitment of the

benthic organisms. This is precisely what may have taken place at PHS, as the 2003 recruitment over the summer will have settled in the outer mudflats before the site was breached.

3.3.4 As far as differences between inside and outside the breached area are concerned, it is worth noting that *P. litoralis* was recorded in high concentrations inside: this oligochaete is a well known opportunistic species with a swimming adult dispersal phase and often an early coloniser of disturbed or newly formed habitats (Talley & Levin, 1999; Levington & Kurdziel, 2000; Stocks & Grassle, 2003). Talley and Levin (1999) stated that *P. litoralis* characterises the early successional stages of community development whereas other worms like enchytraeids and tubificid oligochaetes are more characteristic of older, established communities. Their overall findings are also consistent with those of the present study. In addition, Prenda and Gallardo (1992) also noted that this species was predominantly found in sediments with a high silt and organic content, subjected to low current speeds. This may, in part, explain the distribution of *P. litoralis* inside the site where it was found at its highest densities along the upper shore area and in the far south-eastern lower shore corner.

3.3.5 Although no statistically significant and/or readily interpretable spatial patterns of abundance, biomass, species diversity or species distribution were observed in this initial investigation, some specific differences were recorded between the inside and the outside of the site and between the sampling stations within the two areas.

3.3.6 Hence, for example, significantly higher species diversity, abundance and biomass (both for the whole community and for individual species) were observed on the outside. This is to be expected given that the inside mudflats are at an early stage of development and there is still evidence of agricultural soil and vegetation, particularly in the areas which experience infrequent tidal inundation (L. Mander, University of Hull. Pers. comm.).

3.3.7 Further, on the outside mudflats, there was a fairly clear pattern of reduction in biomass, species diversity and, to a lesser extent, abundance in a high to low shore direction. This may be explained by the increasing particle size and sand content and reduction in organic content towards the lower shore area which would be subjected to stronger current speeds

for longer periods of time than the upper shore areas. Comparable observations have also been made by Allen and Elliott (1999) and Allen (2000). Similarly, the abundance of the dominant species also decreased in a high to low shore direction.

3.3.8 Inside, the stations with the greatest abundance and community biomass were situated in the upper shore area opposite the north-western breach. Other areas of relatively high abundance and biomass were situated in the mid shore area to the west of the north-western breach and along the transect to the east of the south-eastern breach. Similarly, the maximum number of species was found at these sites. In general, it would appear that colonisation is taking place to the greatest degree at those sites which experience the most frequent tidal inundation. These patterns could not however be explained by the sediment characteristics (organic carbon, particle size and silt/sand content). Whilst the community distribution patterns did not clearly correspond to sites of maximum or minimum accretion, recorded by Boyes and Mazik (2004) and CEH (2004), it will be useful to examine future data (2005 onwards) in order to confirm these initial trends.

3.3.9 Moreover it would appear that accretion levels have been high enough for a selected number of species of benthic invertebrates to establish themselves as shown at a couple of sites inside the north-western breach with communities beginning to develop. However, the situation is likely to be considerably more complex than described here as there are likely to be a number of hitherto unidentified factors which may be affecting the development inside the site. All trends and tendencies identified and described here may therefore become more apparent and meaningful as additional data is gathered in the course of future monitoring; a greater and more robust body of data will require the use of more detailed statistical analysis (including multivariate analysis) to test for significant changes in the biological and sedimentary regime as the site becomes more established over the next few years. It is therefore necessary to ensure that future monitoring is sufficiently robust/powerful to allow such analysis. Over time it may also be possible to use this information to derive predictive models of community change both in terms of the macro-invertebrates and also in relation to other components of the community e.g. avifaunal populations.

3.4 ORNITHOLOGY

3.4.1 The current habitat is of a transitional nature, with die-back of terrestrial vegetation in some areas, and initial colonisation by salt marsh flora in other areas. In addition, the areas of accreting mud are only just developing (and accreting rapidly), with the invertebrate community reflecting this dynamic transitory phase. As the rate of accretion slows, the invertebrate community will develop and a larger, more diverse assemblage should characterise the area, this being more suitable to support a feeding wader assemblage than that at present.

3.4.2 The use of the area (as a whole) by wading birds and wildfowl has been reviewed by Mander (2004). Inside the site, birds were noted to be present in the south-eastern side of the site but this area was not considered to be important for feeding or roosting. Shelduck and Teal were observed to be feeding in large numbers in the area directly opposite the western breach. These species are non-selective feeders, feeding on organic matter, seeds and invertebrates. The area in which maximum densities were recorded does not drain fully at low water and therefore no invertebrate sampling could be carried out. However, moderate to high (in comparison with the rest of the area within the managed realignment site) abundance and biomass values for invertebrates were recorded in the adjacent areas. It is therefore possible that colonisation has taken place, to a certain degree, within the area where maximum utilisation by birds was recorded.

3.4.3 In contrast, large numbers of wading birds and Shelduck were found to be feeding on the outside established mudflats. This suggests the newly accreting mudflat inside the area does not yet support communities rich enough in terms of species diversity, abundance and biomass to be utilised as feeding grounds by birds. This is to be expected, as a stable, mature invertebrate community on the inner site would not be expected to develop for several years yet. No significant change in waterfowl usage on the outside mudflats was noted either during construction or immediately post breach. Occasional disturbance events did occur, but most of these were in relation to third party activity on the bank crest. There has been a small loss in intertidal mudflat post-breach, with the scouring out of several drainage channels in this area. However, this small loss of area does not seem to have had any significant impact on the avifauna in this area.

3.4.4 The monitoring has seen some interaction between populations using the site and the adjacent mudflat complex at Saltend. It appears that some of the Saltend wildfowl population have moved into the site with birds taking advantage of the newly created, but suitable, feeding conditions in the realignment area. Interactions by waders have also been seen between Saltend and Paull, with some species feeding at Saltend moving to the PHS site to roost. Whilst species such as Dunlin and Redshank move between the areas, as was the case prior to the breach, but with movement onto the fronting Foulholme mudflats, it has been most notable for Black-tailed Godwit. This species has recently established a roost on the site, and birds disperse out to feed at Saltend during the low to mid water phase, before returning to PHS to roost around high water. This has increased utilisation by the species at Saltend, reflecting a pattern of both gains and losses from this site over the last year, in relation to the creation of the realignment site. A significant increase in carrying capacity in the middle estuary resulting from the development of the site to date seems unlikely, particularly with the infauna of the new realignment site yet to develop. However, this is expected to occur over the coming years, as the invertebrate community of the site develops.

3.4.5 With regard to bird populations in general, this investigation suggests that if intertidal areas are to be created in mitigation for any lost to industry or other development, a lead-time of three years is required to make the area profitable for feeding birds. The birds observed within PHS to date have been opportunistic and/or used site for feeding during high tide periods when the main established mudflats are covered and unavailable. This may therefore give an indication of the potential time-scale that may be required for the establishment of Paull Holme as a fully developed intertidal system, i.e. before the benthic communities become rich enough in terms of abundance and biomass to support the large bird populations already present on the Humber.

3.4.6 As the results from the volunteer bird survey show this site is of national importance for the Avocet, the Black-tailed Godwit and the Golden Plover. However, what is not clear is the type of survey and the time the surveys were carried out. If the counts were taken during high water then the birds could be using the site as a roost site only and not necessarily for feeding. Roost sites are important but do not indicate high quantities of benthic invertebrates. During the breeding season over 70 Avocet were recorded on 4 occasions during June 2004, with over 50 birds present on

further dates between May and July, compared to a figure of c. 30 birds for 2003. Breeding success was observed in 2004 with a number of adults with young recorded during June and July. The most recent national data on the breeding population (Ogilvie & RBBP, 1999) suggest that around 650 pairs were breeding in Britain, although this figure is likely to have increased in recent years,

3.4.7 At the moment data are not available for the estuary as a whole or at a national level to allow a comparison of usage patterns seen within the site to wider trends in avifaunal populations. However, as the site develops, it is hoped that appropriate data from the WeBS programme for the Humber and nationally will be incorporated into the analysis (as and when it is published).

3.4.8 From the ongoing monitoring, it would appear that third party disturbance (largely walking and dog walking) along the flood defence crest has the greatest disturbance impact to avifauna. This pattern has been seen elsewhere on the estuary, with occasional third party activity often having a greater disturbance impact than ongoing plant operation, this reflecting the habituation effect seen in most avifauna. This effect is usually most prevalent during the winter period when flocks remain in an area for a protracted period, and least effective for passage flocks, which move through an area often within a week. The south-eastern part of the site is most sensitive as it is relatively narrow with birds not able to move out into the middle of the area to avoid disturbance. Prolonged activity in this area during low habituation periods could potentially restrict take-up of the area as a feeding or roosting resource.

3.5 FRESHWATER INVERTEBRATES

3.5.1 It is difficult to evaluate the efficacy of translocation of vegetation and invertebrates from the former borrow pit to the new water bodies. However, the presence of species which do not normally colonise raw, early successional habitats but favour richly-vegetated ponds and dykes and are known to have been translocated, indicates some success. Almost certainly the translocation of perennial water plants has been valuable in providing immediate vegetation structure and by introducing attached invertebrates' eggs, larvae, pupae or adults.

3.5.2 The presence, for example, of several brackish water invertebrates probably indicates that conditions in the new aquatic habitats are sufficiently ion-rich to support a specialised invertebrate fauna. In fact some of these species appear to have established breeding populations. As these new water bodies are hydrologically isolated from the estuary, this development is probably due to aerial deposition. Potentially, the establishment of a pond and connecting dykes with low-end brackish water could provide habitats of regional importance for the conservation of aquatic invertebrates.

3.5.3 Some translocated species on the other hand have not been recorded in the new water bodies. The weevil *Lictodactylis leucogaster*, for instance, was not found despite large numbers transferred and its food plant (spiked water-milfoil) being well-established and vigorous. However, the phenology of this species is not well known and it may not be present in adult form this early in the year. Larvae of *Ilybius* sp/spp were present in the dyke at SP3 (this site covers around 100 metres towards the western end of the new soke dyke east of South Pasture Drain - see Appendix E) and may include *I. subaeneus*, a species which had already colonised this dyke by July 2003.

3.5.4 A very obvious benefit of translocating vegetation from the former borrow pit has been to provide food and shelter for invertebrates in the new habitats. Results show that vegetation has established very well, particularly in the dyke at SP2 (soke dyke is adjacent to car park – see Appendix E), where there are fine stands of Spiked Water-milfoil, Thread-leaved water-crowfoot, Common Stonewort and Sea Club Rush. Lesser Pondweed is more dominant in the dyke at SP3/4, with Water-milfoil and Water-crowfoot more patchy. In this dyke submerged macrophytes were coated in clayey silt, presumably washed in from agricultural field drains.

3.5.5 As indicated above, the newly created aquatic habitat may prove to be of conservation value. As shown in table 4 below, of eight Nationally Scarce water beetles recorded from the former borrow pit, three were found in the new habitats (*Haliplus apicalis, Agabus conspersus* and *Dytiscus circumflexus*). All these species were believed to have been translocated, although it cannot be assumed that they have not established unassisted.

Table 4 Nationally scarce water beetles recorded from the former borrow pit

Species	Translocated	Present in new habitat
Haliplus apicalis	?	Y
Hygrotus parallelogramus	N	N
Agabus conspersus	Y	Y
Ilybius subaeneus	N	Nc
Dytiscus circumflexus	Y	Y
Enochrus halophilus	N	N
Ochthebius marinus	N	N
Lictodactylis leucogaster	Y	Nc

Y – yes, in large numbers (y = in small numbers); N – not found; Nc – not confirmed but may be present

3.5.6 More specifically, six of the beetles recorded during the current survey are listed as Nationally Scarce (Foster, in prep) including *Haliplus apicalis* (Nationally Scarce, NSb*) and *Hygrotus nigrolineatus* (Nationally Scarce, NSa), a genuinely rare species, albeit opportunist and highly mobile, *Scarodytes halensis* (Nationally Scarce, NSb), *Agabus conspersus* (Nationally Scarce, NSb), *Dytiscus circumflexus* (Nationally Scarce, NSb), with a restricted distribution in Britain, *Enochrus bicolor* (Nationally Scarce, NSb), with only a single specimen collected from the dyke at SP2, it is unclear whether a breeding population has established; *E. bicolour* had not been detected previously at PHS.

* Nationally Scarce Category A - Notable A (Na)

Taxa which do not fall within RDB categories but which are none-the-less uncommon in Great Britain and are thought to occur in 30 or fewer 10 km squares of the National Grid or, for less well recorded groups, within seven or fewer vice-counties.

Nationally Scarce Category B - Notable B (Nb)

Taxa which do not fall within RDB categories but which are none-the-less uncommon in Great Britain and are thought to occur in between 31

and 100 10 km squares of the National Grid or for less well recorded groups, between eight and twenty vice-counties.

3.5.7 In addition, many specialist invertebrates of coastal or brackish waters are also of conservation interest in the sense that their habitat is highly restricted and many have quite exacting requirements. The water beetles *Haliplus apicalis, Agabus conspersus* and *Enochrus bicolor*, the Caddis fly *Limnephilus affinis* and the amphipod *Gammarus zaddachi*, for example, are all associated with coastal or brackish standing waters; the lesser Water Boatman *Sigara concinna* is also characteristic of ion-rich waters. The presence of several such species suggests that the new water bodies at Paull are sufficiently ion-rich to develop a specialised coastal invertebrate fauna.

3.5.8 Lastly, it should be noted that although some 'brackish' water invertebrates tolerate high salinities, many seem to favour low-end brackish conditions. Such communities are quite distinct from those of saline lagoons or estuarine habitats subject to frequent tidal incursions. Long-term studies of an Essex salt marsh subject to rare episodes of tidal flooding have indicated that most brackish water beetles only reappeared when salinity fell below about 15 ppt and electrical conductivity was less than 15 mScm-1 (Greenwood & Wood, 2002).

3.6 VOLUNTEER AND OTHER MONITORING

Vegetation

3.6.1 A total of 137 species was recorded across the site. When compared with the seed mixtures planted on the banks by the Environment Agency, it is possible to see that the area has been colonized by opportunist species typical of this habitat., One species of note here is Corn Parsley (*Petroselinum segetum*) a locally frequent coastal species typically restricted to the south and east of England only; this was recorded in sector E.

3.6.2 An interesting feature here is that Yellow Oat-grass and Smooth Meadow-grass have not taken at all perhaps suggesting little tolerance of brackish/salty conditions. Otherwise, there do not appear to be other

interesting species. The colonization by *Salicornia* (Annual Glasswort; a target species) and the salt marsh species e.g. salt-marsh grass (*Puccinellia maritima*) is expected. Section G appears to be the most successful (well vegetated anyway) so could be subject to less disturbance from tidal flow.

3.6.3 Tables 1-3 in the results section indicate which species planted by the Environment Agency were subsequently identified in the course of the voluntary monitoring in sectors E, F, G and H (see AppendixD) and in which part of the sector, i.e. (Crest (C), Front Face (F), Rear face (R) and Berm (B).

3.6.4 In general, the planting by the Environment Agency has been successful with the majority of species present in most areas. The salinity of the area may be having a detrimental effect on certain species particularly smooth meadow grass and yellow oat grass. This could be determined by soil analysis if desired.

3.6.5 Of interest is the reported presence of a sub species of the grass soft brome namely *Bromus hordeaceus ssp longipedicilatus*.

Mosses

3.6.6 EYBC recorded a range of mosses in sector F including *Pleurocarpous* mosses, *Cleistocarpous acrocarpous* mosses and *Acrocarpous* mosses; none of these is considered scarce in this region.

Terrestrial Invertebrates

3.6.7 A number of common Lepidoptera, Coleoptera, Syrphidae, Hymenoptera and Odonata have been recorded on site, once again by volunteer surveyors. The species recorded are typical of this type of site. None of the species are notable or protected, but nine species of Odonata and eighteen species of Lepidoptera show a good suite of species at this latitude and could indicate low air-born pollution.

Water voles

3.6.8 Six sections were surveyed and the full results can be found in Appendix G. Briefly, numerous direct sightings of water voles and related signs such as latrines, droppings, feeding remains, burrows and pathways indicate that they are present at Paull Holme Strays. No records of water voles have been recorded on un-vegetated sections.

Student Projects

3.6.9 Two MSc project were undertaken based on work at the PHS site during 2004.

3.6.10 Paul Robertson - Habitat mapping and development at the Paull Holme Strays Managed Realignment site on the Humber Estuary (part of MSc in Estuarine and Coastal Science and management at the University of Hull).

Summary - The project looked at the distribution of habitats using habitat mapping at the Paull Holme Strays site. A contour map of the site was developed to represent a number of monitoring components and modelling of floral development and topography was undertaken to show the potential development of the site over the next ten years. The project explains how the approach to habitat creation employed at Paull Holme Strays is less predictable than pro-active or experimental approaches. Even if models could accommodate other important factors such as drainage and recruitment, the unpredictable hydrological dynamics would still present difficulties for predictions of habitat development.

3.6.11 Jennifer Adamson – The infaunal and hyperbenthic faunal colonisation of a managed realignment site (part of MSc in Estuarine and Coastal Science and management at the University of Hull)

Summary - The project looked at how the site was evolving as an ecosystem. The study intended to illustrate how the habitat is developing with respect to nekton and benthic invertebrate communities by monitoring the site over a three month period. The results showed that the site is being utilised to some extent by some important members of the invertebrate and fish assemblage of the Humber. It is expected that

the site may evolve into an important nursery and feeding ground for a variety of organisms.

4 CONCLUSIONS & RECOMMENDATIONS

4.1.1 The PHS project is the first managed realignment site to be constructed and breached on the Humber estuary. If the results of this investigation are representative, then initial indications can be seen as promising for considerable habitat creation at PHS as well as future managed realignment schemes throughout the Humber.

4.1.2 The main conclusions are:

1. Rates of and total accretion at some stations were considered significant.
2. Stations in the north-west part of the site have shown both highest rates of accretion and total accretion.
3. Colonisation by benthic invertebrates within the managed realignment site is mostly concentrated near the breach sites, close to the western breach and restricted colonisation in some areas may be due to infrequent tidal inundation.
4. Intertidal invertebrate communities within the managed realignment site are not yet rich enough to support similar numbers of birds as observed at other sites on the Humber.
5. Colonisation by typical salt marsh vegetation has been sparse possibly due to limited seed and propagule dispersion within the site.
6. Translocation of perennial water plants has provided immediate vegetation structure to the new fresh/brackish water habitats.
7. Efficacy of invertebrate (also fish and amphibian) translocation to the fresh/brackish water habitats cannot be evaluated but there are indications of representative coastal invertebrate populations developing.
8. The area has been colonized by a number of opportunist terrestrial species typical of this habitat. Two rare terrestrial plant species have been noted in the grassland areas.
9. At present it is too early to sensibly relate the result of monitoring to the habitat and species targets identified in the EAP. However it can be concluded that development of the site has largely been as expected (or faster) over the first year and there appears to be no reason why the quantitative and qualitative targets set should not be achieved.

10. The monitoring programme being implemented appears to be providing a sound basis for observing the development of the site over time and its fulfilment of the targets identified in the EAP.
11. A more comprehensive picture of the project's success will only be possible when additional data is gathered in the course of future monitoring.

4.1.3 The main recommendations are:

1. Comprehensive baseline topographic survey should be an essential component of all future monitoring programmes for realignment sites.
2. Fisheries based monitoring (e.g. the potential for spawning and nursery areas at the PHS site) should be considered for the future monitoring of the site.
3. More sophisticated statistical analysis may be required in the future as the site becomes better established and generates more complex data.
4. Analysis of future monitoring data and changes over time may aid development of predictive models for areas undergoing managed realignment.
5. It is recommended that present results be integrated and assessed with other Humber based (and UK based) projects.

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