Tidal Thames Habitat and Species Audit

Prepared for the

Thames Estuary Partnership

By

Land Use Consultants

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SATL

Contents

Introduction

Land Use Consultants were commissioned by the Thames Estuary Partnership to undertake an audit of key habitats and species associated with the tidal river Thames. The study area is shown on Figure 1, and is delimited by the upstream tidal limit of the river at Teddington Lock to the west and the marine reaches of the estuary between Shoeburyness (Essex), and the Isle of Grain (Kent) to the east. The north and south boundaries of the study area are defined by the 5m contour line along the river, and broadly represents the former floodplain of the river.

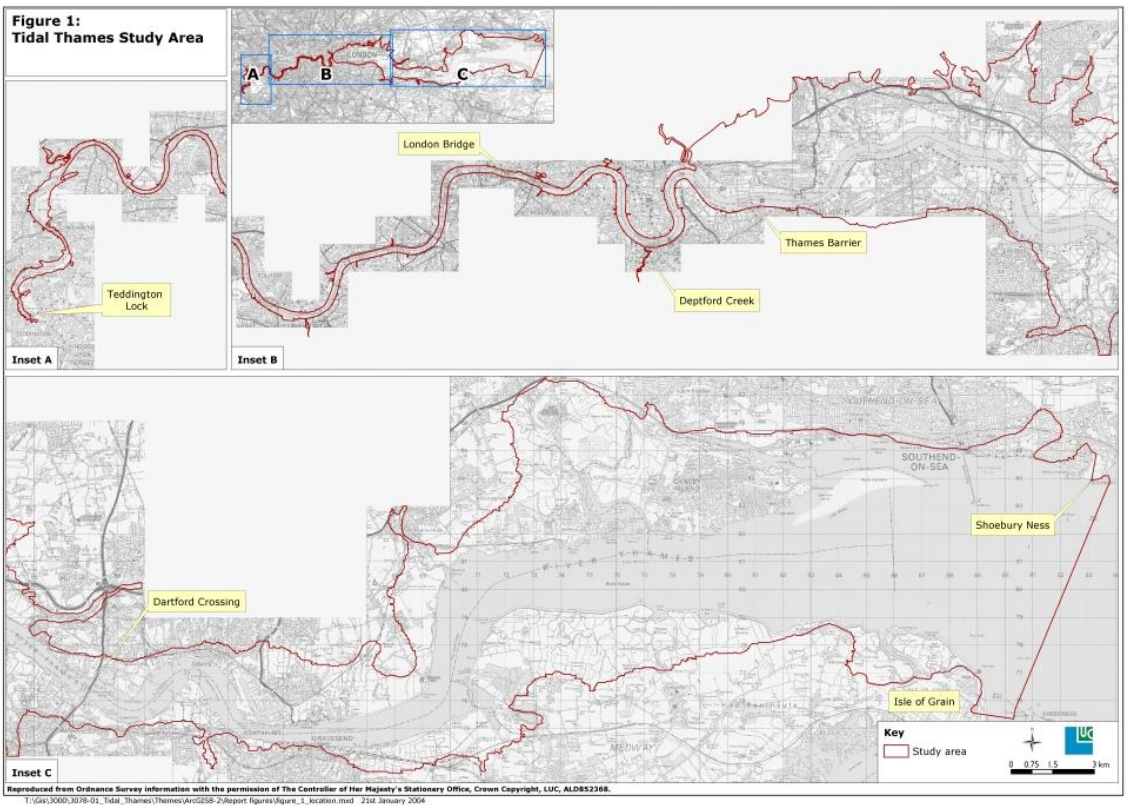


Figure 1: Tidal Thames Study Area

As described by the Tidal Thames Habitat Action Plan[1], (referred to hereafter as the TTHAP) the Thames is a strategically important river for nature conservation with high local, national, and international wildlife value (see Figure 2).

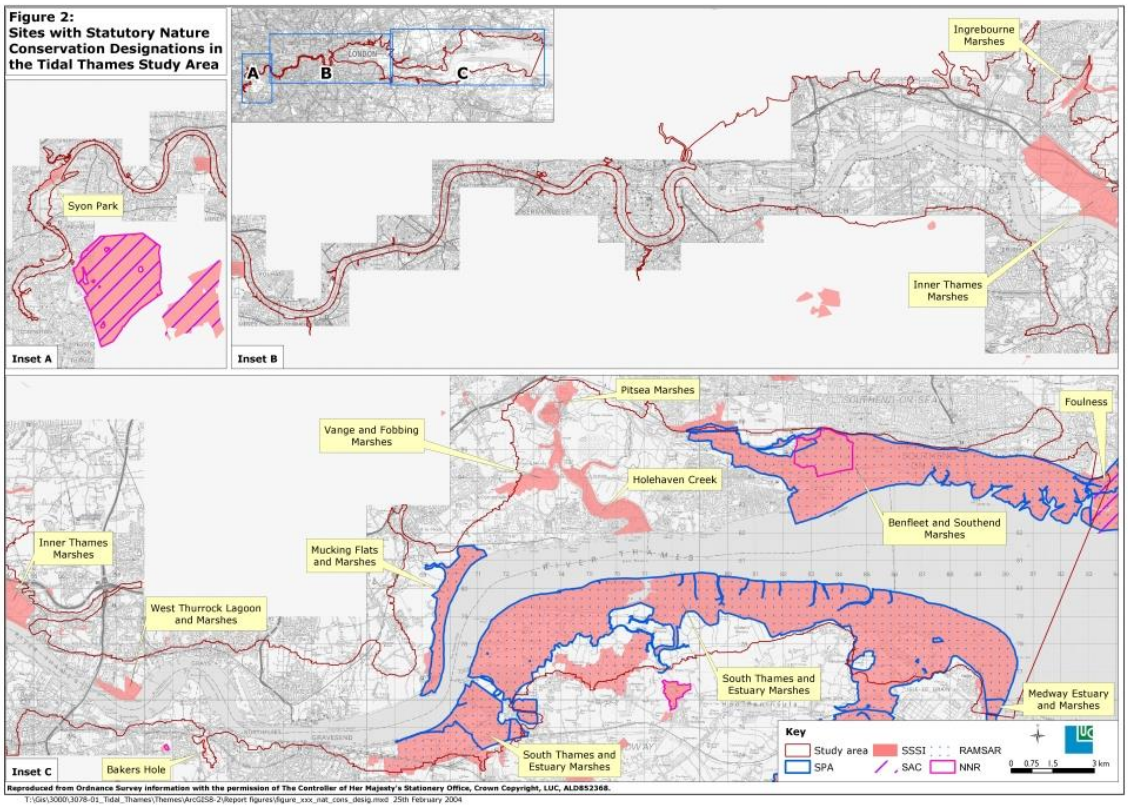


Figure 2: Sites with Statutory Nature Conservation Designations in the Tidal Thames Study Area

[1] Thames Estuary Partnership Biodiversity Action Group (2003) *Tidal Thames Habitat Action Plan*. Thames Estuary Partnership, UCL, London

The TTHAP lists several habitat types along the river of particular biodiversity importance. These have been divided into naturally occurring habitats, and those created by man (see

Table ***1***).

Riverbank and Riverbed Habitats
Gravel foreshore
Sub-littoral sands and gravels
Islands
Mudflats
Natural Riverbank
Tidal Creeks
Riverine and Floodplain Semi-natural Habitats
Reedbeds
Saltmarsh
Saline lagoons
Seagrass beds (*Zostera* spp.)
Semi-natural grasslands of Thames Terrace Gravels
Artificial Habitat
Artificial Structures / Built Areas
Flood embankments
River walls
Open water (Docks)

Table 1: Habitats listed in the TTHAP

Several characteristic species are also listed by the TTHAP and are summarised in Table ***2***.

Algae & Higher Plants
Bladder wrack
Enteromorpha
Golden samphire
Hemlock water-dropwort
Purple loosestrife
Sea Aster
Sea Barley
Sea Clover
Terrestrial Invertebrates
Hornet robberfly
Shrill carder bee
Solitary wasp (*Cerceris fasciata*)
Aquatic Invertebrates
Cockle
Freshwater shrimp (*Gammarus zaddachi*)
Ragworm
Two-lipped door snail
Fish and Lamprey
Bass
Flounder
Salmon
Sea lamprey
Sole
Smelt
Twaite shad
Birds
Avocet
Black-tailed godwit
Common tern
Dunlin
Grey heron
Redshank
Ringed plover
Shelduck
Teal
Marine Mammals
Harbour porpoise
Bottlenose dolphin
Harbour seal

Table 2: Species listed in TTHAP

The original scope of the study was to collect data on these individual habitats and species from existing data sources using, as far as practicable, a Geographic Information System (GIS) to hold and display information. Numerous organisations and individual persons have been contacted for data, and a considerable amount of time has been spent assessing the potential usefulness of various data sources.

The original project scope was to rely solely on existing data to complete the audit. However, as the study progressed, it was felt necessary to undertake select fieldwork to produce a meaningful output, as in many instances, existing data was of limited value or simply unavailable.

Table 3 below summarises the data sourcing and evaluation exercise that was completed by this study.

ORGANISATION	CONTACT	DATA	COMMENT
Thames Estuary Partnership	Jonathan Ducker (Project Manager)	OS 1:50,000 raster tiles for study area. OS Landform panorama for study area. OS MasterMap, selected terms only for study area	Purchased by LUC in the name of TEP from Emap. Purchased by LUC in the name of TEP from Emap. Used to define study area. Purchased by LUC in the name of TEP from Emap.
Environment Agency	Kate Potter (Anglian Region - main point of Agency liaison for Thames, Anglian and Southern Regions for the project)	Provided (on loan) relevant Anglian Region reports	Macrophyte Survey of the Mar Dyke Catchment (1998) Report Sea Bank Corridor Survey (1995) Catchment Summary Report River Corridor Survey: A. Thames: Rainham Sub catchment. Summary Report River Corridor Survey: B. Thames: Fobbing, Pitsea and Canvey Island. Summary Report Coastal Corridor Survey: Q. Thames Coast. Catchment Summary Report No data provided from Southern Region (Kent) Reports returned recorded to Agency, Cobham Road, Ipswich March 2004
Environment Agency	Helen Campbell (Thames Region - GIS Officer) LUC (PG/DP) attended meeting at Woolwich Barrier Meeting to review exiting data availability.	OS 1:10,000 raster tiles were provided for the whole study area. Digital aerial photography from 1999 for Teddington to Barking Creek, and selected 2001 updates was supplied. Apparently no digital or readily available aerials for lower river reaches (Essex/Kent) Institute of Terrestrial Ecology Land Cover Data CASI data Flood defence structure mapping data. Indicative fluvial / tidal flood map	Provided under licence agreement – used to check mapping. Provided under licence agreement – used to help verify inter-tidal substrate distribution. Resolution considered not suitable for habitat mapping. Compared with ITE data and aerials, generally considered not to be reliable for habitat interpretation. Mapping from OS landline, but attribute information too variable to be useful. Data used to define study area but not suitable for defining defence structures / habitat. Not checked by the EA for accuracy. In GIS format.

ORGANISATION	CONTACT	DATA	COMMENT
Environment Agency	Rachel Hill (Thames Region) LUC (PG/DP) attended meeting to discuss how TEP study fits with study being undertaken by KCC on behalf of EA. RH subsequently provided two potentially useful reports she was aware of.	Tidal Thames Benthic Invertebrate Survey Report (4 Volumes) Archaeological survey of the Thames – GIS layers	Seminal study that has been published as various scientific papers, and used as a basis by the main author (Martin Attrill) to define characteristic zones of distinct invertebrate assemblages along the Tidal Thames Not particularly helpful to current study
Environment Agency	Steve Colclough (Thames Region - Fisheries)	LUC attended meeting at Crossness to discuss fisheries and availability of data	Useful verbal information and two background reports. Most fish monitoring data not written up.
Environment Agency	Dave Webb (Thames Region)	LUC (RH) visited the Agency Frimley office to inspect full River Corridor Reports as only summary reports provided by K. Potter.	Survey completed in 1994 and provided useful botanical species records used to help inform saltmarsh / reed swamp zonation.
Environment Agency	Antonia Scarr (Thames Region)	Provided useful feedback on LUC summary table for river plant zone classification and organised photocopies of species maps from Ecoscope bird Report.	
Environment Agency	Mark Davison (Thames Region)	Provided various invertebrate taxa list for the tidal Thames	
Greater London Authority / London Wildlife Trust	John Archer (GLA) and Mandy Rudd (LWT), various telephone and email correspondence.	Provided Phase 1 habitat type data for select London Boroughs with river frontage. Some boroughs subject to current survey and not available.	Variable coverage of river edge.

ORGANISATION	CONTACT	DATA	COMMENT
Essex County Council	Emma Simmonds (County Ecologist) telephone / email discussion over available data Peter J Carter (Aerial photography)	Provided paper black and white copies of 1988 Phase 1 type habitat data. Digital aerial photography available for Essex, but LUC not able to secure it in the time frame of this study.	Survey did not adequately cover river edge / foreshore habitat, and black and white lines difficult to interpret. ES confirmed that ECC are planning to update the survey in the future.
Kent County Council	Andrew Jones / Chris Blair-Myers.	Provided Integrated Habitat survey data foe the study area within Kent.	Saltmarsh habitat acknowledged by KCC to be unreliable in terms of distribution and botanical classification. To be improved as part of Agency commission.
English Nature Kent	Lionel Solly (Kent) Phil Williams (Kent)	Provided MapInfo digital layer of scarce plant survey results of a river wall plant survey. Verbal communication only - confirmed saline lagoon distribution and lack of Zostera data.	Useful and detailed data set.
English Nature Kent	LUC (LB) visited Neil Fuller (Essex Team) in Colchester. Inspected EN library for relevant data/reports	Paper records of a scarce plant survey of Essex river walls available for inspection in Colchester and some scarce invertebrate records. LUC arranged meeting.	
English Nature London	Pete Massini (London)	No data available of direct relevance the study.	
	National datasets	SSSI, AW, NNR, SAC, SPA, RAMSAR	Downloaded from EN website.
Essex Wildlife Trust (EECOS)	Adrian Knowles / Neil Harvey	Telephone contact confirmed that EECOS do hold data of relevance to the project.	

ORGANISATION	CONTACT	DATA	COMMENT
Essex Wildlife Trust	LUC visited Andrew May EWT office in Colchester.	Inspected aerial photographs at office and provided RECORDER data and select plant species records	
Natural History Museum	Roni Robbins	Email and telephone contact only. No records provided.	Records promised for Chinese mitten crab but not provided. LUC did not follow this up as scientific papers refer.
Natural History Museum	Ian Titley	Email, telephone and meeting.	Numerous scientific papers produced by IT on algal species distribution along the tidal Thames reviewed.
Port of London Authority	LUC (DP/PG) attended a meeting with Steve Taylor and Caroline Faulkner at Gravesend, August 2004	No data provided.	PLA have been developing a website and manual for dealing with contamination / spills etc. Digital aerial photography was not available due to do licencing restrictions. There are possibilities for future data sharing between TEP and PLA.
Other	Peter Harvey (Consultant Entomologist)	Email and telephone. Has extensive records on scarce invertebrates within the tidal Thames survey area.	Provided comprehensive species distribution data for the study for a small fee.
	Rodney Burton (Vice County Botanical Recorder for Middlesex)	Letter and email.	Provided useful plant species distribution data for a small fee
	Anne Sankey (Vice County Botanical Recorder for Surrey)	Letter and telephone conversation	Could provide botanical records for a search fee. This was not followed up by LUC.
	Eric Philp (Vice County Botanical Recorder for East and West Kent)	Letter	Confirmed that the best source of data was the Atlas of Kent Flora, and confirmed that the new Kent Atlas is due to be completed in 2005, but that distribution records for halophytes and saltmarsh species have not changed significantly, save that some are now more frequently recorded along roadsides throughout the county due to road salting
	Ken Adams	Email request for information on eelgrass	Confirmed that little information exists due to difficulties in surveying the species. Suggested contact is made with Roger Payne at the Southend Museum (author of the Essex BAP for Zostera.
	Roger Payne (Southend Museum)	Letter request for eelgrass information	Provided information on eelgrass over the phone

Riverbank and Riverbed Habitats

Background

A walkover survey of the River Thames from Teddington Lock downstream to the Greenwich Peninsula was undertaken by an ecologist from LUC to assess the range and type of riverbed substrates that comprise the inter-tidal foreshore habitat that is exposed twice a day along the river edge as part of the normal tidal cycle. The survey was undertaken during low water, in September 2003 and January 2004 from the Thames footpath where it occurred close to the bank top (mainly the southern (right) bank).

Complete access to the river edge was restricted in select locations notably from Putney Bridge downstream to Albion Quay in Wandsworth, and areas between Surrey Quays and the Greenwich Peninsula. Complete walkover of the river downstream of Greenwich Peninsula was not undertaken due to time restrictions. Several sites spaced at intervals along the river were, however, visited in October 2003 from the shore and inspected from a boat at low tide between Greenwich and Dartford in the same month.

Substrates were defined by the walkover based on the following categories assessed by visual inspection of the visible surface deposits only:

- Clay: solid surface comprising sticky clay material
- Silt/mud: very fine deposited material
- Sand: particles 0.06-2mm diameter
- Gravel: loose stone material 2-64mm diameter
- Cobble: loose stone material 64-256mm diameter
- Boulder: loose stone material >256mm diameter

Teddington Lock to Richmond Lock

From Teddington Lock to Richmond Lock, there is limited exposure of foreshore on a typical tidal cycle, as for 11 months of the year the operation of Richmond lock ensures that this section of the river experiences only a half tide. During November, Richmond Lock is left fully opened, and a full tidal cycle is experienced to facilitate sediment flushing from the upper river system. However, in the limited areas where river edge habitat is exposed regularly i.e. at Teddington Lock, along the right bank downstream of the lock and in Richmond adjacent to the White Cross public house, it is composed of similarly sized flint gravel particles with variable quantities of fine sands and silt/mud. Except for one relatively short length of ‘natural’ unmodified London Clay riverbank (southern bank) within Teddington all riverbank habitat associated with the river edge or islands has been reinforced with a variety of hard engineered structures of varying material, form, age, and condition. These include, for example, stone, reinforced concrete, wooden and steel piling.

Richmond Lock to Wandsworth Bridge

Downstream of Richmond Lock, the first extensive areas of regularly exposed inter tidal substrate occurs along the river edge, and are typically dominated by flint gravels with variable quantities of cobble derived (probably) from historic engineering works undertaken to reinforce the riverbank (e.g. stone sets at Isleworth Ait, and downstream of Kew Bridge).

Localised patches of sand dominated substrate (with variable quantities of silt/mud) first begin to appear along the right bank of the river near Isleworth Ait in the downstream lee of a meander promontory where slack water conditions prevail. Slack water conditions and associated sand deposits also occur downstream of structures in the river, as at Kew Bridge and Wandsworth Park where barges and boats are permanently moored adjacent to the river wall, and downstream of a concrete boat slipway upstream of Hammersmith Bridge. Similarly, where slack water conditions prevail along the extreme edge of the river at high tide, and the inter-tidal substrate deposits are wide (>5m), a gradation in sediment particle size is frequently observed. This is typically characterised by a band of fine sand and silt/mud at the top of the deposit adjacent to riverbank (that is often consolidated by emergent aquatic/wetland plants) that grades into flint gravels with occasional cobble.

Flint gravel is still the dominant substrate type along this stretch of river, with variable quantities of fine deposits with occasional cobble-sized stone, brick, and rock substrate.

An extensive stretch of 'natural' clay dominated riverbank fronts Syon Park along the northern bank of the river between Isleworth and Brentford and is notable as it is the largest single expanse of unmodified riverbank within the upper tidal reaches of the Thames. It is intersected with numerous naturally eroded drainage channels, which presumably are reminiscent of what most of the Thames riverbank resembled before historic bank strengthening was undertaken.

The bulk of the remaining riverbank along this stretch is highly artificial having been reinforced with a variety of materials e.g. concrete and steel piles, stone sets, and in some locations, fagotting, which is now defunct.

Wandsworth Bridge to the Isle of Dogs

While flint gravel is still the dominant inter-tidal substrate and occurs with variable quantities of fine sands and silts (depending upon local patterns of deposition), cobble and boulder sized substrates become more locally frequent due to the presence of barge beds (first evident downstream of Wandsworth Park). Barge beds are man-made accumulations of cobble and boulder-sized rock particles that vary individually in material type, age, and size. They are constructed on the foreshore to provide a level riverbed surface for moored boats and barges at low tide as, typically, river edge inter-tidal substrates slope down to the river channel at an angle of between 15 and 30^{o}.

Many of these man-made structures are defunct historic features constructed either behind wooden retaining structures or as loose accumulations of rocks placed/dumped on top of existing bed substrates. Barge-bed material type appears to vary considerably (they were/are presumably constructed from any suitably sized rock type material available at low cost at the time of construction), and range from brick, breezeblock, concrete rubble, flint, and chalk cobbles. The oldest structures are frequently associated with other permanent structures constructed on the riverbed such as stone set landing stages adjacent to the historic wharfs and quays (e.g. at Tower Bridge opposite Butler's Wharf on the southern bank).

Where barge-beds have not artificially changed substrate character, a gradation in substrate particle size across the foreshore like that described previously is often observed, with fine sand deposits occurring at the top of the deposit grading into gravels of increasing particle size towards the mean low water mark. In some locations, notably along the South Bank near Royal Festival Hall, and in front of Tower Wharf (north bank), this pattern is exacerbated because of historic introductions of sand to create artificial sandy beaches for recreational purposes.

Large-scale geomorphological processes are also evident within this reach of the river, with significant deposits of fine sandy silts being deposited on the inside of large meander bends. This can be seen, for example, along the north bank of river at Vauxhall Bridge where extensive areas of fine deposits appear to be actively depositing. Similarly, extensive accumulations of fine muddy silts are frequently observed where adjoining rivers form confluences with the Thames, e.g. at St. Saviours Dock on the south bank in Bermondsey were the 'lost river' Effra joins the Thames as a trickle-flow tributary for most of the time. In addition to depositional processes, small-scale areas of exposed London Clay also exist along the foreshore in a few locations.

All the riverbank along this section of river is strengthened, with no natural bank occurring. Typically, this takes the form of vertical walls >4m in height of varying age, condition, design, and material. Typical wall materials consist of brick, stone, concrete, steel, and wood. Frequently walls are faced with timber rubbing strips or boarding.

Isle of Dogs to Shoeburyness Point

Flint gravel, cobble and boulder are still locally frequent at least until the Woolwich Ferry. After this point, a sea change in inter-tidal substrate type occurs around the Isle of Dogs near Millwall Park where the first large deposits of inter-tidal mud (mudflats) occur. In general terms, these become wider and more extensive with increasing proportions of maritime sand towards Shoeburyness.

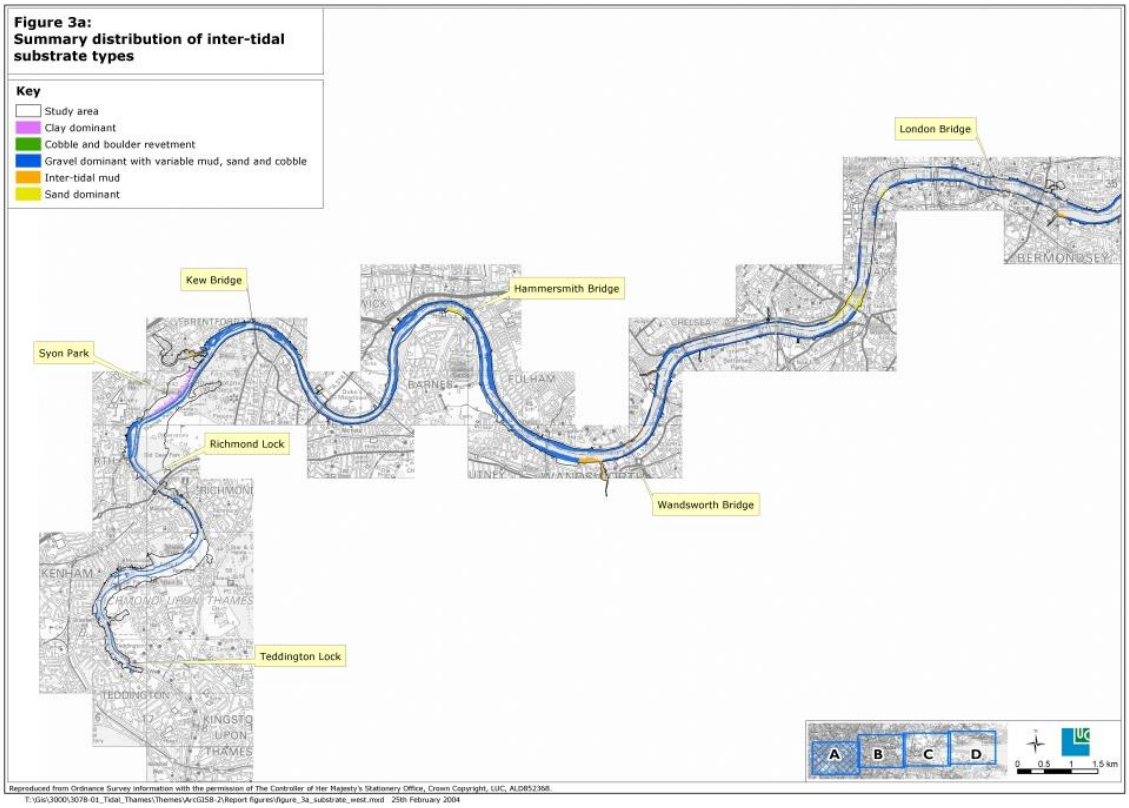
The most extensive and significant mudflats from a landscape and nature conservation perspective include the extensive mud and sand flats within the last 25km of the tidal Thames from Mucking Flats downstream to Shoeburyness and include Blyth Sands (north Kent) and the Essex resorts of Canvey Island and Southend-on-Sea.

Natural riverbank has been replaced entirely by engineered structures constructed to protect low-lying land within the floodplain from tidal inundation. A variety river wall, embankment and toe-protection structures occur that range in design, age and condition. These include

concrete and sheet piling walls, rip-rap boulder revetment, brick/laid stone gabions and vegetated embankments.

Distribution of Inter-tidal Foreshore Substrates

Figure 3 shows the approximate extent and distribution of inter-foreshore habitat along the tidal river Thames as indicated by Ordnance Survey MasterMap *Foreshore* data has been reclassified based on the fieldwork previously described, and aerial photography interpretation where available. While MasterMap data do not necessarily provide a precise representation of current of individual foreshore boundaries (they are dynamic features), Figure 3 is useful for showing the general extent and broad distribution of these habitat features.



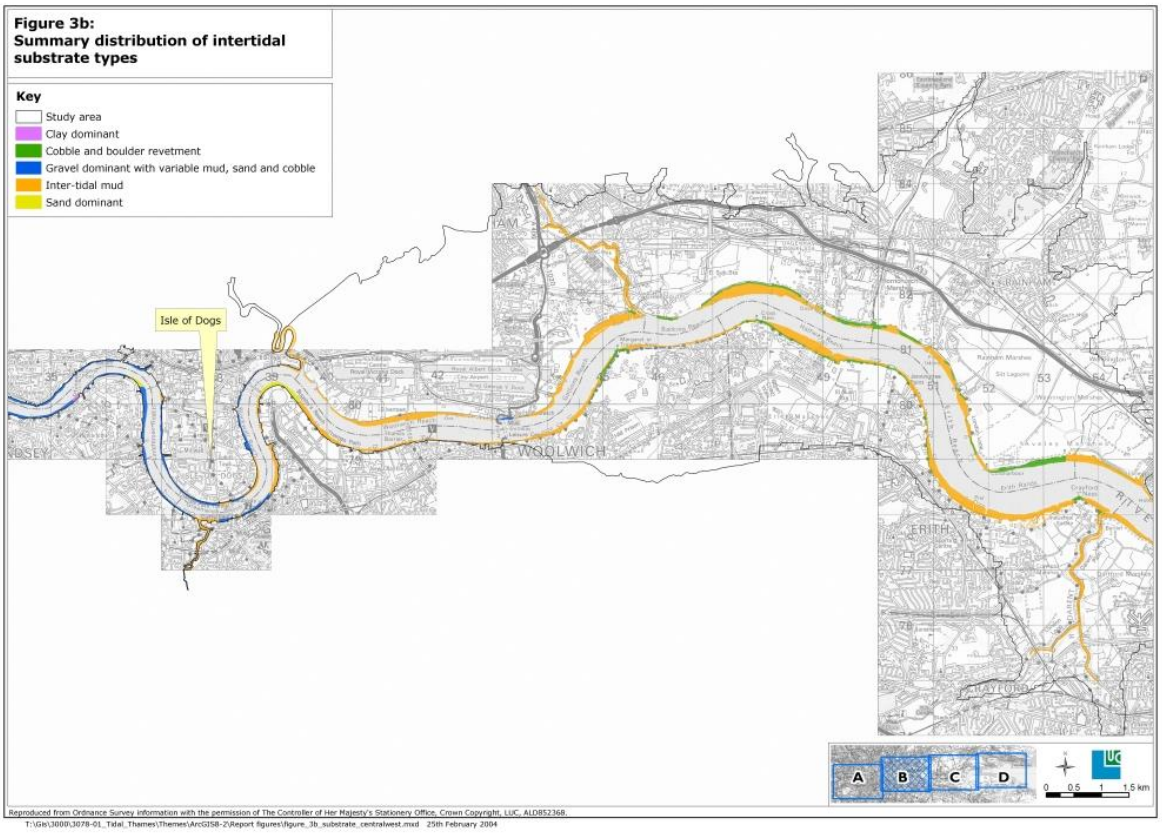


Figure 3b:
Summary distribution of intertidal substrate types
Key
Study area
Clay dominant
Cobble and boulder revetment
Gravel dominant with variable mud, sand and cobble
Inter-tidal mud
Sand dominant
Isle of Dogs
WOOLWICH
ERITH
A
B
C
D
0 0.5 1 1.5 km
Reproduced from Ordnance Survey information with the permission of The Controller of Her Majesty's Stationery Office, Crown Copyright, LUC, ALD852368.

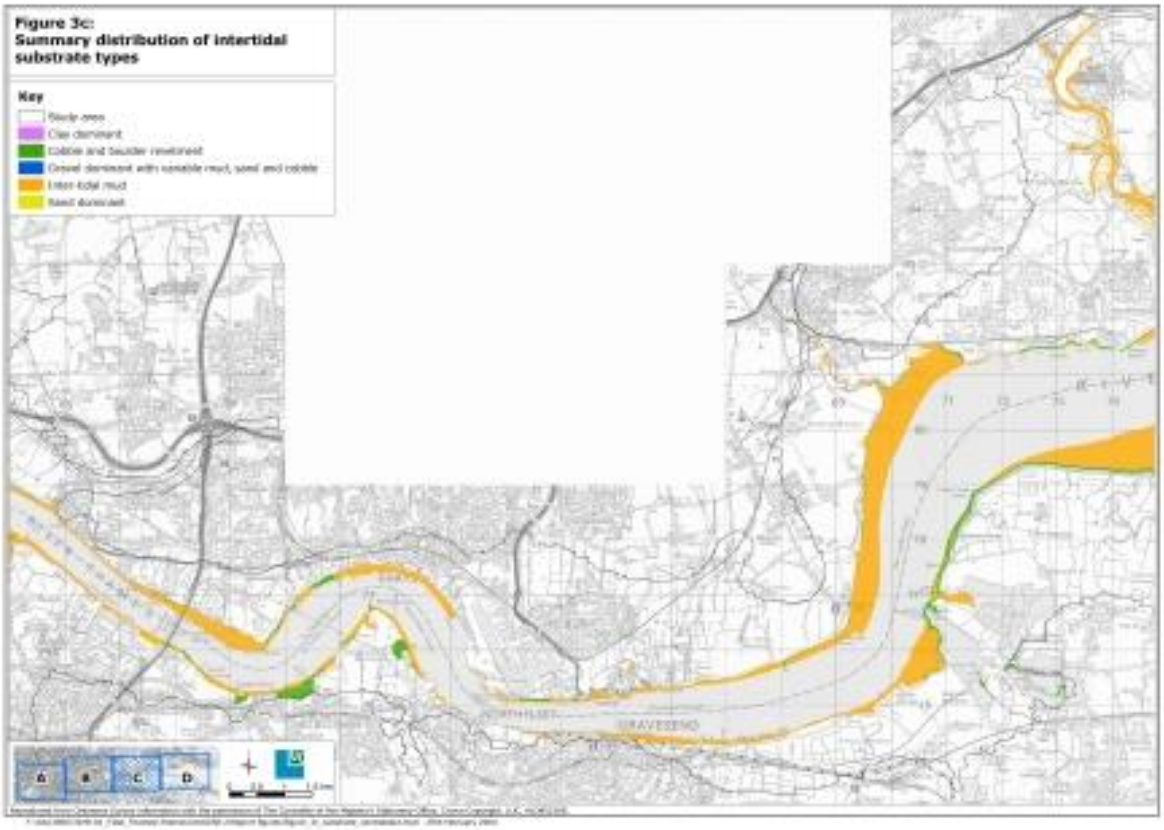


Figure 3c:
Summary distribution of intertidal substrate types
Key

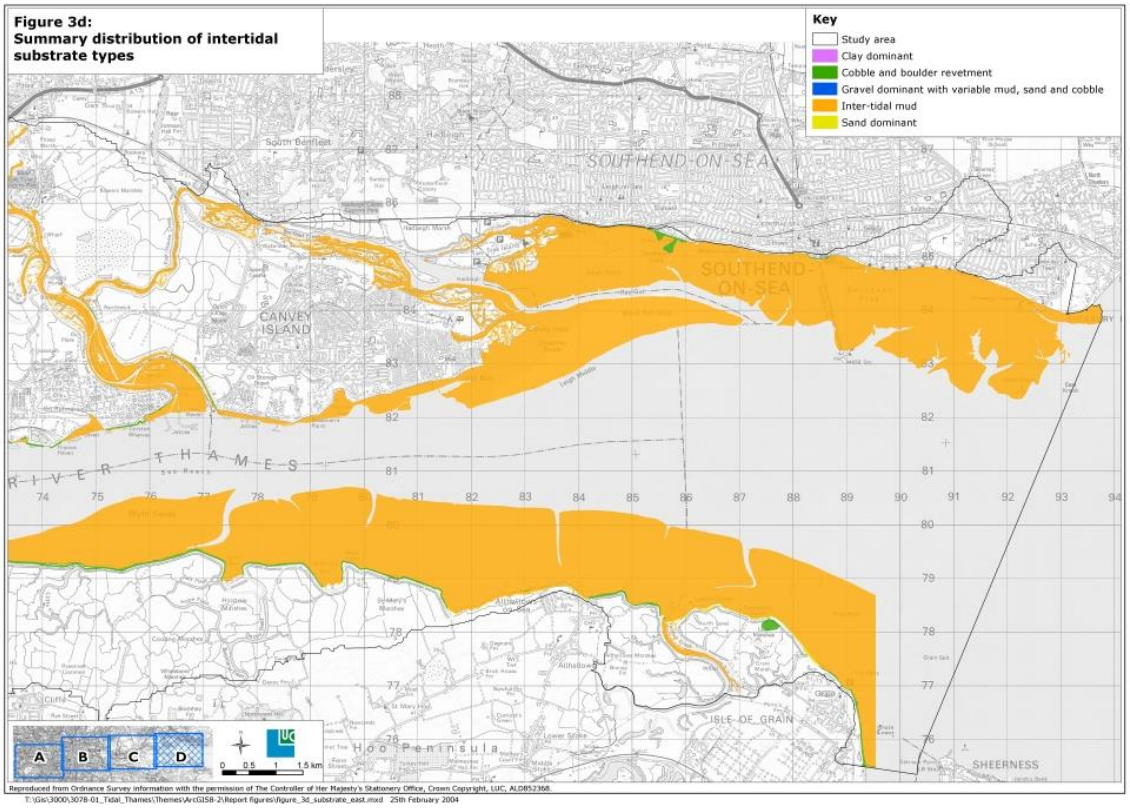


Figure 3: Summary distribution of intertidal substrate types

Gravel Foreshore

A review of available reports and data to help classify and map the foreshore habitat resource of the tidal Thames has been undertaken as part of this study, and has confirmed that substrate data appears to exist only as spot records taken as part of foreshore surveys for other features of interest (e.g. invertebrates and archaeology). These data are very specific to individual sites (often individual core samples) and are unhelpful in establishing broad patterns of substrate type and distribution due to the considerable local variation in substrate that can occur across an individual foreshore location, and variable use of unqualified terms to describe sediments (e.g. shingle, stones, large rocks). It is of note, however, that the general descriptions regarding substrate type and distribution reported elsewhere[2] are entirely consistent with the current survey findings.

Flint gravel is the dominant foreshore substrate from Teddington Lock to Woolwich, but within this zone there is considerable local variation in gravel dominance that reflects prevailing geomorphological processes and anthropogenic factors.

[2] Atrill, M. J. (1998) A Rehabilitated Estuarine Ecosystem. The Environment and Ecology of the Thames Estuary. Kluwer Academic Press.

Sub-littoral Sands and Gravel

Very little background information on sub-littoral substrates of the tidal Thames has been discovered by this study. Several studies that have investigated geomorphological processes in the lower Thames have been completed by HR Wallingford and Marine Ecological Surveys Ltd. on behalf of P&O Ports Ltd. and the Port of London Authority to support a development proposal for a container port (London Gateway Port) near Thames Haven, but they are too narrowly focussed on their scope to provide useful information on broad-scale patterns of sub-littoral substrate type and distribution.

The P&O work does, however, confirm that the sublittoral sediments of the deep-water channels in the lower Thames tend to be characterised by coarser sands and gravels, of a larger particle size than corresponding inter-tidal substrates. This observation also corresponds (albeit on a much smaller scale) with the gradation in sediment particle size frequently observed across individual inter-tidal bed deposits in the upper reaches of the tidal Thames i.e. with finer substrates occurring at the top of the deposit near the riverbank and coarser sediments near low water. This reflects (presumably) the increased erosional forces of the river towards the centre of the channel.

It can be predicted that sublittoral substrates, at least in the upper reaches of the river (Teddington to Woolwich), will be dominated by flint gravel at the larger end of the gravel particle size range with, cobble and boulder sized particles also occurring. Discussions with the Lock Keepers at Teddington and Richmond, who have seen the riverbed almost completely exposed at low tide on occasions during the November draw-off period when fluvial flows are also low, confirm that this is the case.

Very limited information on the distribution of sub-littoral sand and gravel habitat exists for the tidal Thames, but it is considered likely that it occurs along the entire length of the river. The value of sub-littoral gravels as egg-laying habitat for spawning fish and lamprey will be influenced by several factors including gravel particle size, prevailing water salinity, and velocity. It would be valuable to assess, in more detail, the size range and distribution of sub-littoral sands and gravels in relation to fish spawning in the upper reaches of the river to confirm if there are specific spawning locations of importance for specific species e.g. smelt and sea lamprey, or whether suitable spawning habitat areas are more widely distributed.

Islands

Nine mid channel-islands of varying size occur between Teddington Lock and Chiswick Bridge in the upper reaches of the tidal Thames and are probably surviving remnants of the prehistoric river system when the entire length of the tidal of the Thames consisted of a multiple braided channel that flowed through mud and gravel deposits, which often formed small islands known locally as eyots or aits.

These occur downstream from Teddington Lock in the following order:

1. Eel Pie Island – Twickenham (SU165733)
2. Glover's Island - Twickenham (SU178737)

3. Corporation Island - Richmond (SU176746)
4. Flowerpot islands (2 no.) - Richmond (SU175747 & SU174747)
5. Isleworth Ait – Isleworth (SU757167)
6. Lot's Ait - Brentford (SU185777)
7. Brentford Ait – Brentford (SU185777)
8. Oliver's Island – Strand on the Green (SU195776)
9. Chiswick Eyot – Chiswick (SU19779)

Historic photographs[3] indicate that the banks of these islands were once natural and, often supported fringing emergent aquatic vegetation. Today all appear to be artificially strengthened, typically consisting of vertical steel sheet piles.

Mid-channel islands are restricted in their distribution to the upper reaches of the tidal Thames between Teddington and Chiswick. Many are undeveloped, isolated and are dominated by substantial areas of natural vegetation, notably mature trees that provide nesting opportunity for birds (the most noticeable being grey heron), roosting habitat for bats, and ground vegetation and microhabitat conditions that often provide suitable habitat conditions for distinct assemblages of invertebrates that include species restricted their distribution in the UK.

Mudflats

As described previously, the first significant deposits of inter-tidal mud that can be seen at low tide along the foreshore of the river Thames occur at the Isle of Dogs. Here a combination physical factors (flow, channel width, water depth and bed level etc.) are such that suspended solids in the water column settle out of suspension and begin to form extensive mudflats along the river edge.

Typically, mud deposits along the tidal Thames consist of fine particles of silt, sand and other organic matter, however specific data on their material composition and particle size distribution is not readily available, except as individual spot records for specific locations undertaken as part of previous unrelated surveys. It would appear, however, that there is considerable variation in the sand content within individual mudflats, to the extent that number of the more extensive inter-tidal areas in the lower marine reaches below Gravesend would be better described as sand flats. This is reflected by the term sand in many of the larger inter tidal areas off Kent (Blyth Sands) and Essex (Chapman Sands, Leigh Sand, Marsh End Sand).

Discrete deposits of mud occur along the foreshore and adjoining creeks of the tidal river Thames, but the most extensive inter-tidal mudflats first occur around the Isle of Dogs. Mudflats typically support distinct assemblages of aquatic invertebrates characterised by species that burrow beneath the mud surface notably annelid worms and molluscs. Invertebrate species composition and relative abundance varies along the river in relation

[3] Croad S. (2003) Liquid History – The Thames Through Time. English Heritage & B T Batsford

to prevailing river water salinity, and (to a lesser extent) substrate particle size, and its chemical constituency. East of the Thames Barrier, the foreshore mudflats become increasingly important as feeding habitat for wading birds and waterfowl species particularly during the winter months. Below Gravesend, in the marine reaches of the river, the mud and sandflats also support cockle beds that are harvested commercially and are reported to be the most productive beds in UK coastal waters.

Natural Riverbank

Natural riverbank is a scarce feature along the tidal Thames, as virtually the entire length of both riverbanks has been replaced and/or strengthened by walls or piling or, have been affected by earth embankments built to contain the river and protect surrounding land from tidal and fluvial flooding. The river Thames was originally completely unaffected by riverbank strengthening and was uncrossed by bridges. In Bronze Age times (c2300-700 BC), the river is thought to have consisted of a braided multi-channelled system. Since this period in history, development alongside the river (mainly since the Roman occupation (43AD - c410)) has resulted in the river becoming progressively engineered into a single channel contained behind artificially strengthened and raised banks constructed to stop erosion and out of bank tidal and fluvial flooding.

There are thought to be only three locations in the upper reaches of the river where natural clay riverbank has been unaffected by historic engineering. These are principally (as recorded by the current survey) a short section (<20m long) along the south bank downstream of Teddington Lock, and a more significant length (circa 1000m) on the north bank of the river at Syon Park. A short section is also reported to occur at Duke's Hollow by Barnes Bridge (north bank) but this was overlooked by the current assessment.

The Syon Park riverbank consists of numerous naturally eroded clay drainage channels that conduct river floodwater to and from an adjoining SSSI flood meadow in front of Syon House. The channels themselves are overgrown with mature riparian trees, and the exposed clay riverbanks are riddled with what, appears from a distance, to be the burrow holes of Chinese mitten crabs.

Natural riverbank is a scarce habitat feature along the tidal Thames, with the largest single stretch occurring between Isleworth and Brentford on the north shore of the river in front of Syon House. The specific habitat conditions, associated with the riverbank top (shaded, muddy ground with flood debris) provide ideal habitat for a specialist wetland mollusc species with high individual nature conservation value. This species, the German hairy snail *Perforatella rubiginosa*, is known from only a limited number of riparian habitats along the upper reaches of the Thames in the UK.

Tidal Creeks

Tidal creeks are the downstream open channel reaches of tributary rivers that have unrestricted hydrological connectivity with the tidal river Thames such that they are directly influenced, at least in their downstream reaches, by the regular tidal cycle of the Thames.

Not all tributary rivers that flow into the Thames possess the above features, and many are completely covered/culverted[4], and/or have impeded hydrological connectivity to the river because of permanent sluice gates or tidal barriers. Tributary rivers that are restricted by permanent sluice structures include, for example, the river Ingrebourne and Mar Dyke along the north bank of the Thames near Rainham and Purfleet respectively. While Barking Creek (the confluence of the river Roding), and the River Darent have flood defence barriers constructed at their confluences which are operational at certain times of the year and states of tide.

Rivers that historically had open channel confluences with the Thames, particularly within the City of London area, and now have been completely enclosed and flow underground, possess limited ecological value by virtue of being devoid of natural light.

The most significant tidal creek systems in terms of their relative ecological value are associated mainly with the lower reaches of the Thames downstream of the City of London, and include:

- Deptford Creek (south bank of the Thames – confluence of the river Ravensbourne
- Bow Creek - River Lee (north bank at Canning Town)
- Barking Creek – River Roding (north bank at Barking)
- Cliffe Creek (south bank at Cliffe)
- Mucking Creek (north bank at Mucking)
- Holehaven Creek (north bank west of Canvey Island)
- Benfleet Creek (incorporating Oyster Creek & Smallgains Creek) (north bank east of Canvey Island)

In terms of understanding the ecological value of individual tidal creeks, only one system (Deptford Creek) appears to have been studied in any detail[5]. The Deptford Creek study was comprehensive and collated baseline data on a range of plant and animal taxa, including the lower and higher plant flora (largely confined to plants growing on the creek walls), aquatic invertebrates (micro and macro fauna), terrestrial invertebrates (on the creek walls), fish, birds, and mammals.

In general terms, the survey findings confirmed that Deptford Creek supports a diverse but generally unremarkable animal and plant fauna in terms of species with high individual nature conservation value and were influenced strongly by the highly urban nature of the surrounding landscape. There were exceptions to this, however, notably the presence of three animal species dependent upon habitats intimately associated with the Creek, namely two species of invertebrates that have restricted distributions in the UK, the Adonis ladybird *Adonis variegata*, a weevil *Kalcapion semivittatum*, and the black redstart (a nationally rare bird species whose national population is less than 100 pairs).

In general terms, however, the most ecologically valuable tidal creeks associated with the tidal Thames, are those that are located outside the urban conurbation of London, and which

[4] Barton, N. J. (1962) *The Lost Rivers of London*. Historical Publications, London.
[5] Steele, J. (1999) *Deptford Creek – Surviving Regeneration*. Deptford Forum Publishing

possess extensive mosaics of inter-tidal mud and saltmarsh habitat, namely Cliffe Creek, Mucking Creek, Holehaven Creek and Benfleet Creek, in the more marine environments of the lower reaches of the river. This combination of habitat, coupled with their generally isolated and undisturbed (by human activity) nature provides locally valuable feeding, roosting, and breeding habitat for a variety of wading bird and waterfowl species. Tidal creeks are also likely to be of high local importance as sheltered refuge habitat for developing fish fry, and will probably be used by a wide variety of marine and euryhaline fish species (e.g. bass, flounder, shad and smelt). The fishery function and productivity of tidal creek systems is currently the subject of investigation by the Environment Agency (pers comm. Steve Colclough).

Tidal creeks are the downstream sections of tributary rivers that are directly influenced by the daily tidal cycle of the river Thames. The most ecologically valuable creeks, are likely to be those with open channels associated with the lower reaches of the river that are undisturbed by human activity, possess mosaics of inter-tidal mud and saltmarsh habitat, and have completely unimpeded hydrological links to the river. Although the ecological functioning of these specific systems has not been extensively researched to date, they are considered to provide particularly important habitat for feeding and roosting wading birds and waterfowl, and also productive refuge and feeding areas for developing fish fry.

Riverine and floodplain semi-natural habitats

Reedbed and Saltmarsh

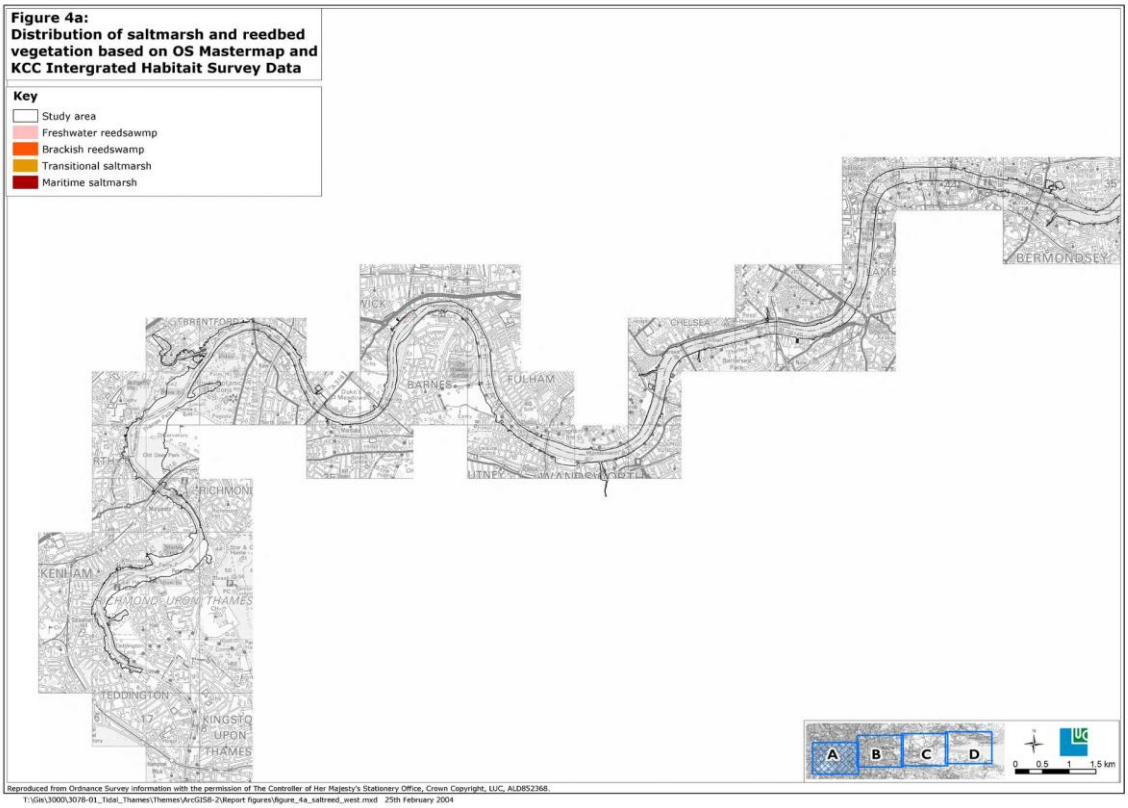
Background

A comprehensive desk exercise has been undertaken together with targeted, but limited, fieldwork to synthesise existing knowledge on the aquatic and wetland plant communities intimately associated with the tidal river Thames. The main focus has been on the flora of the river foreshore, banks and embankments, recognising that plants that are characteristic of saltmarsh habitat are frequently found in association with reedswamp vegetation in more brackish conditions upstream of the lower marine reaches of the Thames estuary.

Data that has been reviewed for this study includes botanical information and habitat survey reports supplied by the Environment Agency (principally River Corridor Survey reports for the Thames, English Nature (scarce plant survey reports), and the Lee Valley Regional Park Authority (botanical survey report); London Ecology Unit Handbooks; Natural History Society and Field Club Transactions; and botanical records provided by Rodney Burton, the BSBI vice-county recorder for Middlesex.

In light of the limited availability of aerial photographs covering the entire study area (in particular most of Essex), and a complete lack of any comprehensive vegetation mapping data that accurately covers river edge vegetation along the tidal Thames, OS MasterMap data[6] combined with Kent County Council Integrated Habitat Survey data (which we have reclassified) has been used to show the approximate distribution of reedbed and saltmarsh

vegetation within the study area (Figure 4). Both OS and KCC data sets are acknowledged to have limitations in terms of their accuracy and extent of coverage with respect to river edge vegetation, and the true extent of both these habitats within the study area can only be elucidated by undertaking field assessment combined with, where practicable, up to date aerial photographic analysis.



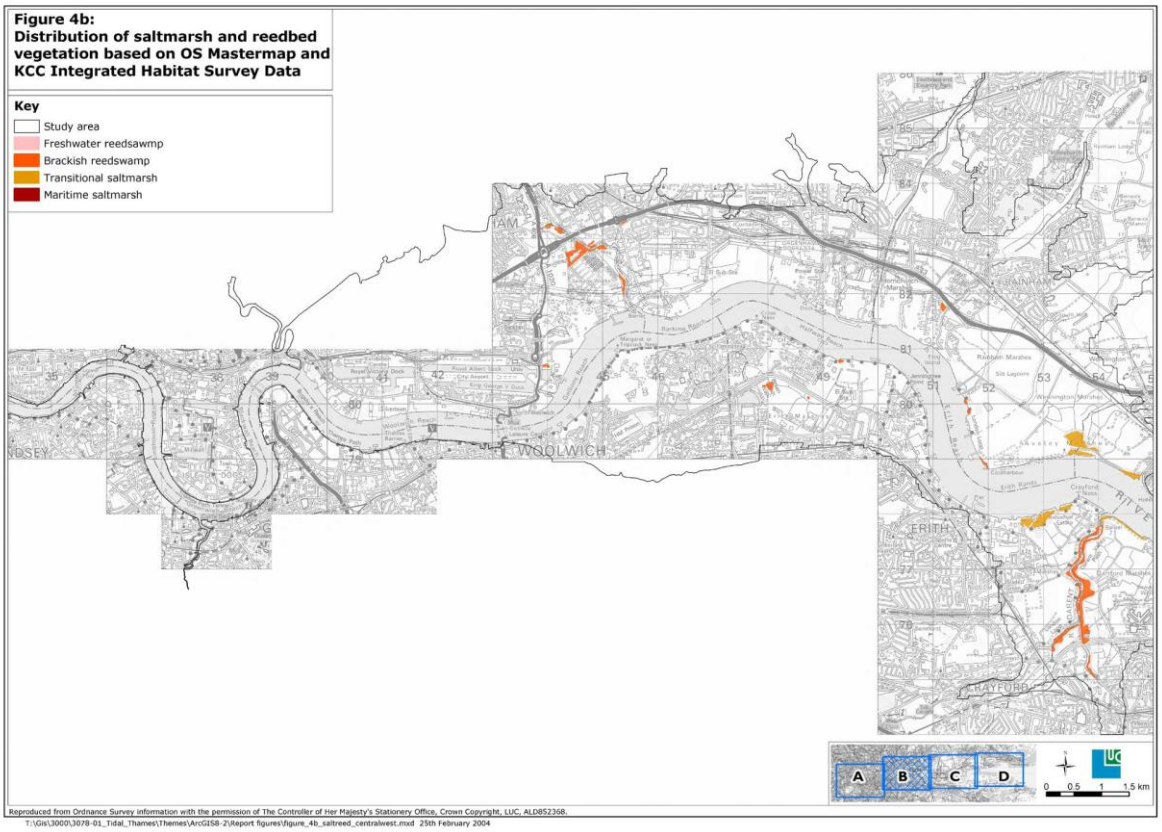


Figure 4b:
Distribution of saltmarsh and reedbed vegetation based on OS Mastermap and KCC Integrated Habitat Survey Data
Key
Study area
Freshwater reedsawmp
Brackish reedswamp
Transitional saltmarsh
Maritime saltmarsh
WOOLWICH
ERITH
CRAYFORD
A
B
C
D
0 0.5 1 1.5 km
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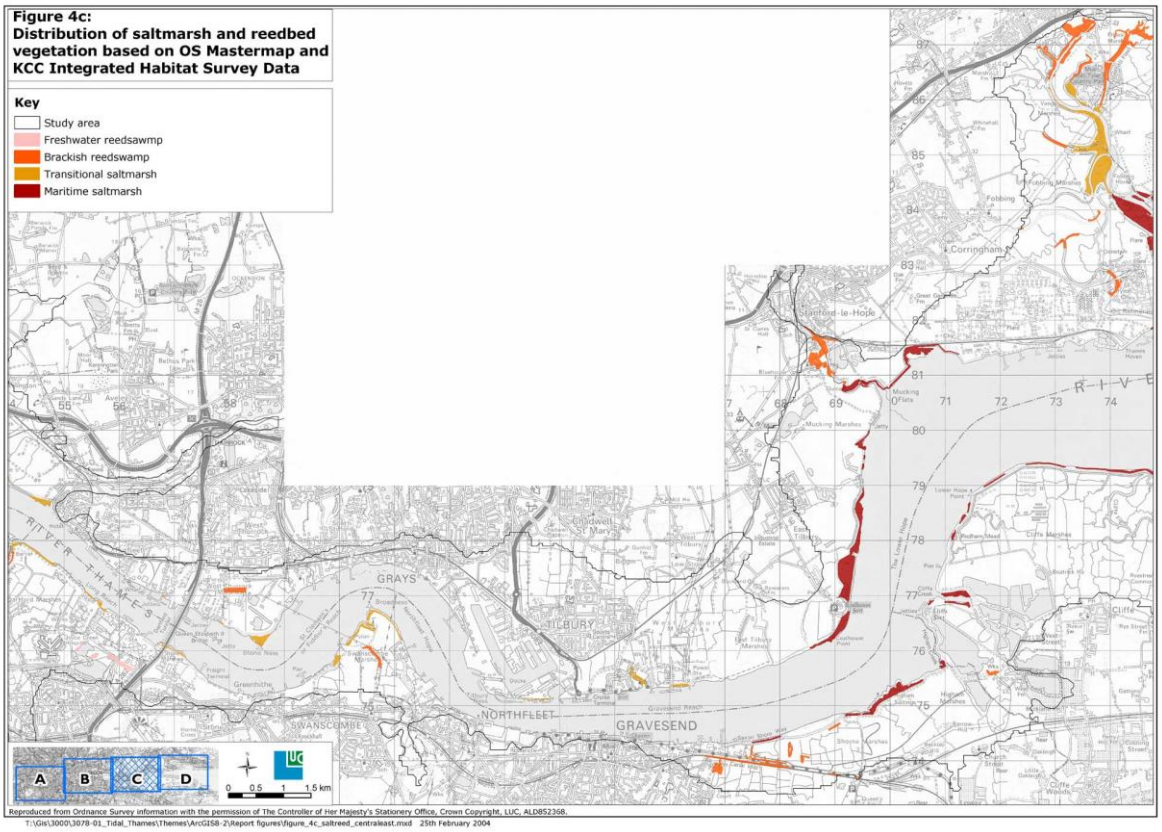
Figure 4c:
Distribution of saltmarsh and reedbed vegetation based on OS Mastermap and KCC Integrated Habitat Survey Data
Key
Study area
Freshwater reedsawmp
Brackish reedswamp
Transitional saltmarsh
Maritime saltmarsh
Corringham
Stanford-le-Hope
Mucking Marshes
GRAYS
TILBURY
NORTHFLEET
GRAVESEND
SWANSCOMBE
RIVER THAMES
A
B
C
D
0 0.5 1 1.5 km
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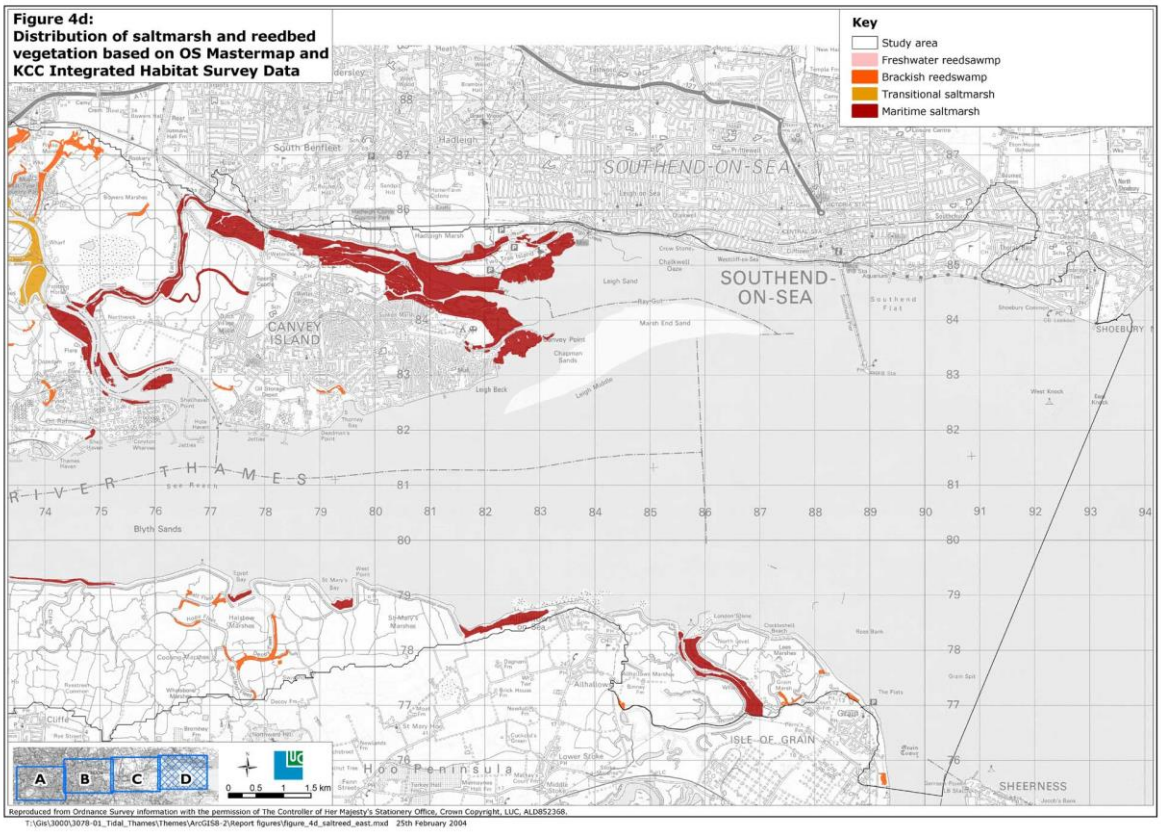


Figure 4: Distribution of saltmarsh and reedbed vegetation based on OS Mastermap and KCC Integrated Habitat Survey Data

Significant stands of reedbed and reedswamp vegetation occur within the study area as narrow fringes growing on riverbanks and/or beyond the river edge and have been under-recorded by this study. For example, reed occurs on low-lying former floodplain land now reclaimed as grazing marsh e.g. Swanscombe Marshes, and along tributary rivers such as the River Ingrebourne. Reed and associated saltmarsh species also be found growing in grazing marsh drainage ditches throughout the study area, and in and around other man-made wetland habitats such as pulverised fuel ash lagoons.

Distribution of Reed and Saltmarsh

The tidal Thames supports a diverse mix of inter-connected wetland habitats that vary in relation to physical, chemical, and biological factors as well as human development. In general, extensive areas of naturally occurring semi-natural riverine wetland habitat are restricted to the lower estuarine reaches below Woolwich, and are characterised by wide inter-tidal mudflats, with fringing areas of reedswamp and saltmarsh type vegetation that typically occurs in front of raised earth embankment flood defence structures or along tidal creeks. Upstream of Woolwich (through London to Teddington) fringing wetland plant communities are either non-existent, or occur in only small, isolated patches where habitat conditions enable opportunistic colonisation, or, more commonly, as linear strips growing on reinforced sloping riverbank.

Reed and Saltmarsh Zonation

The desk study together with select fieldwork has confirmed that four distinct zones of broadly similar vegetation character occur along the river from Teddington to the North Sea. We have described these zones based on the vegetation character as follows: freshwater reedswamp (Zone 1); brackish reedswamp (Zone 2); transitional saltmarsh (Zone 3); and maritime saltmarsh (Zone 4).

Distribution data for key saltmarsh and brackish water plant species known to occur along the Thames have been used to help define the boundaries of these zones. Upstream limit data for select halophytes is summarised in

Table ***4*** and shown on Figure 5.

Species	**Distribution along the Tidal Thames**
Sea Aster ***Aster tripolium***	Very common in a range of habitats, found upstream to Greenwich, with occasional plants found upstream e.g. at Barnes.
Grass leaved orache ***Atriplex littoralis***	Scattered along the tidal Thames, largely up to Swanscombe Marshes, occasionally found upstream e.g. Tripcock Ness (1983), and East India Dock Basin (2001).
Sea purslane ***Atriplex portulacoides***	Common plant associated with saltmarsh in the lower estuary, found upstream to Swanscombe Marshes.
Sea club-rush ***Bolboschoenus maritimus***	Common in brackish ditches and on the river foreshore. It is thought to occur naturally up to Kew.
Danish scurvy-grass ***Cochlearia anglica***	Frequent on muddy shores near high tide mark, found upstream to East India Dock Basin.
Sea milkwort ***Glaux maritime***	Scattered along the tidal Thames, recently found upstream to the East India dock basin.
Sea rush ***Juncus maritimus***	Occasional in saltmarshes of the lower estuary, recorded upstream to Swanscombe Marshes.
Sea lavender ***Limonium vulgare***	Uncommon in saltmarshes in the lower estuary, with only a single record from the London area at Swanscombe Marshes.
Sea plantain ***Plantago maritima***	Frequent in saltmarshes and tidal foreshore, found upstream to north Greenwich.
Reflexed saltmarsh-grass ***Puccinellia distans***	Frequent along ditches and creeks, and occasionally on saltmarsh, found on the river wall at Belvedere in 1997 (its furthest upstream location). Also, commonly naturalised by roads that are regularly salted in winter.
Borrer's saltmarsh-grass ***Puccinellia fasciculata***	Rather irregular occurrence along the tideway, generally in wet habitats with brackish ground water such as the edge of reedswamps at the foot of the river wall.
Common saltmarsh-grass	

Species	Distribution along the Tidal Thames
P. maritime	Frequent in saltmarshes along the tidal Thames. Found near Crayford Ness in 1980, but now no longer found above the Dartford River crossing
Common glasswort ***Salicornia europaea***	Infrequent in saltmarshes, found upstream to Ripple Level in 1991
Purple glasswort ***S. ramosissima***	Rare in slightly brackish ditches. A patch at Duke's Hollow, showing genetic traces of *S. triqueter*, also established in the East India Dock Basin in small quantities.
Grey club-rush ***Schoenoplectus tabernaemontani***	A national rarity, once widespread by the subtidal unembanked Thames, last recorded off Kew in 1940
Triangular club-rush ***S. triqueter***	Frequent along the tidal Thames, upstream to the East India Dock basin.
Lesser sea-spurrey ***Spergularia marina***	Frequent along the tidal Thames, upstream to Crossness STW. Also recorded from the East India Dock Basin.
Greater sea-spurrey ***S. media***	Frequent in saltmarshes along the tidal Thames, upstream to Swanscombe Marshes.
Annual sea-blite ***Suaeda maritima***	Frequent in saltmarshes along the tidal Thames, found upstream to North Greenwich and Silvertown
Sea arrow-grass ***Triglochin maritimum***	

Table 4: Saltmarsh and brackish water plant species distribution in the tidal Thames

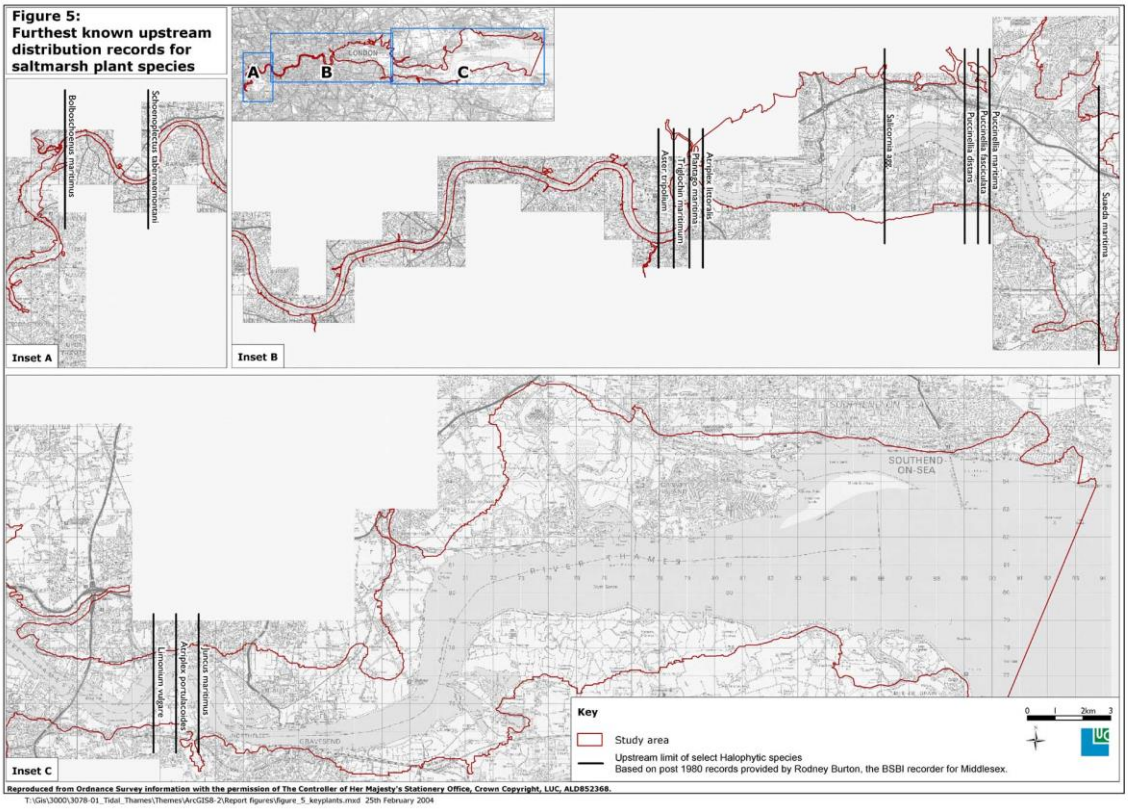


Figure 5: Furthest known upstream distribution records for saltmarsh plant species

A similar zonation pattern of vegetation appears to exist up tidal creeks associated with the Thames, but initial observation suggests that the transitions between zones 1 to 4 are more condensed, and that, in general, stands of littoral and sub-littoral vegetation tend to be more abundant than those found along the main river.

Zone 1 ("Freshwater" reed swamp): Teddington to Greenwich

The "freshwater" reed swamp Zone occurs between Teddington and Greenwich and is characterised by the occurrence of freshwater plant species that typically take opportunistic advantage of cracks in river walls, and damp riverbank tops, where in the height of summer colourful displays of vegetation covered river walls and bank tops can be observed particularly within the borough of Richmond upon Thames.

Characteristic wetland plants that can be found growing opportunistically on river walls, bank tops or on the inter-tidal foreshore, include Gipsy-wort *Lycopus europaeus*, hemlock-water dropwort *Oenanthe crocata*, marsh ragwort *Senecio aquaticus*, purple loosestrife *Lythrum salicaria*, yellow flag *Iris pseudacorus*, Himlayan balsam, *Impatiens glandulifera*, lesser pond sedge *Carex acutiformis*, amphibious bistort *Polygonum amphibiuim*, water mint, *Mentha aquatica*, mugwort *Artemisia vulgaris*, marsh yellow-cress *Rorippa palustris*, great hairy willow herb *Epilobium hirsutum*, reed-grass *Phalaris arundinacea*, wild angelica *Angelica sylvestris*, and pink water speedwell *Veronica catenata*.

Common reed *Phragmites australis* dominated wetland habitat or reedbed/reedswamp appears to be restricted within Zone 1 to a narrow fringe along the natural riverbank at Syon Park where shading by surrounding riparian trees does not limit reed growth. Similar conditions exist at Chiswick Eyot where two distinct stands of common reed also occur.

It has not been possible to map the distribution of this fringing plant community type within the scope of this study.

Zone 2 (Brackish reed swamp): Greenwich to Erith

The presence of vertical river walls of varying design, form, age, and condition severely limit opportunity for littoral and sub-littoral vegetation colonisation, and many river walls and inter-tidal foreshore in this zone are completely devoid of higher plant growth. The exceptions occur where crevices or ledges on river walls in poor states of repair, or on sloping rip-rap type embankment occur. Plant assemblages are typically made-up species that can tolerate brackish water conditions e.g. *Oenanthe crocata*, and *Rumex conglomerata* alongside more salt tolerant species such as *Beta vulgaris*, *Aster tripolium* and *Apium graveolens*.

In contrast to Zone 1, where physical conditions are not limiting, a reedswamp type vegetation will develop and is frequently dominated by either *Bolboschoenus maritimus* (which is locally replaced by *Schhoenoplectus tabernaemontani*) or common reed *Phragmites australis*. Extensive areas of this brackish reed swamp dominated by common reed can be found growing on the inter-tidal muds of Barking Creek.

B. maritimus is a characteristic plant of brackish water conditions, and its presence reflects the higher prevailing water salinity along this section of the river. *B. maritimus* and *Phragmites australis* rarely occur in mixed assemblages, but generally form single species stands. According to the NVC, these two rather distinct plant communities are best described as S21 *Bolboschoenus maritimus* swamp, and S4 *Phragmites australis* swamp.

Zone 3 (Transitional saltmarsh): Erith to Gravesend

This zone marks a sea change in riverbank flood defence type with vertical sheet piling and sloped rip-rap embankments being replaced by earthen sea walls, which are often set back from the river channel behind relatively extensive areas of semi-natural riverine vegetation. These areas are dominated typically by *Bolboschoenus maritimus* and *Phragmites australis*, with *Aster tripolium* prominent along the edges, and more frequent saltmarsh associates such as *Triglochin maritima*, *Spergularia media*, *Plantago maritima*, *Salicornia europaeus* and *Suaeda maritime*.

Using the NVC to describe these transitional saltmarsh communities is problematic without additional vegetation survey. However, the component communities of what is essentially a transitional stand type are drawn from the following: S4 *Phragmites australis* swamp and reed beds, S21 *Scirpus maritmus* swamp and SM11/12 *Aster tripolium* salt-marsh community which occurs prominently as a fringing band among often heterogeneous stands of the S4 and S21.

Local variation within this broad assemblage of vegetation was observed near Swanscombe, where *Spartina anglica* (SM6 *Spartina anglica* saltmarsh) occurs in areas of slack water, together with fragmented stands of lower and middle saltmarsh plant species.

Although a clear definition of transitional saltmarsh is problematic, the field survey undertaken as part of this study indicates that the vegetation in this zone is clearly distinct from both the upstream brackish reedswamp and adjoining maritime saltmarsh zones. The clear difference is that, although many characteristic saltmarsh plants are found, they typically occur only in fragmented ('untidy') associations.

Zone 4 (Maritime saltmarsh): Gravesend to Shoebury Ness

This zone corresponds with the prevailing maritime conditions of the lower reaches of the Thames estuary, and is characterised by extensive mud and sandflats, together with adjoining areas of saltmarsh vegetation in front of raised earth flood embankments along the river edge. Several nationally important sites for nature conservation fall within this zone, including Benfleet and Southend Marshes SSSI and South Thames Estuary and Marshes SSSI that together form extensive areas of saltmarsh, mudflat, and grazing marsh. These sites are designated primarily for their ornithological importance; however, saltmarsh vegetation is also described in the respective SSSI citations and includes reference to nationally scarce plant species including *Inula crithnoides*, *Puccinellia fasciculata* and *Spartina maritime*.

The relatively extensive areas of maritime saltmarsh habitat within this zone reflect several factors:

- Highly maritime environment influenced by the North Sea;
- Large areas of undefended shoreline which provide suitable conditions for saltmarsh development;
- Availability of suitable sheltered sites, e.g. around headlands;
- Increased deposition of sediment.

Saltmarsh vegetation within this zone frequently exists in relatively extensive intact stands, and typically displays vegetation zonation across an individual marsh with plant species characteristic of lower, middle, and upper saltmarsh communities occurring.

A typical Thames saltmarsh features a lower marsh of pioneer vegetation comprised of *Spartina anglica* or *Salicornia* agg occupying exposed muds. These species help stabilize the substrate and further slows tidal flow allowing increased sediment to be deposited, and gradually causes the marsh to rise above the mean high-water level. *Spartina anglica* is better able to establish itself in more exposed situations than *Salicornia* as it possesses more robust underground runners (rhizomes), compared to *Salicornia* agg. that requires a 3-day period free from immersion to allow roots to take hold. These stand types are best described by the NVC as SM6 *Spartina anglica* saltmarsh, and SM8 Annual *Salicornia* saltmarsh.

The development of a stable substrate raised above all, but the highest tides enable a different suite of plants to become established. This is usually characterised by the development of middle marsh community, including *Puccinellia maritima* (SM13) and *Atriplex portaculoides* (SM14), together with a range of associates including, for example, *Plantago maritima*, *Suaeda maritima*, *Armeria maritima*, *Limonium* spp. and *Triglochin maritima*. In south-east England, including the Thames estuary, these two communities form the bulk of saltmarsh vegetation and often span the entire length of the marsh.

In some circumstances there are transitional zones between the typical lower and middle communities involving *Suaeda maritima* (SM9) or *Aster tripolium* (SM11).

The absence of upper marsh vegetation is a regular feature of many of the Thames estuary saltmarsh habitats within Zone 4. It is unclear whether this is a natural phenomenon or is associated with a lack of suitable space for landward migration. However, where sufficient space is available, an upper saltmarsh community along the Thames is typically characterised by a high abundance of the following saltmarsh specialist plant species *Juncus gerardii*, *Juncus maritmus*, *Glaux maritima* and *Artemisia maritima,* along with a range of more wide-ranging species, for example *Agrostis stolonifera, Festuca rubra, Atriplex prostrata* and *Leontodon aumtumnalis*. In addition, and of regional importance, is the frequent presence of the nationally scarce species *Inula crithmoides* and *Suaeda vera*, that typically grow at the top of the marsh along the drift-line. Upper marsh vegetation is recognized by the NVC as: SM16 *Juncus gerardii*, SM17 *Artemesia martimus*, SM18 *Juncus maritmus*, SM21 *Suaeda vera* and SM26 *Inula crithmoides* saltmarsh communities.

In the absence of upper saltmarsh vegetation, the marsh usually terminates with *Elytrigia atherica* dominated vegetation (SM24), which is often present as a narrow strip along the riverward side of the embankment or seawall.

The evaluation of existing survey data, together with targeted fieldwork has provided a sound basis to develop a broad ecological overview of the characteristic plant communities found within each zone. However, it is important to note that the demarcation of these boundaries is only based on limited field survey, and further fieldwork during the growing season would be necessary to firmly establish the location and fully describe the character and variation of the characteristic plant communities.

Habitat Distribution

Habitat Distribution within the Tidal Thames Study Area

The high entomological importance of Thames terrace grassland sites is thought to be a result of a unique regional combination of climatic, geographic, and ecological conditions which enable an unusual assemblage of invertebrate species, including those that are characteristic of heath, coastal sand dunes, and chalk grassland habitats to thrive (Harvey, 2000a).

The majority of known Thames terrace grassland and equivalent brownfield sites occur in South Essex, and to a lesser extent in North Kent and greater London. The current distribution of important unimproved Thames Terrace grassland and comparable brownfield sites known to Peter Harvey is shown on Figure 6. It is of note that select areas in north Kent, particularly several sand and chalk pits around Swanscombe, and the silt lagoons at Cliffe are under-recorded and are considered likely to possess invertebrate value by Harvey.

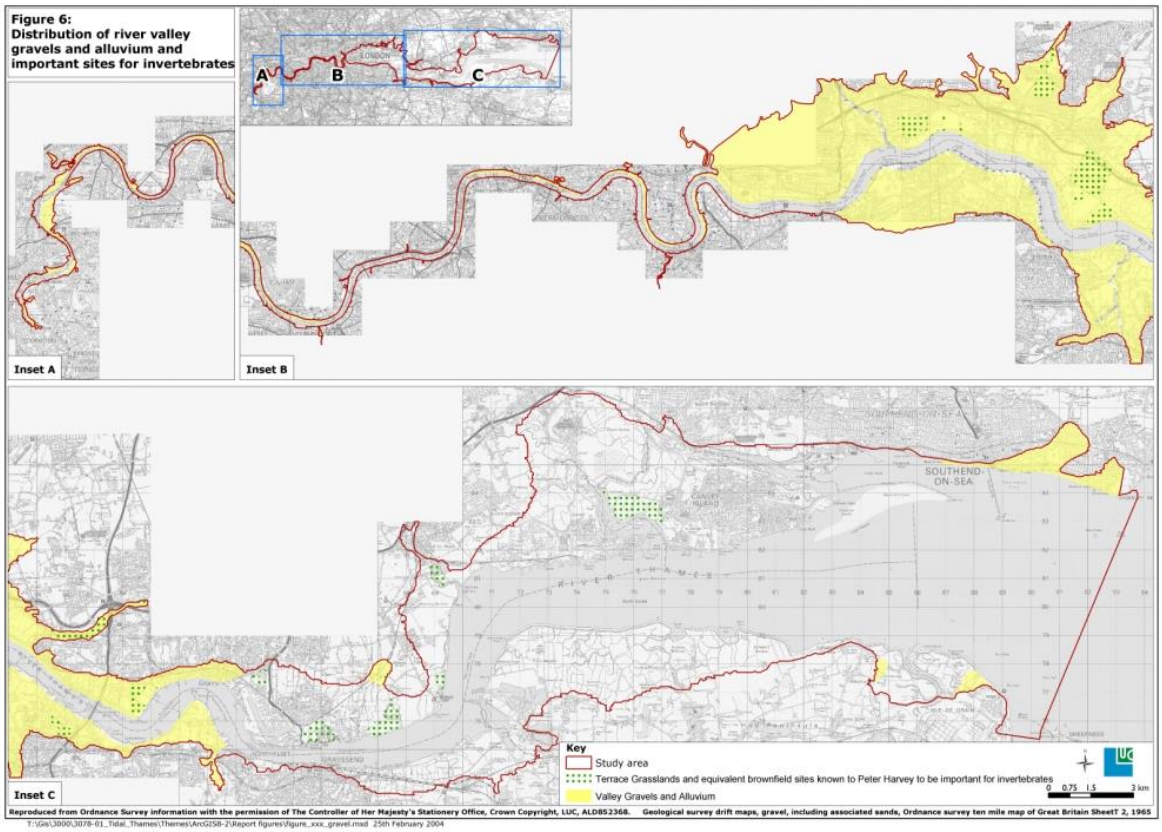


Figure 6: Distribution of river valley gravels and alluvium and important sites for invertebrates

Semi-natural Thames Terrace Grasslands

Ancient unimproved Thames terrace grasslands are those that have formed by natural colonisation processes on terrace gravels and represent the most ecologically important sites within the study area by virtue of their naturalness. Such sites are very restricted in their distribution, with many sites having been lost to development. Notable remaining examples currently known to Peter Harvey occur at West Tilbury (Broom Hill and Hall Hill), the western side of Mucking Heath (Orsett Golf Course), and a small area at Aveley.

Brownfield Sites

Important examples of brownfield land of equivalent high invertebrate conservation interest to Thames terrace grasslands within the study area, can be found in association with sand and gravel extraction sites (particularly those with exposures of terrace sands and gravels), Pulverized Fly Ash (PFA) and silt lagoons, and derelict post-industrial land in general.

One of the most notable brownfield sites in the study area occurs at Northwick Road on Canvey Island, and is known to support 32 Red Data Book invertebrate species, including four species

that occur nowhere else in the UK. Key species include the Canvey Island ground beetle *Scybalicus oblongiusculus*, and the Morley weevil *Sitona cinerascens*, as well as the most important remaining population of the shrill carder-bee *Bombus sylvarum* in the Thames region and perhaps the UK.

Key Invertebrate Species

Three aculeate Hymenoptera species are identified as being flagship species in the Tidal Thames HAP.

A provisional list of invertebrate species which are indicators of Thames terrace grassland habitat has been developed by Harvey (2004 unpublished draft) and is shown below in

Table ***5***.

Aculeate Hymenoptera (bees, wasps, and ants)	**Coleoptera (beetles)**
Andrena florae	*Mordellistena* spp.
Andrena fulvago	
Andrena spectabilis	**Diptera (flies)**
Andrena tibialis	*Dorycera graminum*
Andrena trimmerana	*Dysmachus trigonus*
Astata pinguis	*Epitriptus cingulatus*
Bombus humilis	*Gymnosoma nitens*
Ceratina cyanea	*Thecophora atra*
Cerceris quinquefasciata	*Thereva bipunctata*
Coelioxys vectis	*Thereva plebeian*
Dasypoda altercator	
Gorytes tumidus	**Hemiptera (bugs and hoppers)**
Hedychridium niemelai	*Asiraca clavicornis*
Hoplitis spp.	*Sciocoris cursitans*
Hylaeus cornutus	
Hylaeus signatus	**Araneae (spiders)**
Lasioglossum pauperatum	*Bianor aurocinctus*
Lasioglossum pauxillum	*Euophrys aequipes*
Lasioglossum xanthopum	*Xysticus kochi*
Megachile leachella	*Zodarion italicum*
Nomada flavopicta	
Nomada fulvicornis	
Passaloecus clypealis	
Psen unicolor	
Smicromyrme rufipes	
Sphecodes longulus	
Sphecodes rubicundus	
Tiphia femorata	

Table 5: Thames terrace grassland/brownfield site indicator species

Six invertebrate species have been identified by Peter Harvey as being particularly characteristic of Thames terrace grasslands and their brownfield equivalent sites. These are the hornet robberfly *Asilus crabroniformis*, shrill carder bee *Bombus sylvarum*, solitary wasp *Cerceris fasciata*, brown carder bumblebee *Bombus humilis*, and two species of fly, namely *Dorycera graminum* and *Gymnosoma nitens* and are described in more detail in subsequent sections.

Semi-natural grasslands of the Thames terrace sands and gravels comprise remnant areas of unimproved grassland formed on terrace gravels within the eastern corridor of the tidal Thames study area. These grasslands are typically flowering herb species rich, and where they occur near a range of other habitat features (notably, extensive areas of bare ground and scrub), frequently support assemblages of specialist terrestrial invertebrate species that thrive in the continental weather conditions of the region and possess very high individual nature conservation value by virtue of being restricted to only a handful of sites in the UK. Similar man-made (brownfield) habitat conditions typically associated with derelict industrial land areas, and past quarrying activity can also support similar assemblages of invertebrates within the region.

Artificial Habitat

Artificial Structures and Built Areas

The Thames HAP has identified artificial structures and built areas adjacent to the Thames channel as being of importance with respect to providing roosting, and in some cases nesting habitat for birds. Of particular importance are a series of redundant barges that have been deliberately left in the river channel along the foreshore near Rainham and provide locally important roosting areas for wintering wading birds such as dunlin. Other artificial structures along the riverside of habitat importance include pontoons and jetties, such as, for example, the derelict floating pontoon Convoy's Wharf on the south bank of the river in Lewisham, which is known to provide foraging, and potential nesting habitat for black redstart.

Very little information on the ecological value of individual structures within and immediately adjacent to the river is available, and they have not been assessed in any detail as part of this study.

Flood Embankments

Raised flood embankments are a characteristic feature of the lower reaches of the tidal Thames in Essex and Kent. Typically, embankments are constructed out of locally won clayey soils (dug from the adjoining grazing marsh) and protect land used for agricultural purposes (notably damp pasture grazing marsh) from flooding. When clay and sub-soil material is sourced locally to construct embankments, the excavated trenches left behind on landward side fill with water (typically brackish) and form distinct habitat and landscape features known locally as borrow dykes. Where there is little intervening land between the river edge and the

embankment, the riverward embankment face is frequently faced off with concrete or stone to protect from wave-wash erosion. In locations setback for the main river channel, embankments tend not to be reinforced and typically become vegetated by grassland.

Earth embankments can develop significant ecological interest, providing habitat for a range of plant and invertebrate species, that are most frequently found in association with saltmarsh and grazing marsh habitats. In many locations along the Thames, earth embankments often represent the only stretch of species rich grassland in a largely agricultural or industrial landscape.

Vegetation

The vegetation of a typical earth embankment can be split into three broad zones, namely the riverside sloping face, the bank top (typically flat and often supports a footpath) and the landward slope. The vegetation present within each zone, is influenced by a range of factors including the chemical and physical make-up of the underlying soil, embankment management regime, aspect, river water salinity (salt spray) and trampling pressure.

The river facing bank slope is typically influenced strongly by the vegetation it adjoins (which itself is controlled by various factors including prevailing river water salinity) and will frequently contain elements of a halophytic flora more commonly associated with saltmarsh habitat. Classically the foot of the river facing slope is characterised by a narrow strip of sea couch *Elytrigia pycnanthus*, often with various halophytic and mesophytic herb associates such as grass-leaved orache *Atriplex littoralis*, sea wormwood *Seriphidium maritimum* and knotted hedge-parsley *Torilis nodosa*. This vegetation tends to have strong affinities to the National Vegetation Classification (NVC) SM24 *Elymus pycnanthus* salt-marsh community.

Further up the river facing embankment slope towards the bank top, halophytic herb species tend to decrease in number and are replaced by more ubiquitous tall-herb vegetation. Couch grass *Elytrigia repens* and the tussock forming false oat grass *Arrhenatherum elatius* tend to be the dominant grass species, with couch often forming dense single species stands. Flowering herbs characteristically include cut-leaved crane's-bill *Geranium dissectum,* grass vetchling *Lathyrus nissolia,* zig-zag clover *Trifolium medium,* bristly oxtongue *Picris echioides,* hoary ragwort *Senecio erucifolius* and the nationally scarce dittander *Lepidium latifolium*. In some locations, colourful alien plants including salsify *Tragopogon porrifolius*, bastard cabbage *Rapistrum rugosum* and Greek dock *Rumex cristatus* also occur. In overall terms, this grassland type is not satisfactorily described by the NVC.

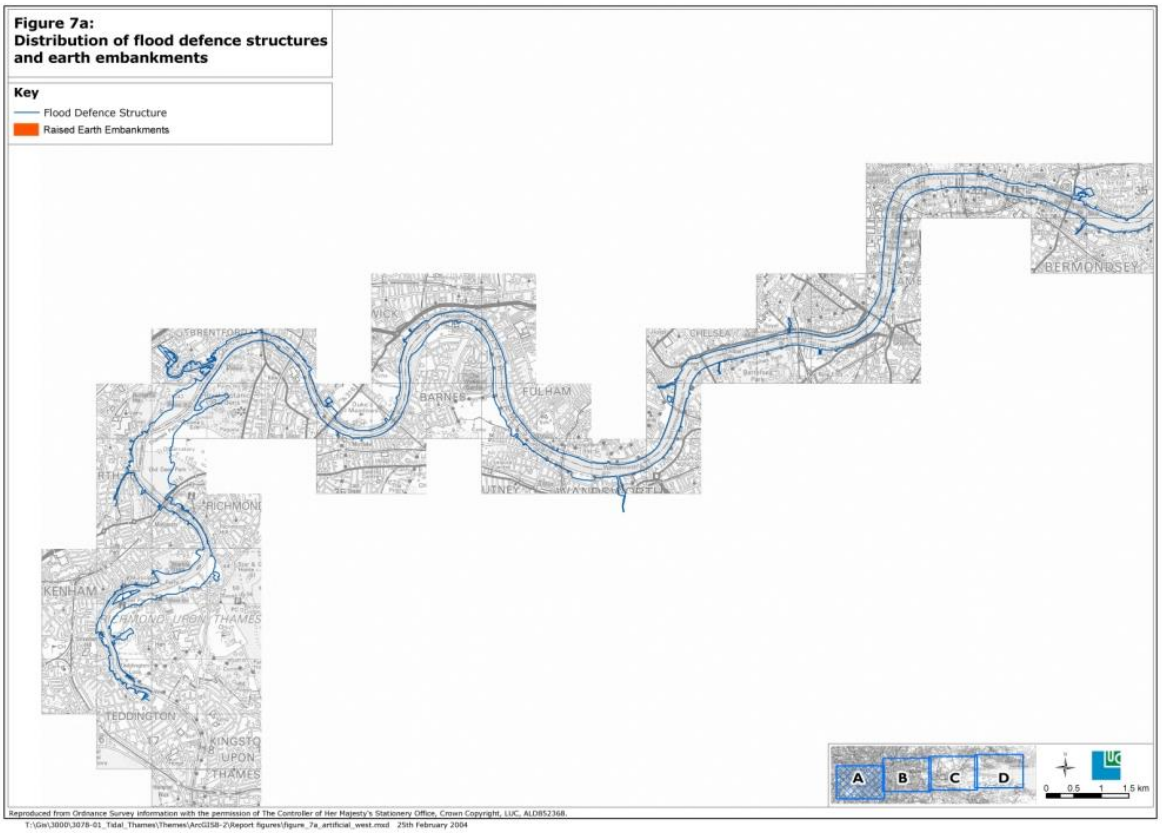
The vegetation of the embankment top is typically influenced by trampling pressure and disturbance resulting from footpath usage, and the associated grassland vegetation is typically of a much shorter sward height, less rank, and more open with patches of bare ground than the adjoining embankment faces. This combination of factors, means that plant species, which would otherwise be competitively excluded by taller more rank vegetation, tend to thrive on embankment tops, and include the nationally scarce *Bupleurum tenuissimum,* sea barley *Hordeum marinum* stiff saltmarsh-grass *Puccinellia rupestris*, Borrer's saltmarsh-grass *Puccinellia fasciculata* and annual beard grass *Polypogon monspeliensis*.

False oat grass, often with frequent couch grass, tends to dominate the vegetation growing on the landward slope of the embankment and has some affinity to MG1 *Arrhenatherum elatius* grassland. Floristically this grassland type is typically plant species poor with tall grasses and

herbs shading out lower growing species. Typical associated species include common vetch *Vicia sativa,* dandelion *Taraxacum officinale* agg*.* ribwort plantain *Plantago lanceolata*, Yorkshire fog *Holcus lanatus*, and in some locations a wider range of more stable grassland species such as yarrow *Achillea millefolium*, bird's-foot trefoil *Lotus corniculatus*, knapweed *Centaurea nigra*, and ox-eye daisy *Leucanthemum vulgare*. The nationally scarce sea clover *Trifolium squamosum* is most frequently recorded growing on the landward facing embankment slope but thrives in more open sward conditions.

On the foot of the rear facing slope (often adjacent to a borrow dike), tall fescue *Festuca arundinacea* dominated grassland is often found as fragmented stands where ground water levels are high. It is best described by the NVC as MG12 and can be regarded as the brackish water equivalent of the MG13 *Agrostis stolonifera-Alopercurus geniculatus* inundation grassland. It requires periodic flooding by brackish water, or small amounts of salt-spay to maintain itself. The large tussocks of tall fescue are distinctive and occur typically with an understorey of common couch, red fescue *Festuca rubra*, and a variety of common mesotrophic herbs as well as brackish species such as wild celery *Apium graveolans*.

Figure 7 shows the distribution of flood embankments within the tidal Thames study area that are shown on 1:10,000 Ordnance Survey base maps to have two sloping faces.



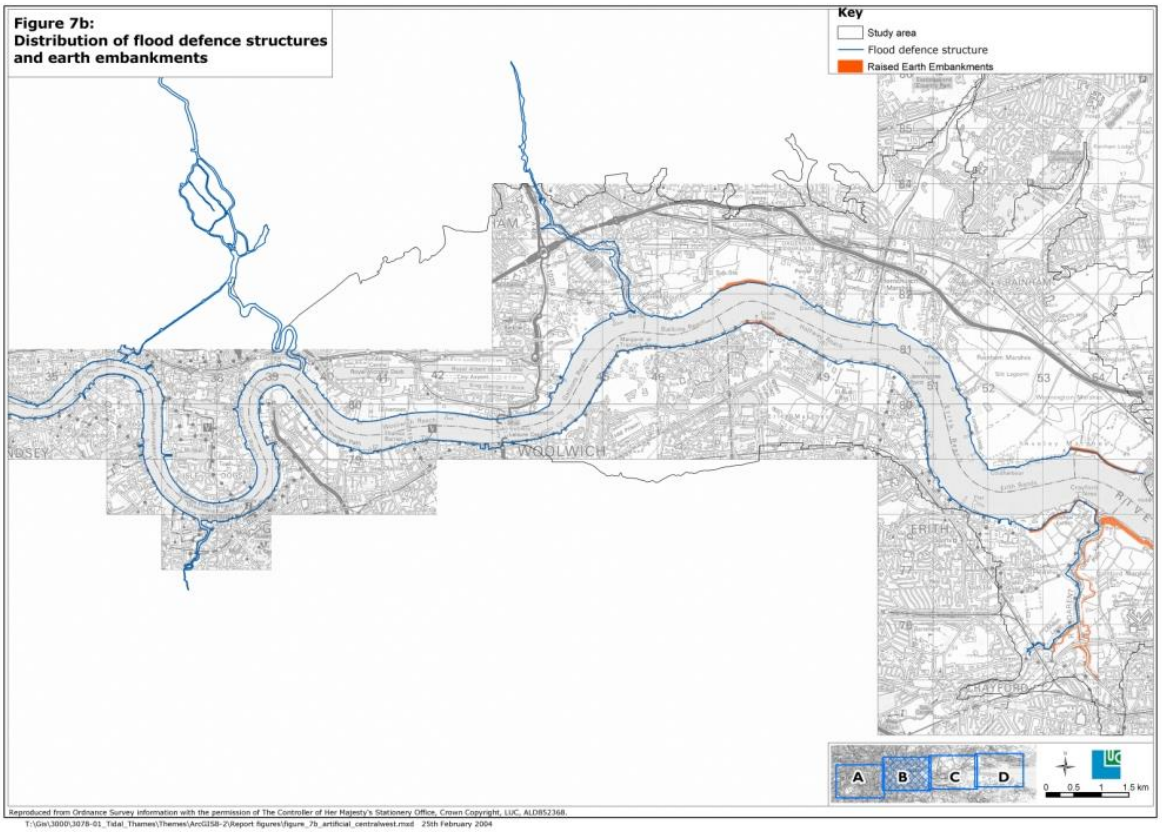


Figure 7b:
Distribution of flood defence structures
and earth embankments
Key
Study area
Flood defence structure
Raised Earth Embankments
WOOLWICH
A
B
C
D
0 0.5 1 1.5 km
Reproduced from Ordnance Survey information with the permission of The Controller of Her Majesty's Stationery Office, Crown Copyright, LUC, ALD852368.
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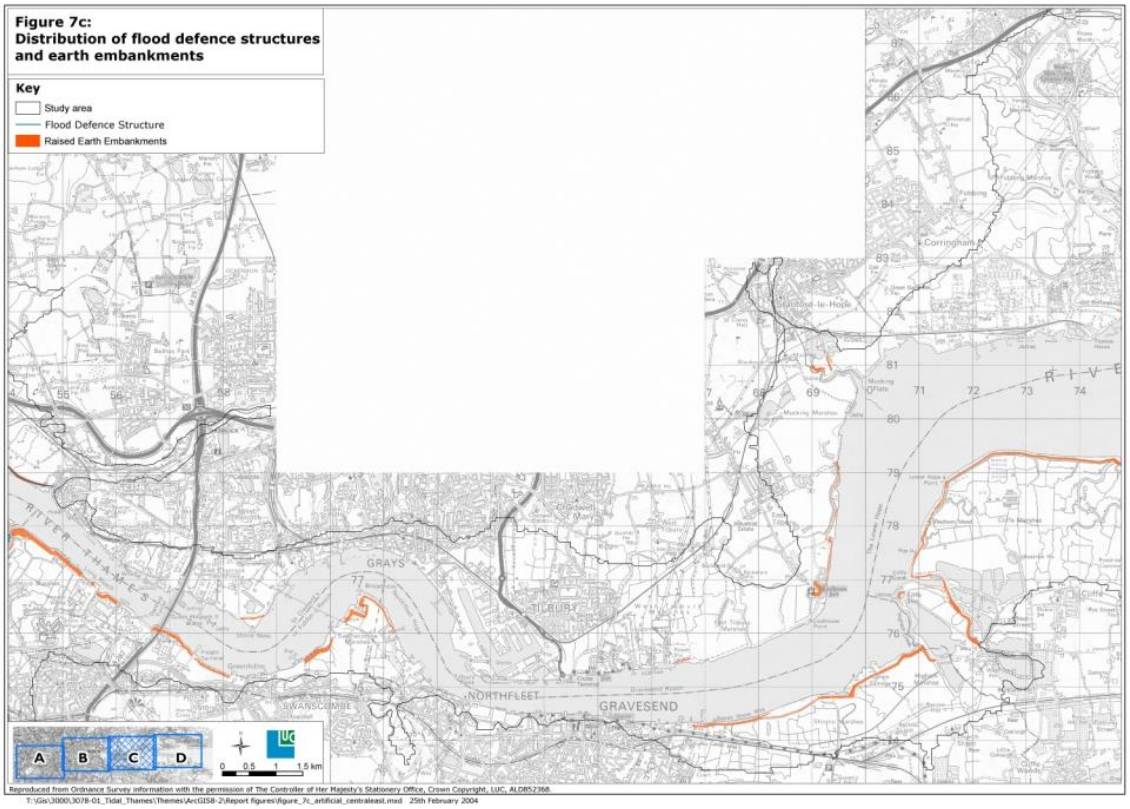


Figure 7c:
Distribution of flood defence structures
and earth embankments
Key
Study area
Flood Defence Structure
Raised Earth Embankments
GRAYS
TILBURY
NORTHFLEET
GRAVESEND
SWANSCOMBE
A
B
C
D
0 0.5 1 1.5 km
Reproduced from Ordnance Survey information with the permission of The Controller of Her Majesty's Stationery Office, Crown Copyright, LUC, ALD852368.
T:\Gis\3000\3078-01_Tidal_Thames\Themes\ArcGIS8-2\Report figures\figure_7c_artificial_centraleast.mxd 25th February 2004

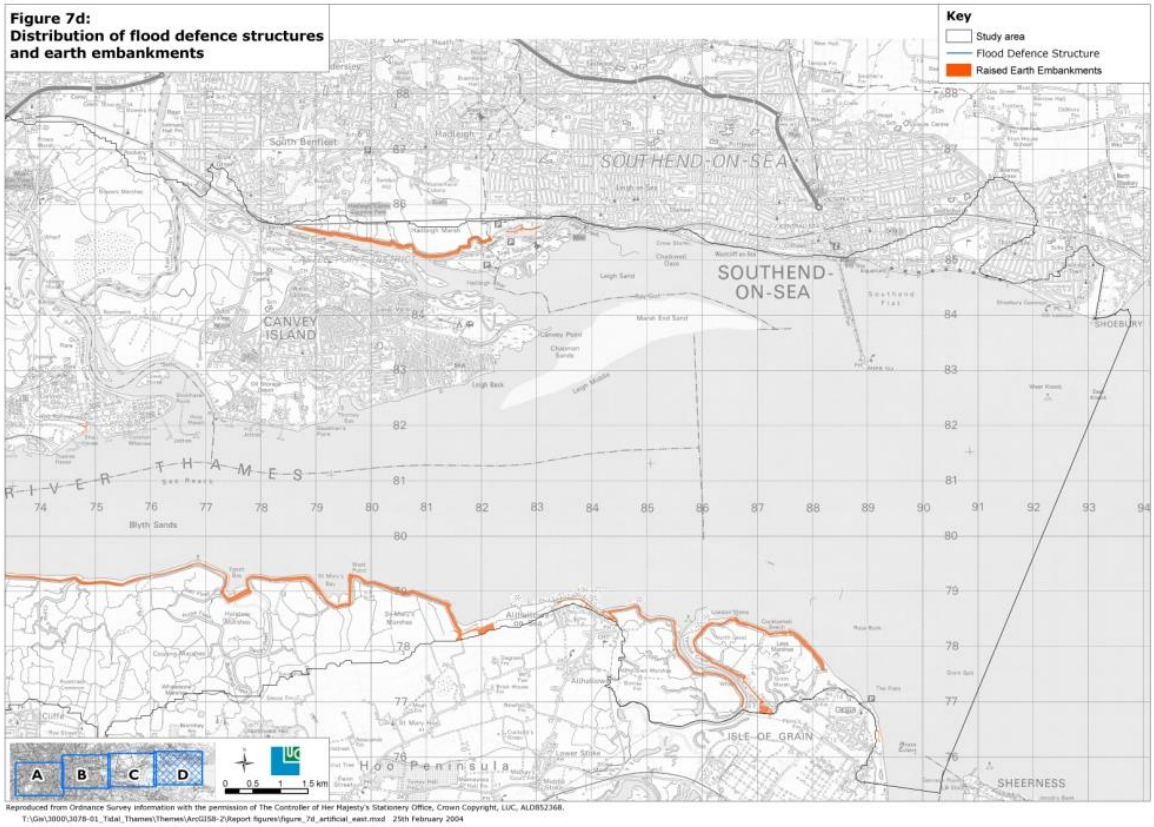


Figure 7: Distribution of flood defence structures and earth embankments

Flood embankments constructed out of earth are a common feature along the marine reaches of the tidal Thames. Frequently these structures develop distinct plant and animal assemblages and possess species with high individual nature conservation value. The most ecologically valuable embankments tend to be those that experience a degree of trampling disturbance, which enables low growing, non-competitive plant species and bare ground requiring invertebrates to thrive.

River Walls

As described previously, most of the riverbank habitat of the tidal Thames has been artificially strengthened, and in many locations, has been completely replaced by vertical wall-like structures or sloping revetment that provides limited opportunity for wetland and aquatic plant and animal species colonisation above and below the waterline.

Several factors influence the assemblage of animal and plant species utilising river wall habitat at any one point along the river. One of the most fundamental factors is the prevailing river water salinity. This is described in more detail in previous sections of this report; however, distinct zones of invertebrate and plant species with broadly similar species assemblages occur along the river in correspondence to the downstream increase in prevailing river water salinity.

The physical structure of the wall, and particularly its material form, age and condition also have a fundamental influence on the range and abundance of individual plant and animal

species that can be found at any one point along the river. While this is not currently well understood with respect differences between wall design, material, age, and condition, it would appear from visual inspection that there is a strong positive correlation between river wall structural complexity and associated plant and animal species diversity.

In simple terms, the greater the associated range of crevices and niches that can provide shelter, refuge or rootholds for plants (i.e. the greater the wall's structural complexity) at a single point along the river, the greater the plant species diversity and biomass it can support. For example, revetment consisting of individual stone sets, typically has a greater range of plant species growing between the block joints than, for example, a concrete slab revetment wall with fewer joints at a similar location on the river.

A similar correlation appears to exist between river wall condition and plant species diversity, with walls in a poor state of repair/condition generally supporting a higher plant species diversity than similar walls in a good state of repair. This is exemplified in Deptford Creek, where the most floristically diverse walls are reported to be those with the greatest range of crevices for opportunistic plant colonisation, namely crevices, gaps, and ledges. Typically, these tend to be old wooden or brick walls in poor states of repair.

In summary, plants will colonise opportunistically any river wall and associated structure where a roothold can be attained, as shown for example by the extensive wetland plant colonisation on the stone set wall and associated mooring structure upstream of Richmond Bridge.

Aquatic, wetland, and terrestrial invertebrates also depend on river walls and associated structures along the Thames, and a positive correlation has been shown to exist between habitat complexity and wall invertebrate species diversity at any one point along the river[7]. While this particular study was widely focussed and included both artificial and natural riverside habitats (e.g. saltmarsh and river walls) it differentiated between walls constructed from brick, boulder, concrete, wood and metal, and found that the brick and boulder walls possessed a greater invertebrate diversity than concrete or metal walls.

In addition to the factors described above, relative wall height in relation to the mean high-water level is also likely to fundamentally influence the distribution of species on an individual wall. Although not well reported, visual observation of river walls along the Thames during this study indicates that a vertical zonation of plants and algae exists up a wall depending upon an individual species tolerance to submersion.

Efforts have been made as part of this study to assess the Environment Agency (Thames Region) flood defence structure condition assessment database to classify and map river wall type based on form and material type along the tidal Thames. However, that the terms used to describe river wall structure and conditions were too variable to be helpful. Figure 7 does, however, show the location of the flood defences along the tidal Thames and represents the extent of river wall type structures within the study area.

[7] Atrill, M. J. *et al* (1999) The impact of encroachment and bankside development on the habitat complexity and supralittoral invertebrate communities of the Thames estuary foreshore. Aquatic Conservation: Marine and Freshwater Ecosystems **V9**, 237-247

River walls are man-made structures constructed to strengthen and / or replace natural riverbank to prevent riverbank erosion and contain floodwaters. The physical character of river walls is extremely variable along the tidal Thames, and an extensive range of wall types of widely varying design, material, age and condition occur. River walls can provide permanent habitat for a large range of riverine and riparian animal and plant species. The precise species composition and abundance of which is controlled by several biological and physical factors, including river water salinity, wall height in relation to mean high water, and the structural complexity of the wall.

Open Water

The TTHAP has identified that areas of open water, and in particular open water dock basins, can often provide important areas for roosting wildfowl and wading birds, breeding sites for common tern and backwater refuges for fish fry.

Very little specific survey information exists on the ecological value of individual Dock basins has been discovered by this study. Reference is however regularly made to Docks being used by juvenile smelt (as nursery areas), and common tern for feeding and breeding where artificial tern rafts have been provided.

Higher Plants

Hemlock water-dropwort *Oenanthe crocata*

Hemlock water-dropwort is a large white-flowered umbellifer that grows in a variety of habitats including shallow water streams, on the banks of rivers, streams, lakes, ponds and canals, marshes, wet woodland, in crevices in waterside masonry, amongst flushed stones and boulders at the top of beaches, and on dripping or flushed sea cliffs. It is a common species in Britain but exhibits a marked westerly and southerly distribution pattern. Within the tidal Thames study area, it is a widespread and characteristic species of a variety of riverbank and creek habitats along the entire length of the river, although its preference for freshwater conditions means it is generally most frequently recorded between Teddington and Greenwich in close association with the river.

Purple-loosestrife *Lythrum salicaria*

Purple loosestrife is a perennial herb that is common throughout Britain and grows on the margins of slow-flowing rivers, canals, lakes, flooded gravel-pits, in tall-herb fens and willow carr. It thrives in permanently wet, or periodically inundated, fertile soils, and tends to avoid acidic conditions. Within the tidal Thames study area, it is found most frequently in association with the riverbank in the upper freshwater reaches particularly where sloping reinforced riverbank provides colonisation opportunity.

Its overall distribution both nationally and within the tidal Thames is stable, with many recent records from country parks, urban nature reserves, school ponds and other such places

indicating that its distribution has almost certainly increased because of deliberate plantings (R. Burton pers comm.).

Sea aster *Aster tripolium*

Sea aster is a short-lived perennial herb that is widespread around the coast of Britain. It typically occurs at low elevations in ungrazed or lightly grazed saltmarshes, especially along tidal creek, muddy sea banks, tidal river embankments and in brackish ditches. It is a common species of wet mud by and near the tidal Thames on saltmarshes and inter-tidal habitats and occurs throughout the middle and lower reaches of the river wherever suitable habitat exists. Its seeds may be carried some distance by the wind and germinate outside its usual habitat. Within the tidal Thames, it is currently found up to Limehouse and Greenwich, but several records have also been made further upstream, for example as far west as Barnes, however it does not seem to persist in these areas.

The distribution of *A. tripolium* is relatively stable both nationally and within the tidal Thames study area.

Sea barley *Hordeum marinum*

Sea barley is a nationally scarce annual maritime grass species with a scattered distribution around the south and east coasts of England and Wales. It has two main strongholds in the UK, the East Anglian coast, and the Bristol channel. It is dependent upon barish ground, particularly the trampled margins of dried-up pools and ditches in grazing marshes, on tracks and seawalls, and in the uppermost parts of saltmarshes. Within the tidal Thames study area, it is widespread upstream to around Dartford Marshes on earthen seawall embankments, particularly in rutted saline areas on the bank top and occasionally on the outer (seaward) face.

Sea barley has contracted in range in the UK, particularly along the south coast because of habitat loss, notably the replacement of earthen sea walls with harder flood defence structures, the infilling of pools and ditches, and the wholesale conversion of coastal grazing marshes to arable land. It is also susceptible to successional plant competition and requires the continuous creation of open bare ground conditions to persist.

Golden-samphire *Inula crithmoides*

Golden-samphire is a nationally scarce perennial herb with a distinct coastal distribution pattern. It occurs in two distinct types of habitat within the UK - sea-cliffs and saltmarshes. Within southeast England (i.e. the coasts of Kent, Essex and Suffolk) it typically occurs on upper saltmarshes frequently along the drift-line. Within the tidal Thames, it is generally associated with the river facing sloping face of embankments and seawalls, where it often extends onto the adjoining saltmarsh habitat. It is a species that is associated mainly with the marine reaches of the estuary and is not currently known to occur upstream of Swanscombe marshes.

The distribution of this species within the tidal Thames is believed to be stable, with most losses from outlying squares having occurred in the 19th century.

Sea clover *Trifolium squamosum*

Sea clover is nationally scarce annual flowering herb that has a similar broad distribution pattern to sea barley, with a scattered distribution around the coast of south and east England and Wales, and particular concentrations around the Essex and Kent coasts and the Bristol channel. It occurs on the uppermost parts of saltmarshes, brackish meadows, and by tidal rivers and creeks. Along the tidal Thames, it is relatively widespread, and has been recorded upstream to Swanscombe Marshes, where it is associated with short, open grassland that is grazed or trampled, and particularly the footpath tops of flood embankments.

Many former sea clover sites around the UK have been lost because of coastal flood defence related development, and a lack of grazing on coastal grasslands.

Distribution of Key Species

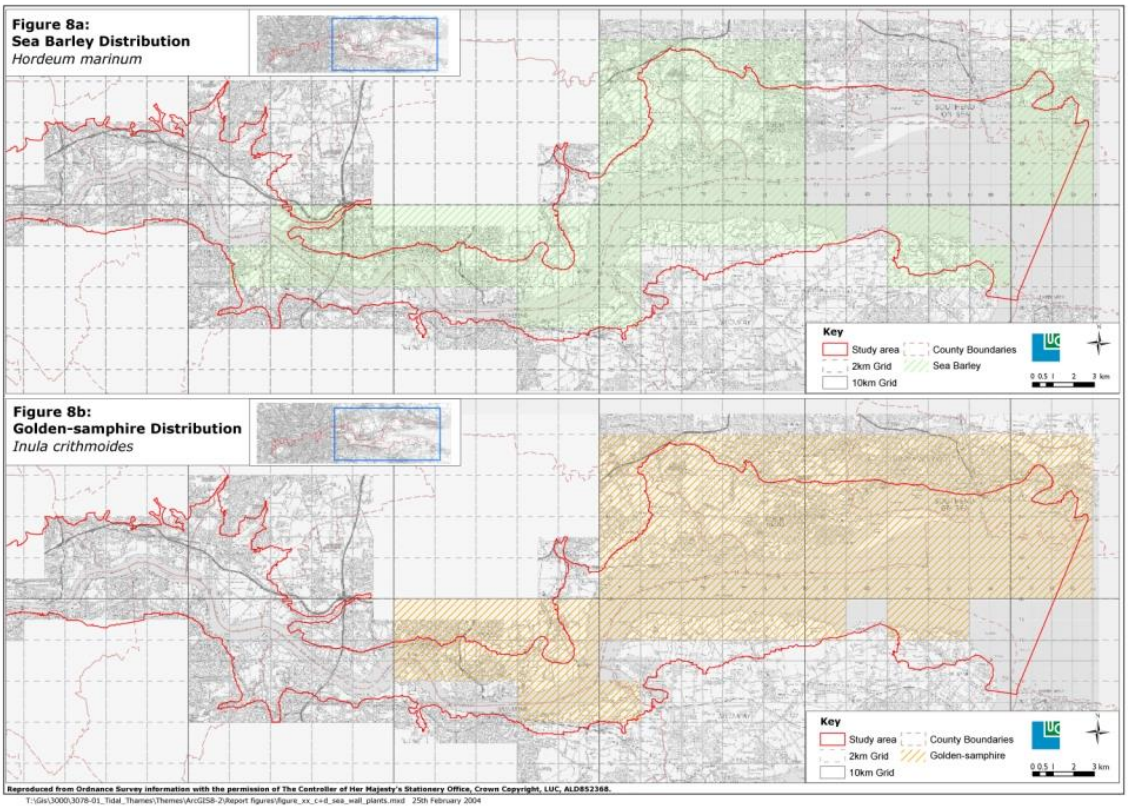
Various sources of data have been reviewed to map the distribution of select plant species identified by the tidal TTHAP. Key data sources can be summarised as:

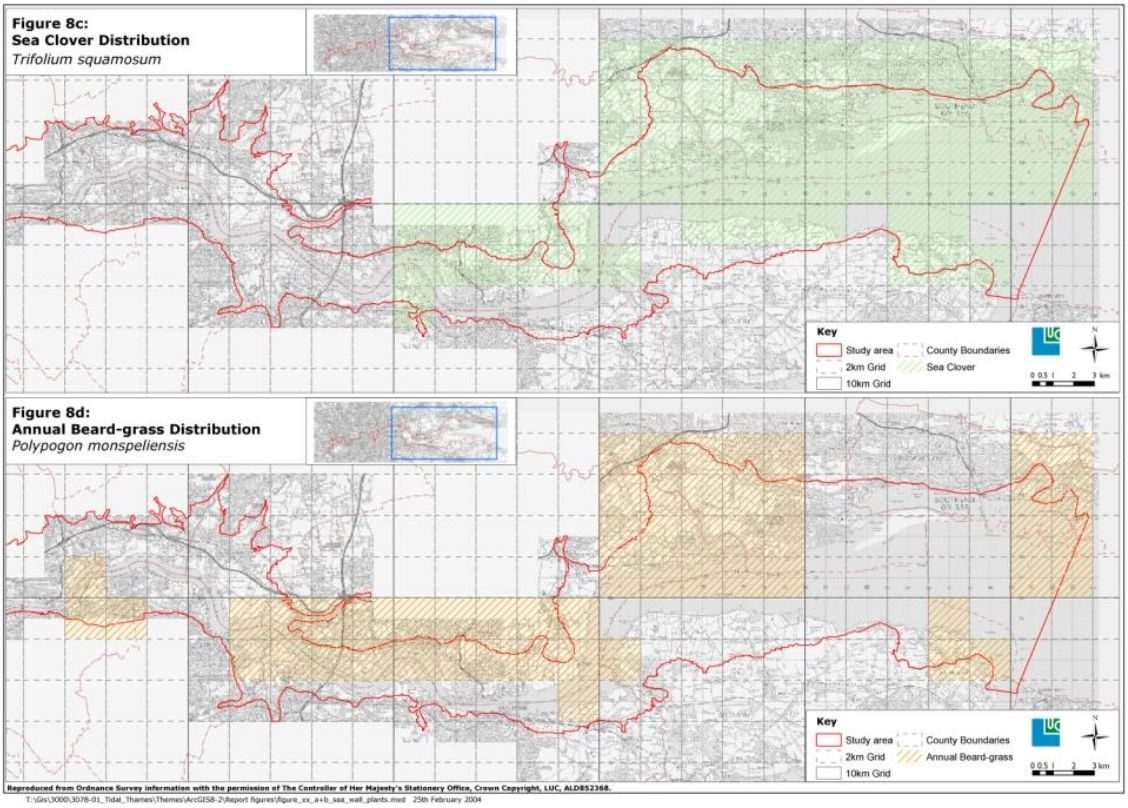
- All post 1980 records for individual plant species provided by Rodney Burton (BSBI Recorder).
- Sea wall plant survey data for Kent (2000) (Carter Ecological Ltd.) and Essex (1991) (Ecosurveys) provided by English Nature Kent and Essex, respectively. The former was provided in digital form, the latter exists only as a 10-file paper copy in the EN office.
- Essex Wildlife Trust RECORDER Database records.
- Preston et al (2002) New Atlas of the British & Irish Flora. Oxford University Press.
- Only nationally scarce plant species identified by the TTHAP have been mapped by this study i.e. those species that are recorded nationally in 16-100 10km squares. These species are:
  - Sea barley *Hordeum marinum* (Figure 8a)
  - Golden-samphire *Inula crithmoides* (Figure 8b)
  - Sea clover *Trifolium squamosum* (Figure 8c)

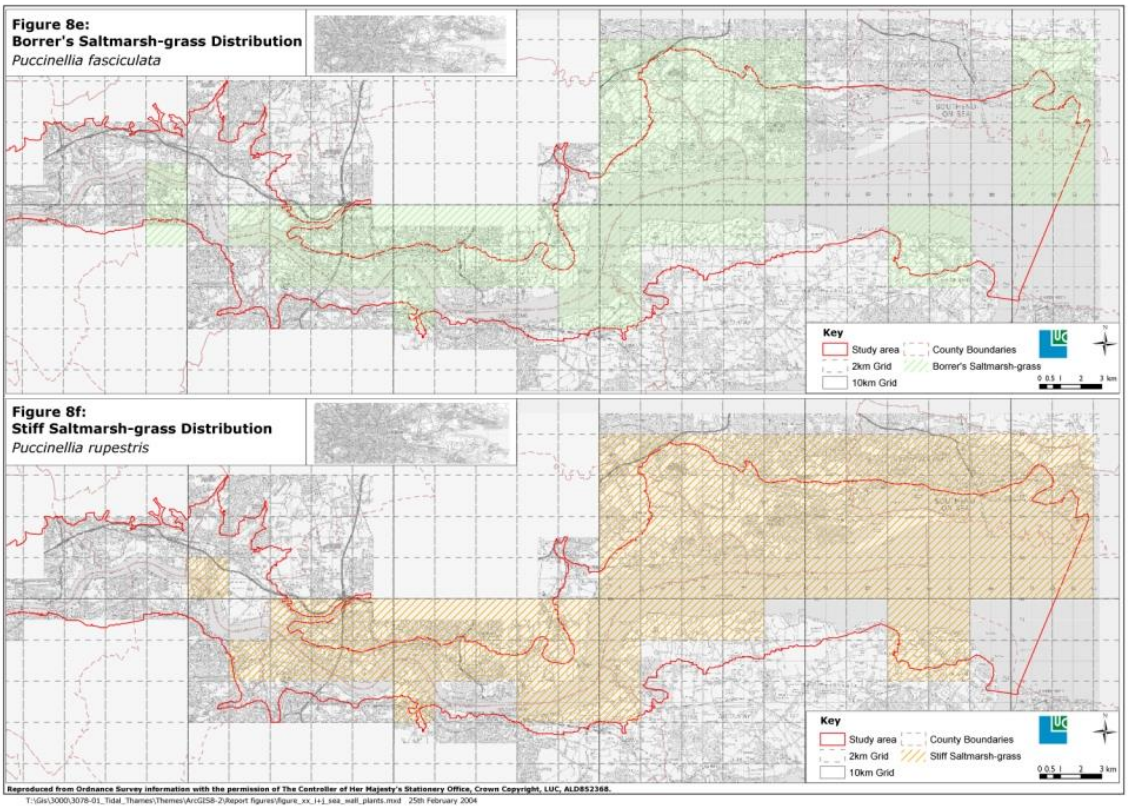
Records for several other nationally scarce plant species that have strongholds along the tidal Thames but are not specifically referred to by the HAP were also attained as part of the study, and distribution maps have also been produced. These species are:

- Annual beard-grass *Polypogon monspeliensis* (Figure 8d)
- Borrer's saltmarsh grass *Puccinellia fasiculata* (Figure 8e)
- Stiff saltmarsh-grass *Puccinellia rupestris* (Figure 8f)

- Slender hare's ear *Burpleurum tenuissimum* (Figure 8g)
- Least lettuce *Lactuca saligna* (Figure 8h)







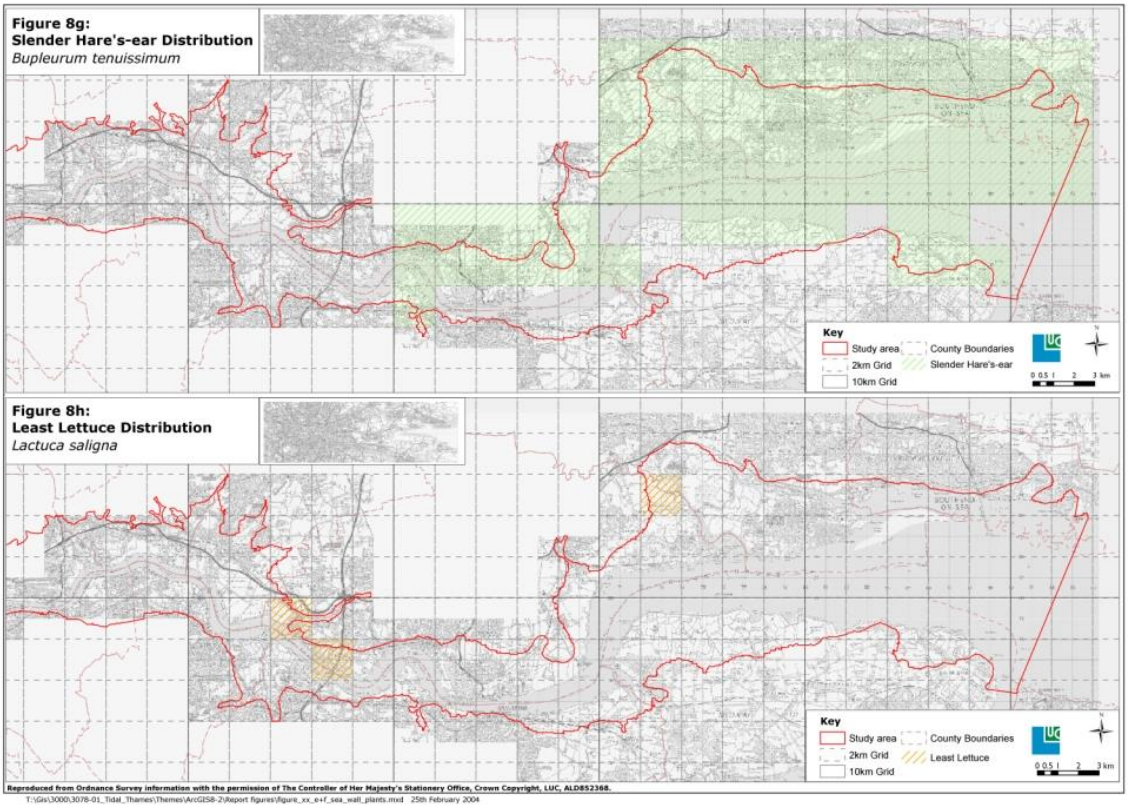


Figure 8: Distribution of selected plant species

Terrestrial Invertebrates

Hornet robber fly *Asilus crabroniformis*

Hornet robber fly is a large and spectacular fly that is designated as a nationally Notable invertebrate species, and a priority species under both UK and Essex BAPs.

It is typically found in association with open, unimproved, or semi-improved pasture, heathland, sand dunes and occasionally wide forestry rides. It is restricted to southern England and Wales and has been recorded from 142 (post-1970), 123 (post-1980) and 101 (post-1990) 10km squares in Britain (Smith, 2000 *cf* Hampshire Biodiversity Partnership 2001). However, the species account provided in the UK BAP, causes some confusion, as it suggests that only 40 post-1970 10km squares for this species are known. Recent distribution maps indicate that the UK stronghold is in west Hampshire and east Dorset.

The species appears to prefer sites that provide a mosaic of mixed height vegetation, rather than sites with heavily grazed short swards. Adults are active in air temperatures above 16°C from late-June to late-October, and feed on a range of insects including grasshoppers, adult beetles, and flies. Adults are known to range over distances of 500m or more from core breeding sites.

The presence of livestock is thought to be an important aspect in its life cycle, as eggs are laid primarily in, or immediately beneath, drying friable soil mixed with dung. Larval habits are still largely unknown, but it is thought that they feed on dung beetle larvae and other soil invertebrates.

The national decline of this species is thought to be associated with inappropriate habitat management, particularly overgrazing by livestock. In addition, general habitat loss and fragmentation, together with the use of persistent parasite treatments for stock - which kills dung beetle larval hosts, are also thought to have contributed its decline.

Figure 9a depicts the current distribution of hornet robber fly within the tidal Thames study area based on records collated and provided by Peter Harvey.

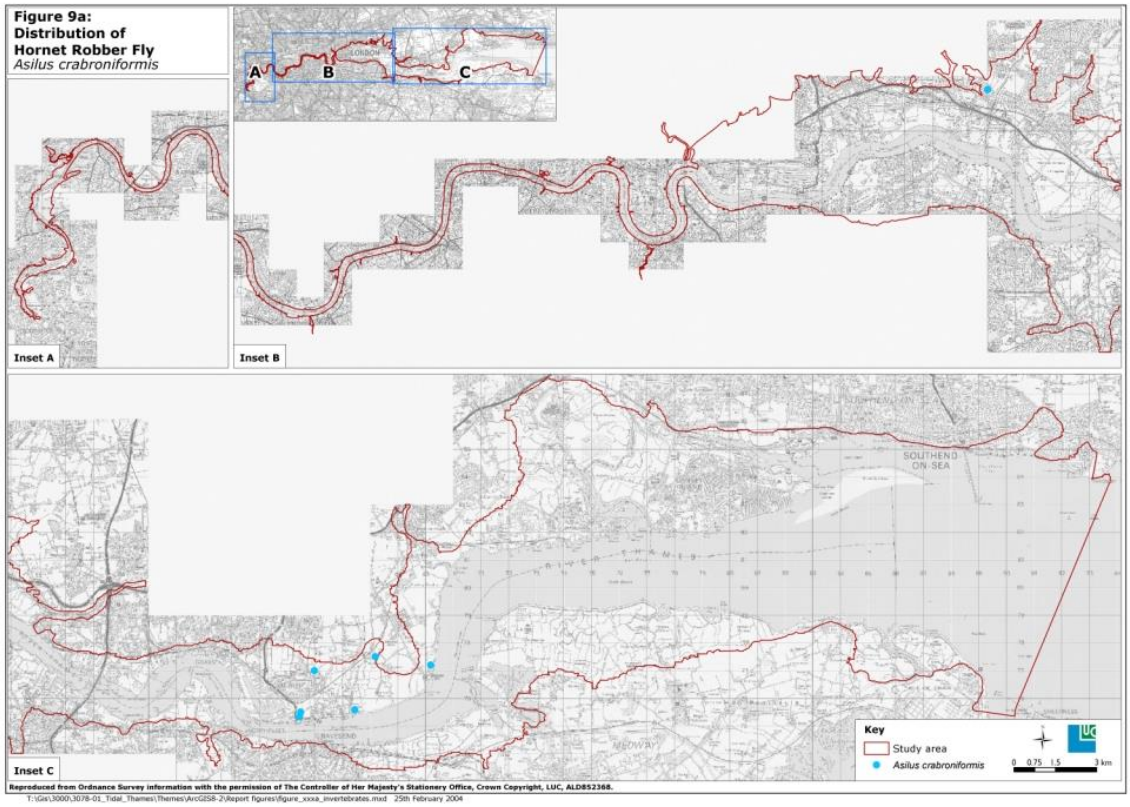


Figure 9a: Distribution of Hornet Robber Fly

Shrill carder bee *Bombus sylvarum*

Shrill carder bee is a nationally Notable invertebrate species, and a specific target of the UK and Essex BAPs. Nationally this species has a distinct southern distribution, and is associated with a wide variety of open, flower-rich situations, including inland and coastal habitat types.

Shrill carder bee was widespread and common in the 19th and early 20th centuries, especially in southern England. However, post-1960 records suggest a decline, with just seven confirmed populations reliably identified in the southeast in the 1980's, and perhaps just three by 1997 when it was considered close to extinction in Britain.

Within Essex, shrill carder bee appears to be associated with tall, herb-rich grasslands in the early stages of succession. Typically, such sites support abundant forage-plants that provide a continual source of nectar and pollen throughout the growing season. Important grassland sites for this species frequently include flowering plant species belonging to the pea family (Fabaceae), birds-foot trefoil *Lotus corniculatus* and *L. glaber*, the clovers *Trifolium repens* and *T. pratense*, and late flowering plant species such red bartsia *Odontites vernus*. Other favoured flowering plants include white dead nettle *Lamium album*, black horehound *Ballota nigra*, common knapweed *Centaurea nigra* and thistles.

Figure 9b depicts the current distribution of shrill carder bee within the tidal Thames study area based on records collated and provided by Peter Harvey.

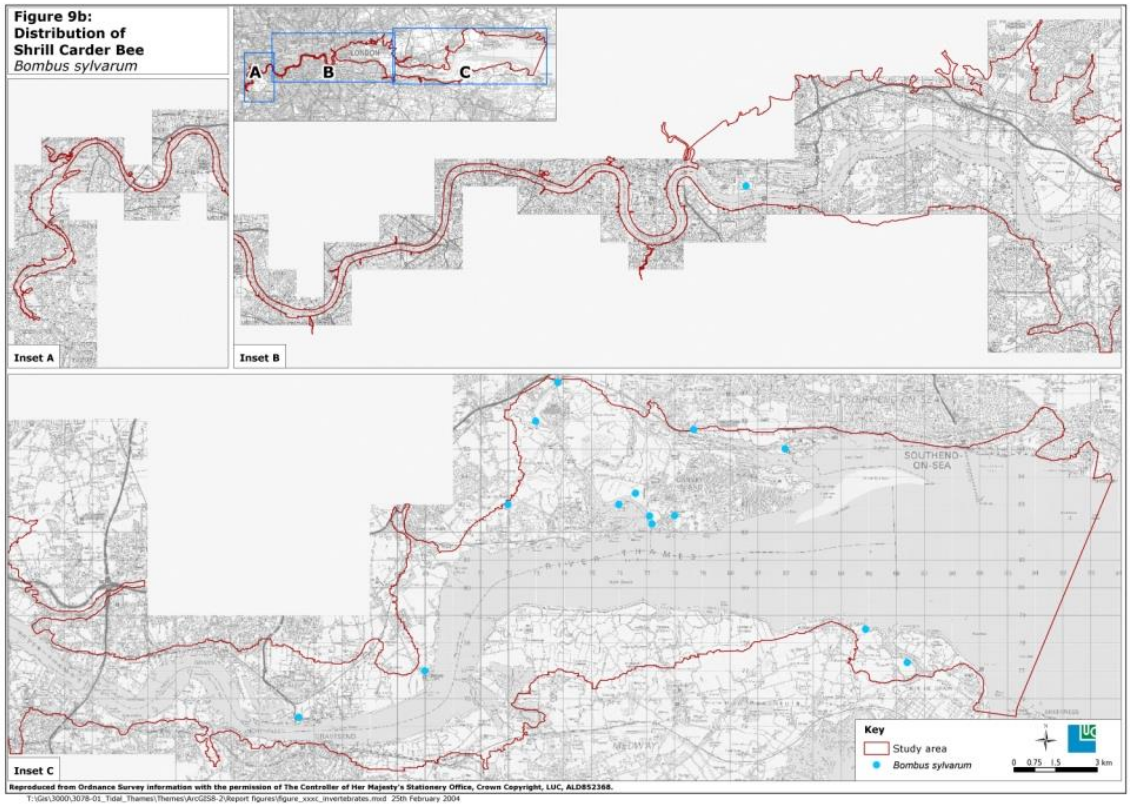


Figure 9b: Distribution of Shrill Carder Bee

Solitary Wasp *Cerceris quinquefasciata*

Cerceris quinquefasicata is a medium-sized yellow and black wasp designated as Red Data Book 3 (Rare) and a UK BAP target species.

Nationally this species it is confined to the southern counties of England where it is found in association with open, sandy situations including heath, sand and gravel pits, and other disturbed sites with bare ground including well-trodden footpaths and banks. *C. quinquefasciata* nests gregariously in areas of bare or sparsely vegetated hard sunbaked sandy ground.

It has been known from 49 10 km squares in southern and eastern England but has been found in only 14 squares since 1980, largely in south-eastern England (Essex, Kent, Norfolk, Oxfordshire and Suffolk). There are no post-1970 records for the coasts of Dorset, Devon, and Cornwall, despite several earlier records.

The national decline of this species is thought to be due to loss of open areas of sandy ground for nesting and flower-rich sandy grasslands for foraging.

Figure 9c depicts the current distribution of *C. quinquefasciata* within the tidal Thames study area based on records collated and provided by Peter Harvey.

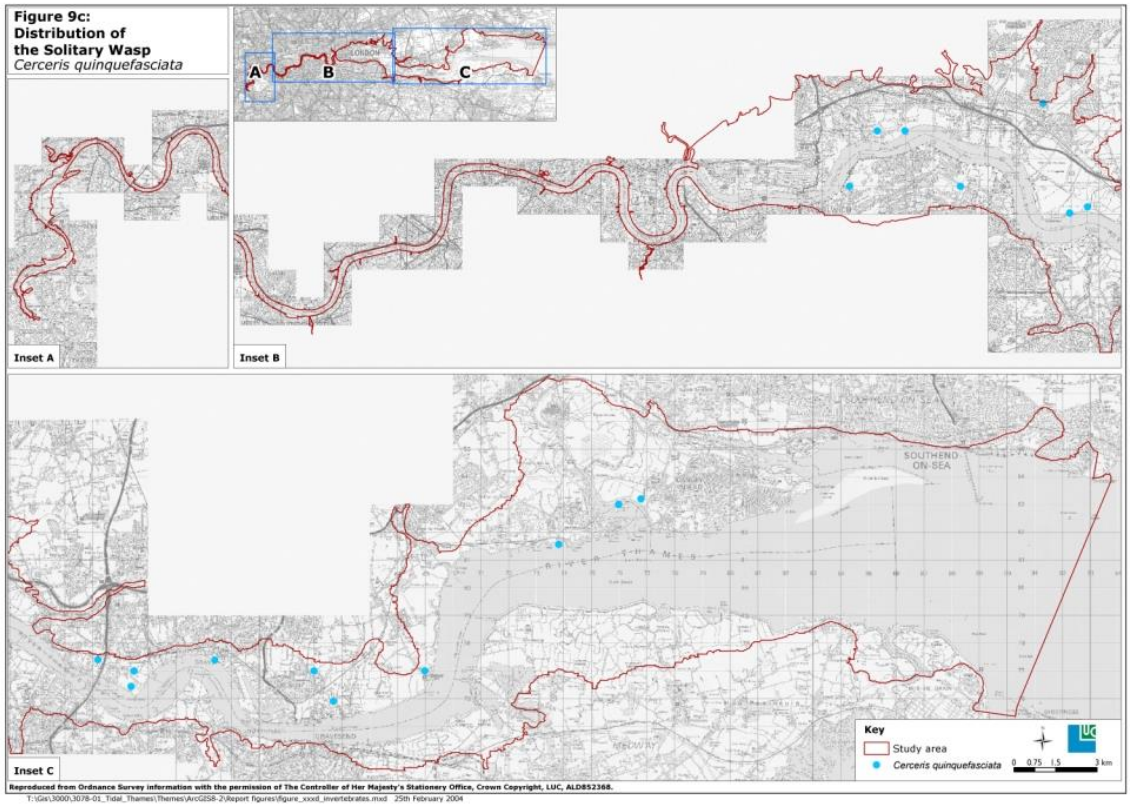


Figure 9c: Distribution of Solitary Wasp

As described previously, three other invertebrate species have been identified by Peter Harvey as being particularly characteristic of Thames terrace grasslands and their brownfield equivalent sites. These are *Gymnosoma nitens* (Diptera), the brown carder bumblebee *Bombus humilis*, and *Dorycera graminum* (Diptera), and their distributions (according to Harvey) have been plotted (Figures 9d, e & f).

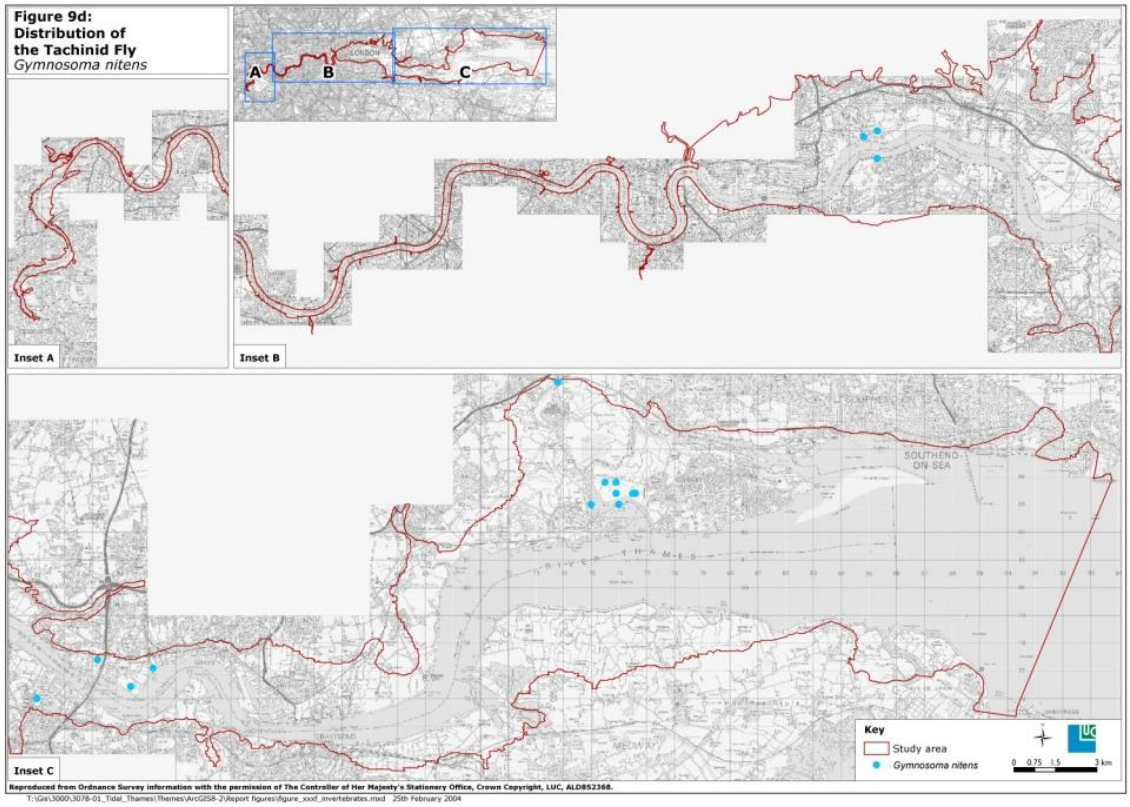


Figure 9d: Distribution of Tachinid Fly

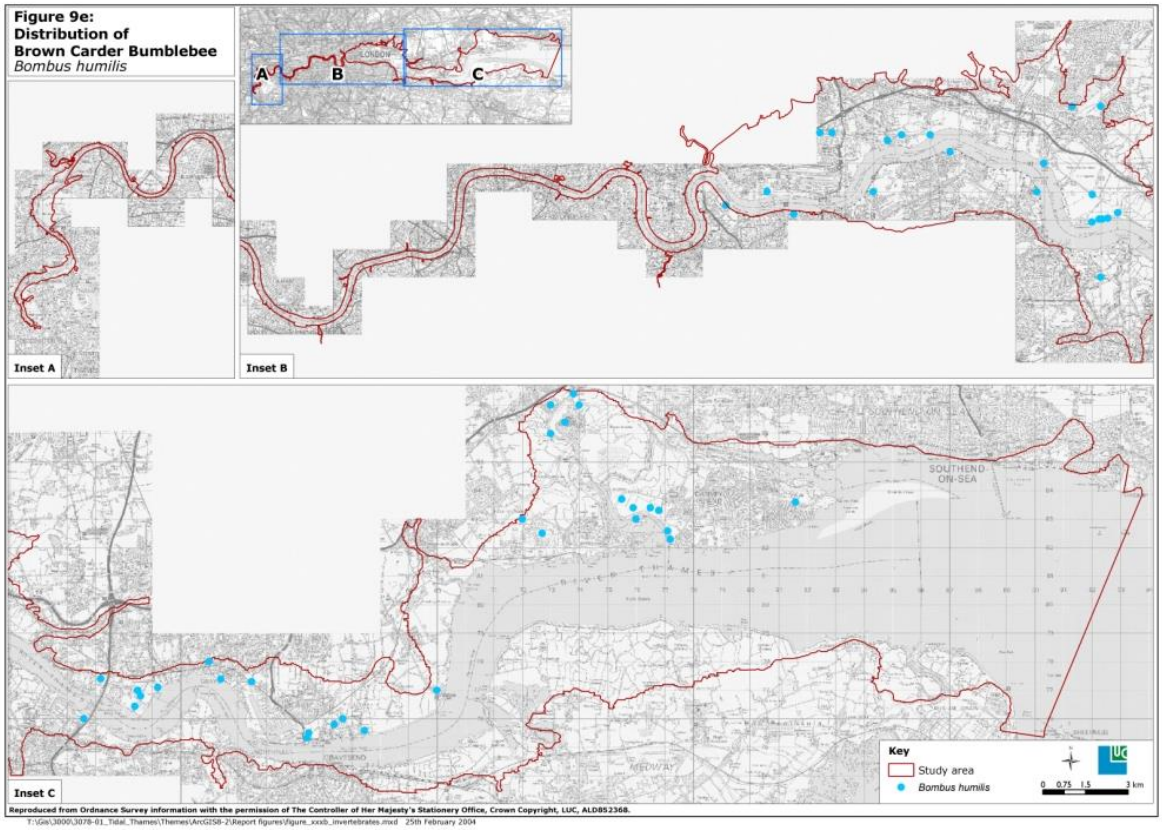


Figure 9e: Distribution of Brown Carder Bumblebee

Aquatic Invertebrates

A comprehensive account of the aquatic invertebrate communities that characterise the tidal Thames is provided by Atrill (1998a). This is based on a comprehensive survey of the aquatic macro-invertebrate fauna from the inter-tidal foreshore of the tidal river Thames undertaken on behalf of the Environment Agency by the Benthic Ecology Research Group from the University of Plymouth in 1997.

This study, along with other invertebrate species list data provided by the Agency, consultants' reports produced on behalf of P&O Ports Ltd. and the Port of London Authority to support a development proposal for a container port (London Gateway Port) near Thames Haven, and various published scientific papers have been reviewed.

A summary of these data is provided in Table 6.

Table 6: Summary of Aquatic Invertebrate Distribution in the tidal Thames (TTHAP species in bold)

	Zone 1	**Zone 2**	**Zone 3**	**Zone 4**
Distribution	Teddington to London Bridge (30km) Inter-tidal substrates tend to be dominated by gravels with varying degrees of sand and mud and cobble. Invertebrates generally restricted to sub-tidal areas except where cobble provides 'under-stone' refuge opportunity.	London Bridge to Crossness (21km) Transition area between freshwater and estuarine conditions (mid-tide salinity 5-10 PSU), first appearance of permanent inter-tidal mudflats.	Crossness to Gravesend (22km) Transition area between estuarine and marine conditions (mid-tide salinity typically 10-20 PSU). Sediment characteristics like Zone 2 but with increasing sand content towards Gravesend.	Gravesend to Shoeburyness (31km) Outer estuary zone incorporating all the extensive areas of inter-tidal mud and sand flats that support a diverse and highly productive macro-invertebrate community that in turn supports internationally important numbers of wintering wildfowl and waders. Sediment variable sandy mud and sand flats.
Invertebrate Assemblage Description	Defined by freshwater invertebrate species that are tolerant of elevated water salinity (immediately below the Teddington Weir salinity levels increase). Invertebrate species diversity is typically low, **with the amphipod *Gammarus zaddachi* being the dominant species in terms of biomass and abundance and an important food source for a variety of fish and bird species**. Other characteristic species of the core invertebrate assemblage of Zone 1 include: the river limpet *Ancylus fluviatilis;* the common pond snail *Lymnaea pergra*; pea mussels *Sphaerium corneum* and *Pisidium* sp.; the leeches *Erpobdella testacea* and *Glossiphonia complanata*; the mayfly nymph *Caenis moesta*; and various oligochaete worms in the following general order of abundance *Psammoryctides barbatus*; *Limnodrilus hoffmeisteri* and *Tubifex tubifex.*	Defined by freshwater invertebrate species that can tolerate increased salinity, and estuarine species that can tolerate a wide fluctuation in salinity. Invertebrate species diversity is generally low due to these rather stressful environmental conditions. Inter-tidal mud habitats tend to be dominated by tubificid oligochaetes, principally the freshwater species *Limnodrilus hoffmeisteri*, and the estuarine species *Tubifex costatus* supplemented with ***G. zaddachi***, *Corophium lacustre*, the spire snail *Potamopyrgus antipodarum* and the oligochaetes *Tubifiex tubifex* and *Monopylephorus rubroniveus*. Sub-tidal areas exhibit slightly different invertebrate assemblages that are often patchy and defined by substrate stability, with mobile crustaceans notably the prawns and shrimps *Palaemon longirostris*, *Crangon crangon* and *Neomysis integer*, being found frequently along this zone.	Defined by a mixture of estuarine and marine invertebrate species. Like Zone 2, inter-tidal mud flats tend to be dominated by tubificid oligochaetes, notably *Tubifex costatus* (which is gradually replaced by the *Tubificoides benedeni* towards Gravesend) with the amphipod *Corophium volutator* **and the ragworm *Nereis diversicolor* often occurring in high biomass and numbers**. **Other less frequent species include *Gammarus zaddachi* (which is replaced by *Gammarus salinus* after West Thurrock)** the shore crab *Carcinus maenas* and the bivalve molluscs *Macoma balthica* (the Baltic tellin), and *Scrobicularia plana* (peppery furrow shell). The sub-tidal fauna is patchy and dependent upon substrate stability but tends to be dominated by *C. volutator* with other characteristic core species including a number of polychaete and oligochate worm species and the shrimp *Crangon crangon*.	Defined by outer estuarine and marine invertebrate species, with the following core species characterising the inter-tidal zone: **Bivalve molluscs: cockle *Cerastoderma edule***; peppery furrow shell *Scrobicularia plana*; common mussel *Mytilus edulis*; Baltic tellin *Macoma balthica*. Prosobranch molluscs: slipper limpet *Crepidula fornicata* Gastropod molluscs: laver spire shell *Hydrobia ulvae*; edible periwinkle *Littorina littorea* Annelid worms: *Scoloplos armiger*; *Nephytys hombergi*; *Pygospio elegans*; *Monopylephorus rubroniveus*, *Caudelleriella* sp., *Tubificoides benedeni* (oligochaete); *Arenicola marina*; *Eteone longa*; *Cumopsis goodsiri*; *Glycera tridactyla and* **the ragworm *Nereis diversicolor*** Arthropods: shore crab *Carcinus maenas*; *Corophium arenarium*; *Cumopsis goodsiri*; *Urothoe poseidonis*; Bathypoereia sp.
Notable species	The German hairy snail *Perforatella rubiginosa* is a snail species with a limited distribution and high individual nature conservation status in the UK. It is a rare species classified by the UK Red Data Book as RDB category 2 (Vulnerable). It lives in marshes on river floodplains, and typically is found among flood debris in muddy,	The brackish water amphipod *Corophium lacustre* is listed as a Red Data Book species (RDB 3 (rare))[11] having once been known only from the Norfolk Broads and Hampshire. It is now known to inhabit a large stretch of the tidal Thames from Kew downstream to Crossness where it lives in tube burrows constructed out of mud. It	The sub-tidal region of Zone 3 represents the upper limit for several marine/outer estuarine species, including the laver spire shell *Hydrobia ulvae* (occurs as far upstream as Purfleet) and the common mussel *Mytilus edulis* (West Thurrock).	**Cockle *Cerastoderma edule* are harvested as a commercial crop from the inter-tidal mud and sand flats of the lower estuary. Since the collapse of the Dutch cockle fishing industry, in the late 1980s and declines in other UK cockle stocks (e.g. in the Welsh Dee and**

[11] Bratton, J. H. (1991) British Red Data Books: 3. Invertebrates other than Insects. JNCC, Peterborough

	poorly vegetated ground shaded by willows[8]. It is thought to be a relatively recent colonist to the UK with a stronghold in Eastern. Europe, but is known from several sites along the Thames in Zone 1 (Isleworth Ait; Old Deer Park, Richmond; Brentford Ait West and East; Syon Park; corporation Island, Richmond)[9]. **Thames door snail *Balea biplicata* RDB 3 (rare) (formerly known as *Lacinaria biplicata*). Surviving colonies concentrated on the banks of the River Thames at Kew, Richmond, Isleworth, Chiswick and Purfleet. It inhabits ground litter among nettles and under willows, though not in marshy places - frequently associated with human rubbish. At Purfleet it lives on a dry overgrown band of chalky ground. Mainly a central European species thought to have been accidentally introduced to the UK possibly in Roman times.** Chinese mitten crab *Eriocheir sinensis*, is a non-native exotic species of crab that is known to occur as far west as the River Colne within the Thames catchment. It is thought to have colonised UK waters from Germany where it was introduced in 1912[10] from the far East.	is most abundant within Zone 3 and often occurs in high abundances > 80,000m^2, with the mud burrows providing habitats. for other invertebrate species e.g. the isopod *Sphaeroma rugicauda*. The RDB 3 category describes species that are not likely to exist in more than 15 10km squares of the National Grid. Given its now established presence in a large proportion of the tidal Thames (not known at the time of publication of the RDB), its status as a RDB species is debatable. Shore crab *Carcinus maenas* has been observed on the foreshore as far up as Woolwich. **The most upstream distribution of the polychaete annelid worm Ragworm *Nereis diversicolor* is known from the foreshore at Cuckholds Point opposite Limehouse basin.**		**the Wash) the Thames cockle fishery expanded rapidly and is now the most productive in the UK. Cockle harvesting is closely.** **monitored and regulated by the Kent and Essex Sea Fisheries Committee.** **The ragworm *Nereis diversicolor* is regarded as a key prey item for the following species of wading birds: avocet, ringed plover, oystercatcher, grey plover, redshank, dunlin, bar-tailed godwit, and black-tailed godwit.**

[8] Kerney, M. (1999) *Atlas of the Land and Freshwater Molluscs of Britain and Ireland*. Harley Books.
[9] Killeen, I. (1999) Distribution and conservation Status of Perforatella rubiginosa (Pulmonata: Helicidae) in Britain. Journal of Conchology, 36 (6),:29-41.
[10] Clark, P. F, *et al* (1998) The Alien Chinese Mitten Crab, *Eriocheir sinensis* (Crustacea: Decapoda: Brachyura), in the Thames Catchment. *Journal of the Marine Biological Association of the United Kingdom*. **78** (4): 1215-1221.

Birds

Redshank *Tringa totanus*

Background

Redshank is a medium-sized olive-brown wader that is dependent upon moist or wet ground conditions in open flat or gently sloping lowlands, valleys and coastal saltmarsh for breeding, migration stop over, and wintering. Redshank is polytypic with six sub-species described by Cramp & Simmons (1983) – two of which two occur in Europe but are indistinguishable in the field.

Redshanks are critically dependent upon high-water tables and local saturation of soils in open sites with short ground vegetation that lack closed stands of shrubs and trees. Within the UK, these habitat conditions are typified by low/moderately grazed wet floodplain grassland, grazing marsh and coastal saltmarsh. Sites that provide these conditions along with standing shallow pools of open water well into the early summer are thought to be optimal for redshank breeding.

Redshank are known to feed on a wide variety of invertebrate prey species, but typically will feed only a limited range of items: crustaceans, molluscs and polychaete worms on estuarine sites, and earthworms and cranefly larvae from moist soils inland. Non-biting midge larvae taken from shallow pools of standing water and water-filled drainage ditch margins associated with wet grassland-type habitats are also reported to be an important redshank food source. Redshank diet and method of feeding varies considerably with season (reflecting invertebrate prey species availability for example) and habitat type. Coastal habitats offer the greatest potential range of invertebrate prey than inland sites, with birds being able to take advantage of inter-tidal feeding areas (e.g. estuarine mud and tidal creeks), as well as nearby wet grassland/grazing marsh.

Breeding Population

Redshank breeds in nearly all European countries. Within the UK, however, the highest breeding densities are found on the north Norfolk coast and the western Isles of Scotland. A suite of four SPA sites that reflect this distribution pattern, has been selected on the basis that together they support about 5% of the UK breeding population, and about 3% of the international breeding population.

Redshank are ground nesters, laying eggs from early April in shallow scrapes in the ground, or on depressions formed on grass tussocks. These nesting structures are frequently lined with grass or leaves, and often possess intertwined overhanging leaves and stems that form a partial or complete canopy over the eggs and a side opening.

Non-breeding Population

Non-breeding redshank (passage migrants and winter visitors) occur around most of the UK coastline, and on some inland wet grasslands, with approximately 70% occurring on estuaries. Twenty-seven SPA sites have been designated on the basis that they each support more than 1% of the international non-breeding population. Together they include all the main UK wintering areas of redshank spread from the Moray Firth in north-east Scotland, to sites on the west, east and south coasts of England. All are multi-species SPAs, of importance for a range of other waterbirds. Of relevance to the current study, is the inclusion of the Thames Estuary and Marshes SPA within this suite of sites with the site being reported to support over 1000 wintering.

Breeding Distribution along the Thames

Redshank is mainly a winter visitor and passage migrant within the central London area because suitable permanent habitat conditions are limited. Redshank is, however, reported to be opportunistic, and is known to utilise suitable ephemeral habitats found in association with man-made industrial activity e.g. gravel extraction, water storage (reservoirs) and sewage treatment for both breeding and non-breeding use. Pulverised fuel ash storage lagoons associated with power stations along the lower reaches of the Thames have also provided suitable (but ephemeral) habitat conditions for redshank.

The coastal and estuarine saltmarsh and wet grassland/grazing marsh habitats of Essex and north Kent are a stronghold for redshank within the study area (see Figure 10a). The total Essex breeding population (i.e. includes areas outside the study area) was estimated to be in the range of 1,100-1,300 breeding pairs in 1996, while the total Kent population was estimated to be between 675-1,050 breeding pairs between 1988-1994.

Redshank has suffered a moderate contraction in its range within the study area, probably due to the loss and fragmentation of suitable wet grassland type breeding habitat as direct result of drainage and agricultural intensification since the 1970s. In addition to direct habitat loss and changes in the management regime of previously suitable holding areas, future threats to redshank habitat occur in association with habitat loss and/or disturbance resulting from sea-level rise, coastal squeeze, and general development along the Thames.

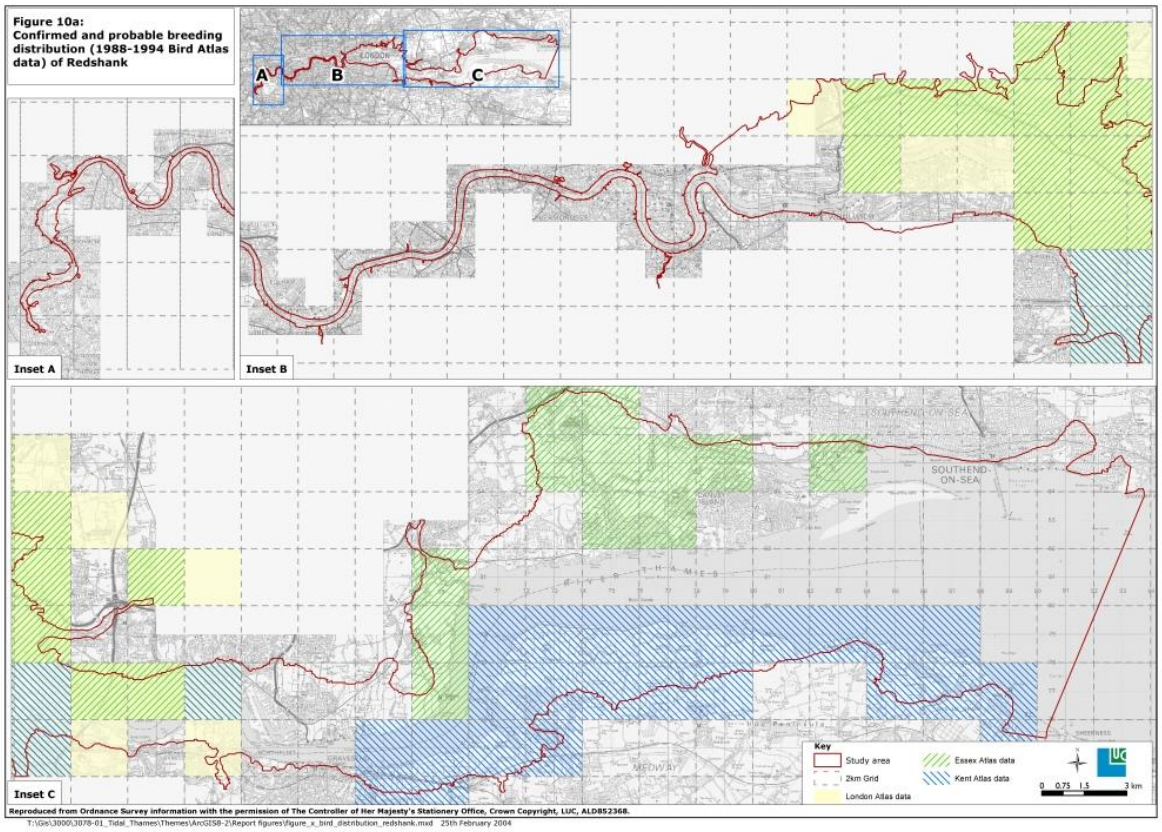


Figure 10a: Confirmed and probably breeding distribution of Redshank

Avocet *Recurvirostra avosetta*

Background

Avocet is a medium-sized black and white wader with a long black up-curved bill and long grey legs. It is a migratory bird, found throughout Europe, but is largely restricted to coastal areas. It is found breeding, over-wintering and on passage in Britain. It has specialised habitat requirements and is normally found only in shallow water coastal habitats, notably saline lagoons that possess bare or sparsely vegetated islands and banks that provide nesting habitat.

Aquatic invertebrates form the main part of an avocet's diet, with insects, crustaceans, and worms being gleaned from loose mud from suitable shallow waterbeds by sweeping its bill from side to side and locating prey by touch.

Breeding Population

Avocet breeds throughout Europe, North Africa and Southern and Eastern Asia in a series of isolated areas. In the UK, the breeding population is concentrated on the coasts of East Anglia, Norfolk, Suffolk, and North Kent. Nesting has also been recorded on the coasts of Lincolnshire, Yorkshire, and Sussex, while attempted breeding has occurred inland in the London area, at Rutland Water, and on the Ouse Washes, indicating a continuing expansion in range. The vast majority of UK breeding avocet (93%) are found within a suite of six SPA's all of which are

located around the east coast of England from East Anglia to the mouth of the Thames estuary. Together these account for 2% of the total international breeding population – around 550 breeding pairs.

Avocet distribution declined in north-west Europe in the 19th century largely due to habitat loss, hunting and egg-collecting. It became extinct as a breeding species in Britain in 1842, and in Sweden. Both countries were re-colonised early this century, and the breeding numbers along the North Sea increased from 1800 pairs in 1924, to nearly 20,000 pairs in the 1980s. This is thought to be related to better protection, extension of breeding habitat, and improvement in feeding conditions. The increase in the British population is related mainly to habitat creation and management aimed specifically at avocet conservation.

Avocets are ground nesters and use shallow scrapes lined with vegetation (short stems, roots, and leaves) for egg laying. The nest is usually located in open ground near shallow water feeding areas. Eggs are laid from mid-April, and just one brood is produced each year. Where preferred nesting habitat conditions are not available, avocet has been known to use wet grassland for breeding.

Non-Breeding population

Around 4000 avocets are thought to over-winter in Britain, with the highest concentrations using river estuary sites in Devon, Cornwall, and Suffolk. Avocet have only wintered in Britain in relatively large numbers since the mid 1970's, a fact which is attributed to the increasing UK breeding population which tend to remain in the country rather than migrate. Avocet is, however, highly susceptible to cold weather, and substantial mortality can occur in periods of prolonged freezing conditions.

Together, the UK suite of 16 SPA sites, situated largely around the East Anglian coastline, support over 2000 individual birds (1997 data). The Thames Estuary and Marshes SPA support around 22% of the UK wintering population (around 300 birds).

Breeding Distribution along the Thames

Avocet appears to be largely restricted in its breeding distribution within the tidal Thames study area to the lower marine reaches of the river in Kent, and the Cliffe Pools saline lagoon complex (Figure 10b). Kent supports approximately 20% of the UK breeding population (135 pairs in 1994) a striking increase since 1988 when just 35 pairs were recorded in the county.

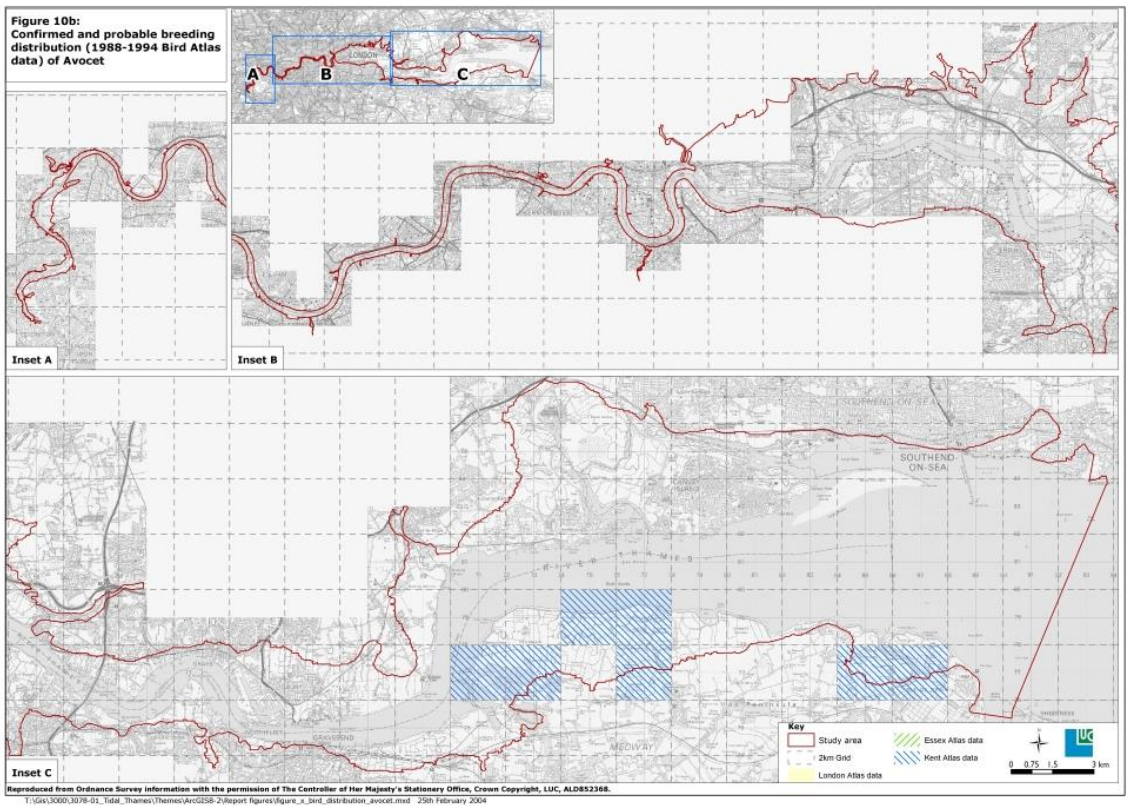


Figure 10b: Confirmed and probably breeding distribution of Avocet

Black-tailed godwit *Limosa limosa*

Background

Black-tailed godwit is a large wader with a long straight bill, long black legs and long neck. It is generally seen in small groups but occasionally in larger flocks of several hundred in the winter. It depends on traditionally managed (low intensity) coastal wet grassland and fen habitat for breeding and feeding and has seen substantial decreases in numbers throughout the 19th century as a result of habitat loss to changing agricultural practice and land drainage. Numbers are, however, gradually recovering in the UK as a direct result of more informed habitat management and creation aimed at meeting the specific habitat needs of this species.

Breeding Population

Black-tailed godwit is polytypic with three sub-species worldwide. In the UK, the nominate race *Limosa. l. limosa* breeds in England, and the Icelandic race *L l. islandica*, breeds in small numbers in Shetland and Orkney.

Black-tailed godwit is a ground nester and requires marsh, damp meadow and/or bog habitat, in which a rudimentary nest scrape hidden within grass tussocks is constructed. Breeding sites tend to be highly localised, and the main breeding areas in Britain are in East Anglia - notably the Ouse and Nene Washes which have SPA status, and together support a significant

proportion of the total UK breeding population (30-50 breeding pairs). Far greater numbers of breeding black-tailed godwit breed in Belgium, the Netherlands and Germany.

During the spring and summer, black-tailed godwit feed on damp soil and ground invertebrates including beetles, beetle larvae, flies, worms, and small molluscs.

Non-Breeding Population

The main concentrations of black-tailed godwit outside the breeding season occur on the estuaries of the Stour and Hamford Water in eastern England, and on the Ribble and the Dee in the northwest. Birds depend upon inter-tidal mud for invertebrate prey when the tide is out, and nearby damp pasture for roosting when the tide is in. The highest numbers of birds occur from mid-August to mid-September (over 16,000 throughout Britain). This is also a time when the Icelandic birds (*L. l. islandica*) have arrived for the winter, and the European birds are still yet to fly south. The Icelandic population remain in Britain over winter.

While the size of the British wintering population is subject to debate, recent research suggests that it is in the order of 12,000 birds. A suite of 27 SPA sites around the British coast, including the Thames Estuary and Marshes SPA is currently estimated to support a total population of nearly 9000 birds. The Thames Estuary and Marshes SPA support around 300 individual birds. Hole Haven Creek SSSI in Essex is also reported to support nationally and sometimes internationally important wintering numbers.

Breeding Distribution along the Thames

Black-tailed godwit is a scarce breeder along the tidal Thames with possible (but not confirmed) breeding records for several sites along the Kent section of the river (Figure 10c). No breeding records exist for the Essex side of the river, although it is reported as ‘summering’ on Rainham marshes but did not show behaviour indicative of breeding.

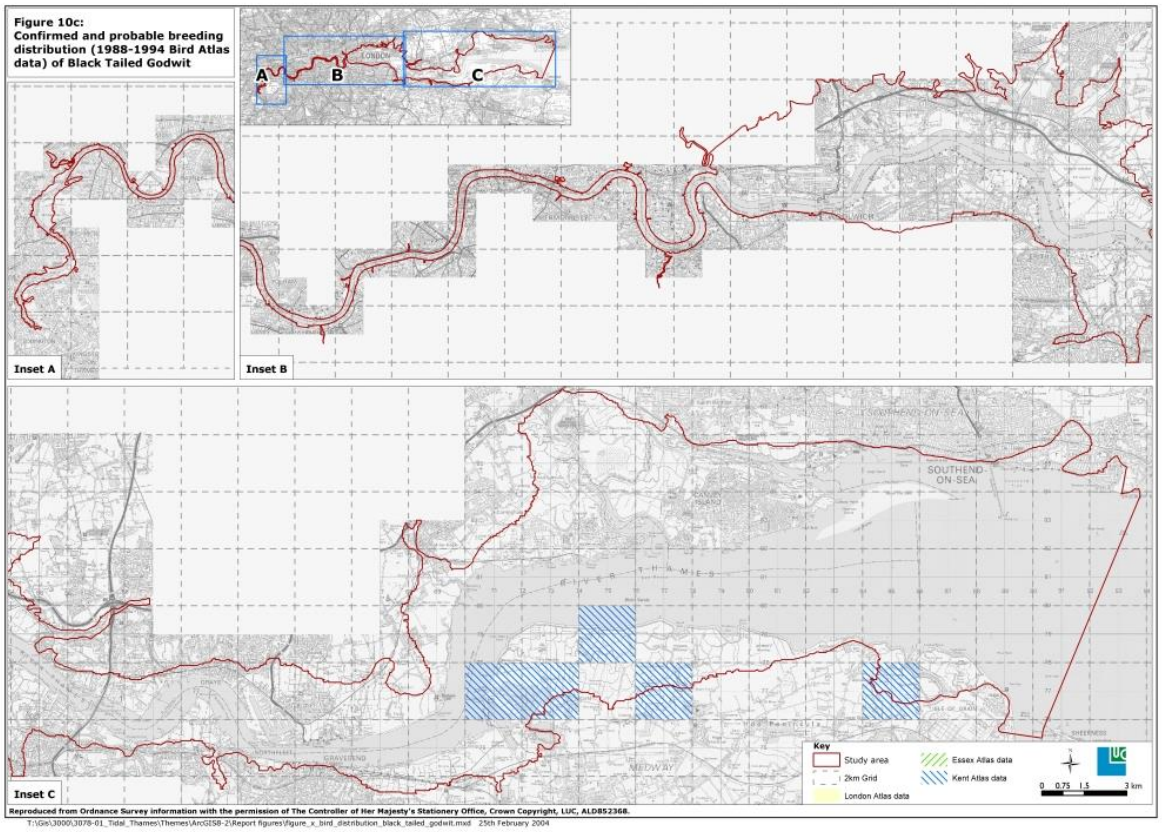


Figure 10c: Confirmed and probably breeding distribution of Black-tailed godwit

Common Tern *Sterna hirundo*

Background

The common tern is similar in size to a small gull, with silver-grey wings and back and short red legs. It occurs throughout the northern hemisphere extending south almost to the equator in West Africa and northern South America. It is a long-distance migrant, wintering mainly in the southern hemisphere. It occupies both coastal and inland regions and is able to utilise a range of habitats for breeding. There are four sub-species, although only *Sterna hirundo hirundo* breeds in Europe.

Common tern is an opportunist feeder, switching rapidly between prey types and feeding methods as circumstances change. Fish form a large part of their diet, particularly small herrings, sprats, and sand eels (saltwater) and roach, perch and minnows (freshwater), which are caught by plunge diving from the air. Shrimps and insects are also eaten. Common tern is generally a solitary hunter, although fish shoals can attract dense feeding flocks.

Breeding Population

Common tern is a ground nesting species that can utilise a variety of coastal and inland habitats for nesting. Along maritime coasts, it favours flat rock surfaces on inshore islands or islets, or open shingle and sand on upper beaches or in dunes. It will also use undisturbed mainland peninsulas, sand or shingle spits, or saltmarshes. Inland breeding is common in

central, eastern, and southern England especially on rocky or stony islands in freshwater lakes, on shingle banks in rivers, or artificial sites such as patches of dumped dredging material, gravel-pits, and rafts. Even flat gravel-covered roofs of buildings close to feeding sites are used occasionally.

A large proportion of the British breeding population breeds in Scotland, notably in the northern and western Isles, and on the west coast. Coastal colonies in England are mainly concentrated in the north-east, East Anglia, at a few localities along the south coast, and in the north-west. Inland breeding takes place mainly in eastern Scotland and in central, eastern, and southern England.

Although the common tern utilises a wide range of habitats for breeding, nests are nearly always constructed on the ground and in the open - usually on a bare or sparsely vegetated substrates. A scrape is constructed in which eggs are laid from mid-May.

The British breeding population is estimated by JNCC to be around 12,000 pairs (1993 data). There was a decline in the population during the 20th century as well as a shift northward in distribution, with fewer birds breeding in England and more in Scotland. These declines were attributed mainly to loss of natural nesting habitat resulting from development pressure and increased recreational disturbance.

A total of 22 coastal SPA sites located throughout the UK together support about 50% of the estimated common ten breeding population in the UK. The nearest SPA to the Thames study area is Foulness SPA on the Essex coastline.

Non-Breeding Population

Common tern is a long-distance migrant, and the British breeding population winters along the coastline of West Africa.

Breeding Distribution along the Thames

Common tern is widely distributed throughout the study area, utilising a variety of habitats types for breeding (Figure 10d). Breeding numbers within the London area have increased since the first record in 1958 at Queen Mary Reservoir (outside the study area). Increases in breeding success within London are attributed to several factors, the most notable being the increased availability of suitable nesting sites associated with flooded gravel workings where low shingle islands provide relatively predator free nest sites around the London fringe.

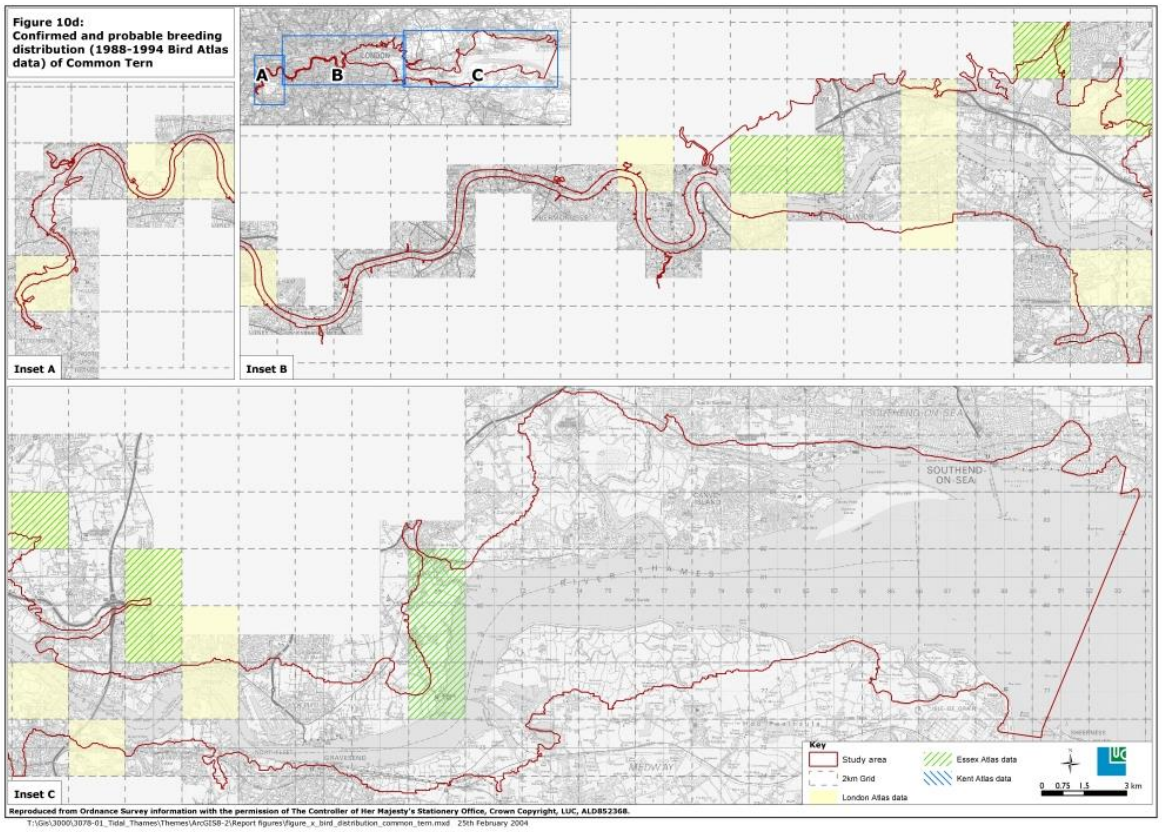


Figure 10d: Confirmed and probably breeding distribution of Common tern

Since this time, a conservation initiative originally aimed to counter loss of nest sites to rising water levels around gravel pits has been implemented in London with great success. Floating gravel-topped rafts have been installed in several sites across the capital, including Royal Victoria and Albert Docks, East India Dock, and Blackwall Basin along the Thames, and have significantly contributed to an increase in common tern breeding in the London area.

Common tern can be seen at many locations along the Thames diving for fish, with particularly large groups at the end of the summer and in early autumn on route to wintering grounds in Africa.

Grey Heron *Ardea cinerea*

Background

Grey heron is a large, long-necked wetland bird that occurs throughout Europe and in parts of Africa and Asia.

Fish form the major constituent of its diet, a fact for which they have been persecuted in the past. In freshwater, prey species are wide ranging and include for example, eel, roach, perch, stickleback, and goldfish (from ornamental ponds). In coastal areas heron will feed on, eels, flounders, wrasse, and crabs are frequently eaten. Other prey occasionally includes small mammals, birds, amphibians, crustaceans, reptiles, and insect larvae.

The distribution of heron in the UK is closely linked with the distribution of suitable waters (for feeding) and trees (for roosting and nesting). A range of aquatic and wetland habitats will be used, including slow-flowing rivers, canals, streams, ponds, lakes, gravel-pits and reservoirs, oxbows, deltas, marshes, ditches, and estuaries.

Breeding Population

The British breeding population was estimated at 10,300 nests in 1991 but is thought to have increased significantly since then. Herons breed in colonies (heronries) in treetops and construct large nests made from sticks with several nests occupying the same tree. Where suitable trees are not available, heron has been recorded nesting on the ground, particularly in reed beds.

Non-Breeding Population

North European grey herons are reported to frequently migrate to eastern England to over-winter. It is also considered likely that there are local movements between breeding and wintering grounds within the UK which probably relate to regional differences in the winter food availability at individual sites.

Breeding Distribution along the Thames

Grey heron is found along virtually the whole of the Thames estuary, and is absent from only the most disturbed stretch in central London where suitable nesting sites are absent (Figure 10e). Heron is present on the Thames throughout the year, with many nesting sites located on islands (aits) within the Thames itself and can be seen frequently fishing and foraging along the foreshore.

Records of heronries within the study area include:

- Rainham Marsh – 20 occupied nests on Aug 4th 1999
- Brentford Ait, 23 pairs 1998
- Isleworth Ait, 7 pairs 1998
- Corporation Island, 6, 1998
- Crossness, 13 pairs, 1998
- Thamesmead, 13 pairs, 1998

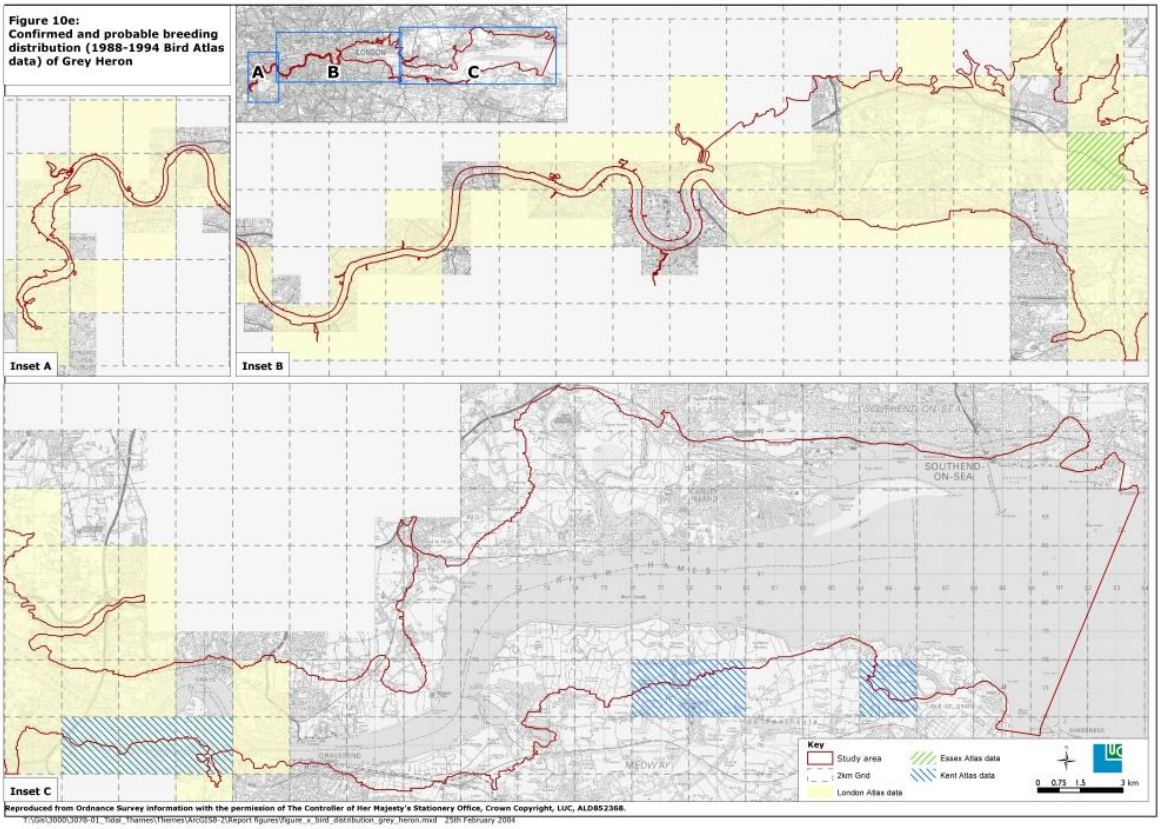


Figure 10e: Confirmed and probably breeding distribution of Grey Heron

Ringed Plover *Charadrius hiaticula*

Background

Ringed plover is a small wader with a round head, short orange bill and legs. It has a wide breeding range that includes the Arctic and the temperate coasts of north-western Europe, as well as a few inland areas of Europe. Two sub-species are recognised, *Charadrius h. hiaticula*, and *C. h. tundrae*.

Ringed plover is mainly a bird of maritime coastal habitats, but will also occupy adjoining hinterland areas including estuaries, rivers, lakes, tundra, gravel-beds, sandbars, and grasslands of sparse and low growth. It is also known to use artificial inland sites where habitat conditions are suitable. These are frequently provided, for example, by development related site clearance activity that leaves bare open substrates, and sand and gravel extraction operations. However, ringed plover tends to be most abundant and concentrated on wide sandy or shingle tidal beaches, with access to suitable resting or nesting places above the highwater mark.

Ringed plover search for food close to their roosting sites on sand and shingle shores, sandbanks and mudflats, saltmarsh, short grassland, and flooded fields. Their diet includes small insects, worms, crustaceans, shrimps, marine snails, beetles, spiders, and small fish.

Breeding Population

Only *C. h. hiaticula* breeds in the UK, and England forms the southern edge of its breeding range. The UK breeding population is based mainly on coastal sand, gravel and shingle beaches, upper saltmarshes, and artificial habitat such as the shores of gravel pits and reservoirs. Short-grazed coastal pastures, Machair – Outer Hebrides and arable fields in eastern England may also be frequently used.

Nests are typically scrapes on the ground located in open disturbance free situations sometimes sheltered by short vegetation. The UK breeding population is estimated to be around 8,500 pairs (1997 data).

A suite of five SPA designated sites supports approximately 13% of the UK ringed plover breeding population. Four of these are off the west coast of Scotland, with the north Norfolk Coast SPA representing England. Together these sites account for 13% of the British breeding population, and 7% of the international breeding population.

Non-Breeding Population

Non-breeding passage or wintering birds are found around the coastline of much of Britain and Ireland, with small numbers found on a few inland wetlands. There are 24 SPA designated sites throughout Britain and Ireland which together support passage and wintering populations in late summer/early autumn and winter, respectively. Of particular significance with respect to the current study, is the importance of Benfleet and Southend Marshes SPA and the Thames estuary and Marshes SPA for passage migrants. Each site supports an estimated 800 and 600 birds respectively which together represent nearly 3% of the UKs passage population of ringed plover.

Breeding Distribution along the Thames

A variety of habitats along the tidal Thames are used by breeding ringed plover (Figure 10f). Plovers are widely distributed along lower reaches of the river along Essex and Kent and into London where they have been recorded breeding on sand and shingle beaches along tidal creeks, settlement and PFA lagoons and as occasional breeders on grassland close to seawalls. Within the London area breeding records are mainly from sewage treatment work, gravel pits and reservoir sites.

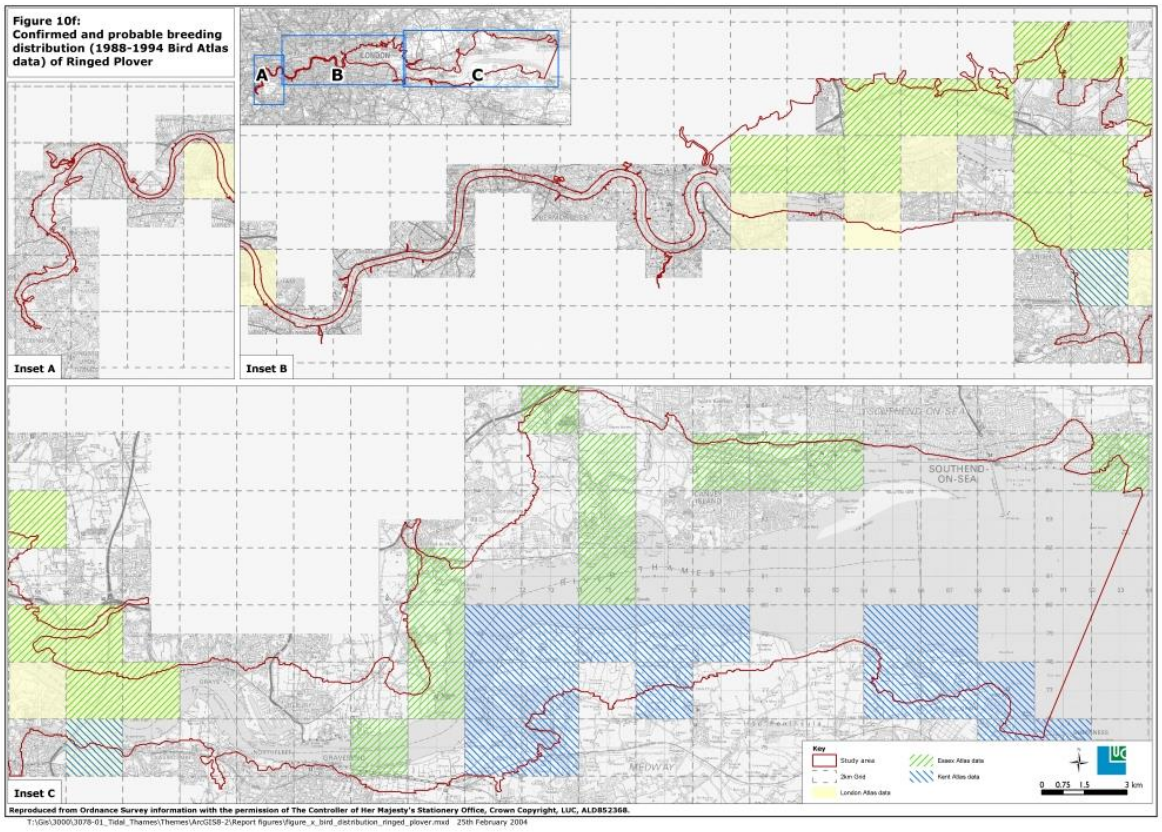


Figure10f: Confirmed and probably breeding distribution of Ringer Plover

Shelduck *Tadorna tadorna*

Background

Shelduck occurs discontinuously throughout Europe to central Asia, and south to Iran and Pakistan. It has very specific habitat preferences, favouring warm semi-arid and mild maritime climates. It depends on salt or brackish water, either on shallow coasts and estuaries or inland seas and lakes. In recent years, inland sites inlcuding gravel workings and reservoirs have been adopted.

Shelduck has a coastal distribution in Britain, with inter-tidal sands and mudflats forming the main foraging areas. The snail Hydrobia is a major component of their diet, although other invertebrate prey items including worms, sandhoppers and fly larvae, shellfish, crabs, and shrimps are also eaten.

Breeding Population

Shelduck are hole nesters, with the entrances of disused rabbit burrows amongst dense vegetation making preferred nesting habitat, although trees and buildings are also occasionally used. Nests are formed from vegetation and lined with duck down.

Up to 50,000 shelduck are estimated to occur around the coastline of Britain during the breeding season, although only around 12,000 are thought to breed regularly. The UK

population is increasing, with a trend towards increased inland breeding thought likely to be due to overpopulation of coastal sites.

Non-Breeding Population

Many British birds migrate to traditional moulting areas after the breeding season– notably Heligoland Bight off the German coast, where thousands of shelduck congregate every year. Significant late summer moulting congregations also occur in the UK, notably on the Humber estuary, the Wash, Bridgewater Bay in the Severn estuary and the Firth of Forth. During moulting, birds are temporarily flightless until flight feathers re-grow.

Wintering shelduck are widely distributed around the UK coast, with notable concentrations occurring along the estuaries of East Anglia, the south coast of England, the Severn Estuary, north-west England, eastern Scotland, and the east coast of Northern Ireland.

An estimated 84% of the wintering UK population (around 70,000 birds) are supported by a suite of 32 SPA designated sites, all located around the coastline of Britain and Ireland. The Thames Estuary and Marshes SPA is one of these sites and is reported to support around 2000 wintering birds (<1% of the total UK wintering population).

Breeding distribution along the Thames

Shelduck is widely distributed within the tidal Thames study area where suitable feeding and roosting habitat occurs, Notable breeding areas include Rainham Marshes, Rainham gravel pits, Berwick Ponds, and West Thurrock (Figure 10g).

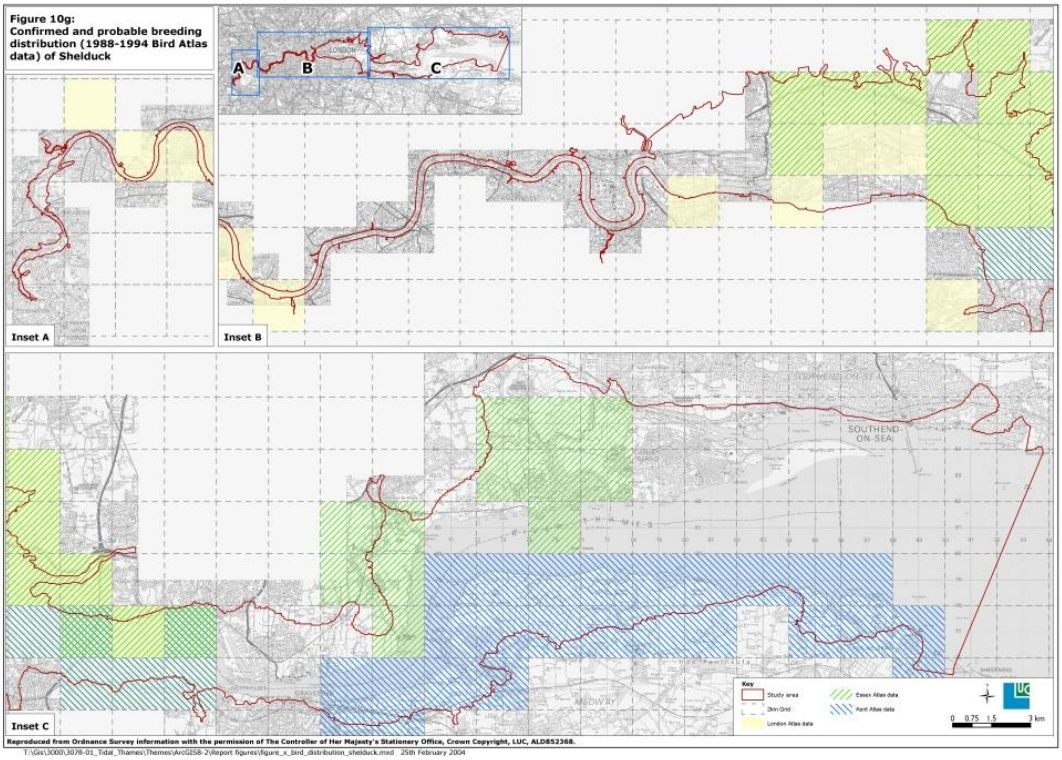


Figure 10g: Confirmed and probably breeding distribution of Shelduck

Teal *Anas Crecca*

Background

Teal is a small duck of which the males are particularly distinctive possessing a chestnut brown head and dark green eye patch extending to the back of the head. It is a migratory species with a wide global distribution across Eurasia and North America. There are three sub-species of teal, but only *Anas crecca* occur Britain.

Teal have a varied diet, feeding in both shallow waters pecking from the surface and filtering water through its bill, or up-ending to feed on submerged plant material and invertebrates. Their diet consists mainly of seeds from a variety of plants, although they also eat aquatic molluscs, fly larvae, water beetles and worms.

Breeding Population

Teal have a wide global distribution across Eurasia and North America, breeding in boreal regions on both continents. They depend on wetland habitats including moorland, bog, and marsh in upland and coastal locations for breeding habitat. Typically, teal depend upon small outlying or isolated pools, ponds, lagoons, oxbows, and slow flowing streams with extensive emergent vegetation as breeding habitat. Nests are constructed on the ground in hollows close to the waters and are lined with vegetation and duck down.

The British breeding population has suffered a significant contraction in range over the last thirty years, falling by at least a third since 1970. There are now only an estimated 2,600 pairs regularly breeding in Britain, located mainly in the north of England and north and west Scotland.

Non-Breeding Population

Large numbers of teal over-winter in Britain and Europe wherever inland and coastal wetland sites provide suitable damp ground conditions for feeding.

The British non-breeding teal population is estimated to be around 136,000 individuals, of which around 47% are supported in a network of 30 SPA designated sites, located around the British and Irish coasts. The Inner Thames Marshes SSSI supports over 1,000 wintering teal that are attracted to the site by the reinstatement of pumping operations on the silt lagoons at Rainham Marsh.

Distribution along the Thames

Teal is an uncommon breeding bird in the tidal Thames study area. Specific sites that regularly hold low numbers of breeding birds include Cliffe Lagoons (Kent) and Rainham Marshes (Essex) for example. It is estimated that a maximum number of 10 breeding pairs of teal occur across the entire county of Essex, with a similar total numbers of breeding birds being estimated for Kent, and less than 5 confirmed breeding pairs in the London area.

Teal is a common and widespread throughout the study area in the winter either in large flocks on suitable wetland sites or as small groups of individual birds seen foraging along the Thames foreshore (Figure 10h).

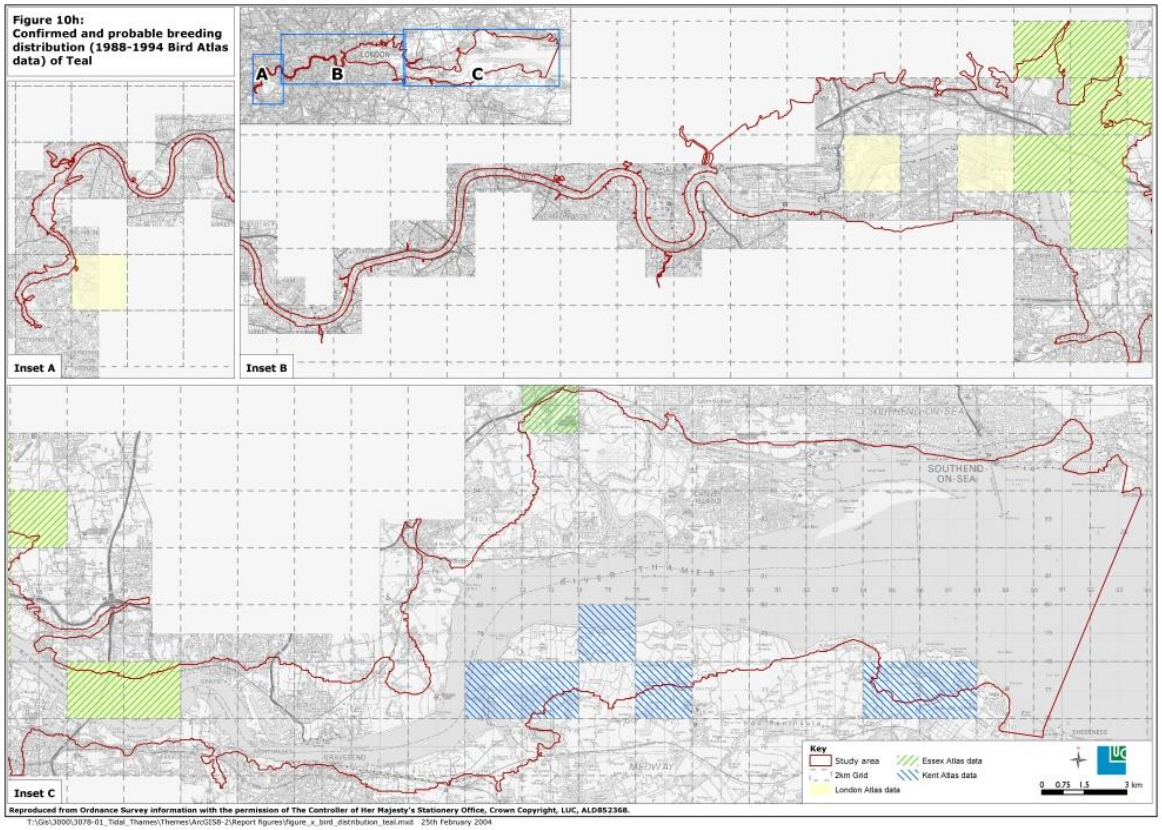


Figure 10h: Confirmed and probably breeding distribution of Teal

Dunlin *Calidris alpina*

Background

Dunlin is the smallest common wading bird in the UK, and occurs as a breeding resident, passage migrant, and as over-wintering birds. Dunlin has a wide global distribution, but has specific habitat preferences, namely moist boggy ground devoid of dense vegetation.

The vast majority of dunlin that over-winter in the UK is of the sub-species *Calidris alpina alpina*, although *C.a. artica* stops off as a passage migrant. The sub-species *C.a. schinzii* is the main breeding species in Britain.

Breeding population

Dunlin's preferred breeding habitat is upland moorland. Within the UK, highest breeding concentrations occur in the Flow Country of Caithness and Sutherland, and peat moors in the Orkneys, Shetland, Grampians, Pennines, and Outer Hebrides in Scotland. Small numbers also breed in the Southern Uplands of Scotland, and the hills of central Wales and Dartmoor. The total UK breeding population is estimated to be around 9,000 breeding pairs (1997 data).

Dunlin nest on the ground, typically on a tussock or under low vegetation in an area of moist boggy ground with pools or flowing water.

A suite of seven upland SPA's in the north of England and Scotland together support around 7000 breeding birds (circa. 75% of the UK breeding population).

Non-Breeding population

After lapwing, dunlin is the most numerous waders to winter in the UK and is found on estuaries and open coasts throughout the country. They are highly site-faithful, moving little between wintering areas either within or between years, and occur in particularly high densities in estuaries.

The UK has a suite of 28 SPAs (all estuarine) which together support well over 420,000 wintering birds (circa 80% of the total wintering population in the UK). Within this suite of sites, two occur within the tidal Thames study area, Benfleet and Southend Marshes SPA and Thames Estuary and Marshes SPA. Both sites each support over 11,000 wintering birds.

Dunlin feeds depend upon inter-tidal mud for a range of food prey items including invertebrates, molluscs, microscopic crustacea and worms at low tide, and adjoining saltmarsh, grazing marsh or other structures above the waterline for roosting when the tide is in.

Several abandoned barges occur within the Thames near Rainham marsh and are used frequently be roosting dunlin in large numbers with up to 3,000 roosting birds being recorded at high tide in the winter. The PFA lagoons at West Thurrock power station have also been reported to be an important high tide roost site for dunlin, but since its operational abandonment and gradual drying out, their value as a roost site has declined dramatically.

Breeding Distribution along the Thames

Dunlins are not known to breed within the tidal Thames study area, and a breeding distribution map for this species has not been produced.