North Thames Estuary & Marshes Aquatic Macroinvertebrate Survey Report 2022

April 2024

Natural England Commissioned Report NECR530

www.gov.uk/natural-england

NATURAL ENGLAND

About Natural England

Natural England is here to secure a healthy natural environment for people to enjoy, where wildlife is protected and England's traditional landscapes are safeguarded for future generations.

Further Information

This report can be downloaded from the Natural England Access to Evidence Catalogue. For information on Natural England publications or if you require an alternative format, please contact the Natural England Enquiry Service on 0300 060 3900 or email enquiries@naturalengland.org.uk.

Copyright

Catalogue code: NECR530

Report details

Author

Toby Abrehart

Natural England Project Manager

Jonathan Bustard, Thames Estuary Senior Adviser

Contractor

Abrehart Ecology Limited

Keywords

Aquatic, invertebrates, SSSI, Tilbury, brackish, saline, lagoon

Acknowledgements

Natural England would like to thank landowners for land access permission and for related practical support.

Citation

Abrehart Ecology. 2023. Tilbury Aquatic Macroinvertebrate Survey (2022) Report. NECR530 Natural England.

Foreword

Aquatic habitats across the North Thames Estuary & Marshes were surveyed in 2022 to determine their quality for aquatic invertebrates and collect evidence to assess the case for designation as a Site of Special Scientific Interest (SSSI). The report does not itself make a case for designation, rather it provides an objective record of survey findings to support Natural England's independent assessment of special interest. Natural England commission a range of reports from external contractors to provide evidence and advice to assist us in delivering our duties. The views in this report are those of the authors and do not necessarily represent those of Natural England.

Executive summary

Abrehart Ecology Ltd was commissioned by Natural England, to undertake an aquatic macroinvertebrate survey of eight compartments of the Tilbury area from Tilbury Fort to Mucking village.

The study aimed to update the records and status of macroinvertebrates at eight main compartments of the survey area: from Tilbury Fort to north of Mucking Marshes. Additionally, the survey was used to evaluate the conservation value of each compartment and the overall condition of the site.

Samples were taken from the eight compartments in May, July and August/September 2022. The eight survey compartments were Mucking Wetlands, Mucking Landfill (Enovert), East Tilbury Quarry (Walsh), Fields East of Coalhouse Battery, Coalhouse Fort and surrounds, 'LTC4, i8 and Bowaters', Ashfields (including i3), and Tilbury Fort and Marshes.

Summary of overall biodiversity value:

1. In total, 166 taxa of aquatic invertebrates were recorded within the survey area, and of these, 130 were identified to species level. Each of the eight compartments were scored using the Site Analysis for Freshwater Invertebrate Surveys (SAFIS) method, which indicated that each compartment is of a 'Very High' conservation value (Community Conservation Index (CCI) score) with up to 16 species of interest in a single compartment. The water quality was deemed good to excellent using the Biological Monitoring Working Party (BMWP) scoring system.

2. Over the sampling efforts, 13,593 specimens were recorded. These records included fifty-three taxa of aquatic Coleoptera, twenty-one taxa of Hemiptera, twelve tax of crustacean, ten taxa of Odonata larvae, three taxa of Hirudinea and eighteen taxa of aquatic molluscs (sixteen gastropods and two bivalves). Four species of RDB3 beetle, one pRDB3 beetle and twenty notable beetle species.

3. The conservation value of all the compartments (taken from the SAFIS analysis) was very high, and all compartments supported a number of RDB, Notable and local species. There were very few invasive species found through the survey area with common species including *Potamopyrgus antipodarum*, most notable was the Australian tubeworm - *Ficopomatus enigmaticus* was found in three areas around Tilbury from Coalhouse Fort to Tilbury Fort.

4. **Compartment A - Mucking Wetlands**
   This compartment comprised two clay-lined ponds surrounded with *Phragmites australis* with an additional third pond to the east of the site closer to the estuary edge, this pond supported a range of emergent species with *Bolboscheonus maritima* and *Phragmites australis* with stands of *Carex divisa*. This pond was well used by duck that were often fed by people, and macrophytes were limited and often grazed.

The combined three ponds had 25 taxa, of which 19 were identified to species. Four were Notable b (Nb) and three were local. The four notable b species were all beetles with *Berosus affinis, Berosus luridus, Helochares lividus* and *Rhantus grapii*. The three local species were red-eyed damselfly *Eyrthroma najas* and two backswimmers, *Sigara concinna* and *Sigara stagnalis*. The ponds were all with low salinity. The ponds have a very high conservation value with a CCI score of 23.1.

5. **Compartment C – Mucking Landfill Site (Enovert) including Gobions Lake**

This compartment was divided into two sampling areas for reporting. The large lake at the west of the site known as Gobions Lake (or Golden Gates Lake) and the three ponds in the southern edge of the Enovert site. Gobions lake was a *Phragmites australis* fringed lake supporting abundant waterfowl, this was a disused aggregates quarry now under Essex Wildlife Trust management. The remaining three ponds were all settling ponds from previous quarrying activities all with dense *Phragmites australis* fringed margins.

Gobions Lake had 77 taxa, of which 55 were identified to species. One RDB3, four were Notable b (Nb) and 14 were local. The RDB3 was *Hydrochus elongatus*, the four notable b species were all beetles with *Berosus affinis, Noterus crassicornis, Anacaena bipustulata* and *Hygrotus parallellogrammus*. Of the seven local species three were Hemiptera, three were beetles, one spider. Two locally common species were crustaceans with one introduced species *Crangonyx pseudogracilis*. The sample sites were all with low salinity. The ponds have a very high conservation value with a CCI score of 29.25.

The combined three ponds had 59 taxa, of which 46 were identified to species. Three were RDB3, three were Notable b (Nb), 14 were local and two were locally common. The two RDB3 species were beetles, *Graphoderus cinereus* and, *Graptodytes bilineatus*. The three notable b species were all beetles with *Berosus affinis, Haliplus apicalis and Helochares lividus*. Of the 14 local species five were Hemiptera, seven were beetles, one spider and one dragonfly (*Orthetrum coerulescens*). Two locally common species were crustaceans with one introduced species *Crangonyx pseudogracilis*. The sites were brackish with a 5-9ppm. The ponds have a very high conservation value with a CCI score of 32.13.

6. **Compartment D - East Tilbury Quarry (Walsh)**

The compartment comprised a series of borrow dykes, a large *Phragmites australis* fringed settling pond and a new area of lagoons (high-tide roost). All sampling points showed brackish water conditions with values ranging from 4-9ppm.

Across the three sampling areas within this compartment a total of 36 taxa were recorded with 27 species. One was RDB3, four were Notable b (Nb), one Notable r (Nr), one Notable A (Na) seven were local and two were locally common. The RDB3 species was the mollusc *Hydrobia neglecta acuta*, the four notable b species were all beetles with *Berosus affinis, Berosus signaticollis, Enochrus bicolor and Rhantus*

frontalis. The Na *Enochrus Haliplus*, the Nr *Sigara selecta*. Of the seven local species four were Hemiptera and three were beetles. Two locally common species were crustaceans with one introduced species *Crangonyx pseudogracilis*. All sampling locations showed brackish water conditions with values ranging from 4-9ppm.The ponds have a very high conservation value with a CCI score of 41.6.

7. **Compartment L – Fields East of Coalhouse Battery**
   Across the one sample of the campsite ditch a total of 37 taxa were recorded with 32 species. Four were Notable b (Nb), one was Notable a (Na) and four were local. The four Nb were beetles, *Berosus affinis, Helochares lividus, Hygrotus parallellogrammus* and *Rhantus frontalis.* The Na was *Enochrus halophilus* with three of the local species were beetles and *Sigara selecta*. Of the seven local species four were Hemiptera and three were beetles. The sampling location showed brackish water conditions with a value of 6ppm.The ditch has a very high conservation value with a CCI score of 21.47.

8. **Compartment E – Coalhouse Fort and surrounds**
   Across the five sampling points a total of 24 taxa were recorded with 20 species. The saline lagoons had a limited fauna dominated with *Cerastoderma glaucum* and *Idotea chelipes*, with notable molluscs being *Ecrobia ventrosa, Hydrobia acuta neglecta* and *Ecrobia ventrosa*. The sampling locations showed brackish water conditions ranging from 4.65 to 9.3ppm. With the exception of point 23 (moderate), all other sampling points had very high conservation CCI scores.

9. **Compartment 'LTC4, i8 and Bowaters'**
   LTC4 samples were from ditches with *Phragmites* and *Bolboscheonus maritima* dominating the margins and were opaque, showing brackish water conditions with high conductivity values of 15-20ppm.

   Across the two samples a total of 26 taxa were recorded with 21 species. Five were Notable b (Nb), one was Notable rare (Nr) and three were local. The five Nb were beetles, *Berosus affinis, Enochrus bicolor, Noterus crassicornis, Hygrotus parallellogrammus* and *Rhantus frontalis*. The Nr was *Sigara selecta*. Of the three local species two were beetles and the Hemiptera was *Notonecta viridis*. The ditch has a very high conservation value with a CCI score of 26.60.

10. **Compartment 'i3 and Ashfields'**
    The i3 samples were also from two ditches and an ephemeral pond in the Ashfields complex, all with *Phragmites australis* and *Bolboscheonus maritima* dominating.

    The i3 and Ashfields samples supported 43 taxa were recorded with 29 species. One was pRDB3, two were Notable b (Nb), one was Notable rare (Nr) and eight were local. The pRDB 3 was *Berosus fulvus,* the two Nb were beetles, *Berosus affinis* and *Rhantus frontalis*. The Nr was *Sigara selecta*. Of the eight local species four were beetles and four Hemiptera. The sampling location showed brackish water conditions with a value of 15-20ppm. The ditch has a very high conservation value with a CCI score of 34.62.

11. **Compartment Tilbury Fort and Marshes**

    This compartment was a series of moat/lagoons, tidal ditches, ephemeral ditches and drying pools, all within a heavily horse-grazed marsh system. Many of the ditches had aquatic macrophytes with the main lagoons supporting dense mats of marine algae.

    Across the ditch and pool samples a total of 89 taxa were recorded with 63 species. One pRDB3, two RDB3, 10 Notable b (Nb), two Notable b (Nb) and one Notable rare (Nr), 15 local and two locally common species. pRDB3 *Berosus fulvus*, RDB3 *Graptodytes bilineatus*, *Hydrobia acuta neglecta*, Nb all beetles, *Berosus affinins, Berosus luridus, Berosus signaticollis, Haliplus apicaulis, Helophorus arvernicus, Limnoxenus niger, Noterus clavicornis*, *Ochthebius marinus*, *Rhantus frontalis* and *Rhantus suturalis*. Na was *Cercyon bifenestratus* and *Enochrus halophilus* and the Nr was *Sigara selecta*. The sampling location showed brackish/saline/hypersaline water conditions with values of 15-44ppm. The combined ditch data had a very high conservation value with a CCI score of 40.9.

    Two samples (52 and 53 on figure 10) were taken from one ditch to the northwest of the Fort Road, no other samples were possible as the ditches were too dry. The one ditch sampled was a *Phragmites australis* choked ditch with limited areas of open water. Across the two samples in this area, of a total of 17 taxa, 14 species were recorded. One Notable b (Nb) *Haliplus apicalis*, five were local and one locally common *Gammarus duebeni*. The sampling location showed brackish water conditions with a value of 6ppm. This ditch has a very high conservation value with a CCI score of 22.50.

Invasive Non-Native Species

Five invasive non-native species (INNS) were found across the survey area, the common freshwater shrimp *Crangonyx pseudogracilis*, and two molluscs, the nationally common *Potamoprygus antipodarium* and the increasing *Physella acuta.* The mollusc *Heleobia charruca* and the Australian tubeworm *Ficopomatus enigmaticus.*

Table 1. Summary of rare species diversity and abundance. Blank cells indicate where species were not recorded.

Status	Number of species	Number of sampling points	Total numbers	Beetle species	Hemiptera species	Mollusc species	Odonata species	Crustacean species	Arachnid species
RDB3	4	15	62	3		1			
pRDB3	1	6	14	1					
Nb	15	54	234	15					
Na	2	11	100	2					
Nr	1	8	50		1				
Local	24	140	1442	11	9		2		1
Locally common	3	38	1781					3	

Contents

Methods

Sample point locations

Sampling points, mapped in figure 1, were chosen once on site to allow the most diverse habitats to be sampled. Data and sample collection were undertaken by two surveyors, including an experienced on-site surveyor (Toby Abrehart FLS MCIEEM) and a second team member responsible for recording abiotics, health and safety, and assisting with sample collection (Daniel Anderson BSc (Hons), Alister Killingsworth BSc (Hons) MSc GradCIEEM) and Dr Simon Forster BSc PhD). All the sampling was undertaken during summer 2022 (May to September). The sample sites were identified by Toby Abrehart as suitable to survey and verified in the field.

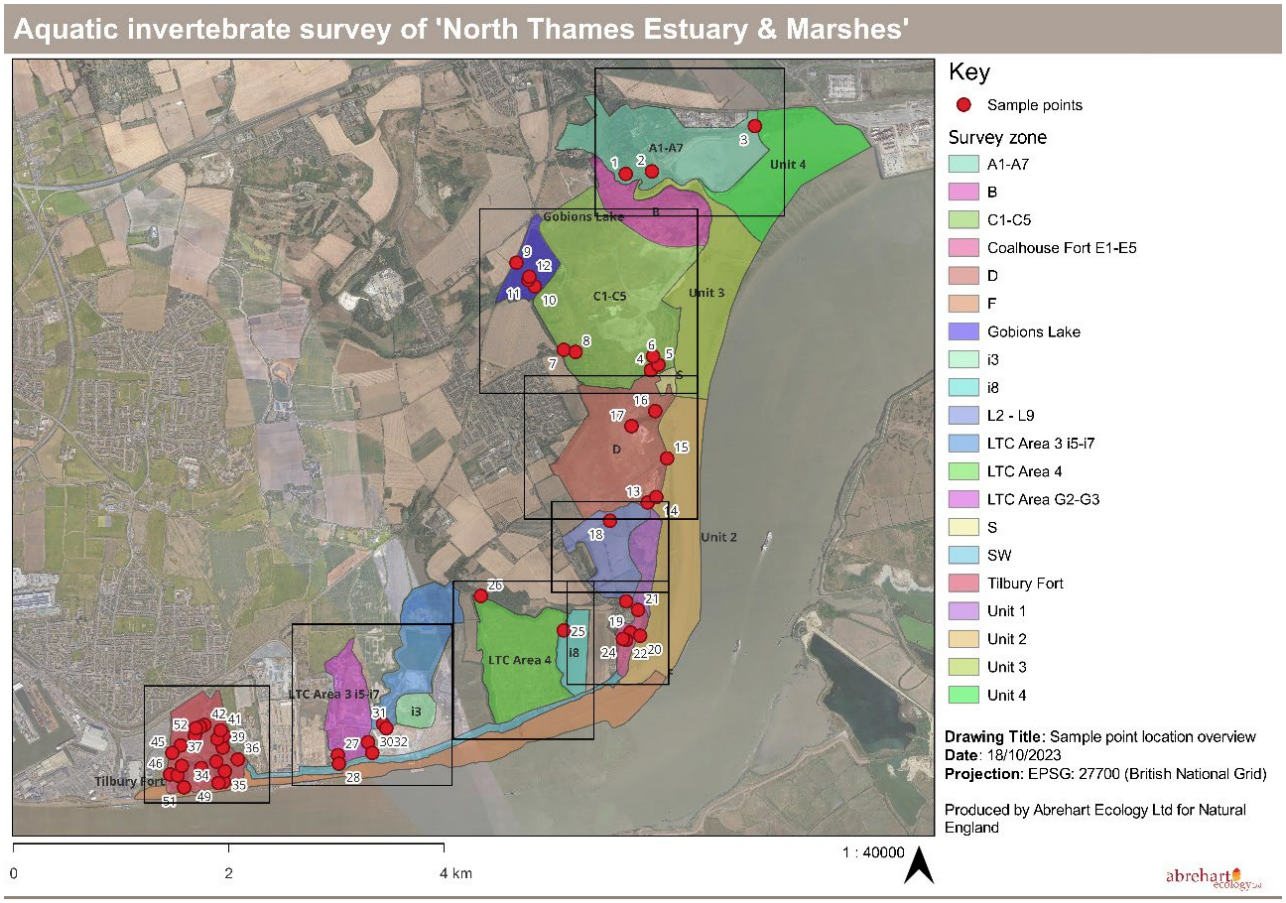


Figure 1. Sample point locations. Map data Aerial Imagery Copyright is from @ECNES 2023

Table 2. Locations of the survey areas and sampling points

Survey Compartment Name	Sub-Compartment Code	Sampling Point name	Sample Point Map number	Number of samples taken	Grid ref
Mucking Wetlands	A	*Carex divisa* pond 1	3	Once only	TQ70248139
Mucking Wetlands	A	EWT 2	2	Once only	TQ69298097
Mucking Wetlands	A	EWT 1	1	Once only	TQ69068093
Mucking Landfill (Enovert)	C1	Mucking Marshes 6	4	2 samples	TQ69287912
Mucking Landfill (Enovert)	C1	Mucking Marshes 7	5	2 samples	TQ69357917
Mucking Landfill (Enovert)	C1	Mucking Marshes 7	6	2 samples	TQ69307925
Mucking Landfill (Enovert)	C1	Mucking Marsh 8a	7	2 samples	TQ68477931
Mucking Landfill (Enovert)	C1	Mucking Marshes 8	8	2 samples	TQ68587929
Mucking landfill (Enovert)	Gobions Lake	Mucking Marshes 9	9	2 samples	TQ68038012
Mucking landfill (Enovert)	Gobions Lake	Mucking Marshes 10	10	2 samples	TQ68207990
Mucking landfill (Enovert)	Gobions Lake	Mucking Marshes 11	11	Once only	TQ68147996
Mucking landfill (Enovert)	Gobions Lake	Mucking Marshes 12	12	Once only	TQ68157999

Survey Compartment Name	Sub-Compartment Code	Sampling Point name	Sample Point Map number	Number of samples taken	Grid ref
East Tilbury Quarry (Walsh)	D	East Tilbury Marshes 1	13	2 samples	TQ69257789
East Tilbury Quarry (Walsh)	D	East Tilbury Marshes 2	14	Once only	TQ69337794
East Tilbury Quarry (Walsh)	D	East Tilbury Marshes 3	15	Once only	TQ69437830
East Tilbury Quarry (Walsh)	D	East Tilbury Marshes 4	16	2 samples	TQ69327874
East Tilbury Quarry (Walsh)	D	East Tilbury Marshes 5	17	2 samples	TQ69107860
Fields east of Coalhouse Battery	L	Coalhouse Fort Campsite	18	Once only	TQ68907772
Coalhouse Fort & surrounds	E2	Coalhouse Fort 1	19	2 samples	TQ69097668
Coalhouse Fort & surrounds	E4	Coalhouse Fort 2	20	2 samples	TQ69187665
Coalhouse Fort & surrounds	E1	Coalhouse Fort 3a	21	1 Sample	TQ69167689
Coalhouse Fort & surrounds	E1	Coalhouse Fort 3	22	2 samples	TQ69057661

Survey Compartment Name	Sub-Compartment Code	Sampling Point name	Sample Point Map number	Number of samples taken	Grid ref
Coalhouse Fort & surrounds	E3	Coalhouse Fort 4	23	Once, dry on second visit	TQ69057697
Coalhouse Fort & surrounds	E1	Coalhouse Fort 5	24	Once only	TQ69027662
LTC4, i8, Bowaters	LTC4	LTC4 East 2	25	Once only	TQ68477670
LTC4, i8, Bowaters	LTC4	LTC4 North 1	26	Once only	TQ67707702
Ashfields	G2	Ashfield A1 west ditch (Middle)	27	Once only	TQ66377554
Ashfields	G2	Ashfield A1 west ditch (South)	28	Once only	TQ66387546
Ashfields	G2	Ashfield A1 east ditch (north)	29	Once only	TQ66657566
Ashfields	G2	Ashfield A1 east ditch (south)	30	Once only	TQ66697556
Ashfields	i3	i3 central north	31	Once only	TQ66797583
Ashfields	i3	i3 southern ditch	32	Once only	TQ66827579
Tilbury Fort & Marshes	TFM2	Tilbury Fort 1	33	2 samples	TQ65317529
Tilbury Fort & Marshes	TFM2	Tilbury Fort 2	34	2 samples	TQ65247548
Tilbury Fort & Marshes	TFM3	Tilbury Fort 3	35	Once, dry on second visit	TQ65327539
Tilbury Fort & Marshes	TFM5	Tilbury Fort 4	36	2 samples	TQ65447550

Survey Compartment Name	Sub-Compartment Code	Sampling Point name	Sample Point Map number	Number of samples taken	Grid ref
Tilbury Fort & Marshes	TFM1	Tilbury Fort 4a	37	Once, dry on second visit	TQ64917563
Tilbury Fort & Marshes	TFM1	Tilbury Fort 4a	37	Sample location moved to east	TQ64967564
Tilbury Fort & Marshes	TFM5	Tilbury Fort 5a	38	2 samples	TQ65307561
Tilbury Fort & Marshes	TFM5	Tilbury Fort 5	39	Once, dry on second visit	TQ65317572
Tilbury Fort & Marshes	TFM3	Tilbury Fort 6	40	Once, dry on second visit	TQ65257569
Tilbury Fort & Marshes	TFM3	Tilbury Fort 7	41	Once, dry on second visit	TQ65287577
Tilbury Fort & Marshes	TFM3	Tilbury Fort 8	42	Once, dry on second visit	TQ65137582
Tilbury Fort & Marshes	TFM3	Tilbury Fort 9	43	Once, dry on second visit	TQ65097580
Tilbury Fort & Marshes	TFM1	Tilbury Fort 10	44	1 sample	TQ64917563
Tilbury Fort & Marshes	TFM1	Tilbury Fort 10a	44a	1 sample	TQ64967564
Tilbury Fort & Marshes	TFM1	Tilbury Fort 11	45	2 samples	TQ64837556
Tilbury Fort & Marshes	TFM1	Tilbury Fort 12	46	2 samples	TQ64817536

Survey Compartment Name	Sub-Compartment Code	Sampling Point name	Sample Point Map number	Number of samples taken	Grid ref
Tilbury Fort & Marshes	TFM2	Tilbury Fort Tidal Creek	47	Once only	TQ64887535
Tilbury Fort & Marshes	TFM3	Tilbury Fort Moat NE (NW)	48	Once only	TQ64927544
Tilbury Fort & Marshes	TFM1	Tilbury Fort Moat SE	49	2 samples	TQ65267528
Tilbury Fort & Marshes	TFM3	Tilbury Fort Moat N	50	2 samples	TQ65107542
Tilbury Fort & Marshes	TFM1	Tilbury Fort Moat SW	51	Once only	TQ64947524
Tilbury Fort & Marshes	TFM8	Tilbury Fort Marshes 13	52	Once, dry on second visit	TQ65047572
Tilbury Fort & Marshes	TFM8	Tilbury Fort Marshes 14	53	Once, dry on second visit	TQ65057579

1 Aquatic invertebrate sampling

Samples were collected using ten-second sweeps with a net with 0.5mm mesh. Sweeps were repeated three times in different sections of the waterbody profile, that is, floating vegetation (where present), the benthic layer, and the submerged edge of the nearside bank. Once collected each sample was placed into a 5-litre bucket and preserved in 10% Formaldehyde for storage prior to identification. Once identified the picked-out specimens will be stored for one year in 99% Iso-propyl alcohol.

For identification, all invertebrates were separated from the retained sediment, detritus and vegetation under 40 - 80x stereo binocular microscopes. All specimens were then separated into major taxonomic groups, preserved in fresh 99.9% ethanol, and referred to an appropriate taxonomist for identification. Where possible, all specimens were identified to species level. Exceptions to this are groups that require specialist, time-consuming preparatory techniques such as head capsule dissection for chironomid larvae and prolonged clearing procedures for oligochaetes species. Caddisfly and mayfly larvae were similarly separated and identified by Sharon Flint.

2 Water chemistry sampling

At each sample point, waterbody characteristics and a range of other environmental features were recorded. These included exposed and submerged bank profiles, channel width and depth, and levels of grazing, poaching, and shelving. Abiotic parameters were recorded in the surface 10cm of water including pH, conductivity, total dissolved solids, temperature (all measured using a Hanna HI83303 Aquaculture Photometer). Each sample point was recorded on an Archer2 sub-metre DGPS unit.

Water samples were taken using a five-litre bucket within the surface 15cm of water. These were generally taken from banksides, as these areas were most accessible during survey visits and prevented excessive disturbance which would have been caused through entering the waterbodies.

3 Biocontrol

As sampling comprised moving from one system to another, the check, clean, and dry methods were employed as standard. However, protocol also included changing of nets and trays from one waterbody to another. Prior to entering a new waterbody, the net and trays from one site were washed in a solution of Virkon and left to dry. A clean and dry set was then used in the new waterbody. This prevented species or pathogens being transmitted from one area to another. On return to the laboratory the nets were washed again in Virkon solution and left to dry for at least one day before being taken into the field.

On site, in addition to the nets, only waterproof boots enter the waterbody, and these too are washed in Virkon at the end of sampling effort within a marsh system and between water bodies.

4 Laboratory methods

Samples were treated as recommended by the Environment Agency (Murray-Bligh, 1999). Each sample was sorted a little at a time in a white tray. Most samples required at least 10 trays' worth of detritus to be sorted. All beetles, bugs and fly larvae were removed as well as representative specimens of other macroinvertebrate groups (for example, gammarids, mayflies). The abundance of groups not removed from the tray was estimated on a three-point scale. Most molluscs sank during the washing procedure and were recovered at the end. Usually there were vast numbers of snails, so a subsample was taken of between one twelfth and a half (but usually a third to a quarter) of the mollusc sample collected. The subsample was dried and the whole subsample identified under a microscope at low magnification. Many Succineids were kept in spirit rather than dried since they needed to be dissected for accurate identification. Dissected vouchers were sent to an independent authority (Sharon Flint) for verification.

All adult water beetles and molluscs were identified to species. Water beetles in the samples comprised the families Gyrinidae (whirligigs), Haliplidae, Hygrobiidae (screech beetles), Noteridae, Dytiscidae (diving beetles), Hydraenidae, Helophoridae, Hydrochidae, Hydrophilidae (crawling water beetles), Scirtidae, Elmidae (riffle beetles), and Dryopidae.

Several groups within other families were also identified - Donacinae (reed beetles) in Chrysomelidae, *Stenus* within Staphylinidae (rove beetles), and Coccinellidae (ladybirds).

Abundances were estimated or converted from actual counts to an approximately geometric scale:

- A - 1-9, B - 10-99, C - 100-999 and D - >1000.

5 SAFIS analysis

Data collected during the surveys were processed using SAFIS analysis (Site Analysis for Freshwater Invertebrate Surveys v.30.0, (Adrian Chalkley)). The SAFIS routine uses an inbuilt species dictionary to automate the calculation of metrics relating to conservation values and water quality, outlined below. The SAFIS analysis allowed an assessment of conservation value and water quality and also highlighted any species of conservation interest present. For each of the four sample sites, six standard measurements or metrics have been calculated allowing an assessment of the condition of the watercourse as revealed by the invertebrate community it supports. These metrics are:

- The Biological Monitoring Working Party Score (BMWP) (Hawkes, H.A (1998))
- The Average Score Per Taxon (ASPT) (Hawkes, H.A (1998))
- The Community Conservation Index (CCI) (Chad, R. (2004)

For a full explanation of these methods the original research papers should be consulted. However, to interpret the results shown within the current analysis, the following may be a useful summary:

BMWP is a measure of the water quality (oxygenation and cleanliness). BMWP scores are industry standard and reflect the sensitivity of the aquatic invertebrate families to pollution. The higher the family score, the more sensitive to oxygen depletion the family is and therefore their presence indicates a cleaner or less impacted site. The effects of pollution generally are to impose a Biological Oxygen Demand upon the receiving waters and so sensitive families are progressively excluded as the BOD increases. The revised BMWP system (2007) was used for this survey and the following classification may be used as a guide (Table 3).

Table 3. Biological Monitoring Working Party (BMWP) categories & definitions

BMWP score	Definition
< 25	poor water conditions
26-50	moderate
51-100	good
101-150	very good
more than 150	exceptional

ASPT is based on the BMWP score and so is also a measure of water quality. The BMWP score for each family present is totalled to give a site score. A high score can be achieved through a large number of low scoring families as well as a small number of high scoring families. Therefore, an Average Score Per Taxa (ASPT) is also calculated which allows further interpretation of the results (Table 4). The higher the ASPT, the greater the proportion of more sensitive families in the sample and therefore the better the site condition. It is a useful criterion for showing year to year changes and trends in the invertebrate population supported by the water body. Being an average score, the higher its value, the more ecologically valuable the population should be. Any value greater than four generally indicates good water quality but productive water bodies with large and varied populations will usually have an ASPT value between 4.5 and 5.0.

Table 4. Average Score Per Taxa (ASPT) water quality values

ASPT value	Definition
<4	poor water quality
>4	moderate quality
>5	good quality
>6	very good.

CCI is based on the rarity of the individual invertebrates living in the water. It gives a numerical value to the conservation importance of the aquatic community. The higher the CCI value the greater the conservation interest. CCI values can range from less than five for a site with little or no conservation value to a score greater than 20 for sites with very high conservation interest. This group of highest CCI values often indicate a site that is of national importance and of potential SSSI status.

Table 5. Community Conservation Index (CCI) categories and definitions

CCI	Conservation value	
0 - 5	Low	Site supporting only common species and/or low taxon richness
5 – 10	Moderate	At least one species of restricted distribution and/or moderate taxon richness.
10 - 15	Fairly high	At least one uncommon species, or several of restricted distribution, and/or high taxon richness.
15 – 20	High	Several uncommon species, at least one may be nationally rare, and/or high taxon richness
>20	Very high	Several rarities, including species of national importance or at least one RDB /Threatened species, and/or very high taxon richness.

Limitations

Species within the orders Hirundinea (leeches) and Tricladida (flatworms) can be affected by preservation in ethanol (damage to eyes and genital pores – often key features of identification). During the survey these species were found and identified in the field and released. The remainder of the specimens were preserved as normal in isopropanol alcohol as above.

Some of the surveys were carried out in non-optimal conditions due to access issues, meaning that the surveys were carried out on predetermined days rather than optimal ones. This may have reduced the diversity recorded as some sampling was carried out on dull days.

Some of the habitats were ephemeral and in the first surveys in May 2022, the water of several of the ponds and ditches was receding. In the second survey period several of these were dry and accordingly no second samples were taken.

The current survey draws its conclusions from extrapolating findings from a representative selection of the waterbodies within the survey area; sampling alternative waterbodies or sections of waterbody would inevitably yield subtly different findings.

Results

The waterbodies and wetland habitats were located mainly within the eight Areas between Tilbury Fort and the north Mucking Marshes and nearby lagoons.

Table 6. basic water chemistry results. Blank cells present where data not recorded.

Survey Compartment name	Sub-Compartment code	Sampling Point name	Number of samples taken	Grid ref	pH	Ms	pH	mS	cond	Temp
					May-22		Jul-22			
Mucking Wetlands	A	Carex divisa pond 1	Once only	TQ70248139			7.3	3.05	4800	24.6
Mucking Wetlands	A	EWT 2	Once only	TQ69298097			6.8	2.43	1800	20.2
Mucking Wetlands	A	EWT 1	Once only	TQ69068093			6.9	2.31	1700	19.6
Mucking Landfill (Enovert)	C1	Mucking Marshes 6	2 samples	TQ69287912	7.9	4.32	7.6	3.02	5000	25.1
Mucking Landfil (Enovert)	C1	Mucking Marshes 7	2 samples	TQ69357917	7.6	3.42	7.9	3.27	6000	22.7
Mucking Landfill (Enovert)	C1	Mucking Marshes 7a	2 samples	TQ69307925	7.5	3.51	7.9	3.27	6000	22.7
Mucking Landfill (Enovert)	C1	Mucking Marsh 8a	2 samples	TQ68477931	7.2	5.23	7	1.25	9040	24.4

Survey Compartment name	Sub-Compartment code	Sampling Point name	Number of samples taken	Grid ref	pH	Ms	pH	mS	cond	Temp
Mucking Landfill (Enovert)	C1	Mucking Marshes 8	2 samples	TQ68587929	7.4	5.22	7.2	1.23	8880	24.2
Mucking landfill (Enovert)	Gobions Lake	Mucking Marshes 9	2 samples	TQ68038012	8.3	1.38	8.1	1.4	2000	24.4
Mucking landfill (Enovert)	Gobions Lake	Mucking Marshes 10	2 samples	TQ68207990	8.2	1.37	7.9	1.32	2000	24.1
Mucking landfill (Enovert)	Gobions Lake	Mucking Marshes 11	Once only	TQ68147996			7.8	1.4	2000	25.1
Mucking landfill (Enovert)	Gobions Lake	Mucking Marshes 12	Once only	TQ68157999			8	1.36	2000	25.2
East Tilbury Quarry (Walsh)	D	East Tilbury Marshes 1	2 samples	TQ69257789	8.8	2.43	8.5	7	7000	23.1
East Tilbury Quarry (Walsh_)	D	East Tilbury Marshes 2	Once only	TQ69337794	8.1	4.13				
East Tilbury Quarry (Walsh)	D	East Tilbury Marshes 3	Once only	TQ69437830	7.7	6.07				
East Tilbury Quarry (Walsh)	D	East Tilbury Marshes 4	2 samples	TQ69327874	8.2	4.65	8.2	6.56	7000	19
East Tilbury Quarry (Walsh_	D	East Tilbury Marshes 5	2 samples	TQ69107860	8.2	4.65	8.2	6.87	7000	23

Survey Compartment name	Sub-Compartment code	Sampling Point name	Number of samples taken	Grid ref	pH	Ms	pH	mS	cond	Temp
Fields east of Coalhouse Battery	L	Coalhouse Fort Campsite	Once only	TQ68907772			8.8	5.08	6000	26.1
Coalhouse Fort & surrounds	E2	Coalhouse Fort 1	2 samples	TQ69097668	8.7	9.3	9.2	9.3	28000	25.6
Coalhouse Fort & surrounds	E4	Coalhouse Fort 2	2 samples	TQ69187665	8.5	9.2	9.2	9.3	28000	25.6
Coalhouse Fort & surrounds	E1	Coalhouse Fort 3a	1 Sample	TQ69167689			9.2	28	9300	25.6
Coalhouse Fort & surrounds	E1	Coalhouse Fort 3	2 samples	TQ69057661	8.1	9.45	9.2	28	9300	25.6
Coalhouse Fort & surrounds	E3	Coalhouse Fort 4	Once, dry on second visit	TQ69057697	8.1	3.92	8.5	27	9200	24
Coalhouse Fort & surrounds	E1	Coalhouse Fort 5	Once only	TQ69027662	8.2	5.66				
LTC4, i8, Bowaters	LTC4	LTC4 East 2	Once only	TQ68477670			7.5	4.68	15000	17
LTC4, i8, Bowaters	LTC4	LTC4 North 1	Once only	TQ67707702			7.6	8.8	20000	17.3
Ashfields	G2	Ashfield A1 west ditch (Middle)	Once only	TQ66377554			8.4	3.23	6000	24.6
Ashfields	G2	Ashfield A1 West Ditch (South)	Once only	TQ66387546			8.9	3.23	6000	24.8
Ashfields	G2	Ashfield A1 east ditch North	Once only	TQ66657566			8.6	9	27000	27.1

Survey Compartment name	Sub-Compartment code	Sampling Point name	Number of samples taken	Grid ref	pH	Ms	pH	mS	cond	Temp
Ashfields	G2	Ashfield A1 east Ditch South	Once only	TQ66697556			8.4	9	27000	26.7
Ashfields	i3	i3 central north	Once only	TQ66797583			8.9	6	3230	24.8
Ashfields	i3	i3 southern ditch	Once only	TQ66827579			8.4	6	3260	24.6
Tilbury Fort & Marshes	TFM2	Tilbury Fort 1	2 samples	TQ65317529	8.2	9.49	8.6	8.48	17000	25.6
Tilbury Fort & Marshes	TFM2	Tilbury Fort 2	2 samples	TQ65247548	8.3	9.44	8.9	8.56	17000	25.5
Tilbury Fort & Marshes	TFM3	Tilbury Fort 3	Once, dry on second visit	TQ65327539	8.2	8.91				
Tilbury Fort & Marshes	TFM5	Tilbury Fort 4	2 samples	TQ65447550	8.7	7.75	8.6	8.48	17000	25.6
Tilbury Fort & Marshes	TFM1	Tilbury Fort 4a	Once, dry on second visit	TQ64967564			8.6	8.48	17000	25.6
Tilbury Fort & Marshes	TFM5	Tilbury Fort 5a	2 samples	TQ65307561			8.9	8.56	17000	25.5
Tilbury Fort & Marshes	TFM5	Tilbury Fort 5	Once, dry on second visit	TQ65317572	8.6	7.89				
Tilbury Fort & Marshes	TFM3	Tilbury Fort 6	Once, dry on second visit	TQ65257569	8.1	7.75				
Tilbury Fort & Marshes	TFM3	Tilbury Fort 7	Once, dry on second visit	TQ65287577	8.3	6.19				
Tilbury Fort & Marshes	TFM3	Tilbury Fort 8	Once, dry on second visit	TQ65137582	7.8	6.21				
Tilbury Fort & Marshes	TFM3	Tilbury Fort 9	Once, dry on second visit	TQ65097580	8.1	5.06				
Tilbury Fort & Marshes	TFM1	Tilbury Fort 10	1 sample	TQ64917563	8.7	8.41				
Tilbury Fort & Marshes	TFM1	Tilbury Fort 10	1 sample above location moved east	TQ64917563			8.1	9.39	18000	21.4

Survey Compartment name	Sub-Compartment code	Sampling Point name	Number of samples taken	Grid ref	pH	Ms	pH	mS	cond	Temp
Tilbury Fort & Marshes	TFM1	Tilbury Fort 11	2 samples	TQ64837556	9.2	8.43	9.7	9.85	18000	21.1
Tilbury Fort & Marshes	TFM1	Tilbury Fort 12	2 samples	TQ64817536	9.2	8.43	8.9	9.96	15000	22.2
Tilbury Fort & Marshes	TFM2	Tilbury Fort Tidal Creek	Once only	TQ64887535			7.7	9.08	28000	29.5
Tilbury Fort & Marshes	TFM3	Tilbury Fort Moat NE (NW)	Once only	TQ64927544			8.9	9.36	35000	29.9
Tilbury Fort & Marshes	TFM1	Tilbury Fort Moat SE	2 samples	TQ65267528	8.6	9.54	8.7	9.49	44000	29.2
Tilbury Fort & Marshes	TFM3	Tilbury Fort Moat N	2 samples	TQ65107542	8.7	9.1	8.5	9.2	27000	26.8
Tilbury Fort & Marshes	TFM1	Tilbury Fort Moat SW	Once only	TQ64947524			8.7	9.52	43000	29.1
Tilbury Fort & Marshes	TFM8	Tilbury Fort Marshes 13	Once, dry on second visit	TQ65047572			7.2	6	3340	16.7
Tilbury Fort & Marshes	TFM8	Tilbury Fort Marshes 14	Once, dry on second visit	TQ65057579			7.3	6	3310	16.9

Mucking Wetlands – Compartment A

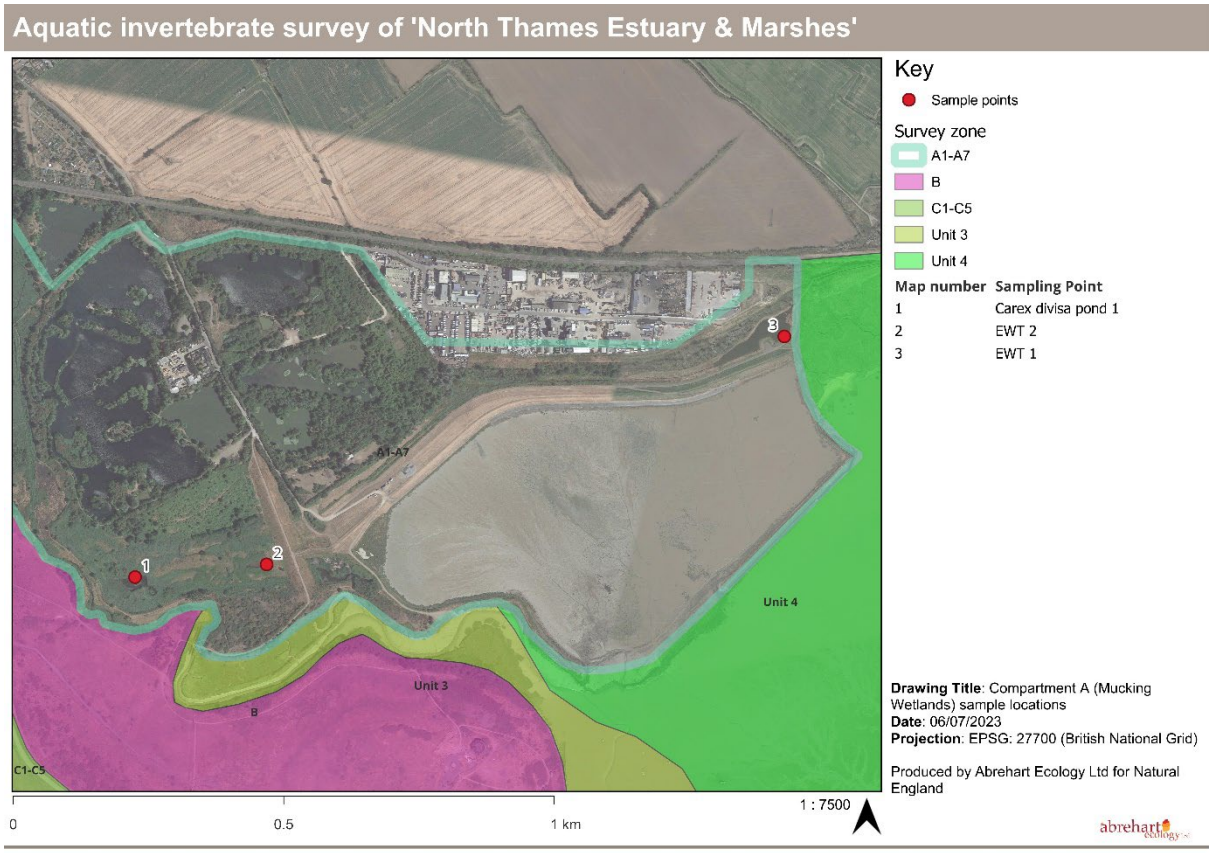


Figure 4. Mucking Marshes – Compartment A sample locations Map data (Aerial Imagery Copyright: @ECNES 2023)

Compartment A covered the area of restored old quarry and landfill sites north of the Enovert land and Essex Wildlife Trust land (EWT). Three waterbodies were surveyed these were reed-fringed ponds one with significant public access in the east of the compartment. Large numbers of wildfowl use this pond and are frequently fed by visitors. The other two are within the EWT lands and have limited public access. All the sites were saline in character with those closest to the River Thames the most saline.

'*Carex divisa* Pond' (TQ70248139) – sub-compartment A1 – map sample no. 3

This was a pond in the east of the compartment, it was partially reed-fringed along the northeastern and eastern side of the pond, the remaining areas were wildfowl grazed. The water was turbid with limited aquatic macrophyte growth, it was heavily grazed. There were smaller stands of *Bolboscheonus maritimus* and *Carex divisa*. The combined samples were taken from the southern bank of the pond.

The water body was 186m long with a width of 45m, when full. At the survey it was at least 1m deep.

A total of 46 specimens were identified of 10 taxa (9 identified to species). These samples were dominated with the leech *Helobdella stagnalis* and small numbers of Corixidae with *Sigara lateralis* and *Sigara concinna* most frequent. Two beetle species, *Haliplus lineatocollis* and *Hygrotus inaequalis* were present as singles and both are common species. Only two species of interest within the sample: both local species *Sigara concinna* and *Sigara stagnalis*. One invasive species was *Physella acuta* with 7 specimens.

Water chemistry was pH 7.2 and conductivity of 4.02µS/cm and 21.1°C.

Table 7. Species of Interest found at the '*Carex divisa* pond'. Blank cells present where non-native species not recorded

Species of Interest	Status	Non-native Species
Sigara concinna	Local	
Sigara stagnalis	Local	

EWT 2 (TQ69298097) – sub-compartment A1 – map sample no. 2

This was the middle of the three ponds, it was created in 2003/4 and was originally 0.24ha and now is 0.03ha. This pond was fringed with a wide band of *Phragmites australis* and smaller stands of *Bolboscheonus maritimus* on the southeast of the pond. Macrophytes were limited with *Myriophyllum spicatum* and a small area of *Crassula helmsii* (that will need removing). The base was of soft clays over a firmer clay base.

The water body was 39m by 13m with a depth of around 1m.

A total of 121 specimens were identified of 16 taxa (12 identified to species). These samples were dominated by Ostracoda species, Hemiptera and *Ischnura elegans. Sigara dorsalis* was the most frequent species, three notable b beetles, *Berosus affinis, Berosus luridus* with *Rhantus grapii*.

Water chemistry was pH 6.9 and conductivity of 2.31µS/cm, 1.7ppt and 19.6°C.

Table 8. Species of Interest found at pond 'EWT2' Blank cells present where non-native species not recorded

Species of Interest	Status	Non-native Species
Berosus affinis	Nb	
Berosus luridus	Nb	
Rhantus grapii	Nb	

EWT 1 (TQ69068093) – sub-compartment A1 – map sample no. 1

This was the western of the three ponds, it was created in 2003/4 and was originally 0.18ha and now is 0.1ha. This pond was fringed with a wide band of *Phragmites australis* and smaller stands of *Bolboscheonus maritimus* on the southeast of the pond. Macrophytes were limited with *Myriophyllum spicatum*. The base was of soft clays over a firmer clay base.

The water body was 69m wide with a width of 33m and a depth of around 1m.

A total of 77 specimens were identified of 15 taxa (12 identified to species). These samples were dominated by beetles, Ostracoda species and Hemiptera. *Sigara dorsalis* was the most frequent Hemiptera species, two notable b beetles, *Berosus affinis* and *Helochares lividus*, local species included *Erythromma najas* and *Sigara stagnalis*.

Table 9. Species of Interest found at pond 'EWT1'. Blank cells present where non-native species not recorded

Species of Interest	Status	Non-native Species
Berosus affinis	Nb	
Erythromma najas	Local	
Helochares lividus	Nb	
Sigara stagnalis	Local	

Water chemistry was pH 6.9 and conductivity of 2.31µS/cm, 1.7ppt and 19.6 C.

Mucking Landfill (Enovert) – Compartment C

This area was in compartment C and covered the area of restored old quarry and landfill sites of the Enovert land and Gobions lake to the west. These four water bodies were mainly old settling ponds and newly created lagoons. The majority of these water bodies were reed-fringed with large areas of open water, with good numbers of wildfowl breeding. All the sites were saline in character with those closest to the river Thames the most saline.

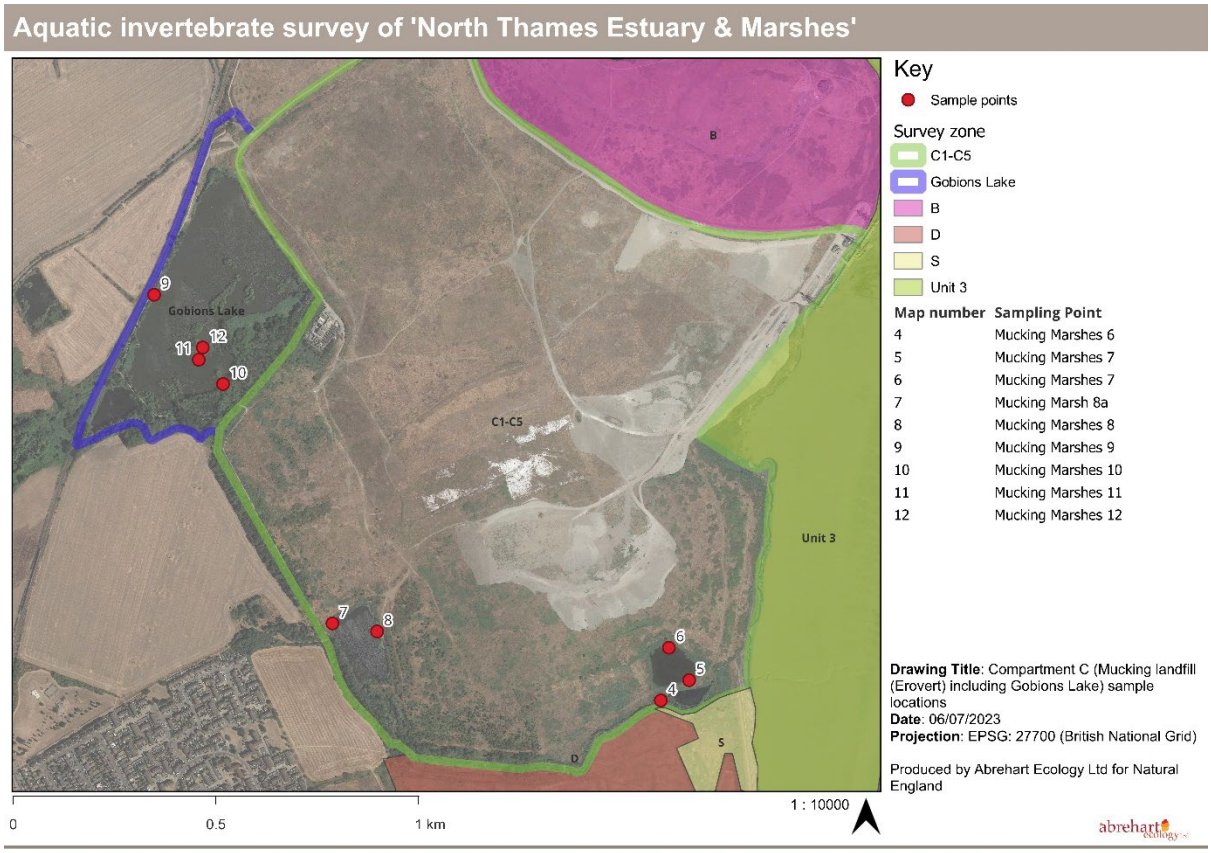


Figure 4. Mucking Marshes – Compartment C sample locations (Aerial Imagery Copyright: @ECNES 2023)

Mucking Marshes 6 (TQ69287912) – sub-compartment C1 – map sample no. 4

This was the smaller southern settling pond in the southeast of the Enovert site. There was a ditch further south that transported water off the site to the south. This pond was fringed with a wide band of *Phragmites australis* and smaller stands of *Bolboscheonus maritimus*. The sample from the first visit was from the western end in the reed-choked section and the sample from the second visit was from the deeper water off the northern bank.

The water body was 148m long with a width of 41m, when full. At the survey it was at least 1m deep. The pond was created in 2003/4 with a size of 0.3ha, this has changed little in size since creation with only a limited *Phragmites australis* development around the edges of the pond.

A total of 184 specimens were identified of 20 taxa (16 identified to species). These samples were dominated by invasive molluscs *with Physella acuta* and *Potamopyrgus antipodarium* with Corixidae and *Ampullaceana balthica* and the mayfly *Cloeon dipterum*. The RDB3 beetle *Graptodytes bilineatus* was present in the May sample, other uncommon species include *Noterus clavicornis* and *Laccophilus minutus* with the Hemiptera *Sigara concinna*.

Water chemistry was pH 7.5 and conductivity of 3.02µS/cm and 25.1°C.

Table 10. Species of Interest found at Mucking Marshes (south-east smaller). Blank cells indicate where non-native species not recorded

Species of Interest	Status	Non-native Species
Graptodytes bilineatus	RDB3	*Potamopyrgus antipodarum*
Laccophilus minutus	Local	*Physella acuta*
Noterus clavicornis	Local	
Sigara coniccina	Local	

Mucking Marshes 7 (TQ69307925 + TQ69357917) – sub-compartment C1 – map sampling nos. 5 & 6

This was the larger northern settling pond in the southeast of the Enovert site. This pond was fringed with a wide band of *Phragmites australis* and smaller stands of *Bolboscheonus maritimus*. The first sample was from the northern end in the reed-choked steep bank, with the second sample from the southern edge where there was a gentle slope into the water. The dominant aquatic macrophytes were *Zannichellia palustris*, with no other species noted.

The water body was 127m by 105m with a depth of around 1m. The pond was created around 2007 as a shallow depression with limited water in it and an area of 0.11ha with a size of 0.3ha, by 2011 the pool had begun to fill with an area of 0.96ha, this has changed little in size since creation reducing to 0.85ha by 2022 with only a limited *Phragmites australis* development around the edges of the pond.

A total of 325 specimens were identified of 31 taxa (17 identified to species). These samples were dominated by invasive molluscs *Physella acuta* and *Potamopyrgus antipodarum*. Rare beetles dominated the importance of the site with *Graphoderus cinereus* and *Graptodytes bilineatus*, both RDB3 species, being present. Four other local beetles and three local Hemiptera were found.

Water chemistry was pH 7.6 and conductivity of 3.27µS/cm and 22.7°C.

Table 11. Species of Interest found at Mucking Marshes Pond (south-east larger). Blank cells present where non-native species not recorded

Species of Interest	Status	Non-native Species
Cymbiodyta marginellus	Local	*Potamopyrgus antipodarum*
Graphoderus cinereus	RDB3	*Physella acuta*

Species of Interest	Status	Non-native Species
Graptodytes bilineatus	RDB3	
Hygrotus confluens	Local	
Hygrotus impressopunctatus	Local	
Ilyocoris cimicoides	Local	
Noterus clavicornis	Local	
Plea minutissima	Local	
Sigara concinna	Local	

Mucking Marshes 8 (TQ68587929 + TQ68477931) – sub-compartment C1 – map sampling nos. 7 & 8.

This site was the mature settling pond in the centre of the site. The pond was surrounded by a 5m wide band of *Phragmites australis* on the western side, with smaller amounts on the north and eastern sides. There was a steep drop into the bottom of the pond, but the depth was not measured. The aquatic macrophytes were dominated with *Zannichellia palustris* and fine algae covering a large area of the vegetation. The *Phragmites australis* created a hover margin on the sides of the pond. One sample was taken on the north side of the Pond on the first visit, and in the June sampling session an additional sample was taken from the southwestern corner.

This pond was created in 1999 with a water area of 0.46ha and abundant bare soils around the scrape. By 2022 the water area was 1.77ha with a Phragmites fringed margin in the north, east and south with dying tree line on the west of the site.

The water body was 201m long with a width of 102m and a depth of over 2m.

A total of 339 specimens were identified of 43 taxa (37 identified to species). These samples were dominated by the invasive mollusc *Physella acuta* and *Crangonyx pseudogracilis*. Rare beetles dominated with *Berosus affinis, Haliplus apicaulis* and *Helochares lividus*. Six other local beetles, five local hemiptera and one local Odonata *Orthetrum coerulescens* were found.

Water chemistry was pH 7.2 and conductivity of 1.23µS/cm and 24.1°C.

Table 12. Species of Interest found at Mucking Marshes Pond (south-west). Blank cells indicate where non-native species not recorded

Species of Interest	Status	Non-native Species
Berosus affinis	Nb	*Potamopyrgus antipodarum*
Crangonyx pseudogracilis	Locally common	*Physella acuta*
Enochrus coarctatus	Local	*Crangonyx pseudogracilis*
Gammarus duebeni	Locally common	
Haliplus apicalis	Nb	
Helochares lividus	Nb	
Hygrobia hermanni	Local	
Hygrotus confluens	Local	
Hygrotus impressopunctatus	Local	
Ilyocoris cimicoides	Local	
Laccophilus minutus	Local	
Noterus clavicornis	Local	
Notonecta viridis	Local	
Orthetrum coerulescens	Local	
Plea minutissima	Local	
Sigara concinna	Local	
Sigara stagnalis	Local	

Gobions Lake (TQ68038012 + TQ68207990 + TQ68147996 + TQ68157999) - map sampling nos. 9-12.

This waterbody was the mature quarry pond in the west of the Enovert site. The lake was used for fishing and supported a large number of waterfowl, especially geese. These geese grazed the *Phragmites australis* margin on the edges of the islands in the centre of the lake. The lake supported various wide bands of *Phragmites australis* which created a hover margin in places. In the first survey session (May), two samples were taken from the western and southern sides of the lake. In the second survey session (July) four samples were taken with the two additional samples taken from the margins of both sides of the largest island in the centre of the site. Aquatic macrophytes were limited in both survey periods, with *Elodea canadensis* and *Ceratophyllum submersum*.

The water body was 601m by 301m with a depth of around 1m. This lake was created prior to 1984. Between 1999 and 2014 it was turned from a flooded gravel pit to a more natural water body. The final water area in 2022 was around 11.3ha with a *Phragmites* fringed margin in the north, east and south with Willow fringe of trees on the west of the site.

A total of 1733 specimens were identified of 62 taxa (44 identified to species). These samples were dominated by the invasive *Crangonyx pseudogracilis, Sigara concinna* and *Asellus aquaticus*. One RDB3 beetle was found with three *Hydrochus elongatus*, four notable b species of beetle and seven local species.

Flying aquatic invertebrates were seen at this waterbody, with Migrant Hawker, Azure Damselfly and Small red-eyed Damselfly present.

Water chemistry was pH 8.1 and conductivity of 1.40µS/cm and 24.1°C.

Table 13. Species of Interest found at Gobions Lake. Blank cells indicate where non-native species not recorded

Species of Interest	Status	Non-native Species
Anacaena bipustulata	Nb	*Crangonyx pseudogracilis*
Argyroneta aquatica	Local	*Potamopyrgus antipodarum*
Berosus affinis	Nb	
Corixa panzeri	Local	
Hydrochus elongatus	RDB3	
Hygrobia hermanni	Local	
Hygrotus parallellogrammus	Nb	

Species of Interest	Status	Non-native Species
Ilyocoris cimicoides	Local	
Laccophilus minutus	Local	
Noterus clavicornis	Local	
Noterus crassicornis	Nb	
Sigara concinna	Local	

East Tilbury Quarry (Walsh) - Compartment D

Sampling occurred within compartment D, the Walsh quarry site. The compartment ranged from a restored gravel quarry and landfill site, a borrow dyke at the base of the seawall and a newly created area of shallow scrapes/lagoons with deeper water and islands used as a high-tide wader roost. The settling pond was reed-fringed with large areas of open water with good numbers of wildfowl and waders using the site for breeding including little ringed plover. The hightide roost site was created in the Autumn of 2021 and accordingly had limited macrophyte cover. All the sampling points were saline in character with those closest to the river Thames the most saline.

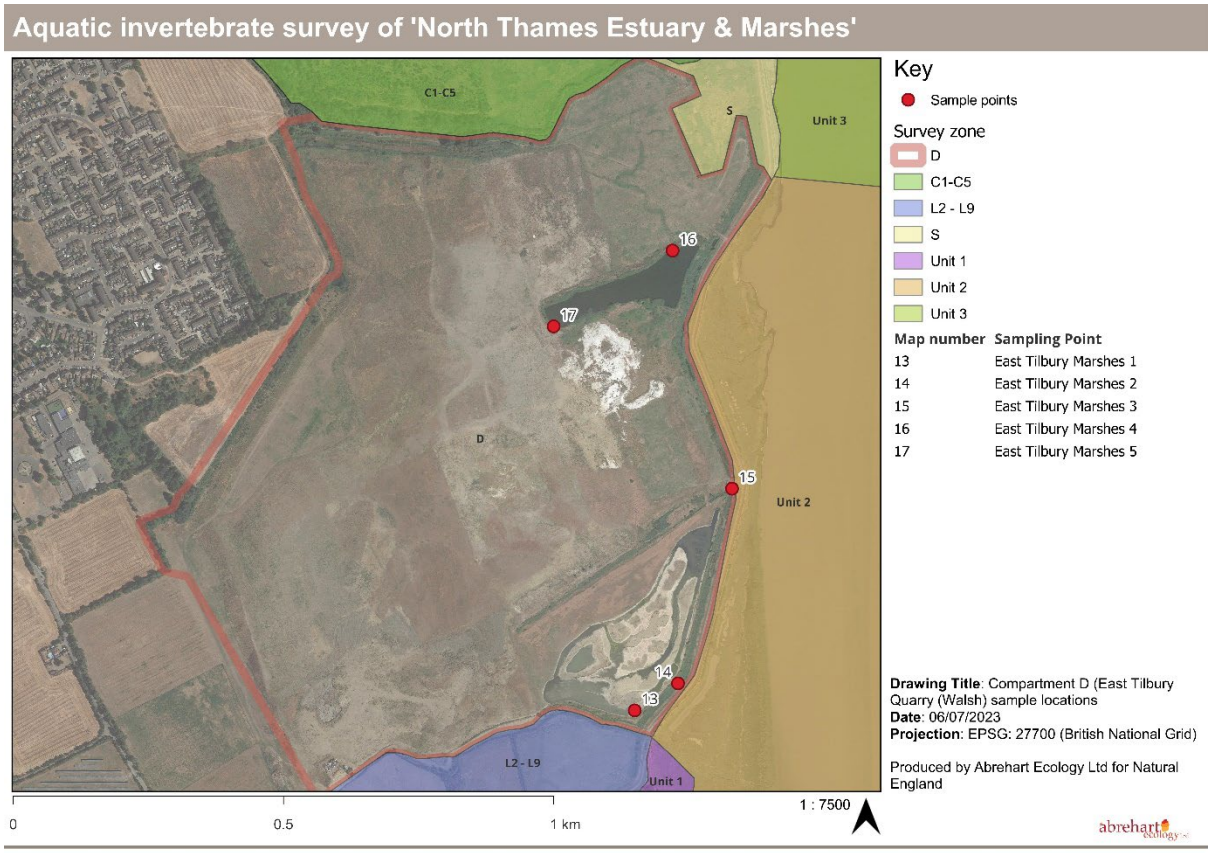


Figure 5. East Tilbury Quarry (Walsh) – Compartment D sample locations (Aerial Imagery Copyright: @ECNES 2023)

East Tilbury Marshes 1 (TQ69257789) - Compartment D – High-tide Roost. Map sampling no. 13.

Two samples were taken from the newly created high-tide roost wetland close to the seawall in the south of the compartment. The lagoons and islands were made with mud and capped with gravel. There were limited aquatic macrophytes with *Zannichellia palustris* in scattered stands across the lagoons. No emergent vegetation was present this year and there were significant areas of exposed mud. There were filamentous algae around the margins though the water was clear with stands of *Zannichellia palustris*.

The water body was 259m long, with a width of 90m and an unknown depth.

A total of 279 specimens were identified of 16 taxa (9 identified to species). Dominant species were Hemiptera with *Sigara concinna* and *Sigara lateralis* common with a high density of *Gammarus duebeni* and *Ampullaceana balthica*. Two notable species were the beetle *Enochrus halophilus* and the backswimmer *Sigara selecta*.

Water chemistry was pH 8.8 and conductivity of 4.65µS/cm and 23.3°C.

Table 14. Species of Interest at East Tilbury Marshes (high tide roost). Blank cells indicate where non-native species not recorded

Species of Interest	Status	Non-native Species
Enochrus halophilus	Na	
Gammarus duebeni	Locally common	
Hygrotus confluens	Local	
Sigara concinna	Local	
Sigara selecta	Nr	

East Tilbury Marshes 2 (TQ69337794) – Compartment D – Borrow Dyke & East Tilbury Marshes 3 (TQ69437830) – Compartment D – Borrow Dyke. Map sampling nos. 14 & 15.

This sampling site was the southern portion of the borrow dyke running parallel to the seawall. It was a five-metre-wide dyke that supported no submerged macrophytes but had abundant emergent vegetation dominated with *Phragmites australis* and *Bolboscheonus maritimus*.

The water body was 478m long with a width of 8m with a depth of around 40cm.

A total of 52 specimens were identified of 15 taxa (13 identified to species). There were only a low number of invertebrates in these samples, no species dominated though Crustaceans were recorded most frequently with *Gammarus duebeni* and *Proaselus meridianus*. Four rare beetles were present with *Berosus affinis, Berosus signaticollis, Enochrus bicolor* and *Enochrus halophilus.*

Water chemistry was pH 8.1 and conductivity of 6.07µS/cm and 21.2°C.

Table 15. Species of Interest at East Tilbury Marshes Borrow Dyke. Blank cells indicate where non-native species not recorded

Species of Interest	Status	Non-native Species
Hydrobia acuta neglecta	RDB3	
Berosus affinis	Nb	
Berosus signaticollis	Nb	
Enochrus bicolor	Nb	

Species of Interest	Status	Non-native Species
Enochrus halophilus	Na	
Gammarus duebeni	Locally common	

East Tilbury Marshes 4 (TQ69327874 + TQ69107860) – Compartment D – map sampling nos. 16 & 17.

This sampling site was the mature settling pond in the centre of the compartment. The pond was surrounded by a 5m wide band of *Phragmites australis* which created a hover margin on the sides of the pond. This sample was taken in the northeast of the pond and the aquatic macrophytes were limited in the May survey.

The water body was 478m long with a width of 8m with a depth of around 40cm. This lagoon/pond has been present since at least 1999 and has not changed size (1.49ha) in the preceding years, other than a small amount of *Phragmites australis* growth around the margins. The lagoon is steep-sided and had limited macrophyte cover.

A total of 416 specimens were identified of 23 taxa (18 identified to species). These samples were dominated by *Gammarus duebeni* and *Palaemonetes varians*. Four Notable b beetles were *Berosus affinis, Berosus signaticollis, Enochrus bicolor* and *Rhantus frontalis*. All the other uncommon species were beetles and Hemiptera.

Water chemistry was pH 8.2 and conductivity of 4.65µS/cm and 23.3°C.

Table 16. Species of Interest found at East Tilbury Marshes 4. Blank cells indicate where non-native species not recorded

Species of Interest	Status	Non-native Species
Berosus affinis	Nb	
Berosus signaticollis	Nb	
Enochrus bicolor	Nb	
Gammarus duebeni	Locally common	
Hygrotus impressopunctatus	Local	
Noterus clavicornis	Local	

Species of Interest	Status	Non-native Species
Plea minutissima	Local	
Rhantus frontalis	Nb	
Sigara concinna	Local	
Sigara selecta	Nr	
Sigara stagnalis	Local	

Fields East of Coalhouse Battery

The fields encompassing sub-compartments L2-9 had limited access, with access available only to the Campsite in the north of the compartment. There were several ditches that were dry with the one accessed in the north of the site which supported a good macrophyte flora and clear water.

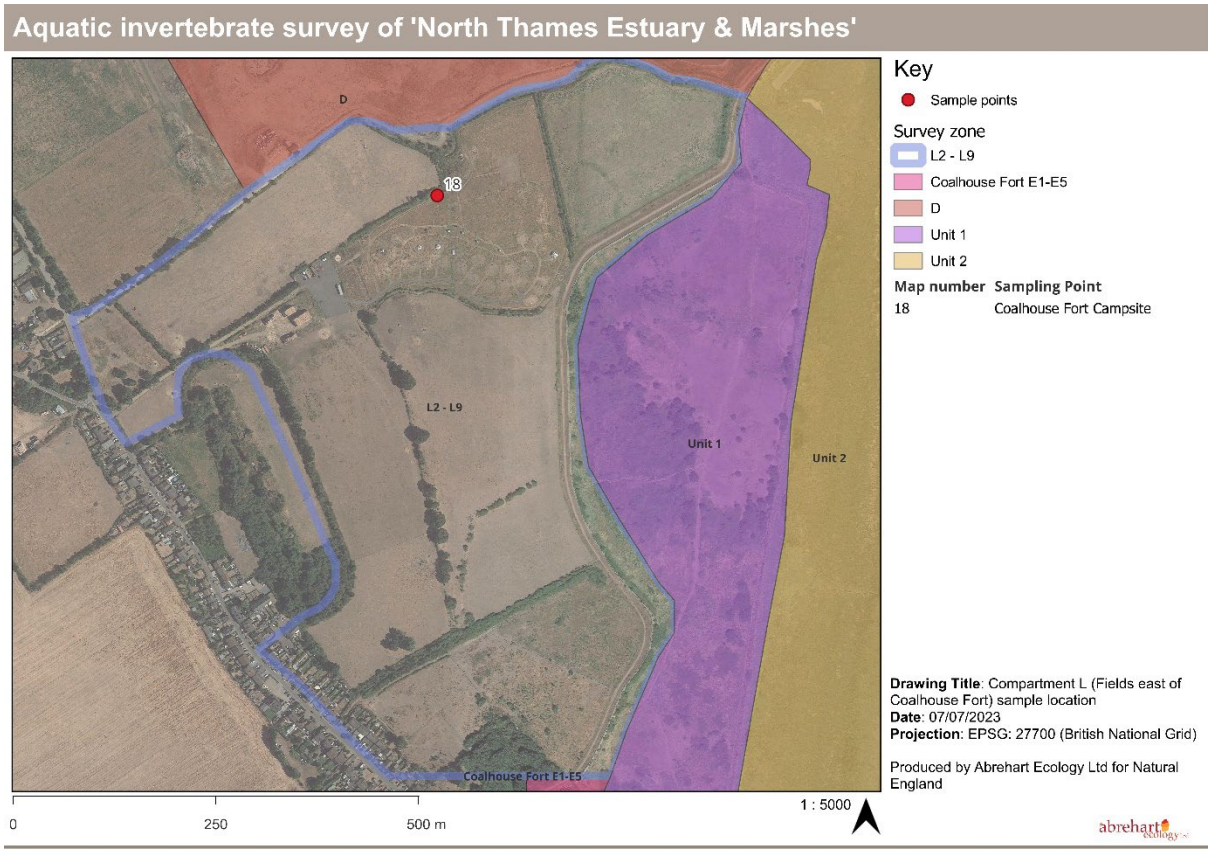


Figure 6. Fields east of Coalhouse Fort sample locations (Aerial Imagery Copyright: @ECNES 2023)

Campsite Ditch (TQ68907772) – sub-compartment L8 - map sampling no. 18

This sample was taken from the ditch on the northern side of the campsite. This was a steep-sided ditch that had been cleared in the past year. The material had been removed and placed in a large pile in the corner of the field. There was limited emergent vegetation with only *Phragmites australis* present as an emergent species. The water flows to the east of the site, then discharges into the river Thames. The margins of the ditch supported a range of species with *Carex otrubae* and *Oenanthe lachinellii* as the most noteworthy species, with a supporting act of *Elytrigia atherica* as the dominant grass. The ditch supported a number of emergent plants, with *Bolboscheonus maritimus* the most frequent. The aquatic macrophytes were dominated with *Zannichellia palustris*. This species, along with *Ranunculus baudotii,* filled the ditch along most of its length.

The water body was 3m wide and had a depth of only 30cm of water, with the remaining depth being soft silts and sediment.

A total of 111 specimens were identified of 37 taxa (32 identified to species). These were dominated by *Ampullaceana balthica and Sigara stagnalis.* Fifteen species of beetle were found, with three Nb *Berosus affinis, Helochares lividus* and *Rhantus frontalis* one Na *Enochrus halophilus*. Corixidae were common in the sample with *Sigara stagnalis* present.

Water chemistry was pH 8.8 and conductivity of 5.08µS/cm and 26.1°C.

Table 17. Species of Interest found at the Campsite ditch. Blank cells indicate where non-native species not recorded

Species of Interest	Status	Non-native Species
Berosus affinis	Nb	
Enochrus halophilus	Na	
Haliplus immaculatus	Local	
Helochares lividus	Nb	
Hydroporus incognitus	Local	
Hygrotus parallellogrammus	Nb	
Lestes viridis		
Noterus clavicornis	Local	
Rhantus frontalis	Nb	

Species of Interest	Status	Non-native Species
Sigara stagnalis	Local	

Coalhouse Fort and surrounds

Coalhouse Fort and surrounding marshes support a range of habitats with the large moats around the fort with *Phragmites australis* choked ditches, saline ditches and a pond. The land to the south of the moats was rough tussocky grasslands with a ditch running through it fed from the moats.

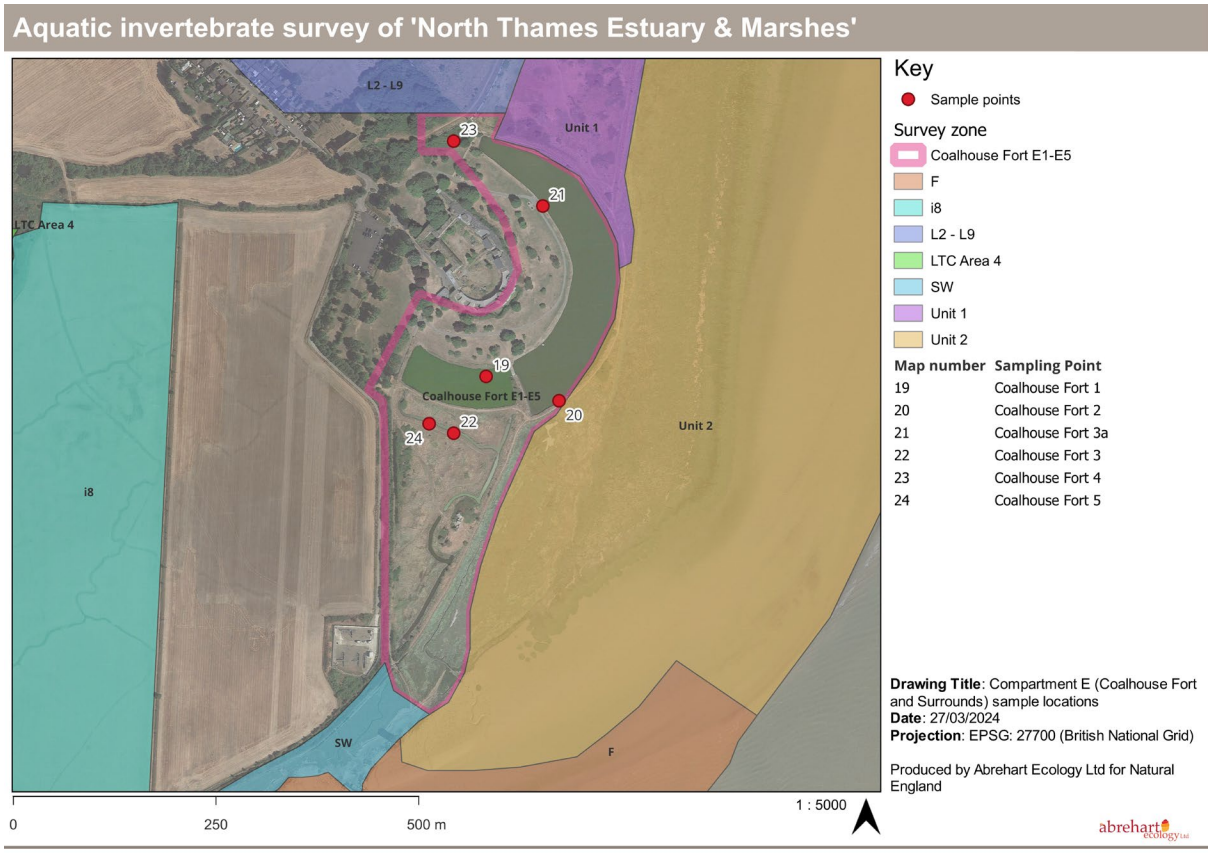


Figure 7. Coalhouse Fort and surrounds sample locations (Aerial Imagery Copyright: @ECNES 2023)

Coalhouse Fort 1 (TQ69097668) - sub-compartment E2 - map sampling no.19

This sample was taken from the northern side of the southern, smaller moat. Water feeds into this lagoon from the main northern moat. From this moat it then feeds into the ditches to the south and then back into the river Thames. The water was opaque with limited visibility, there were no emergent plants present with only *Ruppia maritima* and numerous algae present in the water body. The margins of the moat were unmown rough grasslands, and the

vegetation was left longer here to protect the numerous water vole burrows along the edge of the moat. The vegetation on the banks was dominated by *Elytrigia atherica*.

The water body was 44m wide, with a length of 132m and a depth of only 90cm, of which 50cm was water and the remainder being soft silts and sediment.

A total of 335 specimens were identified of 5 taxa (4 identified to species). These were dominated by *Palaemonetes varians, Idotea chelipes* and *Cerastoderma glaucum*. The rare mysid shrimp *Mesopodopsis slabberi* was present with four specimens found. The invasive Australian tubeworm *Ficopomatus enigmaticus* formed areas of reef within the lagoon.

Water chemistry was pH9.2 and conductivity of 9.3µS/cm and 25.6°C.

Table 18. Species of Interest found at Coalhouse Fort 1. Blank cells indicate where non-native species not recorded

Species of Interest	Status	Non-native Species
Mesopodopsis slabberi	Rare	*Ficopomatus enigmaticus*
Idotea chelipes	Nb	

Coalhouse Fort 2 (TQ69187665) - sub-compartment E4 - map sampling no. 20

This sample was taken from the eastern side of the larger northern moat. Water from this lagoon feeds into the southern lagoon/moat. From there it then feeds into the ditches to the south and then back into the river Thames. The water was opaque with limited visibility, and there were no emergent plants present with only *Ruppia maritima* and numerous algae present in the water body. The margins of the moat were unmown rough grasslands, and the vegetation was left longer here to protect the numerous water vole burrows along the edge of the moat. The vegetation on the banks was dominated with *Elytrigia atherica* and *Atriplex portulacoides*. The eastern side of the lagoon had a row of rock-filled gabions just below the water's surface.

The water body was 405m long, with a width of 66m and a depth of only 90cm, of which 50cm was water with the remainder being soft silts and sediment.

A total of 347 specimens were identified of 11 taxa (10 identified to species). These were dominated by *Palaemonetes varians, Idotea chelipes* and *Cerastoderma glaucum*. *Monocorophium insidiosum* was present with four specimens found. The invasive Australian tubeworm *Ficopomatus enigmaticus* formed areas of reef within the lagoon.

Water chemistry was pH 8.1 and conductivity of 9.450µS/cm and 22.3°C.

Table 19. Species of Interest found at Coalhouse Fort 2. Blank cells indicate where non-native species not recorded

Species of Interest	Status	Non-native Species
Mesopodopsis slabberi	Rare	
Idotea chelipes	Nb	

This sample was taken from the ditch to the south of the moats. This ditch feeds back into the river Thames. The water was opaque with limited visibility, and there were no emergent plants present with only *Ruppia maritima* and scattered algae present in the water body. The margins of the ditch were unmown rough grasslands, and the vegetation was left longer here to protect the numerous water vole burrows along the edge of the moat. The vegetation on the banks was dominated with *Elytrigia atherica* and *Aster tripolium*.

The water body was 4m wide, with a depth of only 50cm, of which 25cm was water with the remainder being soft silts and sediment.

A total of 291 specimens were identified of 5 taxa (4 identified to species). These were dominated by *Palaemonetes varians, Idotea chelipes* and *Ecrobia ventrosa*. *Monocorophium insidiosum* was present with four specimens found.

Water chemistry was pH 8.1 and conductivity of 9.470µS/cm and 25.2°C.

Table 20. Species of Interest found at Coalhouse Fort 3. Blank cells indicate where non-native species not recorded

Species of Interest	Status	Non-native Species
Idotea chelipes	Nb	

Coalhouse Fort 4 (TQ69057697) - sub-compartment E3 - map sampling no. 23

This sample was taken from the pond to the north of the fort. This had *Bolboscheonus maritimus* as the only emergent vegetation. There was limited open water to the eastern side of the pond. The surrounding vegetation was dominated with brambles.

The water body was 4m wide and had a depth of only 90cm, of which 35cm was water with the remainder being soft silts and sediment.

A total of 20 specimens were identified of 8 taxa (5 identified to species). These were dominated by *Sigara lateralis*, with *Sigara stagnalis* also present.

Table 21. Species of Interest found at Coalhouse Fort 4. Blank cells indicate where non-native species not recorded

Species of Interest	Status	Non-native Species
Sigara stagnalis	Local	

Water chemistry was pH 8.1 and conductivity of 3.92µS/cm and 22.3°C.

Coalhouse Fort 5 (TQ69027662) - sub-compartment E1 - map sampling no. 24

This sample was taken from the ditch to the west of the LTC4 landfill site. This was a steep-sided ditch with limited emergent vegetation with only *Phragmites australis* present as an emergent species. Water from the lagoons at Coalhouse Fort feeds into the ditch and then runs back into the river Thames.

The water body was 5m wide and a depth of 60cm, of which 35cm was water the remaining being soft silts and sediment.

A total of 22 specimens were identified of 14 taxa (12 identified to species). All species were recorded in low numbers. Beetles dominated the more uncommon species of this sample. Three notable b species of beetle with *Enochrus bicolor, Hygrotus parallelogrammus* and *Noterus crassicornis. Sigara selecta* was present with four *Gammarus duebeni*.

Water chemistry was pH 8.2 and conductivity of 5.66µS/cm and 25.4°C.

Table 22. Species of Interest found at Coalhouse Fort 5. Blank cells indicate where no non-native species recorded

Species of Interest	Status	Non-native Species
Enochrus bicolor	Nb	
Hygrotus parallellogrammus	Nb	
Noterus crassicornis	Nb	
Sigara selecta	Nr	
Gammarus duebeni	Locally common	
Hygrotus impressopunctatus	Local	

Compartment ‘LTC4, i8 & Bowaters’

This compartment was sampled in two locations: the ‘ditch east of LTC4’ (map sampling no. 25) and the ‘ditch north of LTC4’ (map sampling no. 26).

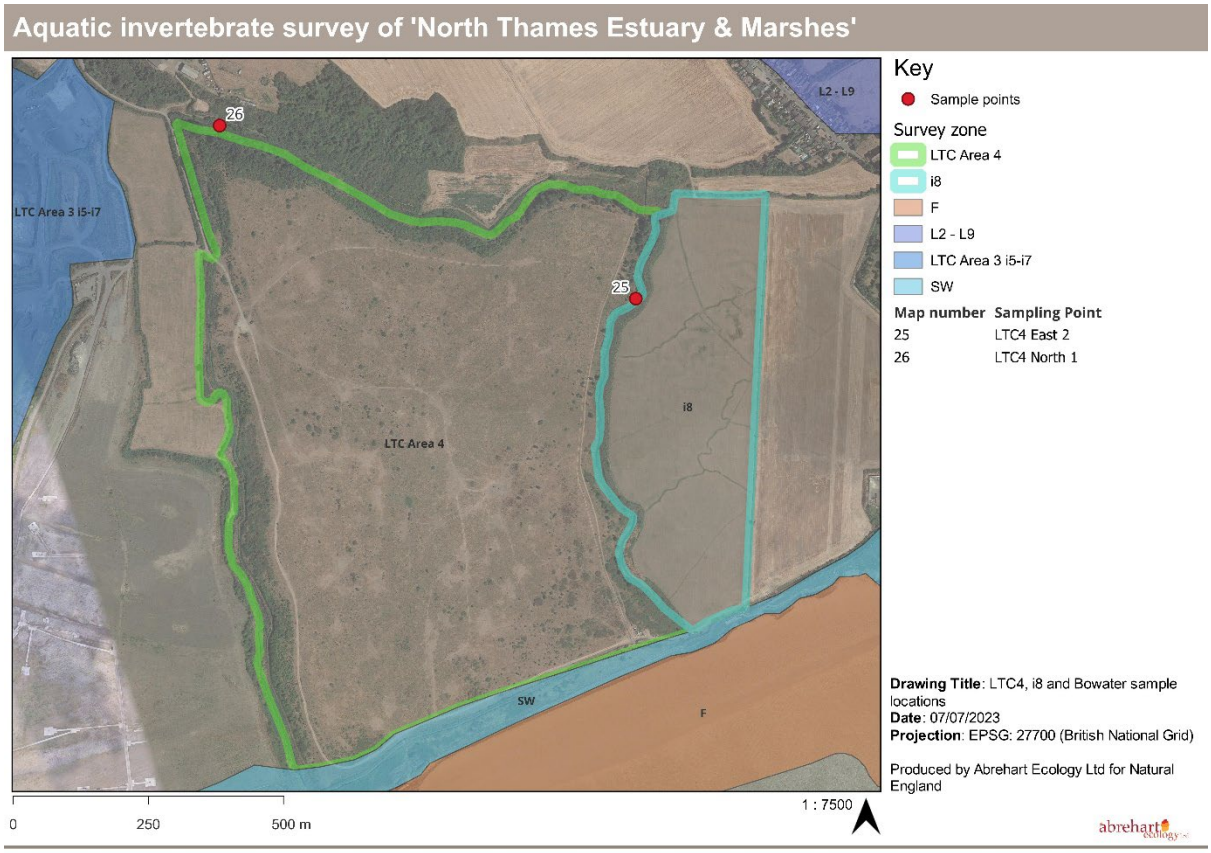


Figure 8. 'LTC4, i8 and Bowaters' sample locations (Aerial Imagery Copyright: @ECNES 2023)

Ditch east of LTC4 (TQ68477670) - sub-compartment LTC4 - map sampling no. 25.

This sample was taken from the ditch to the east of the landfill site. This was a steep-sided ditch with limited emergent vegetation with only *Phragmites australis* present as an emergent species on the east bank. This section of the ditch had been recently cleared, with ruderal vegetation present, dominated by *Atriplex prostrata*. The water was a dense green colour with no visible aquatic macrophytes.

The water body was 5m wide and had a depth of 60cm, of which 35cm was water with the remainder being soft silts and sediment.

A total of 60 specimens were identified of 6 taxa (6 identified to species). All species were recorded in low numbers. Beetles dominated the more uncommon species of this sample. Three notable b species of beetle were present with *Berosus affinis* the most abundant with 32 specimens collected. *Hygrotus parallelogrammus, H. impressopunctatus and one Noterus clavicornis* were also present.

Water chemistry was pH 8 and conductivity of 5.4µS/cm and 15.2 C.

Table 23. Species of Interest found in the ditch east of LTC4. Blank cells indicate where no non-native species recorded

Species of Interest	Status	Non-native Species
Berosus affinis	Nb	
Hygrotus parallellogrammus	Nb	
Rhantus frontalis	Nb	
Hygrotus impressopunctatus	Local	
Noterus clavicornis	Local	

Ditch north of LTC4 (TQ67707702) - sub-compartment 'LTC4' - map sampling no. 26.

This sample was taken from the ditch to the north of the sub-compartment. This was generally a steep-sided ditch with limited emergent vegetation with only *Bolboscheonus maritima* on the north bank present as an emergent species with dense *Rubus* scrub on the south. Water from the lagoons in the north fed into the ditch and then flows south back into the river Thames.

The water body was 10m wide and had a depth of 50cm, of which 25cm was water, with the remainder being soft silts and sediment.

A total of 58 specimens were identified of 9 taxa (7 identified to species). All species were recorded in low numbers. Hemiptera dominated the sample with more uncommon species contained within this sample. Only one local species was noted *Notonecta viridis*, all others were common for this habitat.

Water chemistry was pH 8 and conductivity of 9.34µS/cm and 20°C.

Table 24. Species of Interest found at the ditch north of LTC4. Blank cells indicate where no non-native species recorded

Species of Interest	Status	Non-native Species
Notonecta viridis	Local	

Ashfields (including i3)

This compartment was sampled in three areas: the ditch to the west of the Ashfield A1 site, the ditch to the east of the Ashfield A1 site and the pool within sub-compartment ‘i3’ (north-east of the two ditches).

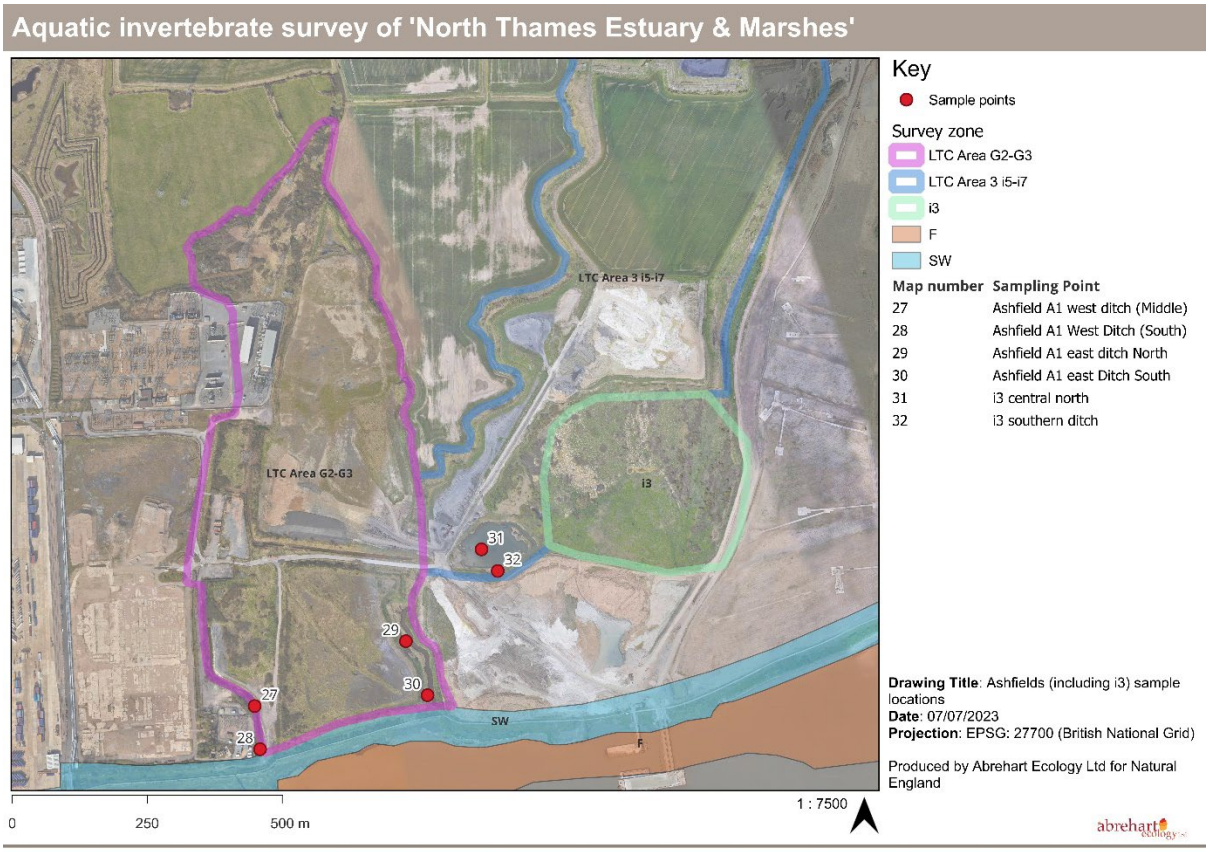


Figure 9. ‘Ashfields and i3’ sample locations (Aerial Imagery Copyright: @ECNES 2023)

Goshems Pool (TQ66827579 & TQ66797583) - sub-compartment ‘i3’ - map sampling nos. 31 & 32.

Two samples were taken, one from the receding water of the pool, and one from the edge of a shallow ditch in the south of this area. The aquatic macrophytes were limited to *Zannichellia palustris* and *Enteromorpha intestinalis*. There were limited emergents with small areas of *Phragmites australis* and *Bolboscheonus maritima*.

A total of 1142 specimens were identified of 17 taxa (13 identified to species). One sample was taken from the pool and one from the ditch. The bulk of the aquatic invertebrates were Chironomidae larvae and *Sigara* species. One Nb beetle was found *Berosus affinis* and three rarer *Sigara* with *Sigara stagnalis* least common.

‘i3’ ditch: water chemistry was pH 8.6 and conductivity of 9.00µS/cm and 27.8°C.

‘i’3 pool: water chemistry was pH 8.4 and conductivity of 9.25µS/cm and 26.3°C.

Table 25. Species of Interest found at the Goshem's Pool sub-compartment. Blank cells indicate where non-native species not recorded

Species of Interest	Status	Non-native Species
Berosus affinis	Nb	
Sigara conicinna	Local	
Sigara limitata	Local	
Sigara stagnalis	Nr	

Ashfield A1 West (TQ66377554 & TQ66387546) – middle and south - map sampling nos. 27 & 28

These samples were taken from the ditch on the west of Ashfield A1, it was 263m long with a width of 6m. There were sections of the ditch with *Phragmites australis* in the central section of the ditch. The aquatic macrophytes were common with abundant *Potamogeton trichoides*. The water depth was around 50cm, with the bottom sediments smelling strongly of hydrocarbons and an oily film created on the surface following the sampling.

A total of 1936 specimens were identified of 30 taxa (19 identified to species). These were dominated by Daphnia and Ostracoda species. Beetles were the most abundant taxa with *Berosus fulvus* (pRDB3), eight species of beetle were found, with two Nb *Berosus affinis* and *Rhantus frontalis*. Corixidae and other Hemiptera were common in the sample with *Sigara stagnalis* most common.

Ashfield A1 West middle: water chemistry was pH 8.4 and conductivity of 3.26µS/cm and 24.6°C.

Ashfield A1 West south: water chemistry was pH 8.9 and conductivity of 3.23µS/cm and 24.8°C.

Table 26. Species of Interest found in the ditch west of Ashfield A1. Blank cells indicate where non-native species not recorded

Species of Interest	Status	Non-native Species
Berosus affinis	Nb	
Berosus fulvus	pRDB3	
Gammarus duebeni	Locally common	

Species of Interest	Status	Non-native Species
Hygrotus cunfluens	Local	
Hygrotus impressopunctatus	Local	
Notonecta viridis	Local	
Rhantus frontalis	Nb	
Sigara concinna	Local	
Sigara limitata	Local	
Sigara selecta	Nr	
Sigara stagnalis	Local	

Ashfield A1 east ditch (TQ66697556 & TQ66657566). Map nos. 29 & 30.

Samples were taken from the large wide shallow ditch to the east of the Ashfield area The ditch was dominated with *Bolboscheonus maritima* in extensive swards along the sides of the ditch. The material here was very soft and anoxic, the water depth was shallow at 20cm.

A total of 485 specimens were identified of 19 taxa (13 identified to species). These were dominated by *Corixinae* species and *Gammarus duebeni*. Four uncommon beetle species with *Rhantus frontalis* and *Laccophilus minutus* most uncommon. Local species were found: *Sigara stagnalis*, and *Notonecta viridis*.

Ashfield A1 East (north): water chemistry was pH 8.4 and conductivity of 9.00µS/cm and 27.1°C.

Ashfield A1 East (south): water chemistry was pH 8.4 and conductivity of 9.00 µS/cm and 26.7°C.

Table 27. Species of Interest found in the ditch east of Ashfield A1. Blank cells indicate where non-native species not recorded

Species of Interest	Status	Non-native Species
Gammarus duebeni	Locally common	
Hygrotus impressopunctatus	Local	

Species of Interest	Status	Non-native Species
Laccophilus minutus	Local	
Notonecta viridis	Local	
Rhantus frontalis	Nb	
Sigara selecta	Nr	
Sigara stagnalis	Local	

Tilbury Fort and Marshes

This compartment, surrounding and to the north of, the Fort was horse-grazed throughout and dominated by a range of grass species with *Hordeum secalinum* a common component. *Phragmites australis* was scattered across the site with *Bolboscheonus maritima* common in some of the ditch margins. Open water was found in all of the ditches sampled with a range of habitats present. These included ephemeral pools, fresh-water ditches, tidal creeks and the fort moats that have little fresh input from the surrounding area. Open water was present in the southern portion of the marsh, which was intersected by a number of ditches. Aquatic macrophytes were present in some of the water bodies present, with *Ruppia maritima* and *Zannichellia palustris* most frequent, although *Ranunculus baudotii* was common in the ditches and ephemeral pools to the north of the fort.

Several lagoon specialist species were found in these samples, *Cerastoderma glaucum, Idotea chelipes, Lekanesphaera hookeri, Ecrobia 51entrose, Conopeum seurati, Ruppia maritima* and *Hydrobia acuta neglecta.*

The compartment is sub-divided into six sub-compartments: TFM9 (the inner moat), TFM2 (the outer moat east), TFM5 (Bill Meroy Creek), TFM3 (the marsh north of outer moat), TFM1 (the outer moat west & ditch), TFM8 (north-west of Fort Road),

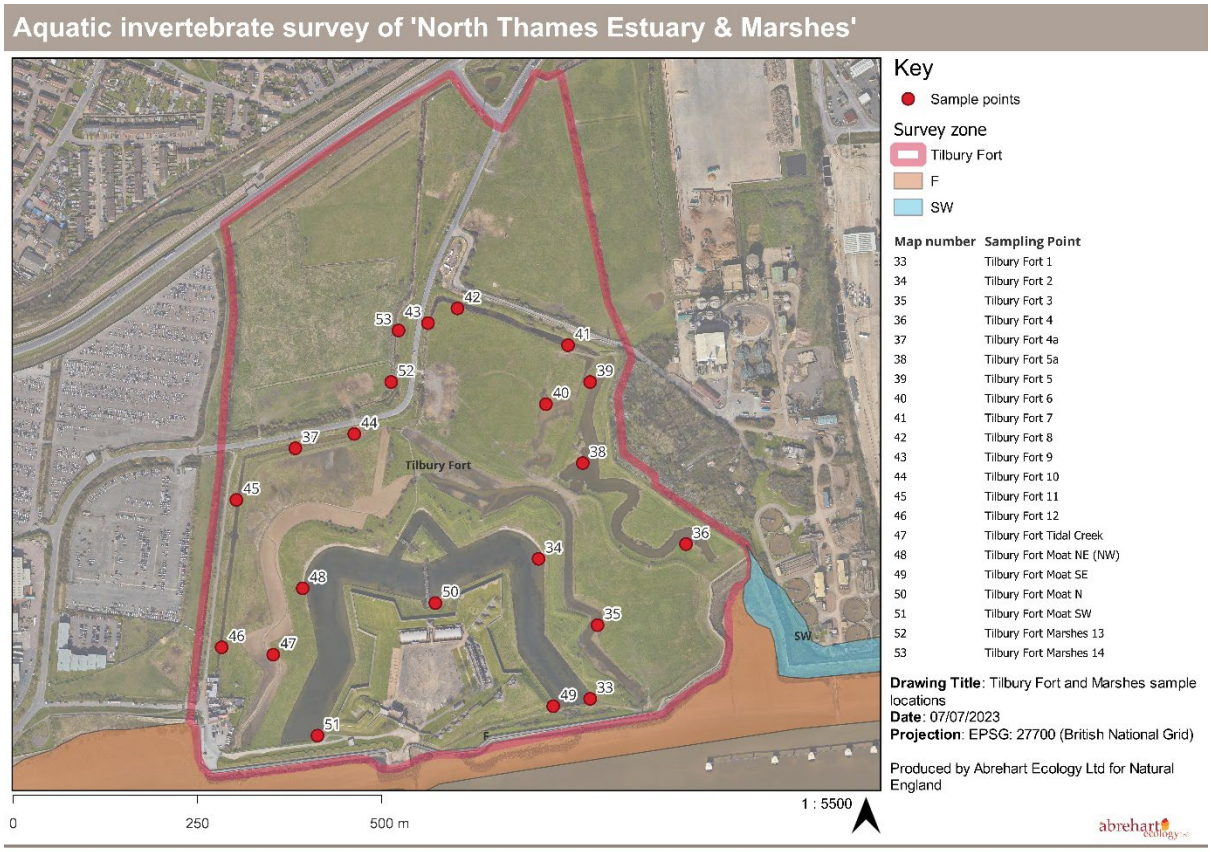


Figure 10. Tilbury Fort and marshes sample locations (Aerial Imagery Copyright: @ECNES 2023)

Tilbury Fort Inner Moat – sub compartment TFM9 (TQ65317529, TQ65247548, TQ64947524, TQ65267528, TQ64927544, TQ65107542). Map sampling nos. 33, 34, 51, 49, 48, 50

Samples were taken from various locations around the inner moat surrounding the fort. The water was open with no floating macrophytes, in fact no emergent vegetation was present. *Ruppia maritima* and *Chaetomorpha* algae were present and submerged macrophytes, both were abundant across the survey areas. The base of the water body was firm under foot and was accessible in chest waders, as the water was only 50-100cm deep.

A total of 734 specimens were identified of 16 taxa (14 identified to species) from these 6 samples. These were dominated by *Cerastoderma glaucum, Idotea chelipes, Conopium seurati, Chironomidae* larvae and *Lekanosphera hookeri,* with *Paleomentes varians* and the fish *Pomatoschistus microps* found occasionally.

Water chemistry ranged from pH 8.1 to 8.9 and conductivity ranged from 15,000 µS/cm in the May to 44,000µS/cm in July, temperature from 24°C in May to 29°C; Clear.

Table 28. Species of Interest found at sub-compartment TFM9. Blank cells indicate where non-native species not recorded

Species of Interest	Status	Non-native Species
Cerastoderma glaucum		
Ecrobia ventrosa	Local	
Gammarus duebeni	Locally common	
Hydrobia acuta neglecta	RDB3	
Noterus crassicornis	Nb	
Sphaeroma hookeri	Locally common	

Outer moat (east) - sub compartment TFM2 (TQ65327539)- map sampling no. 35

A sample was taken from the large wide shallow ditch to the east of the moat and west of Bill Melroy Creek. The marginal vegetation was of *Puccinellia maritima* and *Salicornia* sps. beds. *Ranunculus baudotii* was scattered around the drying water's edge with *Aster tripolium* and *Suaeda maritima* scattered across the area. It appears that the creek may fill on high spring tides and through rain. There was soft, muddy substrate and limited water in the sample area. No aquatic macrophytes were present in the creek.

A total of 28 specimens were identified of 5 taxa (3 identified to species) from this 1 sample. These were dominated by *Gammarus duebeni*, the new introduced mollusc *Heleobia charruana* and the beetle *Enochrus halophilus*.

Water chemistry was pH 8.2 and conductivity of 8910µS/cm.

Table 29. Species of Interest found at sub-compartment TFM2. Blank cells indicate where non-native species not recorded

Species of Interest	Status	Non-native Species
Enochrus haliphilus	Na	
Gammarus duebeni	Locally common	

Outer Moat (west) - sub-compartment TFM3 (TQ64887535) - map sampling no. 47

The second sample was taken from the tidal creek to the west of the site. The tide was out at the time of the sampling and only exposed mud was present. There was no vegetation and the whole area comprised soft mud.

A total of 290 specimens were identified of 9 taxa (8 identified to species) from this 1 sample. These were dominated by *Chironomidae* larvae the bivalve *Cerastoderma galuca*, and saline lagoon species including *Idotea chelipes*.

Water chemistry was pH 7.7 and conductivity of 28000µS/cm.

Table 30. Species of interest found at sub-compartment TFM3. Blank cells indicate where non-native species not recorded

Species of Interest	Status	Non-native Species
Cerastoderma glaucum	Nb	
Ecrobia ventrosa	Local	

Bill Melroy Creek – sub-compartment TFM5 (TQ65447550, TQ65317572 & TQ65307561) - map sampling nos. 36, 38 & 39

A sample (36) was taken from the southern end of Bill Melroy Creek where the vegetation along the margins of the creek was dominated with *Aster tripolium*. The aquatic macrophytes were limited to *Ruppia maritima*, which was present across the creek and was common along the margins of the creek. On the banks of the creek *Elytrigia atherica* was the dominant grass with *Puccinellia maritima* scattered. The margin of the creek was well trampled with frequent poaching. The margin of the creek had a gentle slope leading into some deep soft mud deeper into the creek. The material here was soft and silty with a high clay component. The water where the sampling was undertaken was up to 50cm deep at full reach.

The middle sample (38) was taken from the edge of the creek where there was extensive *Ruppia maritima* in the water with *Potamogeton pusilis*. The most northern sample (39) was taken in limited waters and muds that were present in the Spring of 2022. The vegetation adjacent to these two samples was the same as for the southern sample.

A total of 1120 specimens were identified of 29 taxa (23 identified to species) from these three sample sites (totaling five samples). Ten species of beetle were found: one RDB3 *Berosus fulvus*, one Na *Enochrus halophilus,* three Nb *Berosus affinis, Berosus luridus and Haliplus apicalis.* Four species that were local the Hemiptera *Gerris lateralis* and *Sigara limitata* with two beetles *Hygrotus confluens* and *Hygrotus impressopunctatus*.

Water chemistry ranged from pH 8.5-8.7, and conductivity from 7750µS/cm in May to 17,000µS/cm in July.

Table 31. Species of Interest found at sub-compartment TFM5. Blank cells indicate where non-native species not recorded

Species of Interest	Status	Non-native Species
Berosus affinis	Nb	
Berosus fulvus	RDB3	
Berosus luridus	Nb	
Enochrus halophilus	Na	
Gammarus duebeni	Locally common	
Gerris lateralis	Local	
Haliplus apicalis	Nb	
Hydrobia acuta neglecta	RDB3	
Hygrotus confluens	Local	
Hygrotus impressopuntatus	Local	
Lekanosphaeroma hookeri	Locally common	
Ochthebius marinus	Nb	
Rhantus frontalis	Nb	
Sigara limitata	Local	

Marsh North of Outer Moat – sub-compartment TFM3 (TQ65287577, TQ65137582 & TQ65097580) - map sampling nos. 41 - 43

The first sample was taken at the eastern end of the northern ditch within the Tilbury Fort complex (TF7 – TQ65287577). This ditch was filled with emergent vegetation dominated with *Phragmites australis* and the invasive *Cotula australis*. The ditch was covered in a layer of fine algae which quickly clogged the sampling net. Floating macrophytes were limited to *Ranunculus baudotii* which was common in patches across the ditch length. The ditch was 60cm deep and supported a deep layer of soft muds at the bottom. The northern side of the ditch was heavily grazed by horses and the southern side (the sample side) was fenced off from the horses. The ditch ran north northwest to south southeast.

The second sample was taken at the western end of the northern (TF8 TQ65137582) ditch within the Tilbury Fort complex. This ditch was filled with emergent vegetation dominated with *Phragmites australis* and the invasive *Cotula australis*. The ditch was covered in a layer of fine algae which quickly clogged the sampling net. Floating macrophytes were limited to *Ranunculus baudotii* which was common in patches across the ditch length. The ditch was 60cm deep and supported a deep layer of soft muds at the bottom. The northern side of the ditch was heavily grazed by horses and the southern side (the sample side) was fenced off from the horses. The ditch ran north northwest to south southeast.

The third sample was taken at the southern end of the western extension to the northern ditch (TFM9 TQ65097580). This ditch was filled with emergent vegetation dominated with *Phragmites australis* and *Agrostis stolonifera*. The ditch had a layer of fine algae through the grasses. No floating or submerged macrophytes were present. The ditch was 15cm deep and was firm under the initial soft mud. The ditch was fenced off from the horses and accordingly not grazed or poached.

The water body was 6m wide with a depth of 50cm and there was a large amount of manmade debris fallen across the ditch, creating several hazards. Bramble scrub also encroached across the ditch in some areas.

A total of 576 specimens were identified of 43 taxa (37 identified to species). These were dominated by the mollusc *Ampullaceana balthica* and a twenty-three species of beetle were found: one RDB3 *Graptodytes bilineatus*, one Na *Enochrus halophilus and Cercyon bifenesrtatus,* six Nb *Berosus affinis, Helophorus arvenicus, Limnoxenus niger, Octhebius marinus, Rhantus frontalis and Rhantus sultratus* and four species that were local beetles and one spider.

Water chemistry was pH 7.8 to pH 8.3 and conductivity from 5060 to 6190µS/cm.

Table 32. Species of Interest found at sub-compartment TFM3. Blank cells indicate where non-native species not recorded

Species of Interest	Status	Non-native Species
Argyroneta aquatica	Local	
Berosus affinis	Nb	
Cercyon bifenestratus	Na	
Cymbiodyta marginellus	Local	
Enochrus halophilus	Na	
Graptodytes bilineatus	RDB3	
Helophorus arvernicus	Nb	

Species of Interest	Status	Non-native Species
Hygrotus impressopunctatus	Local	
Limnoxenus niger	Nb	
Liopterus haemorrhoidalis	Local	
Noterus clavicornis	Local	
Ochthebius marinus	Nb	
Rhantus frontalis	Nb	
Rhantus sultratus	Nb	

Outer moat (west) & Ditch – sub-compartment TFM1 (TQ64917563, TQ64967564, TQ64837556 & TQ64817536) - map sampling nos. 44, 37, 45 & 46

Samples were taken in the centre of the ditch running east to west (Tilbury Fort 10a, and to the east 10b) adjacent to the road. The ditch supported a limited emergent vegetation with *Bolboscheonus maritimus* as the only species present. There were no floating macrophytes but there were small stands of *Ruppia maritima* scattered across the ditch. The water was very opaque, and visibility was only a few centimeters. This ditch was poached by horses and had a steep bank leading into the water. The stands of emergent vegetation were unstable to stand on and would slip into the deeper water. Algae was present in the sample area along with the *Ruppia maritima*. The ditch was 60cm deep and is unlikely to dry throughout the year.

Another sample was taken in the north of the section of the ditch oriented north to south Tilbury Fort 11 (TQ64837556). The ditch supported a limited emergent vegetation with *Phragmites australis* with *Juncus maritimus* on the opposite bank. There were no floating macrophytes but there was an abundance of *Zannichellia palustris* across the ditch, with smaller quantities of *Ruppia maritima*. The water was clear with full water depth visibility. This ditch was poached by horses and had a steep bank leading into the water. The stands of emergent vegetation were unstable to stand on. Algae was present in the sample though infrequent. The ditch was 60cm deep and is unlikely to dry throughout the year. On the banks of the ditch *Aster tripolium*, *Puccinellia maritima* and *Artemisia maritima* were all frequent.

The water body was 6m wide with a depth of 60cm and there was a large amount of manmade debris fallen across the ditch, creating several hazards.

A total of 523 specimens were identified of 30 taxa (25 identified to species). These were dominated by *Ischnura elegans, Hydrobius fuscipes* and *Berosus luridus*. Ten species of beetle were found: one pRDB3 *Berosus fulvus*, one Na *Enochrus halophilus*, two Nb *Berosus luridus* and *Hygrotus impressopunctatus*. The Notable r was *Sigara selecta*. Six local species including two rare molluscs were present with *Ecrobia ventrosa* and *Hydrobia acuta neglecta.*

Water chemistry ranged from pH 8.7 to 9.2 and conductivity of 8,430 to 18,000µS/cm.

Table 33. Species of Interest found at sub-compartment TFM1. Blank cells indicate where non-native species not recorded

Species of Interest	Status	Non-native Species
Argyroneta aquatica	Local	
Berosus fulvus	pRDB3	
Berosus luridus	Nb	
Ecrobia ventrosa	Local	
Enochrus halophilus	Na	
Gammarus duebeni	Locally common	
Hydrobia acuta neglecta	RDB3	
Hygrotus impressopunctatus	Nb	
Laccophilus minutus	Local	
Notonecta viridis	Local	
Sigara limitata	Local	
Sigara selecta	Nr	
Sigara stagnalis	Local	

North-West of Fort Road – sub-compartment TFM8 (TQ65057579 & TQ65047572) - map sampling nos. 52 and 53

A sample was taken in the south of the section of the ditch oriented north-south. This sample was taken from west of Fort Road. The ditch supported a limited emergent vegetation with *Phragmites australis* dominating the entire ditch. There were no macrophytes present.

A second sample was taken in the north of the section of the ditch oriented north-south. This sample was also taken from west of Fort Road. The ditch supported a limited emergent vegetation with *Phragmites australis* dominating the entire ditch. There were no macrophytes present.

The water body from which both samples were taken was 3m wide with a depth of 30cm.

A total of 422 specimens were identified of 17 taxa (14 identified to species). These were dominated by *Proasellus meridianlus and Gammarus duebeni.* Four species of beetle were found: one Nb *Haliplus apicalis*, five local species, water spider *Argyroneta aquatica*, *Dysticus semisulcatus, Ecrobia ventrosa, Gerris lateralis* and the beetle *Hygrobia hermanni*.

Water chemistry was pH 7.2 and conductivity of 3340µS/cm.

Table 34. Species of Interest found at sub-compartment TFM8. Blank cells indicate where non-native species not recorded

Species of Interest	Status	Non-native Species
Argyroneta aquatica	Local	
Dytiscus semisulcatus	Local	
Ecrobia ventrosa	Local	
Gammarus duebeni	Locally common	
Gerris lateralis	Local	
Haliplus apicalis	Nb	
Hygrobia hermanni	Local	

Discussion

Nature conservation evaluation

In total, 166 taxa of aquatic invertebrates were recorded within the study area, of these, 127 were identified to species level, with 52 species of beetle and four species of vertebrate - three fish and one amphibian.

Overview

Vulnerable (RDB3)

Three species of RDB3 beetle were found across the sites. *Graptodytes bilineatus* was collected twice from Mucking Marshes (Enovert) Compartment C, and once from Tilbury Fort. *Graphoderus cinereus* was collected once form a pond in Mucking Marshes (Enovert) Compartment C. Three *Hydrochus elongatus* were collected from Gobions Lake only. The pRDB3 beetle *Berosus fulvus* was the most frequent of the rare beetles, collected in six samples with 14 animals collected. These were mainly collected from the choked ditches at Tilbury Fort and in one dyke at the Ashfield site. One RDB mollusc was found, this was the lagoon specialist *Hydrobia acuta neglecta*. This was found 11 times across the compartments. The Mysid shrimp *Mesopodopsis slabberi* was recorded in Coalhouse Fort Moat in one sample with four specimens. This species has only been recorded around 60 times in the UK (NBN).

Notable (a)

Two ‘Notable a’ species were found, both were beetles, *Enochrus halophilus* and *Cercyon bifenestratus. Enochrus halophilus* is strongly associated with brackish waters and is mainly restricted to the east coast of the UK.

Nationally scarce (Notable b)

18species of ‘Notable b’ status were found across the sites, 15 were beetles. 238 specimens were collected of all these species. The most frequent species were *Berosus affinis* (71) and *Berosus luridus* (84). *Rhantus frontalis* next most frequent was recorded at seven sites. With *Noterus crassicornis* (12 specimens from five samples) and *Limnoxenus niger* (14 specimens from three samples) were next frequent. Rarest were *Rhantus grapii* and *Ochthebius marinus* with one specimen each only. Many of these species are associated with coastal levels and marshes systems. In addition, there was one crustacean *Idotea chelipes*, one bivalve *Cerastoderma glaucum* which was recorded in 13 samples and the Bryozoan *Conopeum seurati*, all species associated with saline lagoon habitats.

Notable (r)

A single ‘Notable r’ species, *Sigara selecta*, was identified in eight samples, with up to 22 identified in a sample. Most of the sites supporting this species were in the G2, i3 and LTC4 section of the site.

Local

28 species found were considered of local status, with 1547 specimens recorded. 12 were beetles, eight species of Hemiptera, one mollusc *Ecrobia ventrosa* (recorded on nine occasions with 189 specimens), one Odonata *Orthetrum coerulescens* (one specimen once) and one spider *Argyroneta aquatica* (in ten samples with 25 specimens). The most frequent species were *Sigara concinna* with 431 specimens from 18 samples, *Sigara stagnalis* 348 specimens from 21 samples, a brackish water species and the mollusc *Ecrobia ventrosa* with 189 specimens from nine samples.

Locally Common

Three species were all crustaceans with the shrimp *Gammarus duebeni* most frequent with 1214 specimens from 23 samples. The invasive shrimp *Crangonyx pseudogracilis* with 509 specimens from six samples. Finally, the isopod *Lekanesphaera hookeri* was found in 11 samples with 118 specimens collected.

Community Conservation Index (CCI) –

The survey areas data were collated and grouped according to geographic unit or Compartment, creating ten main areas to assess. 71 sample points were surveyed and the SAFIS analysis showed that of the combined ten larger sites, all had a CCI above 20, with three areas over 30 and one over 40. High conservation status starts at 20, indicating that the whole survey area is of very high conservation value. Aquatic beetles are good indicators of habitat quality and this survey recorded 52 species, 32 of these species are of RDB to local status. The species recorded across the site indicate that each area is of very high conservation status and should be considered for conservation protection

Table 35. SAFIS data per compartment (bold row) and broken down into individual / combinations of water bodies

Sample ID / map number	Compartment	Taxa	Species Contributing to SAFIS	Specimen Count	Revised BMWP	ASPT	Families Contributing to BMWP	Water Quality	LQI	CCI	Conservation Value	Species of Interest
Mucking Marsh A	**A**	**25**	**19**	**244**	**31.1**	**3.46**	**9**	**Good**	**C**	**23.2**	**Very High**	**4**
1+2	A	20	15	198	22.3	3.72	6	Poor	B	25.9	Very High	6
3	A	10	9	46	17.4	3.48	5	Poor	F	13.3	Fairly High	2
Mucking Landfill (Enovert) inc Gobions Lake	**C**	**59**	**45**	**848**	**88.8**	**4.04**	**22**	**Excellent**	**A++**	**32.2**	**Very High**	**5**
4,5+6	C	35	19	509	49.1	3.78	13	Good	D	30	Very High	10
7+8	C	43	38	339	82	4.1	20	Good	A	21.6	Very High	16
Gobions Lake	C	62	40	1733	97	4.41	22	Excellent	A++	29.3	Very High	5
East Tilbury Quarry (Walsh)	**D**	**36**	**24**	**747**	**43**	**3.94**	**11**	**Excellent**	**A**	**39.6**	**Very High**	**6**
13	D	16	9	279	28.2	4.03	7	Moderate	D	27.2	Very High	5
14+15	D	15	9	52	26.7	3.81	7	Moderate	D	15	Fairly High	4

Sample ID / map number	Compartment	Taxa	Species Contributing to SAFIS	Specimen Count	Revised BMWP	ASPT	Families Contributing to BMWP	Water Quality	LQI	CCI	Conservation Value	Species of Interest
16+17	D	23	19	416	38.6	4.29	9	Moderate	C	26.9	Very High	11
Coalhouse Fort Campsite (18)	**L**	**37**	**27**	**111**	**50.5**	**4.21**	**13**	**Excellent**	**A+**	**22**	**Very High**	**5**
Coalhouse Fort, LTC 5	**E**	**62**	**39**	**2280**	**58.9**	**4.21**	**14**	**Excellent**	**A+**	**23.58**	**Very High**	**8**
23	E	10	6	27	16	4	4	Poor	E	9.17	Moderate	0
20+21	E	13	6	714	18.7	4.68	4	Poor	C	45	Very High	2
19,20+22	E	11	6	1511	13.7	4.57	3	Good	C	51.7	Very high	1
24	LTC5	14	11	22	28.9	4.13	7	Moderate	C	27.4	Very High	6
i8 and Bowaters	**LTC4**	**16**	**12**	**119**	**25.7**	**4.28**	**6**	**Moderate**	**C**	**25.45**	**Very High**	**2**
25	LTC4	9	6	58	7.5	3.75	2	Poor	F	15	Fairly High	1
26	LTC4	7	7	60	18.2	4.55	4	Poor	C	31.5	Very High	4
Ashfields inc i3		**43**	**27**	**3563**	**44.4**	**4.04**	**11**	**Excellent**	**A**	**33.7**	**Very High**	**4**
27+28	G2	29	16	1936	36.8	4.6	8	Moderate	B	36.3	Very High	8

Sample ID / map number	Compartment	Taxa	Species Contributing to SAFIS	Specimen Count	Revised BMWP	ASPT	Families Contributing to BMWP	Water Quality	LQI	CCI	Conservation Value	Species of Interest
29+30	G2	19	13	485	31.4	4.49	7	Moderate	C	26.9	Very High	7
31+32	i3	17	13	1142	25.8	3.69	7	Moderate	D	20.5	Very High	5
Tilbury Fort	**TFM**	**91**	**61**	**4129**	**89.6**	**4.27**	**21**	**Excellent**	**A++**	**40.9**	**Very high**	**15**
36,38+39	TFM	23	22	965	32	4.57	7	Moderate	B	47.1	Very High	12
40	TFM	8	6	22	9.9	4.95	2	Poor	D	30.3	Very High	4
41-46	TFM	65	27	1110	66.9	4.18	16	Good	B	36.3	Very High	6
35,47+37	TFM	14	7	433	13.3	4.43	3	Poor	D	28	Very High	5
33,34,48,49,50+51	TFM	11	4	837	4.8	4.8	1	Poor	D	19.3	High	2
52+53	TFM	17	14	422	39.9	3.99	10	Good	B	22.5	Very High	1

Compartment A - Mucking Wetlands: this area comprised two clay-lined ponds surrounded with *Phragmites australis* with an additional pond to the east of the site closer to the estuary edge, this pond supported a range of emergent species with *Bolboscheonus maritima* and *Phragmites australis* with stands of *Carex divisa*. This pond was well used by duck that were often fed, macrophytes were limited and often grazed.

The combined three ponds had 25 taxa, of which 19 were identified to species. Four were Notable b (Nb) and three were local. The four notable b species were all beetles with *Berosus affinis, Berosus luridus, Helochares lividus* and *Rhantus grapii*. The three local species were red-eyed damselfly *Eyrthroma najas* and two backswimmers, *Sigara concinna* and *Sigara stagnalis*. The sites were all with low salinity. The ponds have a very high conservation value with a CCI score of 23.2.

Compartment C – Mucking Landfill (Enovert) & Gobions Lake: This area was divided into two sub-areas for reporting. The large lake at the west of the site (Gobions Lake) and the three ponds in the southern edge of the Enovert landfill site. Gobions lake was a *Phragmites australis* fringed lake supporting abundant waterfowl, this was a disused aggregates quarry now under Essex Wildlife Trust management. The remaining three ponds were all settling ponds from previous quarrying activities all with dense *Phragmites australis* fringed margins.

Gobions Lake had 77 taxa, of which 55 were identified to species. One RDB3, four were Notable b (Nb) and 14 were local. The RDB3 was *Hydrochus elongatus*, the four notable b species were all beetles with *Berosus affinis, Noterus crassicornis, Anacaena bipustulata* and *Hygrotus parallellogrammus*. Of the seven local species three were Hemiptera, three were beetles, one spider. Two locally common species were crustaceans with one introduced species *Crangonyx pseudogracilis*. The sample sites were all with low salinity, Gobions Lake had a CCI score of 29.3.

The combined three ponds of the Enovert landfill had 59 taxa, of which 46 were identified to species. Three were RDB3, three were Notable b (Nb), 14 were local and two were locally common. The two RDB3 species were beetles, *Graphoderus cinereus* and, *Graptodytes bilineatus*. The three notable b species were all beetles with *Berosus affinis, Haliplus apicalis and Helochares lividus*. Of the 14 local species five were Hemiptera, seven were beetles, one spider and one dragonfly (*Orthetrum coerulescens*). Two locally common species were crustaceans with one introduced species *Crangonyx pseudogracilis*. The ponds have a very high conservation value with a CCI score of 32.2. The ponds were brackish with a 5-9ppm.

Compartment D – East Tilbury Quarry (Walsh): comprised a series of borrow dykes, a large *Phragmites australis* fringed settling pond and a new area of lagoons (high-tide roost).

Across the three sampling locations a total of 36 taxa were recorded with 27 species. One was RDB3, four were Notable b (Nb), one Notable r (Nr), one Notable A (Na) seven were local and two were locally common. The RDB3 species was the mollusc *Hydrobia neglecta acuta*, the four notable b species were all beetles with *Berosus affinis, Berosus signaticollis, Enochrus bicolor and Rhantus frontalis.* The Na *Enochrus Haliplus*, the Nr *Sigara selecta*. Of the seven local species four were Hemiptera and three were beetles. Two locally common species were crustaceans with one introduced species *Crangonyx pseudogracilis*. All

sampling locations showed brackish water conditions with values ranging from 4-9ppm. The ponds have a very high conservation value with a CCI score of 39.63.

Compartment L - Fields east of Coalhouse Battery: The ditch sampled was on the northern edge of the compartment, running east along the top of the campsite. This had been cleared in the previous year and was filled with *Zannichellia palustris*.

Across the one sample of the campsite ditch a total of 37 taxa were recorded with 32 species. Four were Notable b (Nb), one was Notable a (Na) and four were local. The four Nb were beetles, *Berosus affinis, Helochares lividus, Hygrotus parallellogrammus* and *Rhantus frontalis*. The Na was *Enochrus halophilus* with three of the local species were beetles and *Sigara selecta*. Of the seven local species four were Hemiptera and three were beetles. The sampling location showed brackish water conditions with a value of 6ppm.The ditch has a very high conservation value with a CCI score of 22.

Across the one sample of the campsite ditch a total of 26 taxa were recorded with 21 species. Five were Notable b (Nb), one was Notable rare (Nr) and three were local. The five Nb were beetles, *Berosus affinis, Enochrus bicolor, Noterus crassicornis, Hygrotus parallellogrammus* and *Rhantus frontalis*. The Nr was *Sigara selecta* of the three local species two were beetles and the hemiptera was *Notonecta viridis*. The sampling location showed brackish water conditions with a value of 15-20ppm.The ditch has a very high conservation value with a CCI score of 26.60.

Compartment E – Coalhouse Fort & surrounds: This compartment comprised the main saline lagoons of the moats and associated ditch running south. These were all turbid with a limited fauna.

Across the six sampling points a total of 25 taxa were recorded with 20 species. The saline lagoons had a limited fauna dominated with *Cerastoderma glaucum* and *Idotea chelipes*, with notable molluscs being *Ecrobia ventrosa, Hydrobia acuta neglecta* and *Ecrobia ventrosa* It was not possible to create a CCI score for these sites as it is too saline and supports saline lagoon species.

Compartment LTC4, i8 and Bowaters: These two areas are reported separately sites, the LTC4 samples were from *Phragmites* and *Bolboscheonus* dominated margined ditches, these ditches were opaque with high conductivity (15-20ppm).

Compartment Ashfields (inc i3): The i3 samples were also from two ditches and an ephemeral pond in the Ashfields A1 area all with *Phragmites australis* and *Bolboscheonus maritima* dominating.

The i3 and Ashfields samples supported 43 taxa were recorded with 29 species. One was pRDB3, two were Notable b (Nb), one was Notable rare (Nr) and eight were local. The pRDB 3 was *Berosus fulvus*, the two Nb were beetles, *Berosus affinis* and *Rhantus frontalis*. The Nr was *Sigara selecta*. Of the eight local species four were beetles and four Hemiptera. The sampling location showed brackish water conditions with a value of 15-20ppm.The ditch has a very high conservation value with a CCI score of 34.62.

Compartment Tilbury Fort & marshes: This compartment was a series of moat/lagoons, tidal ditches, ephemeral ditches and drying pools. All within a heavily horse-grazed marsh

system. Many of the ditches had aquatic macrophytes with the main lagoons supporting dense mats of marine algae.

Across the ditch and pool samples a total of 89 taxa were recorded with 63 species. One pRDB3, two RDB3, 10 Notable b (Nb), two Notable b (Nb) and one Notable rare (Nr), 15 local and two locally common species. pRDB3 *Berosus fulvus*, RDB3 *Graptodytes bilineatus*, *Hydrobia acuta neglecta*, Nb all beetles, *Berosus affinins, Berosus luridus, Berosus signaticollis, Haliplus apicaulis, Helophorus arvernicus, Limnoxenus niger, Noterus clavicornis*, *Ochthebius marinus*, *Rhantus frontalis* and *Rhantus suturalis*. Na was *Cercyon bifenestratus* and *Enochrus halophilus* and the Nr was *Sigara selecta*. The sampling location showed brackish/saline/hypersaline water conditions with a value of 15-44ppm.The ditch has a very high conservation value with a CCI score of 39.00.

Two samples were taken from one ditch west of Fort Road. This site was sampled in two locations along the same ditch, no other samples were taken west of Fort Road as it was too dry. The sampled ditch was a *Phragmites australis* choked ditch with limited areas of open water.

Across the two samples of the ditch a total of 17 taxa were recorded with 14 species. One Notable b (Nb) *Haliplus apicalis*, five were local and one locally common *Gammarus duebeni*. The sampling location showed brackish water conditions with a value of 6ppm.The ditch has a very high conservation value with a CCI score of 22.50.

Table 36. Table showing Saline Lagoonal species found during the survey with conservation status (Blank cells indicate where IUCN Red List category not available)

Listed Species	Common Name	Wildlife and Countryside Act 1981 – Schedule 5	Lagoon Specialist species	Listed species E = England,	IUCN Red List (Based on 2001 guidelines, unless	Nationally Rare Marine Species *	Nationally Scarce Marine Species *	Nationally Rare (Ra) or Scarce (Sc) Plants
Gammarus chevreuxi	A sand shrimp	**N**	**N**	**N**		**N**	Y	**N**
Gammarus insensibilis	Lagoon sand shrimp	Y	Y	E	R - Pre 1994	**N**	Y	**N**
Idotea chelipes	An amphipod	**N**	Y	S		**N**	Y	**N**
Lekanesphaera hookeri	An isopod	**N**	Y	S		**N**	**N**	**N**
Monocorophium insidiosum	A mud shrimp	**N**	Y	S		**N**	**N**	**N**
Cerastoderma glaucum	Lagoon cockle	**N**	Y	S		**N**	**N**	**N**
Ecrobia ventrosa	Spire snail	**N**	Y	S		**N**	**N**	**N**

Listed Species	Common Name	Wildlife and Countryside Act 1981 – Schedule 5	Lagoon Specialist species	Listed species E = England,	IUCN Red List (Based on 2001 guidelines, unless	Nationally Rare Marine Species *	Nationally Scarce Marine Species *	Nationally Rare (Ra) or Scarce (Sc) Plants
Hydrobia acuta neglecta	Mud snail	**N**	Y	S	LC	**N**	**N**	**N**
Conopeum seurati	bryozoan	**N**	**N**	**N**		**N**	Y	**N**
Ruppia maritima	Beaked tasselweed	**N**	**N**	S	L C	**N**	**N**	**N**

41 References

Report to be cited as: Abrehart Ecology, 2022. Tilbury Marsh, Aquatic Macroinvertebrate Survey Report. Report to NATURAL ENGLAND.

Barnard, P. & Ross, E., 2012. The adult Trichoptera (caddisflies) of Britain and Ireland. Royal Entomological Society.

Bass, J. 1998. Last-instar larvae and pupae of the Simuliidae of Britain and Ireland. *Freshwater Biological Association Scientific Publication* 55. Freshwater Biological Association, Ambleside.

Chad, R. & Extence, C. The conservation of freshwater macroinvertebrate populations: a community-based classification scheme. Aquatic Conservation: Marine and Freshwater Ecosystems Volume 14, Issue 6

Dobson, M., Pawley, S., Fletcher, M., Powell, A. *2012*. Guide to freshwater invertebrates. *Freshwater Biological Association Scientific Publication* 68. Freshwater Biological Association, Ambleside.

Eddington, J.M. & Hildrew, A.G., 2005. A revised Key to the Caseless Caddis Larvae of the British Isles. *Freshwater Biological Association Scientific Publication* 53. Freshwater Biological Association, Ambleside.

Elliott, J.M. & Dobson, M., 2015. Freshwater leeches of Britain and Ireland. *Freshwater Biological Association Scientific Publication* 69. Freshwater Biological Association, Ambleside.

Elliot, J.M. & Humpesch, U.H., 2012. Mayfly larvae (Ephemeroptera) of Britain and Ireland. *Freshwater Biological Association Scientific Publication* 66. Freshwater Biological Association, Ambleside.

Foster, G.N., Friday, L.E. 2011. Keys to adults of the water beetles of Britain and Ireland (part 1). *Handbooks for the identification of British insects* 4(5). Royal Entomological Society.

Foster, G.N., Bilton, D.T., Friday, L.E. 2014. Keys to adults of the water beetles of Britain and Ireland (part 2). *Handbooks for the identification of British insects* 4(5b). Royal Entomological Society.

Foster, G.N., Bilton, D.B., Hammond, M., Nelson, B. 2018. Atlas of the Hydrophiloid Beetles of Britain and Ireland. Published for Biological Records Centre, Wallingford by FSC Publications, Telford.

Friday, L.E., 1988. A key to the adults of British water beetles. *Field Studies* 7(1), 1-151

Gledhill, T., Sutcliffe, D.W., Williams, W.D. 1993. British freshwater Crustacea Malacostraca: a key with ecological notes. Freshwater Biological Association, Ambleside.

Hawkes, H.A (1998). "Origin and development of the biological monitoring working party score system". Water Research. 32 *(3): 964–968.*

Huxley, T., 2003. Provisional atlas of the British aquatic bugs (Hemiptera, Heteroptera). Huntingdon: Biological Records Centre.

Hynes, H.B.N., 1993. A key to the adults and nymphs of the British stoneflies (Plecoptera). *Freshwater Biological Association Scientific Publication* 17. Freshwater Biological Association, Ambleside.

Kerans, B.L., Dybdahl, M.F., Gangloff, M.M., Jannot, J.E. 2005. *Potamopyrgus antipodarum:* distribution, density, and effects on native macroinvertebrate assemblages in the Greater Yellowstone Ecosystem. *Journal of the North American Benthological Society* 24(1): 123-138.

Kerney, M., 1999. Atlas of the Land and Freshwater Molluscs of Britain and Ireland. The Conchological Society of Great Britain and Ireland. Harley Books, Great Horkesly.

Killeen, I., Aldridge, D. & Oliver, G., 2004. Freshwater Bivalves of Britain and Ireland. FSC Publications, Telford.

Macadam, C. & Bennett, C., 2010. A Pictorial Guide to British Ephemeroptera. Published for the Riverfly Partnership by FSC Publications, Telford.

Reynoldson, T.B. & Young, J.O., 2000. A key to the triclads of Britain and Ireland with notes on their ecology. *Freshwater Biological Association Scientific Publication* 58. Freshwater Biological Association, Ambleside.

SAFIS: Site Analysis for Freshwater Surveys, version 30.0. Boxvalley AquaSurveys.

Savage, A.A., 1989. Adults of the British Aquatic Hemiptera Heteroptera. Freshwater Biological Association, Ambleside.

Scourfield, D.J. & Harding, J.P., 1994. A Key to the British Freshwater Cladocera. *Freshwater Biological Association Scientific Publication* 5. Freshwater Biological Association, Ambleside.

Smith, K.G.V., An introduction to the immature stages of British flies. *Handbooks for the identification of British insects* 10(14). Royal Entomological Society.

Wallace, I.D., Wallace, B., & Philipson, G.N., 1990. Keys to the case-bearing caddis larvae of Britain and Ireland. *Freshwater Biological Association Scientific Publication* 61. Freshwater Biological Association, Ambleside.

Appendix A– Sample data

Available in separate Excel document, published alongside this report named Tilbury Aquatic Invert Data 2022.

Appendix B– Site photos

Mucking Marshes

Pond 1 - TQ68477931 – C1

Pond 2 - TQ69307925 – C1

Pond 3 - TQ69287912 - C1

Gobions Lake

West shore - TQ68038012

South Shore - TQ68207990

East Tilbury Marshes

Walsh High-tide Roost - TQ69257789 - D

Pond 7 Borrow dyke - TQ69337794 – D

Pond 6 - TQ69327874 - D

Coalhouse Fort and surrounds

Campsite - TQ68907772 – L7

Small Moat - TQ69097668 - E2

Large Moat - TQ69167689 - E1

South Ditch - TQ69057661 – E1

LTC 4 Ditch - TQ67577653

Small Moat - TQ69097668 - *Ficopomatus enigmaticus*

West Ditch - TQ66387546 – G2

East Ditch - TQ66657566 – G2

i3 Habitat creation site

Ephemeral Pond north - TQ66797583 – i3

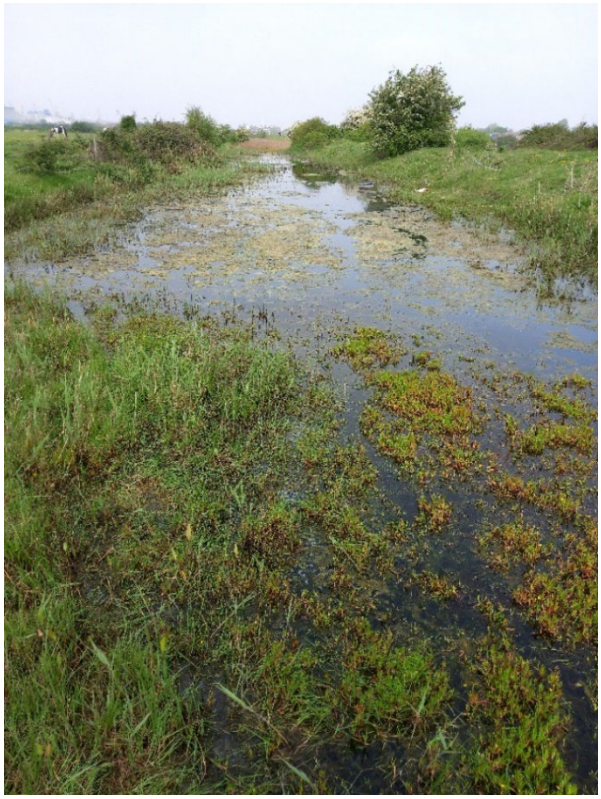
Ephemeral Pond south - TQ66827579 – i3

Tilbury Fort

Bill Melroy Creek - TQ65447550 – TFM5

TF 3 - TQ65327539 – TMF 3

TF10/6 - TQ65257569 – TMF3



TF8 - TQ65287577 – TFM 3

TF 9 - TQ65097580 – TFM3

TF10/5/18 - TQ64917563 –

TF17/4/11 -TQ64837556 – TFM1

TF Creek - TQ64887535 – TFM1

TF Moat NE - TQ64927544 – TFM 1

TF Moat South - TQ65267528 – TFM 2

TF Moat north - TQ65107542 – TFM 3

Pond - TQ67577653 - E3

West Ditch – TQ66377554 – G2

Appendix C: Invertebrate Status Codes

A2.1 Nationally Rare species are those falling within the Status categories defined in the *British Red Data Books* (Bratton, 1991; Shirt, 1987). These are internationally recognised species listed in the various *Red Data Books* published by, or under the auspices of, the International Union for the Conservation of Nature (IUCN). Species included may not be informally removed or transferred between categories. There are four categories as follows:

RDB 1 Taxa in danger of extinction and whose survival is unlikely if the causal factors continue operating. These include:
Species known from only a single locality since 1970;
species restricted to habitats which are especially vulnerable;
species which have shown a rapid and continuous decline in the last twenty years and are now estimated to exist in five or fewer localities;
species believed extinct, but which would need protection if rediscovered.

RDB 2 “Vulnerable”. Taxa believed likely to move into the Endangered category in the near future if the causal factors continue operating. These include:
Species declining throughout their range; species in vulnerable habitats; species whose populations are low.

RDB 3 “Rare”. Taxa with small populations which are not at present endangered or vulnerable, but which are at risk. These include: Species which are estimated to occur in fifteen or fewer localities.

RDB K Taxa suspected to fall within the RDB categories, but which are at present insufficiently known to enable placement.

2.2 Nationally Scarce species are those falling within the Nationally Notable categories introduced by Ball (1986). They are species which are estimated to occur within the range of 16 to 100 ten-kilometre squares of the British National Grid system since 1970. The specific categorisations of species have been revised since their inception for a number of taxa;
those revisions are taken into account in the present report.

Notable species are subdivided as follows:

Na species estimated to occur within the range of 16 to 30 10-kilometre squares of the National Grid System.

Nb species estimated to occur within the range 31 to 100 10-kilometre squares of the National Grid System.

N Diptera (flies) not separated, falling into either category Na or Nb.

A2.3 Nationally Local species are those which, whilst fairly common, are evidently less widespread than truly common species, but also not qualifying as Nationally Notable having been recorded from over one hundred, but less than three hundred, ten-kilometre squares of the UK National Grid. Without exception, “Local” designations have been obtained from the RECORDER software.

The National Status Codes, where these are Local or better, are indicated against species names in Appendices 1, 2 and 3.

www.gov.uk/natural-england