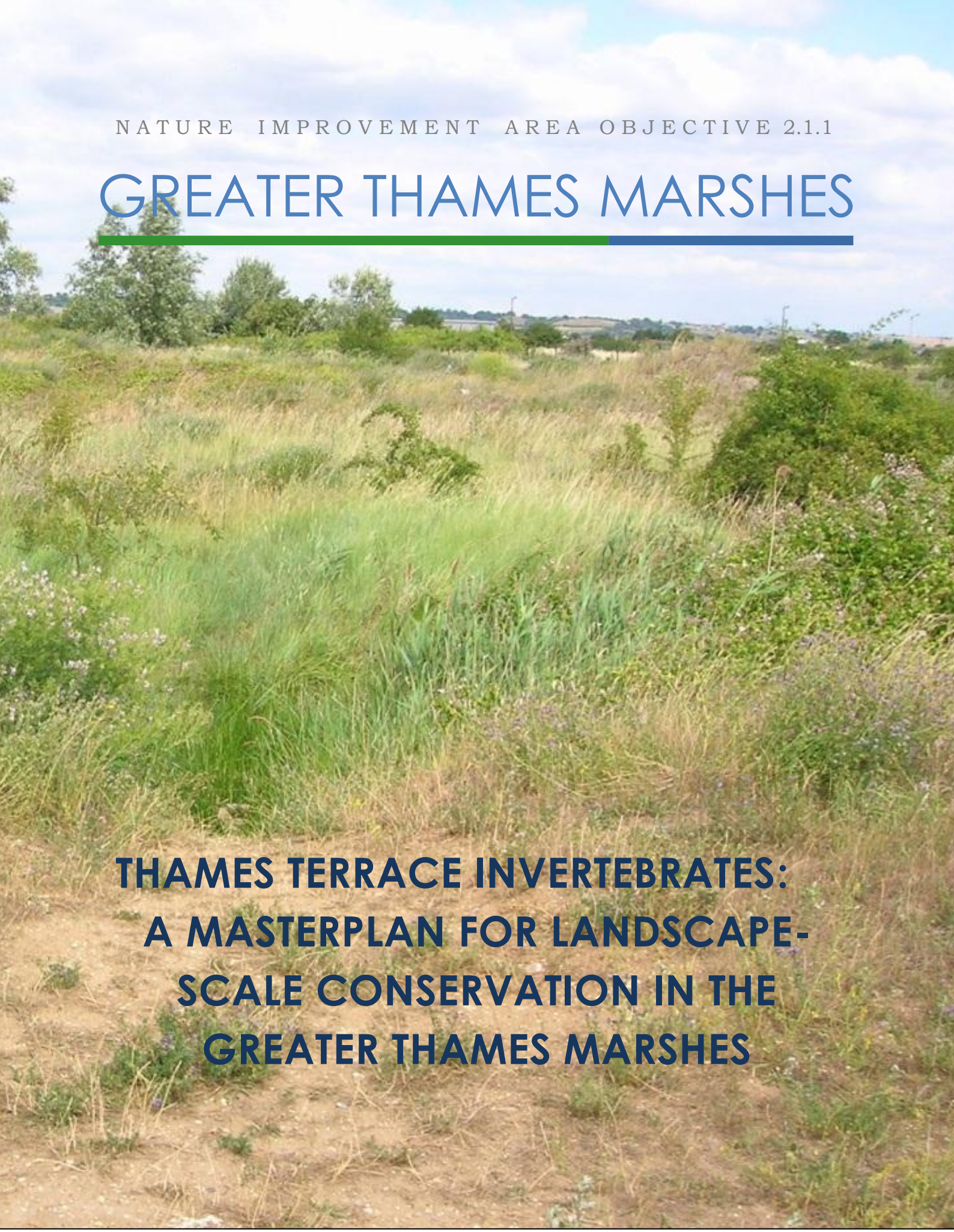
NATURE IMPROVEMENT AREA OBJECTIVE 2.1.1

GREATER THAMES MARSHES



THAMES TERRACE INVERTEBRATES: A MASTERPLAN FOR LANDSCAPE-SCALE CONSERVATION IN THE GREATER THAMES MARSHES

Essex County Council

place services

buglife

UEL University of East London

NATURAL ENGLAND

CONTENTS

INTRODUCTION

'Thames Terrace Invertebrates: a Masterplan for landscape-scale conservation in the Greater Thames Marshes' is a partnership project between Essex County Council, Buglife and the University of East London to create a coherent ecological network for Thames Terrace Invertebrates in the Greater Thames Marshes Nature Improvement Area. The project builds on previous pioneering work, targeting eight sites and three flagship species. It outlines what we currently know and sets the scene for future work, identifying gaps in our knowledge and recommendations for delivery on the ground. It marks the start of what we hope will be a more substantial effort to conserve the full range of Thames Terrace Invertebrates and their habitats.

This Masterplan document will outline the full scope of the project and the planned outputs.

- Section 1 is an introduction to the Greater Thames Marshes Nature Improvement Area, Thames Terrace Invertebrates and their habitats. It describes the habitats and species that will be targeted for action within this project.

- Section 2 will assist local authorities to understand the policy background for this project and for protecting valuable Thames Terrace habitats and species. It contains a strategic evidence base outlining the need for action and recommendations for how the planning system can ensure that priority habitats and species are protected and enhanced.

- Section 3 contains management guidance to help nature conservation professionals and land managers create and manage Open Mosaic habitats.

- Section 4 sets-out the action that will taken to deliver the objectives of this project. It contains site descriptions, management recommendations and delivery schedules for each site to guide management interventions and a monitoring framework to evaluate the outcomes.

INTRODUCTION TO THE NIA & TTI

SECTION I

INTRODUCTION TO THE GREATER THAMES MARSHES NATURE IMPROVEMENT AREA, THAMES TERRACE HABITATS AND ASSOCIATED INVERTEBRATES

The Greater Thames Marshes Nature Improvement Area

The Greater Thames Marshes Nature Improvement Area (NIA) is one of 12 NIAs across England. NIAs are pilot schemes running from April 2012 – April 2015 funded by the Government, aiming to create ecological networks in strategic locations to benefit wildlife and people. They were a major initiative of the Natural Environment White Paper in 2011, and were set up to fulfil the recommendations in Sir John Lawton's 'Making Space for Nature' review, for 'Ecological Restoration Zones' to deliver significant improvements to biodiversity for wildlife and people.

NIAs aim to deliver through:

- Sustainable use of natural resources
- Restoring and creating wildlife habitats
- Connecting local sites
- Joining up local action on a landscape scale

The central tenet of 'Making Space for Nature' and our NIA is for habitats that are 'more, bigger, better and joined-up'.

Our vision for the Greater Thames Marshes Nature Improvement Area is for

"a living and vibrant marshland and estuary landscape where the skills and enthusiasm of residents, visitors, businesses and technical experts are harnessed to work in partnership, delivering more wildlife, more public understanding and enjoyment of the environment and greater resilience by the natural world to the changes brought about by development and climate change"

For more information:

- about NIAs see the Defra (Department for Environment, Food and Rural Affairs) website: http://www.defra.gov.uk/environment/natural/whitepaper/nia/

- about The Greater Thames Marshes NIA and links to the business plan: greaterthamesmarshes.com

- Sir John Lawton's review 'Making Space for Nature': http://archive.defra.gov.uk/environment/biodiversity/documents/201009space-for-nature.pdf

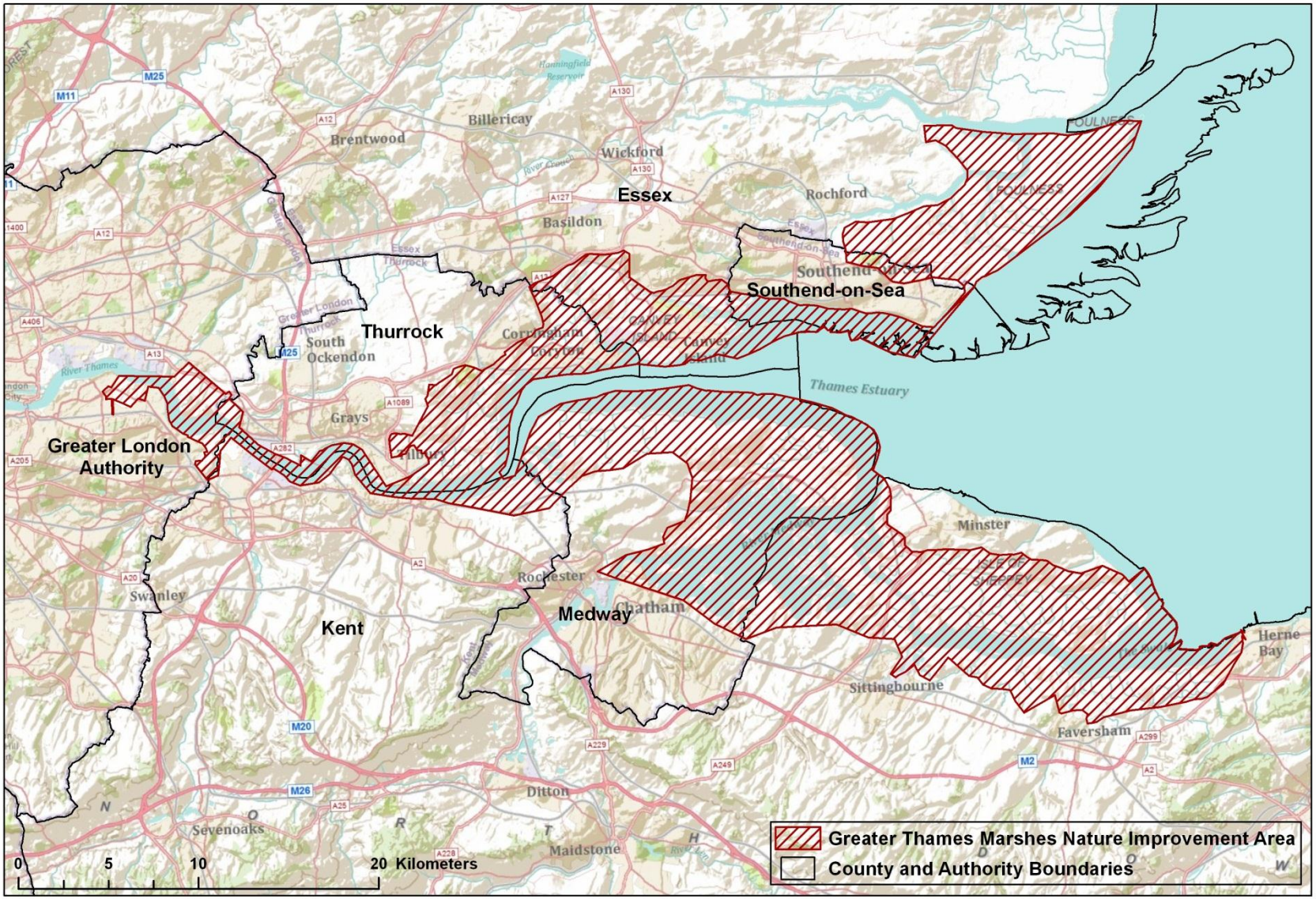


Figure 1. The Greater Thames Marshes Nature Improvement Area

THE NIA LANDSCAPE

The Greater Thames Marshes Nature Improvement Area encompasses a coherent natural landscape across South Essex, Greater London and North Kent of 48,981ha of estuarine and marshland landscape (Fig. 1). It recognises the estuary as an entity, and that although divided between counties, it functions as one landscape.

The Greater Thames Marshes landscape is low-lying, averaging 9m above sea-level. The salt marshes built up over several centuries from material carried south along the Essex coast by the tide, but have reduced over the previous few decades due to sea-defences preventing material being carried south by the sea. The coastline is highly indented, dominated by shallow, tidal winding creeks dissecting mudflats, sandflats and saltmarsh. This is unusual compared to the neighbouring coasts to the north and south. The estuary is highly urbanised with several centres of development, notably much of Thurrock, Basildon, Southend and Medway. The area has a unique climate compared to the rest of the UK, with hot, dry summers and mild winters.

The Importance of the Area

People

The Eastern Thames is one of the most rapidly developing areas of the country and has been identified as "the largest regeneration project in Europe" (Farrell 2009). The population is anticipated to increase from 900,000 to 1.6 million people by 2050 with Medway, Basildon and North Kent focusses for growth and development (Farrell 2009).

Wildlife

It is also an area that is crucial for the biodiversity of the UK. It is one of the most important estuaries in the whole of Europe for wintering wildfowl, supporting 20% of the world's entire population of dark-bellied brent geese. It has some of the richest habitats in the UK, supporting rare invertebrates found nowhere else in Britain along with many other protected and priority species such as Skylark and Water Vole. It is a highly designated landscape for biodiversity because of this with the majority of the coastline under European protection (Fig. 2), but it is underperforming in the face of pressures from development, invasive species and climate change.

Invertebrates are Important – why invertebrates?

65% of all the species on earth are invertebrates. There are more than 32,000 species in the UK alone – that is more than the mammals, birds and plants put together. There are many more scarce invertebrates in the south than the north of Britain and the NIA is a particular stronghold. An astonishing 7,850 invertebrate species occur in the Greater Thames Marshes area and more than 100 of these are Red Data Book or Nationally Rare species that are in decline and are a conservation priority.

THAMES TERRACE INVERTEBRATES & THE NIA

This project is part of Objective 2 'Delivery on the Ground' of the Greater Thames Marshes NIA Business Plan. Objective 2 aims to deliver significant improvements to biodiversity within the pilot period by focussing on new projects for habitat creation, restoration and management.

Project Vision

'Thames Terrace Invertebrates: a masterplan for landscape-scale conservation in the Greater Thames Marshes' will focus on new initiatives where bespoke investment could deliver a step-change in biodiversity value. The project aims to deliver a truly coherent landscape-scale ecological network for Thames Terrace Invertebrates (TTI) that will deliver more wildlife and greater resilience. Targeted sites will be in strategic locations and will be left 'more, bigger, better and joined up' as part of a better known and better understood ecological network for TTI insects.'

Project Overview

The Greater Thames Marshes area, particularly in South Essex, supports an incredible diversity of rare and scarce invertebrate species, including 96% of all the aculeate Hymenoptera (Bees, Wasps and Ants with stings) found in Essex and 74% of all invertebrate species found in the UK, including the very rare bumblebees the Shrill Carder bee *Bombus sylvarum*, the Brown-banded Carder bee *Bombus humilis* and the Red-shanked Carder-bee *Bombus ruderarius* (Harvey 2000). These were formerly UK Biodiversity Action Plan (UKBAP) species. The UKBAP was succeeded in 2012 by the UK Post-2010 Biodiversity Framework. Former UKBAP species and habitats are now listed as 'species of principal importance', or Priority species, under Section 41 of the Nerc Act 2006.

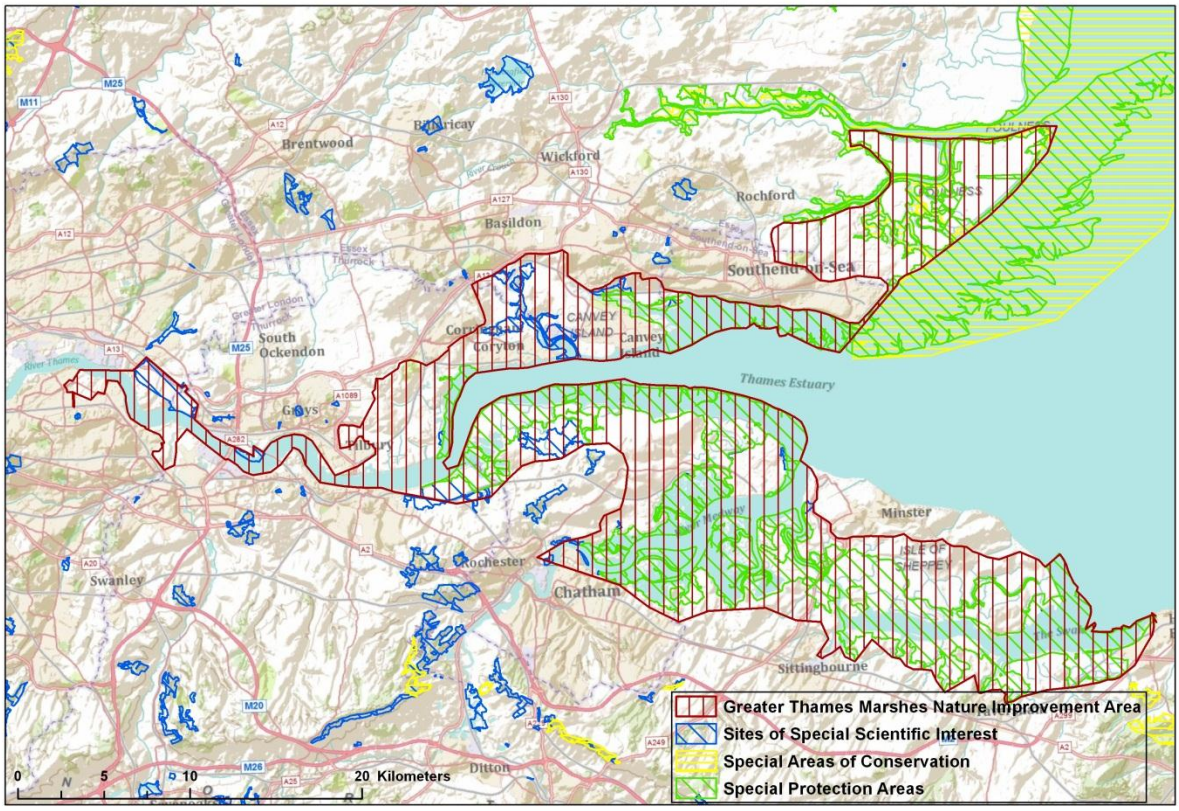


Figure 2. Nationally and internationally designated sites

This astonishing diversity is restricted to a small area under intense development pressure. The area along the Thames is one of the most rapidly developing areas of the country and has been described as 'the largest regeneration project in Europe' (Farrell 2009). The population is expected to increase by nearly 80% by 2050 as people are drawn here by new opportunities. The needs of development and the needs of biodiversity in this area often compete.

Many of the rare invertebrates depend on open, species-rich grassland, which grows on the sands and gravels along the Thames (Thames Terrace Grassland) and used to be extensive across the area. It has largely been lost due to development and the spread of intensive agriculture and is now restricted to a few isolated fragments of remaining ancient grassland (Fig. 3). Newer grassland that has developed on previously-developed, or brownfield, sites has similar characteristics to the natural Thames Terrace substrates and grasslands and contribute to the habitat resource, but these too are under threat. Many of the invertebrates have undergone drastic declines as a result.

Between habitat loss occurring, and a population going extinct, there is often a delay, as it can take several generations to see the effect of reduced food and nesting habitat. This means that for many of our invertebrate species in the Greater Thames Marshes, the damage is likely to have already been done, and the need for protection of habitat and creation of new habitat is urgent to prevent extinctions taking place (Robins and Henshall 2012). The expertise of the partners in this project and the opportunity to create habitat

across the landscape means we have an excellent opportunity to make a real, positive impact on invertebrate species in the Greater Thames Marshes NIA.

This project aims to draw together the pioneering work of Buglife and University of East London into the importance of Thames Terrace Grasslands and Brownfield grasslands for invertebrates to create an ecological network across the NIA for Thames Terrace Invertebrates. Eight sites will be targeted for action, with the aim of creating a total of 98ha of Priority habitats:

- Open Mosaic Habitats on Previously Developed Land (Open Mosaic Habitats)
- Lowland Meadows
- Coastal and Floodplain Grazing Marsh

Action will be focussed primarily on Open Mosaic Habitats. Some sites will target Lowland Meadows and Coastal and Floodplain Grazing Marsh, which both contain beneficial features for the target species and will contribute to an ecological network containing a variety of habitats.

All three habitats, particularly Open Mosaic Habitats, are crucial for the rare invertebrates of the region and the project aims to create a step-change in biodiversity. It will showcase cutting-edge conservation work and build on Buglife's 'All of a Buzz in the Thames Gateway' and 'Stepping Stones' projects.

It has been stated that there is a 'yawning gulf' between academic research into invertebrate conservation and on-the-ground habitat management to deliver that conservation, and it is not clear whose job it is to bridge that gap (Goulson et al. 2011). This partnership project aims to do just that, pulling research together to implement a coherent landscape-scale ecological network for Thames Terrace Invertebrates.

For more information:

- about Buglife's 'All of a Buzz' and 'Stepping Stones' projects: http://www.buglife.org.uk/conservation/currentprojects/Habitats+Action/Brownfields
- the UK Post-2010 Biodiversity Framework http://jncc.defra.gov.uk/page-6189

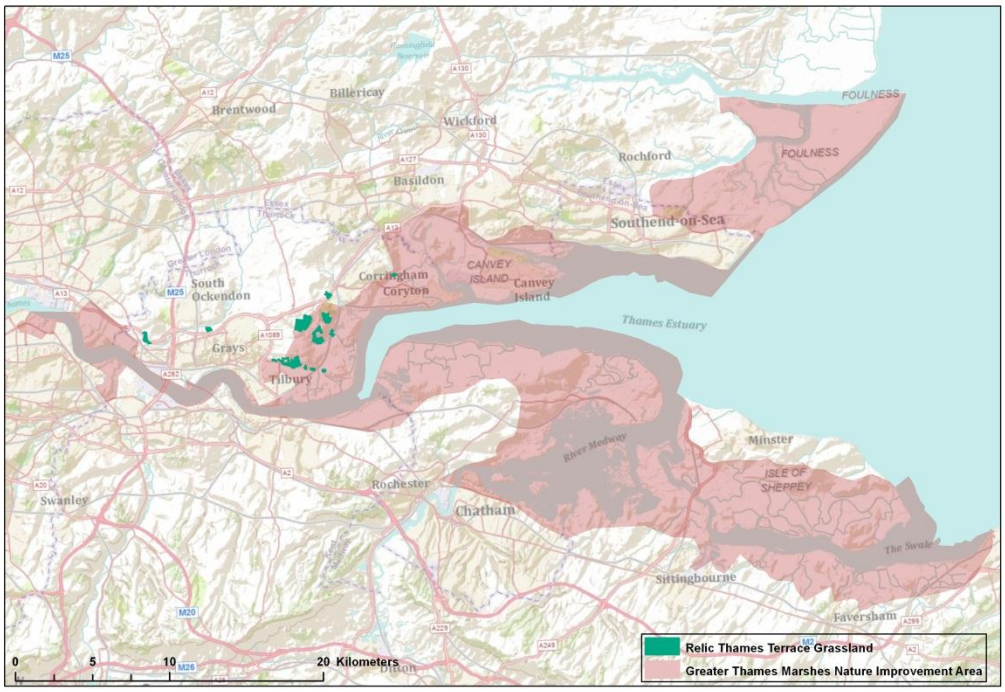


Figure 3. Relic Thames Terrace Grassland

THAMES TERRACE HABITAT PROFILE

Origin

400,000 years ago, as a glacier advanced southwards over the UK, the River Thames changed course. The resulting floods and glacial waters deposited sands and gravels over most of the Greater Thames Marshes area. These sands and gravels contain few nutrients and drain freely.

Diverse flower-rich grasslands develop on low nutrient substrates as no one species is able to dominate due to the lack of nutrients and water. The free-draining substrate and climate of this area, with drier, hotter summers and milder winters than the rest of the country lead to drought conditions. Drought-stressed plants flower more prolifically than plants in conditions with plenty of water (Bodsworth et al. 2005) and so the flowers of Thames Terrace Grasslands are particularly plentiful.

The grasslands were traditionally lightly grazed by cattle and sheep. This, and the dry conditions prevented woodland developing and much of the area was covered in grasslands until relatively recently.

Characteristics

Thames Terrace Grassland is very open, with only small patches of scrub. There is a mosaic of tall grasses and wildflowers along with shorter areas where the soil has been disturbed by grazing. There are small areas of bare ground where the soil is particularly dry or the sands and gravels slipped. Due to grazing and the low nutrients in the soil the grasslands didn't develop into woodland. Thames Terrace Grassland used to be prevalent along the south-facing slopes of South Essex.

Closer to the estuary behind the traditional clay sea walls built to enclose land for grazing, more nutrient-rich grazing marshes developed, with many ditches, drains and creeks

running through them that in winter would flood, bringing more nutrients and richer grass that is important for grazing winter wildfowl such as brent geese. On the banks of the sea wall and between the wall and its borrowditch, drier, more nutrient-poor very flower-rich grassland developed. The ditches of the grazing marshes of the Greater Thames support many very rare invertebrates.

Decline

Increasing levels of development, and a shift away from traditional farming to intensive agriculture has caused a huge decline in the area of species-rich open grassland in the Greater Thames area. The spread of arable farming, the conversion of flower-rich grasslands to grasslands dominated by a few grasses cut for silage, and increased use of herbicides and fertilisers have all contributed.

Since the Second World War, the UK has lost a staggering 98% of its unimproved grassland (Goulson 2006).

Today, true Thames Terrace Grasslands exist only in fragments in a tiny part of South Essex (Fig. 3). It is often forgotten or not realised that the landscape was traditionally open, and landscaping and development schemes often focus on tree-planting, mistakenly believing that woodland is always best for biodiversity. This is not the case in the Greater Thames Marshes area and "well-intentioned tree-planting has damaged many sites of high conservation value" (Goulson 2006).

Similar grasslands occur in the area on other drought-stressed substrates such as old sand and chalk quarries, brownfield land and fuel-ash lagoons. South-facing slopes in these areas often have Thames Terrace sands and gravels exposed but as their value is not recognised, many are often earmarked for development or are landscaped to look 'tidy' (Roberts et al. 2006).

PRIORITY HABITATS OF THAMES TERRACE GRASSLANDS

OPEN MOSAIC HABITATS

Important grasslands have developed in the Greater Thames Marshes area on previously-developed land, more commonly known as 'brownfield' land. Previously-developed land that has a high value for biodiversity is a Priority Habitat – 'Open Mosaic Habitat on Previously-Developed Land' and 'habitat of principal importance' under the Nerc Act 2006. This means it is a priority for conservation in the UK and a material consideration in planning decisions.

Definitions

The National Brownfield Sites Project (2000) defined brownfield land as:

Brownfield: "A brownfield site is any land or premises which has previously been used or developed and is not currently fully in use, although it may be partially occupied or utilised. It may also be vacant, derelict or contaminated. Therefore a brownfield site is not necessarily available for immediate use without intervention."

Brownfield land is synonymous with the term for 'previously developed land', which is defined within Planning Policy Statement 3 as:

Previously developed: "land which is or was occupied by a permanent structure (excluding agricultural or forestry buildings), and associated fixed surface infrastructure".

Open mosaic habitat on previously developed land was added to the UKBAP and became a Priority Habitat in 2007. It remains a Priority Habitat under the Nerc Act 2006. It is defined according to the following criteria (Maddock 2011):

1. The area of open mosaic habitat is at least 0.25 ha in size.

2. Known history of disturbance at the site or evidence that soil has been removed or severely modified by previous use(s) of the site. Extraneous materials/substrates such as industrial spoil may have been added.

3. The site contains some vegetation. This will comprise early successional communities consisting mainly of stress-tolerant species (e.g. indicative of low nutrient status or drought). Early successional communities are composed of (a) annuals, or (b) mosses/liverworts, or (c) lichens, or (d) ruderals, or (e) inundation species, or (f) open grassland, or (g) flower-rich grassland, or (h) heathland.

4. The site contains un-vegetated, loose bare substrate and pools may be present.

5. The site shows spatial variation, forming a mosaic of one or more of the early successional communities (a)–(h) above (criterion 3) plus bare substrate, within 0.25 ha.

These definitions include a wide variety of sites and previous site uses including (Macadam 2012):

- vacant and derelict buildings
- disused railway land
- gravel, clay, chalk and brick pits
- spoil heaps
- disused industrial land
- quarries
- mines
- vacant urban land
- disused airfields

LOWLAND MEADOWS

Much of the original Thames Terrace Grassland on the south-facing slopes of South Essex would have qualified as Lowland Meadows. Lowland Meadows is defined as unimproved neutral grassland across the lowlands of the UK. It includes grassland in churchyards and roadside verges as well as grasslands cut for hay or used for grazing.

Due to the management of many Lowland Meadows, they lack the diversity of wildflowers and mosaic of differing habitats that were found in original Thames Terrace Grasslands and are now found on Open Mosaic Habitats. However, they do provide a forage resource and are an important component of the ecological network.

COASTAL AND FLOODPLAIN GRAZING MARSH

Coastal and Floodplain Grazing Marsh is periodically inundated pasture or meadow with ditches containing standing brackish and freshwater. The ditches often contain a high diversity of plant and invertebrate species.

Very low-lying Thames Terrace Grassland enclosed by the clay sea walls would have been defined as grazing marsh. Today, very few grazing marshes remain unimproved and species-rich, and many in the Greater Thames are managed for wintering wildfowl which can lead to a dense, short grass sward. This is excellent for the migrating and wintering birds that graze in the Greater Thames Marshes in internationally important numbers, but is not so beneficial for invertebrates.

Similar to Lowland Meadows, this Priority habitat contributes to the ecological network across the Greater Thames area and if not cut or grazed short, can provide a good forage resource.

For more information:

- about the Priority habitats see the JNCC website: http://jncc.defra.gov.uk/page-5718

THAMES TERRACE INVERTEBRATES PROFILE

Introduction to TTI

These groups of species are all found in Thames Terrace Grassland:

- Ground-nesting bees and wasps
- Bumblebees
- Robberflies
- Bee-flies
- Ground beetles
- Tiger beetles
- Spiders
- Butterflies and moths

The loss of Thames Terrace Grassland has led to the decline of many of the invertebrates associated with them. Many have been able to persist only in the flower-rich grasslands that develop on Open Mosaic sites, which have the low-nutrient, drought-stressed substrates and mix of habitats that is required.

TARGET SPECIES AND THEIR HABITAT REQUIREMENTS

For habitat creation it is very important to know the requirements of the species you wish to target. Their life histories and habitat requirements should be known so that you can create habitat that will suit their needs. It is also beneficial to target rare and scarce species which may benefit more from targeted habitat creation than widespread species (Plant 1997).

Many Thames Terrace Invertebrates have very complex and specific habitat requirements and life cycles that are not fully understood. Sometimes requirements can be inferred from repeatedly finding a species in the same habitat or on the same plant, but often it is very difficult to know exactly what they require to survive. Instead of trying to cater for as many species as possible and hoping the created conditions are right for all of them, this project will focus on flagship target species, whose needs are understood.

The Target Species

For this project, the target species are three of the UK's rarest bumblebees:

- the Shrill Carder Bee *Bombus sylvarum* (Fig. 5)
- the Brown-banded Carder Bee *Bombus humilis* (Fig. 6)
- the Red-Shanked Carder Bee *Bombus ruderarius* (Fig. 7)

These bees are in decline and in need of conservation. They have complex requirements too, but we know what these are and stand a better chance of re-creating them than for a species we know little about. The bees have real strongholds in the area, have been very well studied, and their ecologies are quite well understood. Due to the pioneering projects

by Buglife and UEL[1] and the work of other dedicated researchers we know what they need to nest in, forage in, and how far they will travel away from the nest to find new food sources and to mate.

All three bees, the Shrill-Carder Bee in particular, have quite specific requirements, but it is likely that by managing habitat for the species we do understand the needs of, and incorporating general features that are known to benefit other rare invertebrates, we will benefit many more than just the three focal species .

The bees are also relatively easy to identify, which is important for monitoring.

Figure 7. *Bombus ruderarius* Red Shanked Carder queen © T. Benton

Figure 6. *Bombus humilis* Brown-Banded Carder Bee queen © S. Falk

Figure 5. *Bombus sylvarum* Shrill Carder Bee queen © S. Falk

[1] For more information about these projects please see Part 2 of this document

Introduction to Bumblebees

Decline

There are 27 species of Bumblebee in Britain. All of our species have undergone rapid and drastic declines in the past 50 years. Most of them exist in small and isolated habitat patches and are clinging on to survival (Goulson 2006). One has disappeared altogether. The short-haired bumblebee *Bombus subterraneus* was described in 1912 as abundant across the whole of the UK. In just 60 years it completely disappeared. The last one was seen at Dungeness in 1988 and it is presumed extinct.

Importance

Bumblebees are important pollinators in the UK, and more declines could lead to serious consequences. Bumblebees pollinate oilseed rape, field beans, sunflowers, peas, runner beans, raspberries, strawberries, apples and currants, as well as many wildflowers – many wouldn't set seed without them (Goulson 2006).

Conservation and need for action

Increasing recognition of their importance over the last decade has led to some attempt to provide habitat for bumblebees and other pollinators with the inclusion of planting 'pollen and nectar mix' along field margins as part of Environmental Stewardship. This has been found to be effective in areas where bumblebees are already present (Carvell et al. 2007) but only 6000ha of pollen and nectar mix has been planted in England for ES, which is only 0.05% of the land area of England (Goulson et al. 2011). Planting flower-rich grasslands only contributes to bumblebee conservation if a local population is present and able to reach it but otherwise it won't – 6000ha sparsely distributed is not likely to have contributed to bumblebee conservation. More targeted approaches are required and innovative approaches are needed to deliver a real step-change for our bees.

Bumblebee life cycle

Queens emerge from hibernation in late spring or early summer and find a nest site in a sheltered location, usually close to the ground in tall vegetation. She builds a ball of pollen and wax lays her eggs into it. She has sperm stored from the previous summers mating, and fertilises her eggs with it. The eggs hatch into larvae, which begin to eat the pollen surrounding them. The queen forages constantly to collect more pollen to keep them sealed in, and spins a cocoon to encase them when they are ready to metamorphose. The larvae grow into workers (female) or drones (males). The males leave the colony, and the workers stay and help to feed the new larvae. The Queen will lay eggs a few at a time all summer. New young queens start hatching when the colony has reached the right number of workers, which varies from 25-500 in carder bees. Young queens and drones mate at the end of the season, and the queens go into hibernation at the beginning of Autumn.

Bumblebees collect nectar and pollen from flowers. Nectar is for energy, and pollen is a bumblebee's only source of protein for growth and food for their larvae.

SHRILL CARDER BEE

The Shrill Carder Bee, *Bombus sylvarum*, is one of the smallest and rarest bumblebees in the UK (Fig 5). Its small size and the high-pitched buzzing led to its name. 90 years ago *B. sylvarum* was so common in Britain that people out looking for bees barely bothered recording it, with comments like "*Bombus sylvarum* everywhere as usual (Hallett 1928 in Edwards and Williams 2004)". Now, it is found in just 7 places in Britain and is on the verge of extinction (Edwards and Williams 2004).

The Thames Estuary has one of the last and largest remaining populations, and along with Salisbury Plain is a real stronghold for the species. The loss of the Thames population would be very serious and it is important to bolster it as much as possible to make sure it can persist in a rapidly developing area.

Habitat requirements

Bombus sylvarum is associated with tall, flower-rich grassland both inland and on the coast. In Essex it is usually found in grassland in the early stages of succession. It forages in Bird's-foot trefoil *Lotus spp.*, red and white clovers *Trifolium pratense and T. repens,* Black horehound *Ballota nigra*, Red Bartsia *Odontites verna* and species of Vetch *Vicia*. It needs tall vegetation to nest in, along with shorter areas rich in *Lotus* to forage. It rarely travels more than 400m to forage, but it does occasionally travel up to 1km to new forage patches if forced to by a lack of food nearby.

Life Cycle

The Shrill Carder Bee completes its colony cycle late in the season. Queens emerge from hibernation in mid-May. They build nests just on or below the ground surface, at the base of tall vegetation or under a litter layer, usually on a south-facing slope in mature undisturbed grassland. Workers start flying in June and the first new queens and males in August. Males patrol scent-marked routes, waiting for new queens to pass in their direction. Once mated, queens hibernate from the beginning of October to the following May.

Shrill Carder queens need nests in tall vegetation close to areas of shorter, more flower-rich vegetation to forage in, as they will not travel far to forage, rarely travelling more than 400m.

Decline

Bombus sylvarum was widespread until the early 1900s, when it started to steadily decline. In 1982 Williams compared the distribution of *B. sylvarum* pre- and post-1960 and found that it's range had reduced by nearly 50%. He called it 'profound deleterious change' (Williams 1982), but it was to get worse.

During work for the UKBAP in South Essex in 1996 (Plant and Harvey 1997), it was found at only one site – Ferry Fields, which was later developed and there were fears it was about to go extinct. By 1997 only three confirmed populations remained.

Today, it has recovered very slightly, although the remaining populations are isolated and fragmented. There are just seven populations, with one of the strongest but most threatened located in the Greater Thames.

BROWN-BANDED CARDER BEE

The Brown-banded Carder Bee *Bombus humilis* is named for its colouring (Fig. 6). Like the Shrill Carder Bee, it used to be widespread across most of Britain but is now restricted to the South East due to habitat loss.

Habitat Requirements

B. humilis is associated with flower-rich grassland, with abundant Dead Nettle family (Lamiaceae) and Pea family (Fabaceae) flowers. It needs tall vegetation to nest in, and good connectivity to areas of forage.

Sister bees (from the same nest) have been found at sites more than 700m apart in Essex, foraging at a wide distance both within and between suitable sites (Connop 2008). In Cornwall populations have been found in very narrow strips of grassland along the tops of cliffs. For this bee, connectivity of habitat seems to be the most important factor in determining where they survive (Saunders 2008).

Life Cycle

Bombus humilis nests on the ground in undisturbed tall rough grassland under leaf litter and moss, usually on a south to southwest facing slope (Saunders 2008, Connop 2008). It usually nests in areas where dead nettle (Lamiaceae) and pea families (Fabaceae) are prevalent. Similar to the Shrill Carder Bee, it completes its colony cycle late in the season. Queens emerge in late May, workers at the end of June and new queens and males in August. Mated queens hibernate from October to May.

Decline

B. humilis has undergone a drastic decline since the early 1900s, and is restricted to remaining fragments of species-rich grassland.

As *B. humilis* completes its colony cycle late in the season it is extremely vulnerable to early cutting of grassland which destroys their nests and forage. Many remaining open grassland or hay meadows are cut early. For example, grassland on sea-wall foldings in Essex is cut short once annually in June or July, destroying bumblebee habitat (Gardiner and Benton 2011).

RED-SHANKED CARDER BEE

The Red-Shanked Carder Bee *Bombus ruderarius* (Fig 7) is named for its colouring and is most commonly associated with open, flower-rich grassland. In Kent and Essex it is often found on brownfield sites with tussocky grassland and scrub, particularly along the East Thames. It is also found in grazing marshes, coastal grasslands and sea walls where there is an abundance of forage plants (Benton 2008).

Habitat Requirements

The Red-Shanked Carder Bee needs areas of tall vegetation to nest in, near shorter areas to forage in. It is often found near hedgerows or woodland edge. It particularly favours white deadnettle, black horehound *Ballota nigra* and Red clover *Trifolium pratense* for foraging.

Like the Brown-Banded Carder Bee it generally prefers plants of Lamiaceae and Fabaceae families, being found on flowers of this family even when other flowering plants are available.

Queens and workers use slightly different forage, with queen's relying on white and red dead nettle, red clover and common vetch when they emerge from hibernation. Workers use a wider range of plants including bird's-foot trefoil, dyer's greenweed, red deadnettle, mallow, narrow-leaved bird's-foot trefoil and melilot. Black horehound is particularly favoured by both (Benton 2008).

Life Cycle

B. ruderarius always nests on the surface or just under it, in areas of tall grass. The nest has a roof of shredded grass and is often in an old mouse or vole nest. They also sometimes nest in tussocks of grass, making nests from grass clippings. Nests are often located near hedgerows or woodland edge.

Queen's emerge from hibernation in April, one of the earliest Bumblebees to do so. *B. ruderarius* has very small nests of only 25-30 workers, a very low number – most bumblebees have around 400. The first workers emerge from the nest in May. Young queens and males start emerging in July. By late August-mid September, the queens have started to hibernate.

Instead of patrolling a set route like most male bumblebees, waiting for young queens to appear, male *B. ruderarius* wait at the entrance to nests, and pounce on young queens when they emerge.

In order to mate, nests need to be close enough together for the males to find another nest besides their own.

Decline

B. ruderarius populations were quite steady until the late 1970s/early 1980s, when they underwent a sudden and drastic decline, a population 'collapse'. From the 1990s onwards, it has been found only in South East England in fragmented populations. During work for the UKBAP, it was found at only one site in South Essex, Broom Hill.

B. ruderarius differs from the other two species in that it has often been found in grass banks by hedgerows in less intensively farmed arable land, and in gardens and roadside banks in urban areas. It seemed to be more able to cope with the changes in the landscape until the sudden decline. Also unlike the other two species it doesn't rely on late-flowering forage, as it completes its colony cycle relatively early in the season.

It is likely that the small nest size and the way males find new queens has led to the sudden decline. The males need to be able to find another nest in order for the next generation of bees to be produced. *B. ruderarius* probably became established in remaining areas of flower-rich grassland in a variety of habitats such as hedgerows in fields and brownfield land, and development of brownfield has gradually isolated the remaining colonies. Once nests become too far apart or with very hostile habitat between them the males will not be able to find the nests, and the population will fail (Benton 2008).

The decline of all three bee species coincides with agricultural intensification in lowland Britain. There was a shift from mixed cultivation to intensive arable, the loss of hedgerows, and the conversion of hay meadow and grassland to improved silage and pasture. Use of chemicals also increased. It is likely that habitat loss is the main cause of the decline in all three species.

EVIDENCE BASE & POLICY BACKGROUND

SECTION 2

This section is designed to assist local authorities, funding bodies and decision makers to understand why Thames Terrace Invertebrates and their habitats are important and how they can help

It sets the scene for the on-the-ground work that will be carried out as part of this project. It outlines the evidence for why we need to take action and the policy context for protection and enhancement of TTI habitat.

Without increased recognition of the importance of Thames Terrace Invertebrate, particularly Open Mosaic, sites, more are likely to be lost in the near future. Development is vital in the Greater Thames Marshes Area and it is important that it takes place. However, recognition of the importance of Thames Terrace habitats will allow it to be identified, the best sites protected, and appropriate mitigation secured.

WHY DO THE TARGET SPECIES NEED HELP?

Metapopulation structure

All three bees have a metapopulation structure. Each metapopulation needs 10-20 square miles of habitat mosaic that includes wildflower-rich grassland. Within that range there are many nests forming smaller sub-populations. A lot of nests fail every year due to predation and parasites. When one sub-population dies out, it is repopulated from a neighbouring area. Habitat fragmentation and isolation of subpopulations prevents recolonisation and weakens the metapopulation, leading to a decline (Edwards and Williams 2004; Robins and Henshall 2012).

The need for a network

Habitat connectivity is vital for metapopulations to be sustained. The rarity and distribution of a species depends on its ability to move through the landscape to new sites (Austin 2000 in Barker 2000). All three target bees are relatively sedentary and don't travel far to new nest sites. They also forage fairly close to their nests, rarely travelling more than 400m although *B. ruderarius* will travel further. This means they are more adversely affected by landscape changes as they don't have the dispersal ability that more mobile species have to find new sites.

WHY ARE THE TARGET HABITATS IMPORTANT?

OPEN MOSAIC HABITATS

Open Mosaic habitats were added to the list of Priority Habitats mainly because of their importance to invertebrates. Many invertebrates have very precise habitat requirements. As well as areas of bare ground and food plants, they may need sheltered places at various times of the year, or rough vegetation or cover at others (Maddock 2011).

Open Mosaic sites have become crucial for invertebrates due to the loss of their natural habitats (Macadam and Bairner 2012). Open Mosaic sites mimic more natural conditions (Eyre 2000), such as the Thames Terrace Grasslands. They act as places of refuge for species which can no longer find suitable habitat in the open countryside (Falk 2000). As well as being an important resource in themselves, they provide linkages and act as 'stepping stones' between more natural habitats.

Open Mosaic sites particularly in urban areas often have non-native plant species such as Buddleia. It is an interesting feature of the sites that despite this they tend not to contain non-native invertebrate species. They usually only contain native species particularly adapted to the disturbance and nutrient conditions found at the sites (Macadam and Bairner 2012).

"Current estimates of the potential contribution to be made by artificial habitats to the conservation of rare and scarce invertebrates are gross underestimates" (Gibson 1998).

Key Evidence:

Nationally:

- Open Mosaic habitats contain as many Red Data Book and Nationally Scarce species as ancient woodlands, and some contain more (Falk 2000).

- 12-15% of all the nationally rare and scarce invertebrates in the UK have been found on Open Mosaic sites and this is thought to be a substantial underestimate (Gibson 1998).

- 35% of all the rare and scarce carabid beetles of the UK are found in Open Mosaic habitats (Eversham et al. 1996).

Locally:

- Canvey Wick SSSI Open Mosaic site supports more species per square foot than any other site in the UK (Robins and Henshall 2012).

- Buglife's All of a Buzz in the Thames Gateway project aimed to gather the information and evidence necessary to develop a strategy for the management and conservation of brownfield habitats. In 2005, 520 sites covering 6900ha were surveyed (Fig. 8).

    - 7,580 individual species were recorded from those sites

    - 3,376 of which were Nationally Rare or Scarce and of conservation importance

    - 2,799 of them are strongly associated with brownfield land in the Thames Gateway

    - Some are found no-where else.

- Work for the UKBAP found that 100 Red Data book and 400 Nationally Scarce species have been recorded on open mosaic sites in the region (Plant & Harvey 1997). These include the Priority Species
    - Hornet Robberfly
    - the target Carder Bees
    - Distinguished Jumping Spider
        - 15 species were found to occur **only** in Open Mosaic sites in the Thames Gateway

- The Shrill Carder Bee, one of the UKs rarest bumblebees, relies heavily on Open Mosaic sites in the area.

Reasons for the decline in Open Mosaic Habitat

Development Pressure

Nationally, prioritisation of development on 'brownfield' land has reduced the density of Open Mosaic sites. The typical lifespan of an Open Mosaic site in the UK is 15-20 years, with some as old as 50 years (Macadam and Bairner 2012). Ordinarily, the cycle of redevelopment means that new Open Mosaic sites appear as others are developed, however in the Greater Thames Marshes area the pressure for development is so great that all sites are in danger of disappearing (Kendle 2000).

In the Thames Corridor, development pressures are particularly great. Commercial interests prevented the UKBAP for bumblebees being implemented. A large nest site of the incredibly rare Shrill Carder Bee *B. sylvarum* was destroyed in 2001 before commissioned bumblebee surveys were even finished. The BAP Bumblebee Working Group felt that there was little the Biodiversity Action Plan could do in the face of commercial interests (Edwards 2002).

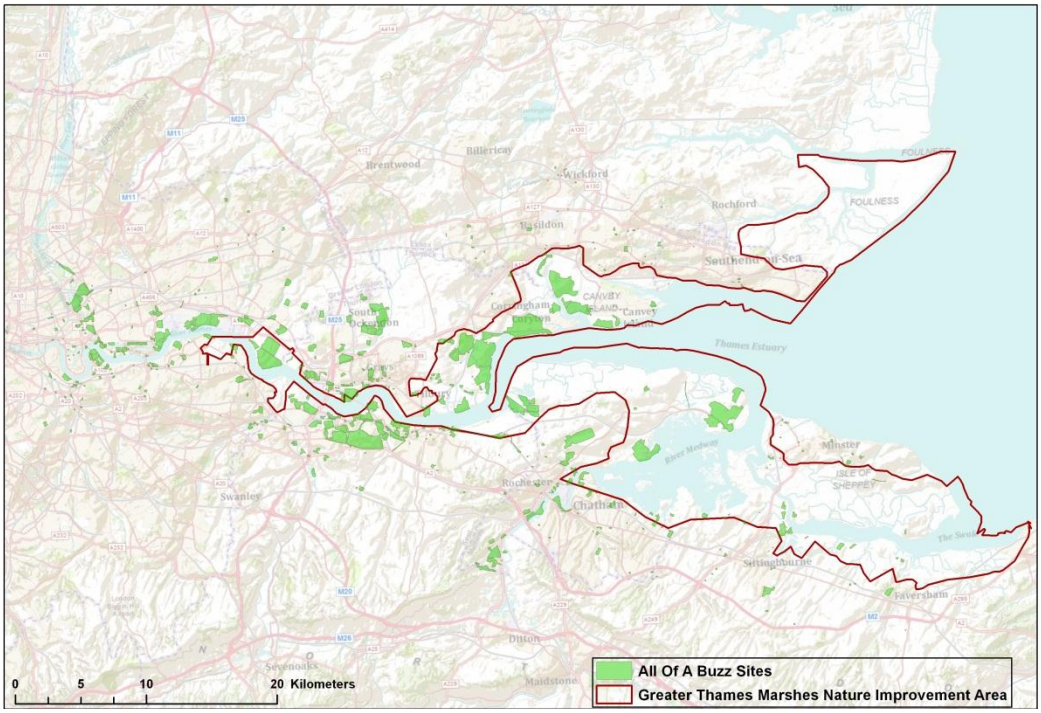


Figure 8. Sites surveyed as part of Buglife's All of a Buzz project

Open Mosaic sites are usually thought to be a relatively new phenomenon associated with recent urban development. However, there is archaeological evidence that invertebrates thought, until recently, to only be associated with natural habitats, were actually in towns and cities as early as Roman times in England. They therefore have a long association with 'artificial' habitats, even though until recently they may not have had to rely on them (Gibson 1998).

During 'All of a Buzz' (AOAB) 198 sites were assessed as High or Medium quality for invertebrates. By 2011, 49% of the medium quality sites and 52% of the high quality sites had been developed or partially developed, or had planning permission granted so were likely to be destroyed in the near future. Only 98 of the 198 high and medium sites remained intact (Robins and Henshall 2012).

Lack of recognition of their importance

The status of Priority Habitat means that wildlife-rich brownfield sites are a conservation priority in the UK (Robins and Henshall 2012). However, Open Mosaic habitat is rarely identified or protected within the planning system (Kendle 2000).

Negative public image

There is usually a strong negative public image attached to Open Mosaic sites (Macadam and Bairner 2012) and many have been 'tidied up'.

Uncertainty around mitigation

There is uncertainty among professionals about how to evaluate the conservation importance of the sites and as a result biodiversity issues are often discounted or ignored in the redevelopment process (Harrison and Davies 2002).

WHY DO WE NEED AN ECOLOGICAL NETWORK?

- The highest number of invertebrate species is found at sites when there are 'clusters' of sites close together, rather than an isolated site (Falk 2000). Most of the remaining habitat for the target bees is in isolated fragments.

- The 7 remaining *B. sylvarum* metapopulations are small and isolated and consist of only 26-48 nests (Ellis et al. 2006). It would be very easy for this species to be affected so badly by predation, parasites, extreme weather or a decline in habitat that it would disappear from Britain altogether.

- It is often assumed in habitat creation schemes that a species will automatically colonise a site if the right conditions are created – in reality that isn't true and will only happen if there is a colonisation source nearby (Falk 2000).

WHAT ARE THE GAPS IN THE EVIDENCE BASE?

Although we understand that Thames Terrace Habitats are important, we lack key knowledge that we need for their conservation.

A crucial gap in our evidence is that we do not know where the important habitat is. All priority habitats except for Open Mosaic Habitat have been mapped and the data is available on the Natural England website. These inventories can be used by local authorities, decision makers and conservation bodies to highlight areas where action could make a real difference, areas that are under threat from development. There is no inventory for Open Mosaic Habitats, making it difficult to protect sites. Mapping the Open Mosaic Habitat resource would contribute to our understanding of, and ability to protect, this priority habitat.

A second gap is that we lack knowledge of how best to restore or create such habitats. Open Mosaic habitats develop over time and their ecologies are not fully understood. Attempts to create or restore Open Mosaic Habitats need to be monitored, to understand if conservation outcomes are being delivered and target species are benefitting.

POLICY CONTEXT

This section outlines the policy basis for NIAs and for protecting priority habitats and species in the UK, including the target Thames Terrace Habitats and Invertebrates. This can be used by local authorities and decision makers to protect and enhance Thames Terrace habitat. For example, it should be used to inform Local Plans and planning decisions and can assist in guiding funding and future project work.

Making Space for Nature

In 2011 Professor Sir John Lawton chaired an independent review of the state of England's biodiversity in wildlife sites and ecological networks, 'Making Space for Nature'. It concluded that England's wildlife areas (both legally protected areas and others) do not currently represent a coherent and resilient ecological network that would be capable of responding to the challenges of climate change and other pressures. The review concluded that establishing such a network would effectively conserve biodiversity and ecosystem services, delivering many benefits to people, while also making efficient use of scarce land and resources. It recommended that priorities in England should include more, bigger, better and joined-up sites for nature. The review recommended Ecological Restoration Zones, where ecological networks would be established.

Natural Environment White Paper

The Natural Environment White Paper 'The Natural Choice: securing the value of nature' was published in June 2011. It was the first White Paper on the environment for 20 years and built on recommendations in 'Making Space for Nature':

"Making Space for Nature found that there are areas of the country where the opportunities and benefits for the whole ecological network justify focused efforts on a grand scale. The report recommended that large areas should be formally recognised as Ecological Restoration Zones.

Reflecting this recommendation, we will enable partnerships of local authorities, local communities and landowners, the private sector and conservation organisations to establish new Nature Improvement Areas (NIAs), based on a local assessment of opportunities for restoring and connecting nature on a significant scale" (HM Government, 2011).

This was summarised in Commitment 9 of the White Paper:

> "To provide inspiration and illustrate what works the Government will support the creation of Nature Improvement Areas. Natural England will set up a competition to identify 12 initial areas. We will provide £7.5 million over the current Spending Review period."

There were 72 initial applications for the competition. The Greater Thames Marshes was one of the 12 successful bids and was awarded £571,875 to deliver the business plan over three years. The NIA was launched in April 2012 and the funded period runs until April 2015.

Biodiversity 2020: a strategy for England's wildlife and ecosystem services

In October 2010, an historic global agreement was reached between the countries signatory to the Convention on Biological Diversity to take urgent action to halt the global declines in biodiversity. The agreed 'Aichi Targets' provide a new global vision for biodiversity policy, in response to the recognition that efforts to protect and enhance biodiversity need to be significantly increased. As part of that agreement, countries were expected to revise their own national strategies and plans for biodiversity to take account of the new global framework. 'Biodiversity 2020' sets out England's national strategy and builds on the Natural Environment White Paper.

2020 Mission

The mission of Biodiversity 2020 is "to halt overall biodiversity loss, support healthy well-functioning ecosystems and establish coherent ecological networks, with more and better places for nature for the benefit of wildlife and people".

Relevant Targets for This Project:

Target 1B More, bigger and less fragmented areas for wildlife, with no net loss of priority habitat and an increase in the overall extent of priority habitats by at least 200,000ha;

Target 1C By 2020, at least 17% of land and inland water, especially areas of particular importance for biodiversity and ecosystem services, conserved through effective, integrated and joined up approaches to safeguard biodiversity and ecosystem services including through management of our existing systems of protected areas and the establishment of nature improvement areas.

Target 3 By 2020, we will see an overall improvement in the status of our wildlife and will have prevented further human-induced extinctions of known threatened species.

"We want a large number of high quality sites which contain the range and area of habitats that species require. We also want ecological connections that allow species, or their genes, to move between these sites. For many species, habitat does not have to be a continuous, physical connection for them to disperse.

An ecological network is this network of high quality sites, protected by buffer zones, and connected by wildlife corridors and smaller, but still wildlife-rich, "stepping-stone" sites (Biodiversity 2020)".

PLANNING

NPPF

The National Planning Policy Framework sets out how the planning system should protect biodiversity and how NIAs relate to it. It also outlines the prioritisation of development on brownfield land and the need to identify those brownfield sites that are of high environmental value.

Paragraph 111 of the NPPF is the key paragraph for this project:

111. Planning policies and decisions should encourage the effective use of land by re-using land that has been previously developed (brownfield land), provided that it is not of high environmental value. Local planning authorities may continue to consider the case for setting a locally appropriate target for the use of brownfield land.

In summary, brownfield land should be a priority for development, if it is not of high environmental value.

Other relevant and important paragraphs of the NPPF

These paragraphs outline how the planning system should protect biodiversity:

109. The planning system should contribute to and enhance the natural and local environment by:

- protecting and enhancing valued landscapes, geological conservation interests and soils;
- recognising the wider benefits of ecosystem services;
- minimising impacts on biodiversity and providing net gains in biodiversity where possible, contributing to the Government's commitment to halt the overall decline in biodiversity, including by establishing coherent ecological networks that are more resilient to current and future pressures;
- remediating and mitigating despoiled, degraded, derelict, contaminated and unstable land, where appropriate.

113. Local planning authorities should set criteria based policies against which proposals for any development on or affecting protected wildlife or geodiversity sites or landscape areas will be judged. Distinctions should be made between the hierarchy of international, national and locally designated sites, so that protection is commensurate with their status and gives appropriate weight to their importance and the contribution that they make to wider ecological networks.

114. Local planning authorities should:

- set out a strategic approach in their Local Plans, planning positively for the creation, protection, enhancement and management of networks of biodiversity and green infrastructure;
- maintain the character of the undeveloped coast, protecting and enhancing its distinctive landscapes, particularly in areas defined as Heritage Coast, and improve public access to and enjoyment of the coast.

117. To minimise impacts on biodiversity and geodiversity, planning policies should:

- plan for biodiversity at a landscape-scale across local authority boundaries;
- identify and map components of the local ecological networks, including the hierarchy of international, national and locally designated sites of importance for biodiversity, wildlife corridors and stepping stones that connect them and areas identified by local partnerships for habitat restoration or creation;
- promote the preservation, restoration and re-creation of priority habitats, ecological networks and the protection and recovery of priority species populations, linked to national and local targets, and identify suitable indicators for monitoring biodiversity in the plan;
- aim to prevent harm to geological conservation interests; and
- where Nature Improvement Areas are identified in Local Plans, consider specifying the types of development that may be appropriate in these Areas.

RELEVANT LEGISLATION

Section 41 (S41) of the Natural Environment and Rural Communities Act requires the Secretary of State to publish a list of habitats and species which are of principal importance for the conservation of biodiversity in England, or priority species. The list has been drawn up in consultation with Natural England, as required by the Act.

The S41 list is used to guide decision-makers such as public bodies, including local and regional authorities, in implementing their duty under section 40 of the Natural Environment and Rural Communities Act 2006, to have regard to the conservation of biodiversity in England, when carrying out their normal functions.

'An ecological network comprises a suite of high quality sites which collectively contain the diversity and area of habitat that are needed to support species and which have ecological connections between them (White Paper)'

USING THE EVIDENCE AND POLICIES TO PROTECT THAMES TERRACE INVERTEBRATES AND THEIR HABITATS

ADDRESSING THAMES TERRACE INVERTEBRATES IN LOCAL PLANS

In accordance with paragraphs 114 and 117 of the NPPF, local authorities should plan for the creation, protection, enhancement and management of biodiversity. They should also identify and map components of ecological networks, including those areas identified by local partnerships. Mapping the complete ecological network of Thames Terrace habitat within the NIA is a key recommendation for future work. In the meantime, the eight sites identified within this Masterplan, along with the relic Thames Terrace Grasslands and areas of Priority Habitats identified in Part 1 are components of the ecological network for Thames Terrace Invertebrates and can be included within Local Plans as important areas for biodiversity.

Paragraph 117 reinforces the requirement to restore and create priority habitats. The recommendations and guidance that follow in part 3 can be used to inform mitigation and/or compensation for the loss of Thames Terrace priority habitat through development. It can also be used to guide any new habitat creation secured through the development management process.

ADDRESSING THAMES TERRACE HABITATS IN THE DEVELOPMENT MANAGEMENT PROCESS

To meet the recommendations in Paragraph 111, it is necessary to know whether a brownfield site is of high environmental value. Brownfield sites need to be adequately

considered in ecological assessments and properly assessed for their environmental value during the planning process the same as any other habitat more typically considered important.

Natural England recommends that if one or more S41 species or habitats are likely to be affected by a development, surveys and mitigation for any impacts are secured from the applicant prior to a decision being taken[2]. Brownfield sites with the potential to qualify as Open Mosaic Habitat therefore need to be surveyed.

Preliminary Ecological Assessments often overlook the potential of previously-developed or brownfield land. Local planning authorities can ensure that potentially valuable sites are recognised by requesting that brownfield sites are properly assessed.

A starting point would be to request that sites are assessed against the criteria for 'Open Mosaic Habitats on Previously Developed Land' priority habitat (Maddock 2011). This will identify whether the site is likely to be important and whether an invertebrate survey is likely to be necessary. If the site meets all of the criteria, it should be treated as any other Priority habitat – that is as a material consideration in planning decisions. Development of the site should then be avoided, or if that is not possible the loss adequately mitigated, or as a last resort compensated (see paragraph 118). If it meets several, but not all criteria, it is still likely to have raised biodiversity interest and it would be wise to recommend an invertebrate survey.

This will enable important Open Mosaic sites to be recognised and protected within the development management process.

NEXT STEPS

For this project

Metapopulations of the target species are already in trouble. It is therefore vital that habitat creation and restoration focusses on improving existing ecological networks. The eight sites that will be targeted for this project are designed to contribute to a landscape-scale network for Thames Terrace Invertebrates, acting as stepping stones between remaining sub-populations.

Habitat creation should aim for high condition habitat, which meets the Priority Habitat criteria for Open Mosaic Habitat on Previously Developed Land. Elements of other important Priority Habitats including Lowland Meadows may be incorporated within large sites. Detailed recommendations for habitat creation follow in Part 3.

For the future

Future work should seek to address the gaps in our evidence outlined above.

[2] Natural England Frequently Asked Questions paragraphs 3.10-3.13 http://www.naturalengland.org.uk/ourwork/planningdevelopment/spatialplanning/standingadvice/faq.aspx#q3a

Buglife and the University of East London are developing a proposal for a research student to monitor the results of this project, to address one of the evidence gaps. They will assess whether the on-the-ground works do deliver the anticipated outcomes and will survey the sites for invertebrates. This will enable an evaluation of the project which can be used to inform future work.

For more information:

- about the Aichi Targets see the website of the Convention on Biological Diversity http://www.cbd.int/sp/targets/
- about the Natural Environment White Paper see Defra's website http://sd.defra.gov.uk/2011/06/the-natural-choice-securing-the-value-of-nature/
- about the National Planning Policy Framework see the UK Government website https://www.gov.uk/government/publications/national-planning-policy-framework--2
- about the Nerc Act 2006 and how local authorities can use the S41 list see Natural England's website http://www.naturalengland.org.uk/ourwork/conservation/biodiversity/protectandmanage/habsandspeciesimportance.aspx

MANAGEMENT GUIDANCE

SECTION 3

This section is for nature conservation professionals engaged in land management such NGO conservation staff, local authorities, those giving stewardship advice to landowners and those designing conservation projects.

GENERAL MANAGEMENT GUIDANCE AND REQUIREMENTS

Introduction

Although the features that contribute to creating a good quality Open Mosaic habitat are quite well understood, there is little guidance for how to successfully create them in such a way as to lead to a high condition Open Mosaic habitat. Open Mosaic sites have usually developed of their own accord after land has been left. This project will build on existing work by Buglife and UEL on Open Mosaic creation and will contribute to understanding of how to create Open Mosaic habitats.

HABITAT CREATION AND RESTORATION

CHARACTERISTICS OF IMPORTANT SITES

Habitat Mosaics

The most important sites have a 'mosaic' of habitats suitable for nesting, foraging and hunting. They have a variety of substrates such as sand, gravel, silt; and mosaics of flower-rich grassland, scrub and bare ground.

Bare Ground

Bare ground is important, particularly if it is south facing. It heats up quickly, ideal conditions for warmth-loving invertebrates and as nesting sites for burrowing species. All invertebrates derive their body heat from their surroundings and need high body temperatures to carry out their lifecycle and daily activities. Bare ground is often necessary to provide these warm microclimates (Kirby 1992, Falk 1995, Key 2000).

Ruderal Habitat

Some ruderal (disturbed) habitat near taller, mature habitat is ideal to provide conditions for all life stages and a variety of invertebrates.

Scrub

Scrub is important as a limited component of an Open Mosaic habitat. It is an important pollen source in spring and early summer and can act as a windbreak. Scattered bushes and clumps are more beneficial than continuous blocks and scrub should not cover more than 10-15% of a site.

Dead wood and unmanaged vegetation

These are important for the species which live inside leaves, stems, flower heads and seeds and which overwinter inside or at the bases of dead stems and in ground litter. For stem-nesting species it is important that these resources remain in place from one generation to the next for the survival of these species.

Wet Areas

Damper or wetter areas such as ditches, puddles and pools increase habitat diversity and are important for certain rare species. Several Red Data Book species such as the spider

Clubonia juvenis and fly *Dolichopus signifer* are associated with damper areas in Open Mosaic habitats.

Aspect

South facing sites are best, to suit warmth-loving invertebrates. South-facing slopes are particularly beneficial for mining bees and ground-nesting species such as the target bumblebees.

Topography

Important sites have a varied topography, from wheel ruts and small rubble piles to sand cliffs and building remains. Cliffs, banks and hollows all contribute to the diversity of habitat. A varied topography also leads to a diversity of microclimates on the site. These can buffer individual populations from the effects of the wider climate (Saunders 2006).

Substrate

Nutrient-poor substrate delays succession, keeping the sites open and delaying scrub encroachment. It is also required for species-rich grassland.

Age

Important Open Mosaic sites tend to be at least 10 years old, with the best being around 50 years old (Harvey 2012).

KEY INFORMATION

Site Specific

It is essential to know the following key pieces of information about a site before designing habitat creation or restoration schemes:

- Substrate type
- Aspect
- Topography
- Any limiting feature e.g. toxicity
- Surrounding land-use

General

In addition, the following key knowledge from research is important:

- Sites need to be protected from development, as it can take more than ten years for a site to develop the necessary habitat characteristics and conditions.

- Most bees could be catered for by providing a mix of just ten important plant species (Goulson et al. 2011). However, they have to be available at the right place and time – for many invertebrates, larvae and adults use different nectar sources (Gibson

1998). It is important to have forage available throughout the colony cycle – for the target species this is from May to September. Black Horehound *Ballota nigra* is particularly important in September for late forage for *B. sylvarum* and *B. humilis.*

Key Forage Plants:

- *Vicia sativa* Common Vetch
- *Vicia villosa* Hairy Vetch
- *Trifolium pratense* Red Clover
- *Trifolium repens* White Clover
- *Lotus glaber* Narrow-leaved Bird's-foot trefoil
- *Rubus fruticosus* Bramble in small amounts
- *Ballota nigra* Black Horehound
- *Lotus corniculatus* Bird's-foot trefoil
- *Odontites verna* Red Bartsia
- *Lathyrus latifolius* Perennial Sweet Pea

- Each life stage may need different habitat structures which take time to develop, for example dead wood, or thick litter to nest in (Gibson 1998).

- It is important to undertake invertebrate management work on a long rotational basis, so that a mosaic of habitats is maintained.

- It is important to maintain areas of open habitat and prevent succession to dense scrub and secondary woodland (Harvey 2012).

KEY TECHNIQUES

Habitat Creation

- Sites can be disturbed by machinery to create a mosaic of disturbed and mature vegetation.

- Uniform sites can be re-profiled by digging hollows, creating scrapes and pools and piling the resulting material to form bunds, banks and cliffs to create a varied topography.

- Wetland areas can be extended by creating scrapes at the edges of existing areas.

- Scrub removal will be important at many sites. The best way to remove it is cut it and then uproot the stumps using heavy machinery. An alternative is to cut to ground level and treat the stumps with herbicide to prevent re-growth. Untreated stumps left in situ will regenerate quickly.

- Any standing dead wood should be left on site. Some of the cut material from scrub removal can be left on site in open positions to provide dead wood piles.

- Green hay can be used to regenerate cleared areas. Hay is cut from a donor site containing the desired species after flowering, and spread the same day on the cleared site. Seeds from the donor site quickly establish at the new site.

- Alternatively, seed can be hand-collected from desired species and manually sown in small areas.

- Natural regeneration is recommended for cleared areas that used to contain a diversity of species which may exist in the seed bank.

- To obtain a low-nutrient substrate, it may be necessary to remove the top layer of nutrient-rich, improved substrate from areas of a site. This should be to around 10cm depth. Alternatively, new substrate can be imported. New substrate can be effective - *Ballota nigra, O. verna, Lotus glaber, Lotus corniculatus, Trifolium pratense and L. latifolius* all grew successfully on a newly-capped landfill site in low-nutrient material at Pitsea (Connop 2008).

Habitat Management

Open Mosaic sites are likely to require little long-term management, other than maintaining the scrub-cleared areas on a long rotation.

Disturbing areas of sites on a long rotation is beneficial to maintain a mosaic.

Light winter grazing is very beneficial for maintaining floristic diversity, areas of disturbed ground, and is important for Priority Species that rely on dung from grazing animals such as the Hornet Robberfly.

Alternatively, grassland areas may be managed by cutting, but this must be done sensitively. For grassland areas, Fenner and Palmer subjected 32 0.01ha grassland plots to a variety of mowing and fertilisation regimes for 11-13 years. They found that annual mowing increased plant diversity, and all mowing reduced invertebrate diversity. An annual cut outside of the invertebrate season is likely to be the most beneficial for both groups (Fenner and Palmer 1998), although this should be done on a long rotation so that not all areas of a site are cut every year.

For more information:

- about creating Open Mosaic habitats see Buglife's information on aggregates sites: http://www.buglife.org.uk/conservation/currentprojects/Habitats+Action/Bringing+Aggregate+Sites+to+Life/Bringing+Aggregates+Sites+to+Life+-+resources+page.htm
- about managing priority habitats for invertebrates (NB does not include Open Mosaic Habitats) http://www.buglife.org.uk/conservation/adviceonmanagingbaphabitats
- about managing habitat for the target bumblebees: http://www.buglife.org.uk/Resources/Buglife/Documents/Shrill%20and%20Brown-banded%20carder%20bee%20species%20management%20sheet.pdf

DELIVERY OF THE NIA PROJECT

SECTION 4

This section describes the target sites for this project, the management recommendations and delivery schedules for each site. It also contains a monitoring framework which will be used to assess the outcomes of the work.

TARGET SITE MANAGEMENT RECOMMENDATIONS

TARGET SITES

Eight sites have been identified for action for this project. They have been identified during previous work as key sites for *B.humilis* and *B. sylvarum* and a wide range of other Priority Species have been recorded nearby. The sites are located in strategic locations. Sites within 10km of the Thames have been identified as the most suitable for conservation (Connop 2008). They are between areas of important Open Mosaic, Lowland Meadows and Relic Thames Terrace Grassland habitat and will contribute to a coherent landscape-scale ecological network (Fig. 9 & 10).

The project partnership will be working with Natural England and other partners to secure long-term management of the sites through Higher Level Stewardship and future funding bids for associated projects.

All sites have been surveyed by experts from Buglife and UEL and the resulting baseline habitat assessment, site descriptions and management recommendations inform the following.

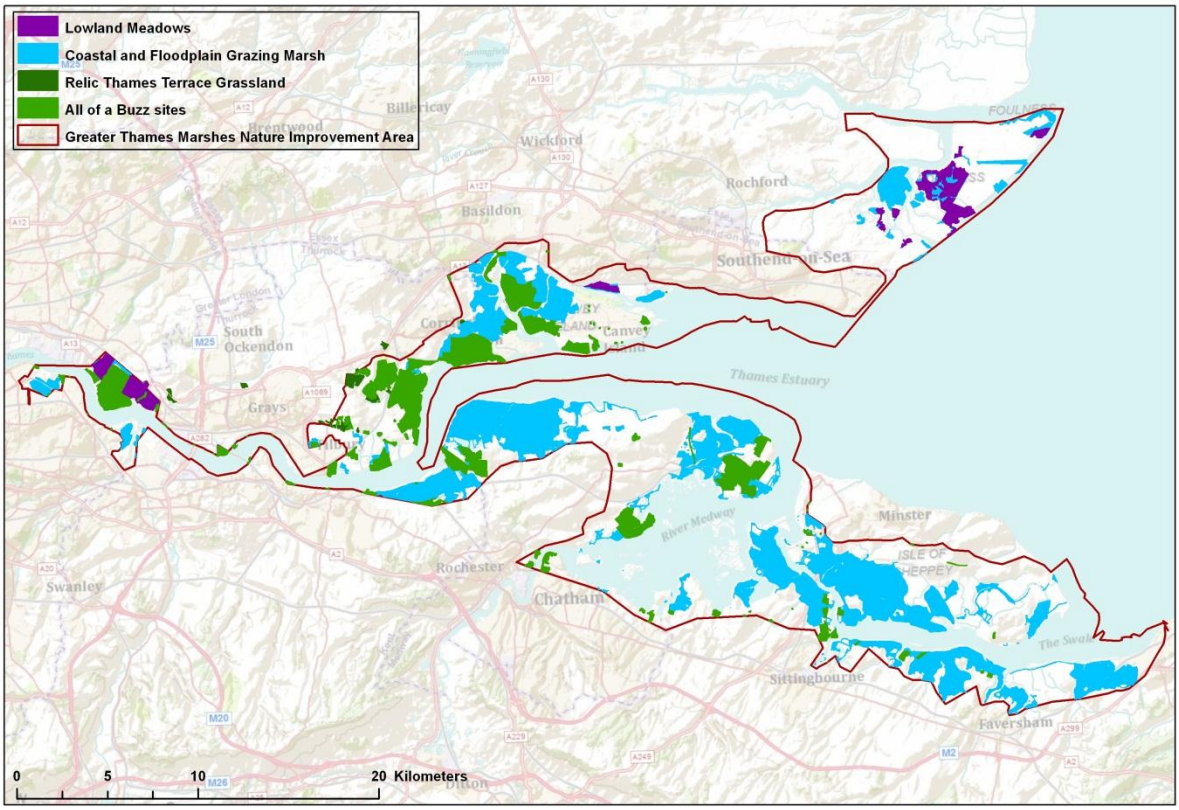


Figure 9. Priority and other important habitats in the NIA

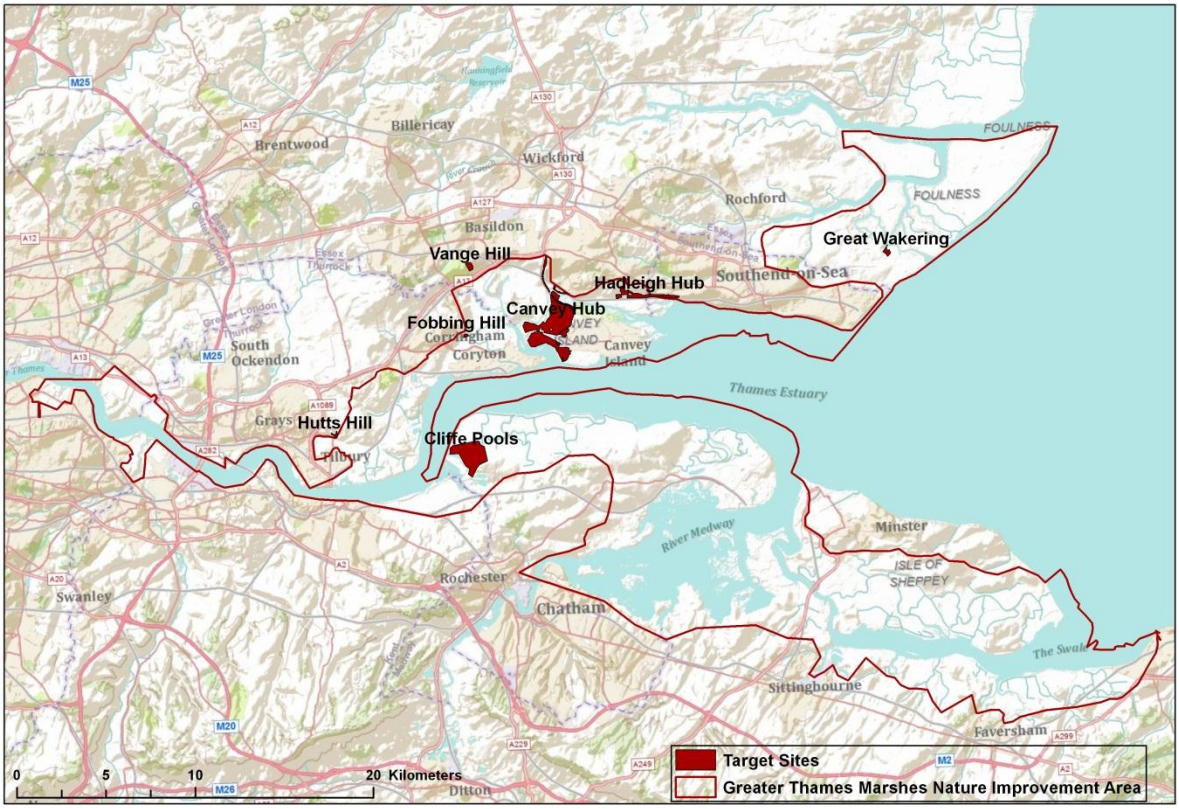


Figure 10. The location of the target sites

GREAT WAKERING

Figure 11. Great Wakering Target Site – baseline habitat assessment

Figure 12. Great Wakering Target Site – Management Compartments

SITE DESCRIPTION

Great Wakering is a Local Wildlife Site (R37) and former landfill site in Rochford District. The landfill closed in 2001, and was sown with a Rye Grass *Lolium perenne* mix. The northern half is managed by Essex County Council and is good quality grassland. The southern half of the site is the target site. The landowner is unknown and the site is unmanaged. It is mainly used for informal recreation, particularly dog walking.

Records for the surrounding area include Red Data Book and Nationally Scarce Hymenoptera (Bees, Wasps and Ants) and Diptera (Flies).

The habitat target at this site is to create Open Mosaic Habitat.

Habitats

Most of the site is dominated by species-poor rough grassland. There are some useful forge plants such as Wild Carrot *Daucus carota* and Ribwort plantain *Plantago lanceolata.* There are well-worn paths across the site that have resulted from informal recreational use across the site, with raised vegetation diversity in those areas. The LoWS citation states that Nationally Scarce Sea Clover (*Trifolium squamosum*) and Pale Flax (*Linum bienne*), both on the Essex Red List, occur along the path margins. Wildlfowers recorded on site include Common Vetch, Meadow Vetchling, Salsify, Smooth Tare and Cut-leaved Crane's-bill. There are nettles across the site, which indicates that the site is likely to be capped with a high-nutrient material.

The site is bordered by scrub which has begun to encroach into the open grassland at the south of the site (Compartment 1). It comprises native species including Hawthorn *Crataegus monogyna*, Blackthorn *Prunus spinosa*, Bramble *Rubus fruticosa*, and Traveller's joy *Clematis vitalba.* There are also small patches of bramble scrub across the site.

Figure 13. Boundary scrub © J. Robins

Figure 14. Rough grassland over most of the site © J. Robins

The sea wall area (Compartment 2) contains an area of rubble which appears to have been created by bank collapse from the capped landfill. The east-facing areas have a greater topographic variation.

Compartment 5 is generally particularly species-poor and has a low structural diversity. The southern part of this compartment contains the majority of the Goat's rue. However, there is a stand of *Phragmites* and at the time of the site visit following heavy snow there was an area of standing water close to the sea wall. These wet areas increase the habitat diversity on site.

Compartment 6 has a greater structural diversity with tussocks of grass. There are large stands of Alexanders, particularly near the sea wall. The central area towards the highest part of the domed landfill had a slightly higher botanical interest and structural diversity than the rest of the site. There is a small stand of Hemlock *Conium maculatum.*

Figure 15. Area of rubble near the sea wall © J. Robins

Figure 16. Stand of Alexanders © J. Robins

Compartment 7 contains a pond and large reedbed. Adjacent to the pond are bunds of hardcore and soil. There has been some tree planting and scrub encroachment around the pond.

Potential

The tussocky areas in the grassland have potential to support nesting Brown-banded carder bees (*Bombus humilis*). The rough grassland is likely to support the Priority Species Phoenix fly (*Dorycera graminum*), which is commonly found on similar unmanaged grasslands in the region (Ismay, 2000; Harvey, 2004). The majority of grassland areas are relatively species poor, but include useful species such as Wild carrot (*Daucus carota*) and Ribwort plantain (*Plantago lanceolata).*

The boundary scrub is useful feature connecting different parts of the site. The scrub may also act as a barrier to drift of fertilisers and pesticides from adjacent arable land.

Rose, Bramble and Traveller's joy (*Clematis vitalba)* in the scrub could potentially support the Red Data Book beetle *Leptophloeus clematidis.* The small patches of bramble scrub throughout the site are currently beneficial, providing a useful nectar resource and potential nesting habitat for stem-nesting species.

The rubble in the sea wall area may be an important area for Ground beetles and spiders. The sea wall itself may be a useful linear feature for bumblebee movement and connectivity

in the landscape. The rough grassland areas along the sea wall have potential to support *Bombus humilis.*

At the time of the site visit, following a period of heavy snow and rain, there was an area of standing water close to the sea wall and adjacent saltmarsh. These damp areas are likely to be important habitat features.

The central areas, the highest part of the domed landfill, appeared to be of most interest, with a slightly raised botanical interest and structural diversity.

Figure 17. Bund of hardcore and soil adjacent to reedbed and pond © J. Robins

Figure 18. Wet Grassland © J. Robins

Problems

Large areas of the site, particularly in Compartment 6, are becoming dominated by the non-native Alexanders (*Smyrnium olusatrum)* which, although it provides some useful early season forage, can easily dominate sites. There also stands of the non-native Goat's rue (*Galega officinalis*) in Compartment 5, which if unchecked can dominate large areas, replacing previously floristically and structurally rich grasslands while providing very few opportunities for invertebrates.

MANAGEMENT RECOMMENDATIONS

- The scrub cover should be maintained at below 10-15% cover, to prevent significant encroachment on the grassland elements of the site.

- The rank grassland areas of the site should be disturbed to break up the grassland, and create bare areas that would be both useful for invertebrates directly and create opportunities to increase the floral diversity of the site, by creating opportunities for germination. Such management should be on a broad rotational basis, to produce a mosaic of various stages of disturbance.

- Disturbance should be avoided near stands of Alexanders, to prevent creating opportunities for it to further dominate the site.

- Low nutrient aggregates should be introduced to the northern parts of Compartment 6. This area includes some south-facing slope, and introduced aggregates here should be designed to include additional topographical variation. This would provide areas of free-draining, low-nutrient substrate, providing bare areas for ground-nesting invertebrates and supporting a raised floristic diversity. Any aggregates imported will need to be placed on areas where the cap is thickest to ensure there is no resultant slumping or damage to the underlying cap.

- Saline scrapes should be created near the sea wall and adjacent saltmarsh. These could extend to the stand of *Phragmites*.

- Stands of Goat's rue should be treated to prevent them dominating the site.

- Hand seed collection of Narrow-leaved bird's-foot trefoil is recommended. Sowing of the seed should target winter-wet areas of the site which are favoured by the species.

BELTON HILLS

Figure 19. Belton Hills Target Site – Baseline Habitat Assessment

Figure 20. Belton Hills Target Site – Management Compartments

SITE DESCRIPTION

Belton Hills is a Local Nature Reserve and Local Wildlife Site (SOM1) owned by Southend-On-Sea Borough Council. It is known to support all three target species Shrill Carder Bee, Red-shanked Carder bee, Brown-banded Carder bee, and a number of Lepidoptera including the Horehound Longhorn moth (*Nemophora fasciella*). The site is important for rare and scarce flora, including the Priority Species Deptford pink (*Dianthus armeria*). It was historically an area of open Thames Terrace Grassland (Fig. 21) but in recent years has become covered with dense scrub and lost much of its biodiversity interest.

Habitat works at this site will be entirely funded by the 2012 Olympics Legacy project, allowing the core NIA and partner funding to be concentrated on other sites, increasing the capacity of the project.

The habitat target at this site is to restore Lowland Meadows, with some characteristics of Open Mosaic sites.

Figure 21. Aerial photograph of Belton Hills in 1940 showing the original open nature of the site

Habitats

The site is dominated by scrub and developing woodland, with only small areas of open grassland remaining. There is evidence that these open areas were created by scrub clearance in recent years. At present the grassland patches are still of value to TTI, however young scrub is encroaching rapidly and they may soon be lost.

Scrub species include Blackthorn, Hawthorn, Rose (*Rosa*) species and large amount of non-native honeysuckle species of only limited value to invertebrates, although native Honeysuckle (*Lonicera periclymenum*) is also present.

A small number of standing dead trees were noted.

Compartment 1 is dominated by scrub. Areas to the north and south of the footpath have been cleared in the previous ten years but young scrub has re-encroached since.

Compartment 2 was cleared of scrub c.2005-2006. Young scrub is encroaching into the grassland but there are still areas of value for TTI. Structural diversity is high compared to other grassland areas on site. Common knapweed *Centaurea nigra* is present.

Compartment 3 is mainly scrub, with areas of Alexanders.

Compartment 4 is south-facing, with species-poor grassland and areas of scrub, with a thick humic layer.

Figure 22. South-facing grassland in Compartment 4 © J. Robins

Figure 23. Previously-cleared area, good quality but young scrub encroaching. © S. Connop

Potential

Compartment 2 - This compartment used to support the best area of vegetation for Shrill Carder Bees with a diversity of wildflowers on a south-facing slope. It is a good example of the high quality habitat that can be created across this site by clearing scrub and allowing open habitats to re-establish.

Compartment 4 has potential to support nesting habitat for *Bombus sylvarum* and *Bombus humilis*. This compartment is likely to have to have a useful seed bank as it has a history of supporting diverse wildflowers.

The standing dead wood is of value to a range of invertebrates and has the potential to provide invertebrate habitat in areas dominated by Alexanders.

Problems

Compartment 3 has a significant cover of non-native Alexanders, and it occurs across the site in both open and scrub areas often in large stands. They occur along the paths, which create localised disturbance and opportunities for it to spread. Any management will need to

take great care in not disturbing areas adjacent to patches of Alexanders, as it is likely to colonise these areas rapidly. Action to clear Alexanders would probably not be a worthwhile use of resources, however, as it can already be found throughout large areas.

MANAGEMENT RECOMMENDATIONS

- Scrub management should aim to retain a mosaic of open areas and scrub of different ages, as young scrub areas will support open areas with a different character.

- All scrub clearance should include scraping off the underlying humic layer to reduce fertility and remove any unfavourable seed bank.

- Some of the scraped areas should be allowed to re-vegetate naturally as there is a history of rich botanical interest within Belton Hills, some of which may be retained in the seed bank and previous vegetation clearances have yielded some positive results (Harvey, 2001).

- The material removed from scraping should be used to construct a bund bordering the arable areas to the south of the site. Such a bund would provide a habitat feature for ground-nesting Hymenoptera, provide sheltered south-facing areas behind them and also reduce fertiliser drift into the site in future. Alternatively, scrub should be allowed to develop along the southern boundary to act as a barrier in place of bunds.

- Cleared areas should be based on a few larger areas rather than a large number of small areas, as edges are vulnerable to rapid scrub encroachment and clearance of large areas will remain open for a longer period of time.

- Efforts should be made to retain the tallest, mature tree species and any standing dead wood found on site as they are likely to be of value.

- Scraping should not be undertaken in areas dominated by Alexanders.

- Mowing the scrub cleared areas must be on a long rotation, rather than annually across the entire site, to ensure that insects that overwinter in dead stems, leaves, and seeds are not lost.

- Creating standing deadwood may be a good use of areas dominated by stands of Alexander, where scrub removal and scraping is difficult.

VANGE HILL

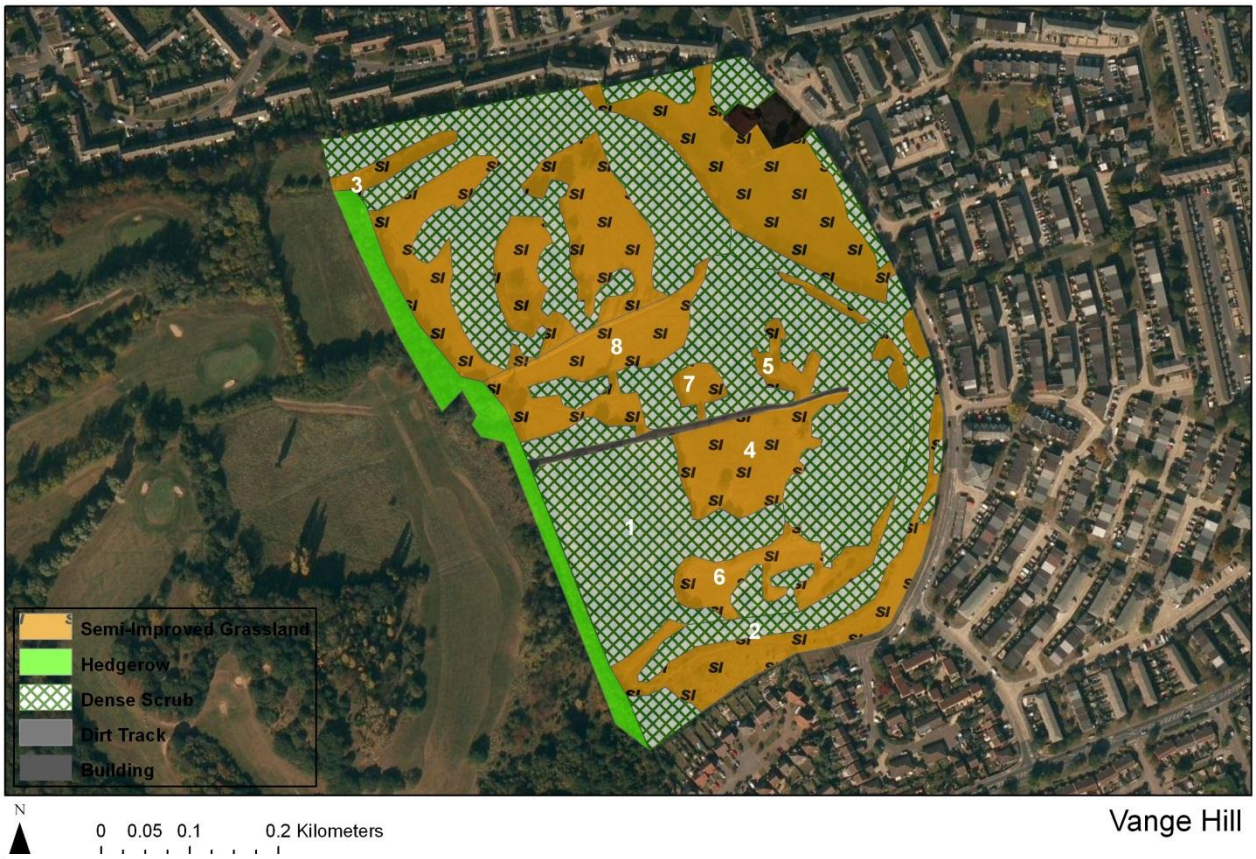


Figure 24. Vange Hill Target Site – Baseline Habitat Assessment

Figure 25. Vange Hill Target Site – Management Compartments

SITE DESCRIPTION

Vange Hill is part of a Local Wildlife Site (BA35) owned by Basildon Borough Council. It is a large south-facing site adjacent to a golf course which in the past supported a rich invertebrate fauna including the Priority species Shrill Carder bee, Brown-Banded Carder bee and Phoenix fly as well as a significant number of Red Data Book spiders, Diptera and Hymenoptera (Harvey 2007).

The habitat target at this site is to create Open Mosaic Habitat, with the grassland areas restored to Lowland Meadows quality.

Habitats

The site is a mosaic of species-rich grassland, species-poor grassland, woodland, young scrub and ditches.

Compartments 1 and 2 are south-facing tussocky grassland, with heavy scrub encroachment. Scrub in compartment 2 is mostly young.

Figure 26. Compartment 2 – previously a Shrill Carder Bee nest site, now scrub is encroaching. © J. Robins

Figure 27. Scrub between Compartments 1 and 2

Compartment 3 contains a wet ditch, very full of standing water at the time of the field visit following heavy rain, which may normally be much drier. It contributes to the on-site habitat mosaic.

Compartment 4 is a mix of species-poor grassland and scrub, with evidence of previous scrub clearance. Young scrub is beginning to dominate the grassland areas. Red Bartsia has been recorded here in previous visits and is expected to remain, but was not evident due to the time of year.

Compartment 5 is heavily managed, species-poor amenity grassland.

Compartment 6 is south-facing grassland, with patches of species-rich vegetation. The northern part of the compartment contains a mound, creating topographical variation, with a greater diversity of species. In the southern part of the compartment there has been scrub and tree planting. There is an open, but sheltered, ride between scrub patches, with young scrub encroaching at the edges.

Compartment 7 is an open, previously scrub-cleared area with rough grassland.

Compartment 8 is species-poor grassland with low structural diversity, managed for recreational use.

Figure 28. The wet ditch in Compartment 3 © J. Robins

Figure 29. Low interest amenity grassland in Compartment 8 © J. Robins

Potential

Previously a dry ditch ran between Compartments 1 and 2 and the scrub boundaries included an open ride-like area between them, with sunny, sheltered warm areas. This area supports Perennial Sweet Pea (*Lathyrus latifolius*), which although non-native has been shown to be an exceptionally useful forage resource for rare bumblebees, particularly early foraging queens.

Compartment 2 has previously supported nesting Brown-banded carder bees in south-facing tussocks.

The wet ditch in Compartment 3 has significant potential as a seasonally wet feature.

Mammal activity has exposed a sandy substrate, indicating the potential of the site to contain original Thames Terrace substrate.

Figure 30. Sandy expsoures caused by mammal activity © S. Connop

Problems

Scrub has since invaded much of the ride area between Compartments 1 and 2, and most of Compartment 2, reducing the extent of open areas significantly.

MANAGEMENT RECOMMENDATIONS

- The ride between Compartments 1 and 2 must be re-opened as it was a particularly valuable feature of the site, creating warm, sunny, sheltered conditions. The young and mature scrub must be removed here with possible complimentary scrapes to encourage the wildflower resources of the site by removing the humic layer and providing germination opportunities.

- Scrub should be cleared from the open rides in the south of compartment 6, where scrub has encroached. These areas should be scraped rotationally to open them up for solitary bees and wasps.

- The humic layer and topsoil should be scraped rotationally from the upper slopes of compartment 6, to encourage the rare flora previously recorded on the site.

- Compartment 2 should be cleared of scrub by cutting the scrub, scraping away the litter and humic layer and treating larger stumps, to encourage the potential of the area for bumblebees. Rotational scraping c. every 10 years would be ideal to maintain the resource.

- Scallops should be cleared out of scrub as has taken place, and should be followed by scraping which does not appear to have been done previously.

- Mowing should be reduced in compartment 5.

- It is recommended that scarification is used in Compartment 5 to create germination sites for wildflowers.

- Red Bartsia should be introduced into areas of Compartment 5 to provide a useful forage area for Shrill carder bees and to trial its use as a hemi-parasite to increase opportunities for less competitive plant species.

- The wet ditch in Compartment 3 should be deepened and a gradual shelf created to retain the wet areas for a longer period throughout the year.

Figure 31. Hutts Hill Target Site – Baseline Habitat Assessment

Figure 32. Hutts Hill Target Site – Management Compartments

SITE DESCRIPTION

The site is owned and managed by Thurrock Council and is used as open space by the adjacent residential community. The site is a relatively steep slope ranging from south-west to south-east facing, and is closely mown and managed as an amenity area.

The habitat target at this site is to create Open Mosaic Habitat.

Habitats

Hutts Hill comprises low interest amenity grassland. There is a thin line of boundary scrub along the south of the site between it and the main road.

Compartment 1 is short mown amenity grassland. There are some disturbed areas where rabbit and mole activity has exposed underlying sands and gravels. Within the generally low interest grassland there are patches with a more open sward, higher herb species diversity and more fine grasses, possibly due to soil variation such as where the underlying sands and gravels are closer to the surface.

There is a central north-south strip of scrub bisecting the site.

Compartment 2 contains a thin scrub boundary and larger area of scrub on the western slopes of the site. Ivy *Hedera helix* is prevalent in some areas.

Compartments 3 and 4 contain the largest and steepest slopes. They are dominated by a mix of rank grassland and scrub. There are a number of garden escapes.

Figure 33. Low interest amenity grassland © J. Robins

Figure 34. Evidence of underlying sands and gravels from mammal activity © S. Connop

Potential

Areas of disturbance from mole and rabbit activity reveal underlying sands and gravel in some areas, suggesting the site is a nutrient-enriched relic Thames Terrace Grassland site, so likely to have the potential for raised invertebrate interest with appropriate management. The most south-facing areas, and the western half of the compartment, have the most interest.

The scrub is likely to be of benefit to overall site biodiversity and act as shelter for the adjacent areas of grassland. The ivy within it is a beneficial source for the Ivy mining bee *Colletes hederae* and is a valuable late-season nectar source which will benefit the target Shrill Carder Bee and Brown-banded Carder Bee.

It is important to note that the Vulnerable Lesser Calamint (*Clinopodium calamintha*) has been recorded on the roadside verge just across the scrub boundary at the south of the site. Appropriate management could allow the species to move into the Hutts Hill site.

Problems

There is significant fly tipping in Compartments 3 and 4.

Figure 35. Scrub and rank grassland at the West of the site © S. Connop

Figure 36. View from Hutts Hill to neighbouring, good quality Hob Hill © S. Connop

MANAGEMENT RECOMMENDATIONS

- Reduce the mowing regime, which appears to be intense due to its use as an amenity area. Compromises between wildlife and public amenity will be required in this instance as it is regularly used by dog walkers and is the nearest open space for the neighbouring community. One option for altering the mowing regime would be to reduce mowing across the site, but maintain the existing mowing regime on wide pathways, leaving the majority of the site rough. This would add an additional visual interest for the public while significantly increasing the structural diversity of the site's grasslands.

- It is highly recommended for some areas of the site to be left un-mown throughout the year to provide overwintering opportunities for invertebrates, for example around trees and patches in the open.

- Scarification is recommended, to create disturbance and opportunities for wildflowers to colonise new areas of the site. This would be useful both in particularly species-poor areas to aid diversification, but also in areas where the interest is visibly raised as it may be that the underlying sands and gravels in these areas are nearer the surface, so represent increased opportunities for localised habitat improvements. Any scarification should be undertaken in winter, and should be low-key so as to avoid adverse impacts on the aesthetics of the area for the local community.

- Scrapes should be created in the eastern half of Compartment 1 which is extremely homogenous and low value. Scrapes should not be restricted to poorer areas,

however, as areas of more interest in the western half are likely to be better for targeted recreation of Thames Terrace Grasslands due to underlying sands and gravels.

- The scrub around the boundary of the site should be retained as it provides shelter and does not require any management.

- Scrub at the top of the slopes to the West of the site should be cleared (Compartment 3). Scrapes could easily be created on these slopes with machinery to remove the thick humic layer which has developed and to potentially expose the underlying substrate, again with the potential for sands and gravels to be exposed.

- Scrub on steep slopes in Compartments 3 and 4 should be cleared. Creating open areas here would be relatively simple with machinery with a long reach. The steep angle of the slopes would also be expected to delay the rate of succession back to rank grassland and scrub.

- Community engagement efforts are recommended to reduce the nutrient enrichment of the site from dog faeces, through signage and/or additional dog waste bins.

FOBBING HILL

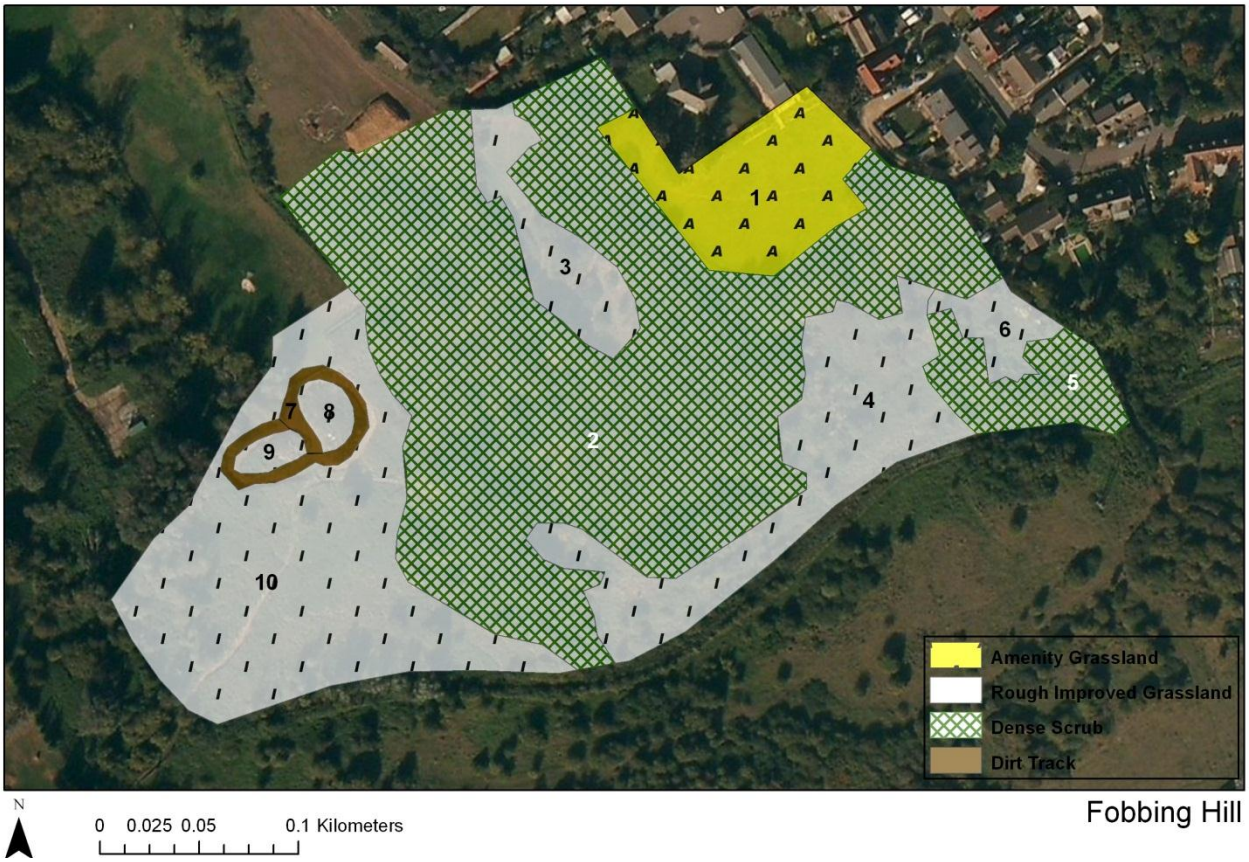


Figure 37. Fobbing Hill Target Site – Baseline Habitat Assessment

Figure 38. Fobbing Hill Target Site – Management Compartments

SITE DESCRIPTION

Fobbing Hill is a south-facing sloping site that is privately owned. It is adjacent to Fobbing and Corringham Marshes SSSI and Corringham & Fobbing Marshes Local Wildlife Site (TH69). In 1997 it was described as unimproved Thames Terrace Grassland with some scrub and elm which needed clearing (Plant and Harvey 1997). Historically it comprised wildflower-rich short swards and bare sandy exposures and Priority Species including the Five-banded digger wasp (*Cerceris quinquefaciata)*.

The habitat target at this site is to create small areas of Open Mosaic Habitat-quality habitat, and restore areas of Lowland Meadows.

Habitats

The scrub and elm has developed over time into secondary woodland. A thick humic layer has developed.

Compartment 2 contains the main slopes of the site. Most of the previous high quality habitat has been lost, and it now comprises secondary woodland and limited ground flora. There are remnant patches of acid grassland with some Sheep's Sorrel *Rumex acetosella.*

Compartment 10 retains some rough wet grassland areas with useful species such as Common Hogweed *Heracleum sphonylium* and patches of *Phragmites.* There are large areas of dense scrub, and some areas of mature woodland.

Compartments 8 and 9 contain some deadwood piles from previous scrub clearance.

Potential

The wet grassland areas are of moderate interest with some useful species and contribute to the habitat diversity on site.

The deadwood piles provide habitat for saproxylic invertebrates.

The remnant patches of acid grassland have the most potential for invertebrates.

Problems

In recent years the scrub encroachment has led to the loss of all bare areas and the majority of open habitats. Large areas of the site have developed into mature woodland and a thick high-nutrient humic layer has developed, leading to the loss of species-rich grassland.

MANAGEMENT RECOMMENDATIONS

- The large block of scrub dominating the south-facing slopes needs to be broken up, to create large open areas throughout.

- Scrub clearance in surrounding areas should target areas with remnant patches of acid grassland to encourage their expansion and work to expose remnants of Thames Terrace sands and gravels (Compartments 1 and 6).

- Individual large trees should be removed to create open areas and areas of disturbance, to allow for wildflowers to colonise these newly created areas rapidly.

- The humic layer in these key cleared areas should be removed by scraping to reduce the nutrient levels and unfavourable seed bank. A very thick layer appears to have developed over the underlying substrate.

- Scrapes in areas with less-accessible underlying substrate should be capped with a lower nutrient material.

- The material from scrapes should be used to create a network of bunds, to increase topographical variation and provide a range of aspects and drainage conditions for a variety of invertebrates.

- The existing deadwood piles should be enhanced using material from scrub clearance, creating a diverse range from dense piles to individual logs, across a range of conditions from wet to open, sunny areas to benefit a variety of invertebrates.

- The wet areas in Compartment 10 should be diversified by creating a network of scrapes and ponds, to provide a mosaic of wet habitats from permanently wet to ephemeral and encourage the *Phragmites* resource.

CANVEY HUB

WEST CANVEY MARSHES

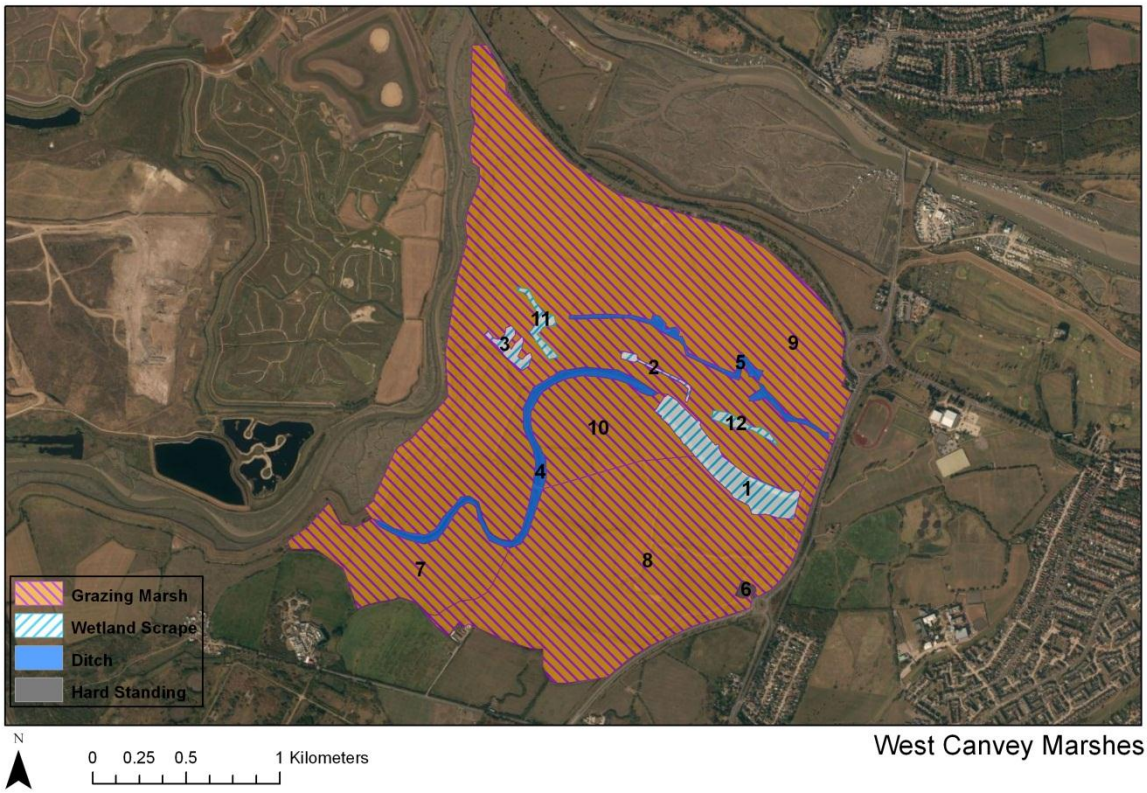


Figure 39. West Canvey Marshes Target Site – Baseline Habitat Assessment

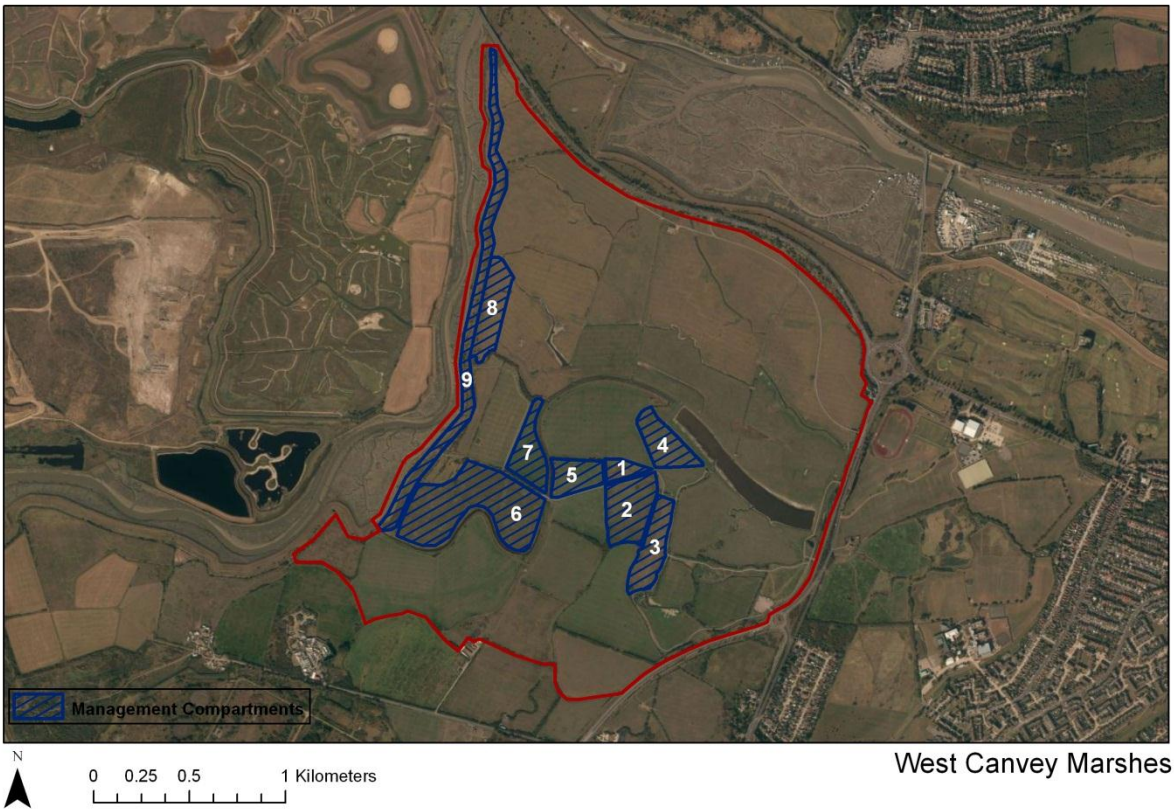


Figure 40. West Canvey Marshes Target Site – Management Compartments

SITE DESCRIPTION

West Canvey Marsh is a Local Wildlife Site (CP4) managed by the RSPB. The site has an existing management plan, work for this project will focus on areas of the site not covered by this plan or on measures that can be undertaken that will not affect delivery of the existing plan. The site visit concentrated on the Roscommon Way Mitigation area. This involved spreading 100 bales of green hay cut from One Tree Hill onto bare ground that had been created using disc cutting to benefit the Shrill Carder bee. A few other areas of interest were also visited. The site is known to support a large number of rare and scarce invertebrates, including the Priority species Brown-banded carder bee, Shrill carder bee, Saltmarsh shortspur beetle, Red-shanked carder bee and a large number of Lepidoptera, in addition to several Red Data Book spiders and Diptera (Harvey, 2006)

The habitat target for this site is to create areas of Open Mosaic Habitat and restore areas of Coastal Grazing Marsh.

Habitats

The site has a mosaic of grazing marsh, wet and dry grasslands, hay-cut paddocks, ditches and scrub.

Compartment 4 is hay cut and grazed. It contains Red Clover, Bristly Ox Tongue *Picris echioides* and Pyramidal Orchid *Anacamptis pyramidalis.* The banks of the watercourse have been re-profiled for Water Voles, with steep banks down to reedbeds. Some scalloping has taken place to produce high quality reedbed and it has a good structural diversity.

Compartment 5 is a paddock used for the annual Canvey Wildlife Event. It was improved in the past and is cut every May. It is species-poor and dominated by coarse grasses.

The south of Compartment 8 has been disc-cut in the past. It is grazed from August until late November. It is rough grassland, the grazing is aimed at breaking up the sward. It contains small amounts of Narrow-leaved Bird's-foot trefoil.

Compartment 10 and the north of Compartment 8 are hay-cut paddocks, cut in the early autumn followed by aftermath grazing. The north of Compartment 8 has a more diverse vegetation structure. Both areas are species-poor but contain good amounts of Red Clover *Trifolium pratense.* There are wet grassland areas.

Figure 41. Hay cut and aftermath-grazed paddock © J. Robins

Figure 42. Wet grassland areas © J. Robins

The borrowdyke has areas of Narrow-leaved Bird's Foot Trefoil. It is lightly grazed and disturbed by livestock.

Path areas around the site are a combination of cut and raked grass, simply cut with the arisings left in place, and left to grown rough.

Potential

The areas of interest are a combination of hay cut paddocks and areas subject to winter grazing, making up 10 ha of the site. Much of this is wet grassland with potential to support good stands of Narrow-leaved bird's foot trefoil.

The borrowdyke is likely to function as a corridor for Shrill and Brown-Banded Carder Bees.

A single Grizzled Skipper *Pyrgus malvae* has been recorded in Compartment 10. This area may have the potential to support more Priority Species.

Figure 43. Borrowdyke likely to function as a bumblebee corridor © S. Connop

MANAGEMENT RECOMMENDATIONS

- A more appropriate source of green hay for Compartment 8 should be identified as the site supports very wet grassland, making the use of green hay from One Tree Hill inappropriate as the conditions of the donor and receptor sites are significantly different. A new source should include Narrow-leaved bird's-foot trefoil and be subjected to light winter grazing after application (Compartments 2 and 3). Potentially Narrow-leaved bird's foot trefoil areas already in good condition within West Canvey

Marsh could be cut and spread onto other areas rather than sourcing material off site.

- Compartment 8 and other managed areas should be subject to an increased disturbance regime using machinery.

- A change in grazing regime to begin from October is recommended. It is acknowledged that livestock must be removed by the end of November, so it is recommended to maintain a higher livestock density for a short period, to prevent livestock reducing late forage for bumblebees.

- Red Bartsia is recommended for introduction to species-poor hay-cut areas, either as a part of green hay or hand seed collection from plants. Red bartsia is a hemi-parasite of grasses so may act to control dominant grasses, creating opportunities for less competitive wildflowers in an open sward, similar to Yellow rattle. Red bartsia is also favoured by Shrill carder bees for foraging.

- Mounds of aggregates are recommended for areas of the site out of the public eye. This could be of particular value to the Sea aster mining bee (*Colletes halophilus*), as nesting areas are considered to be the main limiting factor to their distribution. This could be accomplished simply and cheaply with introduced sand, preferably with a saline character and could be managed by annual light disturbance. An existing mound area already has the potential for the introduction of substrates to create a nesting area (Compartment 1).

- Creating areas of different depths would create a range of drainage conditions to further diversify habitats on site.

SOUTHWICK DYKE OPEN SPACE

SITE DESCRIPTION

Southwick Dyke is a corridor of low interest amenity grassland with a central path in a residential area of Canvey Island, managed by Castle Point Borough Council. The site has raised fertility and is extremely species-poor as a result of its management as an amenity area.

Habitats

The site is species-poor, short amenity grassland with scattered trees and a single rough grassland area. A concrete drainage channel cuts through the centre of the site.

Potential

Improvements to the site could allow it to be a valuable ecological corridor in combination with the Canvey Lake Local Wildlife Site, in the centre of an urbanised area of Canvey Island, where there are very limited opportunities for wildlife. It would also be useful as an educational resource due to its urban setting and position adjacent to the well-used Canvey Lake.

Problems

The amenity use of the site limits the habitat works that can be carried out.

Figure 44. Amenity grassland, drainage channel and pathway © J. Robins

Figure 45. The single area of rough grassland with scattered trees © S. Connop

MANAGEMENT RECOMMENDATIONS

- Mowing regimes should be altered to include areas left rough on a long rotation (Compartments 1-3 and 5-9). There is a significant area of open space, so it should be possible to retain rough areas of value to invertebrates while including regularly mown amenity areas for the benefit of the local community. Such areas could be rotationally mown, or include uncut areas around trees, such as a 5-10m border. A reduced mowing regime would have the additional benefit of reducing maintenance costs significantly. Any rotational management regime should aim to maintain rough areas both around patches of trees and in more open areas which are likely to receive more direct sunlight.

- Potentially interesting areas for management are the small number of raised mounds in the centre of the open space (Compartment 4 is one example), which would likely be better drained and potentially of lower fertility. These mounds would benefit from creating scrapes or scarifying, to provide opportunities for wildflowers in the grass dominated space. They would also represent the best areas for sowing wildflower seed and reducing the mowing regime.

- Introducing key wildflower species would significantly increase the value of the site. Species such as Red clover, Wild carrot and Selfheal (*Prunella vulgaris)* could be easily sown and would likely persist in areas left to grow rough.

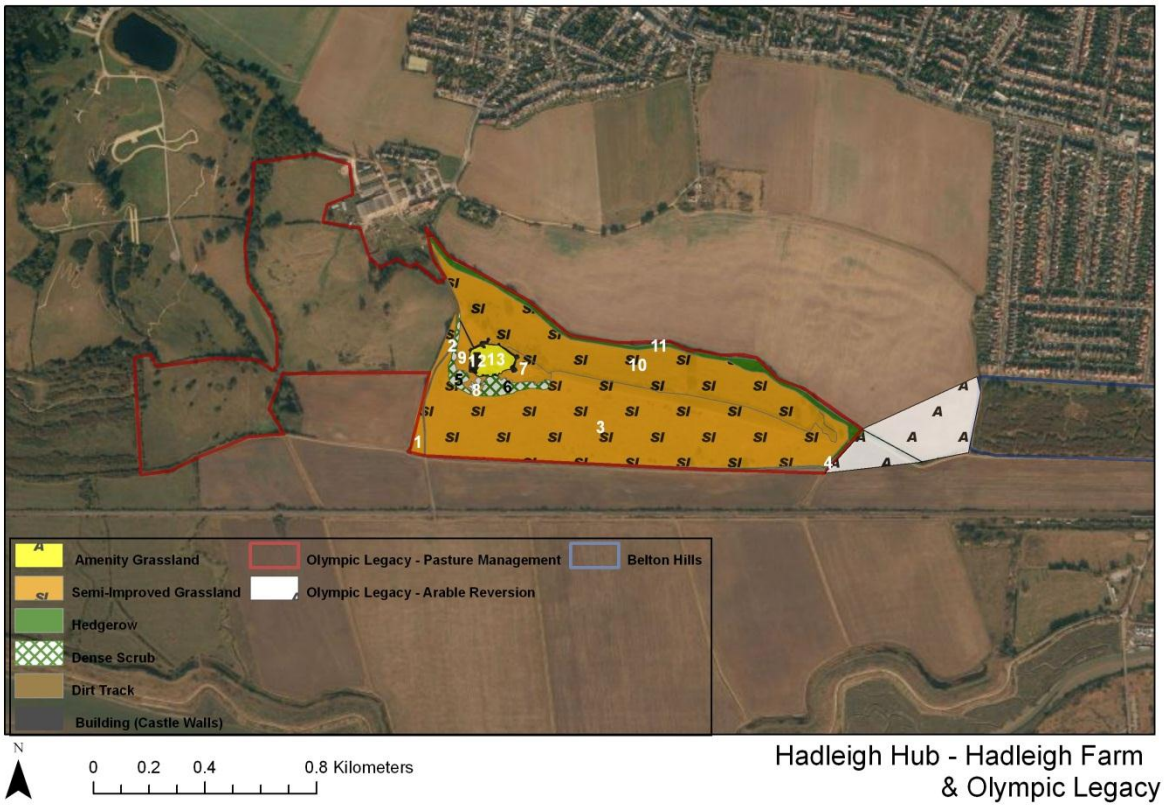


Figure 46. Hadleigh Target Site – Baseline Habitat Assessment

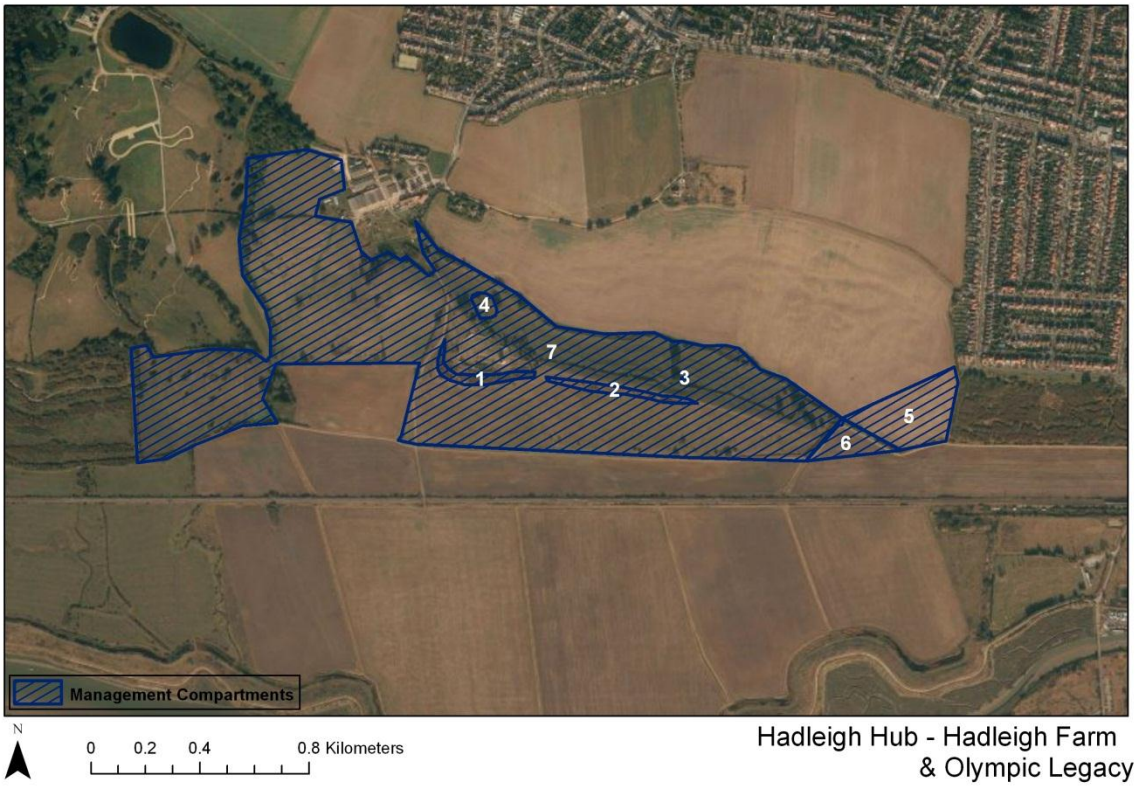


Figure 47. Hadleigh Target Site – Management Compartments

SITE DESCRIPTION

The Hadleigh Castle slopes are dominated by a mosaic of grassland habitats that make up part of the Castle Farm/Hadleigh Castle Grasslands Local Wildlife Site (CP25). It is owned by The Salvation Army and forms part of the 2012 Olympics Legacy Project.

Habitat works at this site will be entirely funded by the legacy, allowing the core NIA and partner funding to be concentrated on other sites, increasing the capacity of the project. This project and management recommendations below have influenced the plans for the site.

Records for the site include the Priority Brown-banded Carder bee, Shrill Carder bee, Red-shanked Carder bee, Phoenix Fly, a range of Lepidoptera and a significant number of Red Data Book Araneae of heathland, dry grassland and landslip habitats.

The habitat target at this site is to restore the existing grasslands to Lowland Meadows and Grazing Marsh and create new Lowland Meadows and areas of Open Mosaic Habitat.

Habitats

Longer sward areas are contrasted by short sward areas caused by rabbit grazing, which support a higher floristic interest and more fine grasses. There are areas of bare ground resulting from small-scale land slips of clays over gravels. There are patches of scrub.

Compartment 3 has a grassland mosaic of species-poor, rank grassland habitat with patches of high quality wildflower-rich vegetation. Shorter areas caused by rabbit grazing have more fine grasses and greater vegetation diversity. There are small landslips which have exposed the underlying sands and gravels in small patches and caused a varied topography. There are scattered bramble patches.

Figure 48. Compartment 3 © J. Robins

Figure 49. Exposures from landslips in compartment 3 © J. Robins

Compartments 5 and 6 are dominated by scrub which is beneficial in the site context. There are areas of open south-facing grassland between the scrub. Within the grassland areas there are very small landslips of clay over the underlying gravels with very small patches of bare ground.

Compartment 8 is open south-facing grassland with small patches of bare ground.

Compartment 10 is north-facing grassland, with a varied topography but fewer exposures. The west of the compartment has some damp and moss-covered areas. At the time of the site visit following heavy snow and rain there was an area of standing water adjacent to some exposures. There is a small amount of standing dead wood with rotten heartwood, and small patches of bramble.

Potential

The intermittent wet areas in Compartment 10 are likely to support an additional invertebrate interest.

The exposures produced from landslips are valuable areas of raised floristic diversity and offer bare areas for ground-nesting invertebrates, as well as a specific assemblage of species associated with landslip habitats. A key area is the south-facing slopes of the central east-west ridge. Drought stress, landslips and rabbit grazing has contributed to the development of species-rich grassland.

The scrub resource of the site is a beneficial feature with little evidence of encroachment into the grassland component of the site.

Grazing takes place across the site.

The area of arable land to the east of the site connects Hadleigh with Belton Hills. Reversion of this site to grassland will connect the two sites, significantly benefitting invertebrates.

Figure 50. Herb-rich vegetation © J. Robins

Figure 52. Scrub and grassland mosaic, compartments 5 and 6 © J. Robins

Figure 51. Standing dead wood, a valuable feature © S. Connop

MANAGEMENT RECOMMENDATIONS

- Some areas of scrub in compartments 5 and 6 should be cleared on the steeper slopes. This would create useful open grassy areas on slopes and would present more exposures to increase the invertebrate interest. Scrub removal should aim to remove individual trees and either treat stumps with glyphosate or uproot them

- Trial scrapes should be created in south-facing slope areas to complement the natural exposures, both in cleared sections of compartments 5 and 6, and on the south-facing slopes on the ridge between compartments 3 and 10.

- Reducing the grazing pressure is recommended. This will encourage the summer wildflower resource and provide opportunities for wildflower species to germinate.

- The south-facing slopes of compartment 3 would benefit from occasional disturbance in addition to grazing to expose underlying soils for invertebrates as well as creating opportunities to diversify the site's flora. Experimental scrapes could be created to investigate the colonisation of bare substrate on a small scale, so as to not interfere with visitors' enjoyment.

- The currently small stands of the non-native Alexanders should be targeted with treatments of glyphosate urgently while they remain manageable. Much of this is on the top of the south-facing ridge.

- Wet grassland parts of compartment 10 should be deepened and expanded, to increase their permanence and encourage a wet grassland vegetation to develop

- Revert the arable field between Hadleigh and Belton Hills to species-rich grassland. This will restore the link between these two sites, greatly increasing the amount and connectivity of habitat for the target species.

CLIFFE POOLS

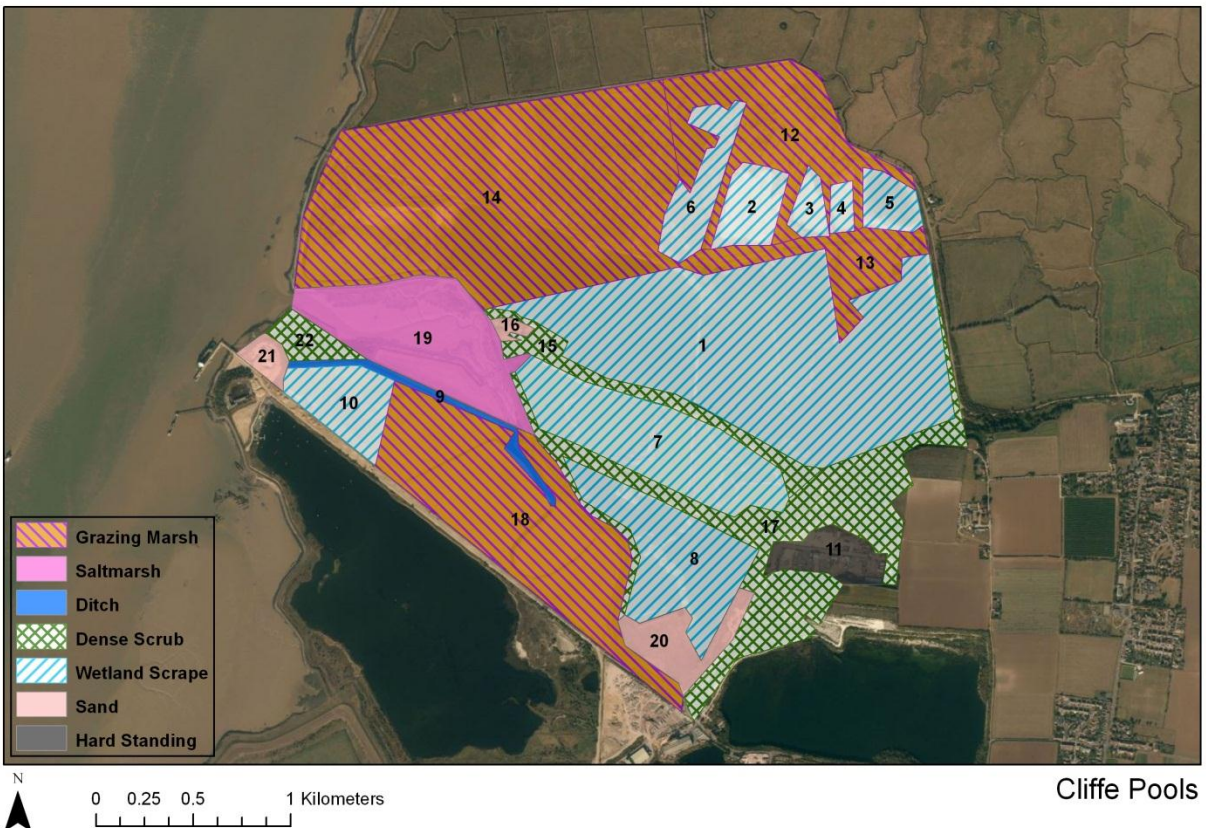


Figure 53. Cliffe Pools Target Site – Baseline Habitat Assessment

Figure 54. Cliffe Pools Target Site – Management Compartments

SITE DESCRIPTION

Cliffe Pools is owned and managed by the RSPB. Three main areas of the site have been identified which are excluded from existing management plans and Higher Level Stewardship agreements. These areas will be the focus of this project. A small number of recommendations have been made for the wider site, but these will not impact upon the delivery of the existing agreements. The site is known to support an outstanding assemblage of Bumblebees, including Brown-banded Carder bee (one of the very few Kent sites to support this species), Shrill Carder Bee, Moss Carder Bee (*Bombus muscorum*) and Sea Aster Mining bee, with grassland areas appropriately grazed and managed to encourage suitable forage, notably Narrow-Leaved Bird's Foot trefoil (*Lotus glaber*).

Habitats

The site contains a diverse range of habitats including 10% of the national resource of saline lagoons, with reedbed, wildflower-rich grassland, rough grassland, scrub and sea wall, much of which is currently part of the site's management plan or under Higher Level Stewardship agreement.

The Clay Storage Areas (Compartments 1 and 2) are generally of low interest, but do contain some Teasel. There are patches of *Phragmites* and some areas with good structural diversity but the majority is rank grassland. There are number of small hummocks providing topographical variation, but covered in dense grasses.

Compartments 3 and 4, the Remediated Area, is dominated by free-draining sandy gravels, potentially with minor contamination. There is a mosaic of bare ground, sparsely vegetated areas and ephemeral pools. There is a dry pit containing hardcore. There are patches of scrub containing Privet *Ligustrum vulgare.* The east of the compartment contains an area of boulders and rubble. There is an area of Sea Aster.

The dredgings areas, Compartments 5 and 6 are outstanding habitat. There is a mosaic of dredgings piles in various stages of vegetating. The surface substrate of the piles varies, with some having gravel exposed where finer material has washed away. There are patches of drought-stressed bramble. There are wet areas which are likely to be saline in character. The main dredgings storage area is large and open. The east of the site has artificial dune and estuarine systems developing. The western areas contain rough grassland, which contributes to the habitat mosaic.

Figure 55. Dredgings area habitat mosaic © J. Robins

Figure 56. Artificial estuarine habitat © S. Connop

The sea wall on the west of the site provides some interesting habitat in the wet areas east of the sea wall, which support Divided sedge (*Carex divisa*).

Potential

The borrowdyke on the edge of Compartment 5 has significant potential, as it is apparently saline.

The remediated area is likely to be high quality habitat for invertebrates, and little work is likely to be required to maintain the area.

The Privet (*Ligustrum vulgare*) has some value for invertebrates.

Areas of sand bordering the lagoons and adjacent Sea Aster are likely to have high value.

The dredgings area is likely to have significant opportunities for ground-nesting aculeate Hymenoptera here as well as active ground species. The presence of Sea aster nearby suggests this area may well be of high value for the Sea aster mining bee.

Problems

There is a significant problem with non-native Alexanders across Cliffe Pools, particularly on the west of the site (west edge of Compartment 6). The extent suggests that it is too late to tackle the problem without a very large expense, and that any management proposals involving disturbance should not take place in these areas as it would only provide opportunities for expansion.

Figure 57. Habitat Mosaic in the remediated area © S. Connop

Figure 58. Slopes dominated by Alexanders in the west of the site © S. Connop

MANAGEMENT RECOMMENDATIONS

- The clay storage area would benefit from disturbance to break up the sward and add some localised topographical variation (Compartment 1). Driving a tractor or digger around the area in winter should be sufficient, creating ridges and thus topographical interest.

- Creating saline scrapes in the clay storage area is recommended to improve the habitat mosaic and also provide some bare ground (Compartment 1).

- Introducing patches of the cinder-like material used on paths in Compartment 3 around the clay storage area could be potentially useful for active ground beetles and spiders, as it warms quickly, provides burrowing opportunities and will likely be regularly disturbed by mammal grazing.

- Wet saline scrapes are recommended for areas east of the sea wall on the west of the site, where Alexanders is a less significant issue (Compartment 2)

- Buddleia needs to be removed from the Remediated area, as the area provides many opportunities for the species to spread and become a serious issue if it shades a significant proportion of the site (Compartment 6). Surrounding scrub should also be cut back and managed to prevent it invading the valuable open mosaic area.

- The borrowdyke highlighted on the edge of Area 5 could be improved by simply driving heavy machinery through to create disturbance and varied topography, as the salinity of the area is already likely to have created some interest (compartment 7)

- Areas of low interest within the remediation area should be improved by creating south-facing bunds, possibly using imported dredgings

- Some rough grassland areas have developed over old piled dredgings and in flatter areas (Compartment 8). These should be scraped to re-expose the underlying sands and gravels

- Bramble, although very beneficial in the drought-stressed condition found in the dredgings area, must be managed to prevent it dominating the site.

- Dredgings piles should aim to include a mosaic of different stages of vegetating and proportion of gravel, managed through long-term rotational disturbance (Compartment 9).

- Creating pools is advised in currently lower interest areas, to mimic the ephemeral pools in the dredgings area.

- The main dredgings storage area should be retained once dredging operations have concluded, while leaving a good layer of dredgings in place to retain the extremely valuable dune-like area and artificial estuary-like habitats that provide novel invertebrate features (Compartment 11). This would likely develop into high quality habitat which would only need very occasional disturbance as the main management technique.

DELIVERY SCHEDULES

HUTTS HILL

Prescriptions (Management Compartment numbers referred to where appropriate, see above maps for locations)	**Outcomes**	**Indicative Costs** (from Nix 2012)	**Timetable**	**Risks/Issues**
Installation of additional dog waste bins at entry to pathways	Reduction in nutrient enrichment. Improvement of amenity environment.	Approx. £250 per bin plus labour	Autumn 2013	Long-term maintenance of bins may not be possible. In this case, additional signage (as below) will be installed instead.
Installation of signage. Encourage clearance of dog waste. Explain effects of nutrient enrichment & importance of the area	Community engagement. Reduction in nutrient enrichment. Improvement of amenity environment.	TBC on sign design. Approx. £200 per single-post 90cmx60cmsign plus labour	Summer/Autumn 2013	
Reduce the mowing regime across the site, maintaining wide mown pathways	Tall vegetation for nesting and forage. Increased visual interest for residents. Reduced maintenance costs for owner.	£0	Beginning Spring 2013, ongoing thereafter	Possible compromise required as area used by local dog walkers, may be necessary to reduce mowing in small patches only.
Leave an un-mown border around trees	Habitat for stem/seedhead nesting invertebrates and tall vegetation for nesting. Reduced maintenance costs for owner.	£0	Immediate and ongoing	Visual impact on amenity users. However, it should increase the visual interest of the site and provide visual continuity with adjacent Hobs Hill
Winter scarification of small areas, in areas used less frequently by the public (<1ha).	Provision of bare ground for ground-nesting and warmth-loving invertebrates, opportunities for beneficial flowers to germinate	£16.70/ha	Winter 2013 and 2014	Visual impact on amenity users. Most appropriate areas to be chosen in conjunction with site owner/manager.
Clearance of scrub on steep slopes of Compartments 2 and 3 (0.65ha)	Increased areas of grassland, exposure of low-nutrient substrate and provision of bare ground. Creation of a mosaic of habitat.	£22/hour for chain sawing £13/hour for brush cutting £7/tonne for disposal of arisings 10p/tree for treating cut stumps	Between 1st September and 28th February inclusive only, to avoid the bird breeding season. 2013/2014 and 2014/2015	Community engagement likely to be required to explain the clearance. However, this will provide an opportunity to promote Thames Terrace Invertebrates Conservation and the NIA.

GREAT WAKERING Management Compartments For Clearance & Scraping Total 0.9ha. Areas to be Disturbed & Sown total 11ha

Prescriptions (Management Compartment numbers referred to where appropriate, see above maps for locations)	**Outcomes**	**Indicative Costs** (from Nix 2012)	**Timetable**	**Risks/Issues**
Maintain boundary scrub	Connective feature around the site. Barrier to fertiliser and pesticide drift from adjacent arable land.	£0	Immediate and ongoing	Scrub may encroach further into the grassland, however this will be an extremely slow process and will be slowed further by the rest of the works.
Scrape clay cap down by 5cm adjacent to the stand of *Phragmites.*	A saline scrape with bare ground at margins.	£22/hour for backhoe excavator plus £12/hour labour	Autumn/Winter 2013/2014	Cap may be too thin. Cap depth will be established prior to any works commencing and scrape depth altered accordingly.
Disturb the rank grassland areas with machinery, avoiding areas where Alexanders are present. Disturb = drive around & scrape surface	Bare areas for ground-nesting and warmth-loving invertebrates. Opportunities for germination of desirable species.	Utilising excavator to be used for scraping - £22/hour for excavator plus £12/hour labour	Autumn/Winter 2013/2014	Alexanders may be inadvertently disturbed, causing spread. Great care will be taken to avoid Alexanders stands.
Treat stands of Goat's Rue with glyphosate. Cut stands once treated. Repeat treatment if re-establishment occurs.	Prevention of spread of this invasive species, increasing chances of less competitive beneficial plants establishing.	Approx. £10/ha for the glyphosate per application £30/hour for ATV spraying £30/ha for cutting	Summer 2013	Weather may not be suitable for glyphosate application.
Collect seed of Narrow-leaved Bird's Foot trefoil by hand. Sow the collected seed in the winter-wet areas of the site.	Increased forage resource for the flagship bumblebee species.	£12/hour/person labour, plus seed storage costs depending on timing	August/early September 2013 and August/early September 2014	Ideally seed will be collected and sown the same day. If not possible, seed must be securely stored between collection and sowing.
Oversow nectar-rich perennial wildflower mix on disturbed areas of the site	Increased forage resource for the target species and creation of Lowland Meadows-quality grassland contributing to Open Mosaic quality site	Approx £100/kg wildflower-only seed mix. 5kg required per ha, = £500/ha Broadcast seeding = £25.70/ha OR Hand seeding = £12/hour labour	Autumn 2013 and Autumn 2014, following disturbance by machinery.	At least 50% bare ground is needed for successful establishment. This depends on disturbance being successful and creating sufficient ground conditions. Works will be planned and timed carefully.

BELTON HILLS Management Compartments For Scraping Total 1ha

Prescriptions (Management Compartment numbers referred to where appropriate, see above maps for locations)	**Outcomes**	**Indicative Costs** (from Nix 2012)	**Timetable**	**Risks/Issues**
Scrape away the humic layer in Compartment 4 (1ha).	Reduced nutrient levels, increasing the potential for species-rich grassland to develop	£22/hour for backhoe excavator plus £12/hour labour	Winter 2013/2014 and 2014/2015	Community engagement may be required to explain why this is beneficial. However, this will provide an opportunity to promote Thames Terrace Invertebrates Conservation, the NIA and the original open nature of Belton Hills
Sow the scraped area in Compartment 4 with either green hay from a wildflower-rich donor site (preferred) or a suitable seed mix containing forage plants (0.75ha)	Provision of forage for the flagship bumblebee species	<u>Green hay</u> £30.90/ha cutting £30/hour for tractor and trailor to transport £12/hour labour for collection and strewing OR <u>Seeding</u> Approx £100/kg wildflower-only seed mix. 5kg required per ha, = £500/ha Broadcast seeding = £25.70/ha OR Hand seeding = £12/hour labour	Following scraping – spring 2014 onwards	Green hay may not be feasible due to timescale i.e must be cut, transported and strewn on the same day. However, a reliable wildflower mix will still provide beneficial forage.
Allow some scraped areas to re-vegetate naturally from the seed bank (0.25ha)	Restoration of historic Thames Terrace Grassland that used to exist at this site	£0	Following scraping – Spring 2014 onwards	Seedbank may not be as beneficial as expected. However, previous natural regeneration has yielded very positive results.
Clear young scrub from previously-cleared areas. Cut the scrub and either scrape away the soil to 6" depth or uproot stumps with machinery to prevent rapid regeneration	Mosaic of scrub, bare ground and grassland areas.	£13/hour brush cutting AND/OR depending on age of scrub £22/hour chain sawing Scraping - £22/hour for backhoe excavator OR £33/hour for 360° excavator plus £12/hour/person labour OR	Between 1st September and 28th February inclusive only, to avoid the bird breeding season. 2013/2014 and 2014/2015	Community engagement likely to be required to explain need for clearance.

		Uproot stumps with machinery - £30/hour plus £12/hour/person labour		
Use the scraped material to construct a bund along the southern boundary of the site	South-facing slopes for ground-nesting invertebrates including the flagship species	£30/hour for tractor, trailer & man to transport material from scraped areas to south of site. £22/hour for machinery to construct bund plus £12/hour/person labour	Concurrant with scraping – winter 2013/2014	
Use cut material from clearance to create log piles in remaining scrub areas and/or woodchip piles in sunny positions	Habitat for saproxylic invertebrates. Reduced disposal costs.	Log piles - £30/hour for machinery, trailer and man to move the cut material plus £12/hour/person additional labour	Concurrant with scrub clearance.	
Small scrapes in remaining grassland areas **avoiding areas with Alexanders**	Small patches of bare ground, mimicking the 'Belton landslips' and small landslips at neighbouring Hadleigh Farm – contribution to the ecological habitat network	£22/hour for excavator plus £12/hour/person labour	Winter 2013/2014	
Retain the tallest, mature trees	Maintenance of habitat mosaic and varied microclimates, as well as habitat for other taxa such as birds	£0	Immediate and ongoing	
Retain standing dead wood	Habitat for saproxylic invertebrates	£0	Immediate and ongoing	
Ring-bark a number of trees to create more standing dead wood, after removing limbs that may be dangerous. Ring-bark trees in areas dominated by Alexanders as no other habitat work can be carried out there	Habitat for saproxylic invertebrates. Improved habitat in invasive-dominated areas.	Approx. £50/tree for ringing only. £170/tree for surgery to remove potentially dangerous limbs prior to ringing.	Autumn – winter 2013/2014 and 2014/2015	Community engagement may be necessary to explain the value of dead wood. However, this will provide an opportunity to promote Thames Terrace Invertebrates Conservation and the NIA and encourage community engagement
Do not disturb the ground near stands of Alexanders as they will spread rapidly into those areas	Prevention of Alexanders spread	£0	Immediate and ongoing	

VANGE HILL Management Compartments Total 4.5ha

Prescriptions (Management Compartment numbers referred to where appropriate, see above maps for locations)	**Outcomes**	**Indicative Costs** (from Nix 2012)	**Timetable**	**Risks/Issues**
Re-open the ride between Compartments 1 and 2 – clear the scrub and remove the stumps by uprooting with machinery	Open but sheltered area that is warm and sunny in summer, ideal conditions for the flagship species	£13/hour brush cutting AND/OR depending on age of scrub £22/hour chain sawing Scraping - £22/hour for backhoe excavator OR £33/hour for 360° excavator plus £12/hour/person labour OR Uproot stumps with machinery - £30/hour plus £12/hour/person labour	Between 1st September and 28th February inclusive only, to avoid the bird breeding season. 2013/2014 and 2014/2015	Community engagement may be necessary to explain the need for clearance
Scrape away the humic layer in the re-opened ride area	Reduced nutrient levels and increased germination opportunities for beneficial wildflowers. Habitat for solitary bees and wasps	£22/hour for backhoe excavator plus £12/hour labour	Following scrub clearance	
Scrape away the humic layer from the upper slopes of Compartment 6. Ideally this would be repeated every ten years.	Reduced nutrient levels and increased opportunity for beneficial wildflowers in the seed bank to germinate. Long-term re-establishment of Thames Terrace Grassland.	£22/hour for backhoe excavator plus £12/hour labour	Following scrub clearance	
Clear scrub in Compartment 2. Cut the scrub and either treat the large stumps or uproot using heavy machinery.	Increased open, grassland habitat for the flagship bumblebees with bare ground initially	£22/hour chain sawing Uproot stumps with machinery - £30/hour plus £12/hour/person labour OR Treat stumps – Approx. 10p per tree	Between 1st September and 28th February inclusive only, to avoid the bird breeding season. 2013/2014 and 2014/2015	
Clear scallops out of remaining scrub thickets. This has been done previously in Compartment 4. Re-clear scallops and repeat across the rest of the site.	Habitat mosaic of scrub and grassland - habitat for stem-nesting invertebrates and flagship bumblebees, sheltered grassland areas, ideal conditions for Red-Shanked Carder Bee nesting	£22/hour chain sawing Uproot stumps with machinery - £30/hour plus £12/hour/person labour OR Treat stumps – Approx. 10p per tree		

Scarify Compartment 5	Increased germination opportunities for beneficial wildflowers. Small areas of bare ground.	£16.70/ha		
Sow Red Bartisa and other forage plants across Compartment 5 after scarification and all scrub-cleared areas	Creation of wildflower-rich grassland	Approx £100/kg wildflower-only seed mix. 5kg required per ha, = £500/ha Broadcast seeding = £25.70/ha OR Hand seeding = £12/hour labour	Following scarification/clearance – late-spring/summer 2014 and 2015	Lack of Red Bartsia seed supply. In this case the wildflower mix will still provide beneficial forage.
Reduce mowing in Compartment 5, in patches if not possible across the whole compartment.	Enhancement of habitat mosaic for the flagship species - tall vegetation for nesting, and for hunting invertebrates, adjacent to shorter forage vegetation and scrub.	£0	Immediate and ongoing	Visual impact for amenity users. However, it should provide increased visual interest.
Deepen the wet ditch in Compartment 11 and create a gradual shelf at one side	A wetland area that retains water for a longer period	£33/hour for excavator plus £12/hour/person labour	Winter 2013 and Winter 2014	

FOBBING HILL Management Compartments Total 1.9ha

Prescriptions (Management Compartment numbers referred to where appropriate, see above maps for locations)	**Outcomes**	**Indicative Costs** (from Nix 2012)	**Timetable**	**Risks/Issues**
Clear scrub around and in remnant patches of acid grassland (Compartments 1 and 6)	Increase in beneficial grassland habitat and enhancement of habitat mosaic. Exposure of Thames Terrace sands and gravels.	£22/hour chain sawing Uproot stumps with machinery - £30/hour plus £12/hour/person labour OR Treat stumps – Approx. 10p per tree	Between 1st September and 28th February inclusive only, to avoid the bird breeding season. 2013/2014 and 2014/2015	Community engagement likely to be required
Clear patches of scrub on the south-facing slope of Compartment 6	Open, sheltered glades, that are warm and sunny in summer.	£22/hour chain sawing Uproot stumps with machinery - £30/hour plus £12/hour/person labour OR Treat stumps – Approx. 10p per tree	Between 1st September and 28th February inclusive only, to avoid the bird breeding season. 2013/2014 and 2014/2015	Community engagement likely to be required
Remove a few individual, large trees	Reduction in canopy cover and increase in sunlight at ground level on south-facing slopes. Creation of disturbed areas to facilitate wildflower colonisation	£22/hour chain sawing	Between 1st September and 28th February inclusive only, to avoid the bird breeding season. 2013/2014 and 2014/2015	Community engagement likely to be required. Trees may be valuable habitat for other taxa.
Scrape away the humic layer in cleared areas	Removal of unfavourable seedbank. Reduced nutrient levels increasing germination opportunities for beneficial wildflowers. Patches of bare ground enhancing the habitat mosaic	£22/hour for backhoe excavator plus £12/hour labour	Following scrub clearance	
Use the material from scraping to create bunds	Increased topographical variation with a range of aspects and drainage conditions	£30/hour for tractor, trailer & man to transport material from scraped areas to south of site. £22/hour for machinery to construct bund plus £12/hour/person labour	Following scraping	
Use material from scrub cutting to enhance existing deadwood piles. Create a range from dense piles to individual large logs, situated in a variety of conditions from shade to	A range of habitats for a range of invertebrates. Increased topographical variation.	Log piles - £30/hour for machinery, trailer and man to move the cut material plus £12/hour/person additional labour	Following scrub clearance	

open, sunny areas			
Create a network of scrapes/small ponds in the wet areas in Compartment 10.	A network of wetland habitats from ephemeral to permanent. Increase the potential of *Phragmites* to spread.	£22/hour for backhoe excavator plus £12/hour labour	Winter 2013 and Winter 2014

WEST CANVEY MARSHES Management Compartments Total 27.1ha

Prescriptions (Management Compartment numbers referred to where appropriate, see above maps for locations)	**Outcomes**	**Indicative Costs** (from Nix 2012)	**Timetable**	**Risks/Issues**
Identify a new source of Green Hay for Compartment 8. It should contain Narrow-leaved Bird's Foot trefoil.	A vegetation mix better suited to the wet conditions, and a better quality grassland.	TBC		Another suitable green hay donor site may not be available. If that is the case Narrow-leaved Bird's Foot Trefoil should be sown in the area.
Increase the disturbance of Compartment 8 and other managed areas. Drive heavy machinery around it during the winter months.	Patches of bare ground adjacent to grassland, enhancing the habitat mosaic and encouraging germination of beneficial wildflowers	Utilising excavator to be used for scraping - £22/hour for excavator plus £12/hour labour	Winter 2013 and Winter 2014	
Sow Red Bartsia in hay-cut areas	Increased foraging resources for the flagship bumblebees. Potentially a reduction in dominant grass cover as Red Bartsia is a hemiparasite of grasses.	TBC	Summer 2013 and Summer 2014	
Create mounds of aggregates in areas out of regular view of the public. Introduced sand would be ideal.	Increased topographical variation, a range of aspects and drainage conditions. Provision of nesting sites for the Sea Aster Mining Bee.	£30/hour for tractor, trailer & man to transport material from scraped areas to south of site. £22/hour for machinery to construct bund plus £12/hour/person labour		
Cover the existing mound area in Compartment 1 with aggregates	Provision of a nesting site for the Sea Aster Mining Bee	£30/hour for machinery, trailer and man to move the material plus £12/hour/person additional labour plus costs of aggregates		

SOUTHWICK DYKE OPEN SPACE Management Compartments Total 1.75ha

Prescriptions (Management Compartment numbers referred to where appropriate, see above maps for locations)	**Outcomes**	**Indicative Costs** (from Nix 2012)	**Timetable**	**Risks/Issues**
Leave some areas un-mown in Compartments 1-3 & 5-9, for example a 5-10m border around trees and several similar-sized patches around the existing mounds in Compartment 4	Increased visual interest for the local community. Reduced management costs. Tall vegetation for nesting. Increased potential for seed-head nesting invertebrates.	N/A	Immediate and ongoing	Community engagement likely to be required to explain altered aesthetic of the area
Scarify the mounds in Compartment 4 and sow a wildflower-rich mix (if mowing is reduced here)	Increased forage resource for the target bumblebees allowing Southwick Dyke to act as a habitat corridor.	£16.70/ha scarifying Approx £100/kg wildflower-only seed mix. 5kg required per ha, = £500/ha Broadcast seeding = £25.70/ha OR Hand seeding = £12/hour labour	Winter 2013 and Winter 2014	

HADLEIGH HUB Management Compartments for Scraping & Weed Clearance Total 5.2ha. Grazing Management influenced across additional 48ha.

Prescriptions (Management Compartment numbers referred to where appropriate, see above maps for locations)	**Outcomes**	**Indicative Costs** (from Nix 2012)	**Timetable**	**Risks/Issues**
Treat stands of Alexanders with glyphosate urgently. Most of it is on the top of the south-facing ridge.	Control of invasive Alexanders, preventing its spread before it becomes unmanageable.	£10/ha/application for glyphosate £30/hour ATV spraying	As soon as possible	Weather may not be suitable for glyphosate application
Clear scrub in Compartments 5 and 6. Treat stumps or uproot with machinery to prevent re-growth.	Disturbed areas increasing germination opportunities for beneficial wildflowers. Patches of bare ground. Enhancement of the habitat mosaic.	£22/hour chain sawing Uproot stumps with machinery - £30/hour plus £12/hour/person labour OR Treat stumps – Approx. 10p per tree	Between 1st September and 28th February inclusive only, to avoid the bird breeding season. 2013/2014 and 2014/2015	Visual impact of scrub clearance may be an issue for visitors and require community engagement
Create small scrapes in the cleared areas in Compartments 5 and 6, and on the south-facing slopes of the ridge between Compartments 3 and 10.	Small bare areas mimicking the natural landslips.	£22/hour for backhoe excavator plus £12/hour labour	Following scrub clearance in Compartments 5 and 6. In the winter months of 2013/2014 on the ridge.	
Expand wet grassland areas in Compartment 10 through scraping. Re- seed with green hay or a suitable wildflower-rich seed mix.	Larger, more permanent wet grassland areas with increased forage resource for the flagship species.	£22/hour for backhoe excavator plus £12/hour labour	Scraping in the winter months of 2013 and 2014. Green-haying or seeding in the summer(s) following scraping.	
Reduce grazing pressure across the entire site	Restoration of grassland mosaic and taller, flowering vegetation	£0	As soon as possible	
Revert Compartments 5 and 6 to grassland				

CLIFFE POOLS – Management Compartments Total 6.9ha

Prescriptions (Management Compartment numbers referred to where appropriate, see above maps for locations)	**Outcomes**	**Indicative Costs** (from Nix 2012)	**Timetable**	**Risks/Issues**
Disturbance of the clay storage area by driving a tractor around it in the winter months	Small ridges increasing topographical variation. A more broken-up sward to enhance the habitat mosaic by giving access to bare ground next to taller vegetation	Utilising excavator to be used for scraping - £22/hour for excavator plus £12/hour labour	Winter 2013 and 2014	
Create several 6" deep scrapes in the clay storage area	Saline scrapes to enhance the habitat mosaic and increase floristic diversity around the edges of the scrapes.	£22/hour for backhoe excavator plus £12/hour labour	Winter 2013 and 2014	
Use the cinder-like material used to cover the paths in Compartment 3, to create patches in the clay storage area.	Increased burrowing opportunities for ground-beetles and spiders. Enhanced habitat for warmth-loving invertebrates as the material warms quickly in the sun. Enhanced habitat mosaic.	£30/hour for machinery, trailer and man to move the material plus £12/hour/person additional labour	Summer 2013	
Remove Buddleia from the remediated area.	Prevention of Buddleia spread, prevention of shading of the open area.	£22/hour chain sawing Uproot stumps with machinery - £30/hour plus £12/hour/person labour		
Cut back the scrub that surrounds the remediated area	Slowed scrub encroachment into the open area whilst maintain scrub as a shelter and forage resource	£22/hour chain sawing	Between 1st September and 28th February inclusive only, to avoid the bird breeding season. 2013/2014 and 2014/2015	
Disturb the borrowdyke in by driving heavy machinery through it.	Topographical variation. Disturbed areas which will encourage beneficial wildflower species	Utilising excavator to be used for scraping - £22/hour for excavator plus £12/hour labour	Winter 2013 and 2014	
Scrape away the rough grassland that has developed over old flattened dredgings piles in Compartment 8	Exposure of the underlying sands and gravels and increased opportunities for beneficial wildflower-rich grassland to develop.	£22/hour for backhoe excavator plus £12/hour labour		
Create south-facing bunds in the remediation area using material from scrapes elsewhere on site, or imported dredgings	Increased topographical variation with a range of aspects and drainage conditions. South-facing slopes to benefit ground-nesting species such as the flagship species	£30/hour for tractor, trailer & man to transport material from scraped areas to south of site. £22/hour for machinery to construct bund plus £12/hour/person labour	Following scraping – Winter – Spring 2013 and 2014	
Cut back Bramble where it is well	Control of Bramble spread whilst	£22/hour chain sawing	Between 1st September and 28th	

established in large clumps. Retain it in the dredgings area.	retaining drought-stressed Bramble which is a valuable forage resource and nesting resource for stem-nesting species		February inclusive only, to avoid the bird breeding season. 2013/2014 and 2014/2015
Retain the dredgings storage area once dredgings operations have ceased. Leave a layer of dredgings material overlying the area.	The valuable dune and estuary-like habitat will be retained, contributing to the habitat mosaic into the future	£0	When dredgings operations cease

MONITORING FRAMEWORK

Buglife and UEL are currently seeking funding for a research post that will monitor the outcomes of the project. This will ensure that the project will fill gaps in our knowledge of how to create and manage habitats for Thames Terrace Invertebrates. Community engagement will be key, with a volunteer monitoring programme for for the sites and community invertebrate identification workshops. The post will disseminate the knowledge gained from the project to planners, land managers and developers.

In the meantime, the framework in Appendix 2 has been developed by Stuart Connop (UEL) for monitoring how the habitat works affect the potential of the target sites to support the target species. Sites were assessed in February 2013 and will be re-assessed annually until the end of the NIA funded period.

REFERENCE LIST

Austin, K. (2000) Connectivity. In: Barker, G. (Ed) (2000) *Ecological recombination in urban areas: Implications for nature conservation. A workshop held at the Centre for Ecology and Hydrology (Monks Wood).* English Nature, Peterborough.

Benton, T. (2008) *Bombus ruderarius (Müller, 1776): Current knowledge of its autoecology and reasons for decline.* Hymettus Ltd, Midhurst.

Bodsworth, E., Shepherd, P. & Plant, C. (2005) *English Nature Research Report No. 650. Exotic plant species on brownfield land: their value to invertebrates of nature conservation importance.* English Nature, Peterborough.

Carvell, C., Meek, W., Pywell, R., Goulson, D. & Nowakowski, M. (2007) Comparing the efficacy of agri-environment schemes to enhance bumble bee abundance and diversity on arable field margins. *Journal of Applied Ecology* **44**: 29-40.

Connop, S. (2008) *Bombus humilis and Bombus sylvarum research project. Summary Report July 2003 – December 2007.* University of East London, London.

Edwards, M. (2002) *UK BAP Bumblebee Working Group Report for 2002.* Unpublished report.

Edwards, M. & Williams, P (2004). Where have all the bumblebees gone and could they ever return? *British Wildlife* **15**.

Ellis, J., Knight, M., Darvill, B. & Goulson, D. (2006) Extremely low effective population sizes, genetic structuring and reduced genetic diversity in a threatened bumblebee species, *Bombus sylvarum* (Hymenoptera: Apidae). *Molecular Ecology* **15**:4375-4386

Eversham, B., Roy, D. & Telfer, M. (1996) Urban, industrial and other manmade sites as analogues of natural habitats for Carabidae. *Annales Zoologici Fennici* **33**: 149-156

Eyre, M. (2000) Invertebrates in disturbed habitats. In: Barker, G. (Ed) *Ecological recombination in urban areas: Implications for nature conservation. A workshop held at the Centre for Ecology and Hydrology (Monks Wood).* English Nature, Peterborough.

Falk, S. (2000) Characteristics of 'recombinant' urban sites in the Warwickshire sub-region, with discussion of their conservation. In: Barker, G. (2000) *Ecological recombination in urban areas: Implications for nature conservation. A workshop held at the Centre for Ecology and Hydrology (Monks Wood).* English Nature, Peterborough.

Farrell, T (2009) The Thames Gateway – towards a core vision for the 21st century. In: *The Thames Gateway – where next?* Ed. Farrell. The Smith Institute, London

Fenner, M. & Palmer, L. (1998) Grassland management to promote diversity: creation of a patchy sward by mowing and fertiliser regimes. *Field Studies* **9**: 313-324

Gardiner, T., & Benton, T. (2011) *The importance of sea walls for the Moss Carder Bee Bombus muscorum in Essex.* Hymettus Ltd, Midhurst.

Gibson, C. (1998*) English Nature Research Report No. 273. Brownfield: red data. The values artificial habitats have for uncommon invertebrates*. English Nature, Peterborough.

Goulson, D. (2006) The demise of the bumblebee in Britain. *Biologist* **53**: 2-7

Goulson, D., Rayner, P., Dawson, B. & Darvill, B. (2011) Translating research into action; bumblebee conservation as a case study. *Journal of Applied Ecology* **48**: 3-8

Hallett (1928) cited in Edwards, M. & Williams, P (2004). Where have all the bumblebees gone and could they ever return? *British Wildlife* **15**.

Harrison, C. & Davies, G. (2002) Conserving biodiversity that matters: practitioners' perspectives on brownfield development and urban nature conservation in London. *Journal of Environmental Management* **65**: 95-108.

Harvey, P. (2000) The East Thames Corridor: a nationally important invertebrate fauna under threat. *British Wildlife* **12**: 91-98

Harvey, P. (2012) *Appendix 3 – Important Features of Open Mosaic Habitat on Previously Developed Land*. Unpublished Report.

Kendle, T. (2000) City habitats, disturbance and nature conservation. In: Barker, G. (Ed) *Ecological recombination in urban areas: Implications for nature conservation. A workshop held at the Centre for Ecology and Hydrology (Monks Wood).* English Nature, Peterborough.

Lawton, J., Brotherton, P., Brown, V., Elphick, C., Fitter, A., Forshaw, J., Haddow, R., Hilborne, S., Leafe, R., Mace, G., Southgate, M., Sutherland, W., Tew, T., Varley, J. & Wynne, G. (2010) *Making Space for Nature: a review of England's wildlife sites and ecological network*. Report to Defra.

Macadam, C. & Bairner, S. (2012) Urban biodiversity: successes and challenges: brownfields: oases of urban biodiversity. *The Glasgow Naturalist* **25**: [online] http://www.glasgownaturalhistory.org.uk/urban_bio/macadam.pdf

Maddock, A. (Ed.) (2011) *UK Biodiversity Action Plan Priority Habitat Descriptions*. JNCC, London.

National Brownfield Sites Project (2000) – Alker, S., Barrett, P., Clayton, D., Jones, G., Joy, V., & Roberts, P. (2000) *Delivering Regeneration: A Brownfield Renaissance. Reporting the findings of the National Brownfield Sites Project.* Urban Mines Limited, Halifax. Cited in Bodsworth et al. 2005.

Nix, J. (2012) The John Nix Farm Management Pocketbook. Agro Business Consultants Ltd, Leicester

Plant, C. & Harvey, P. (1997) *Biodiversity Action Plan – Invertebrates of the South Essex Thames Terrace Gravels – Phase 1: Characterisation of the existing resource. Volume 1 of three: Report*. English Nature, Colchester.

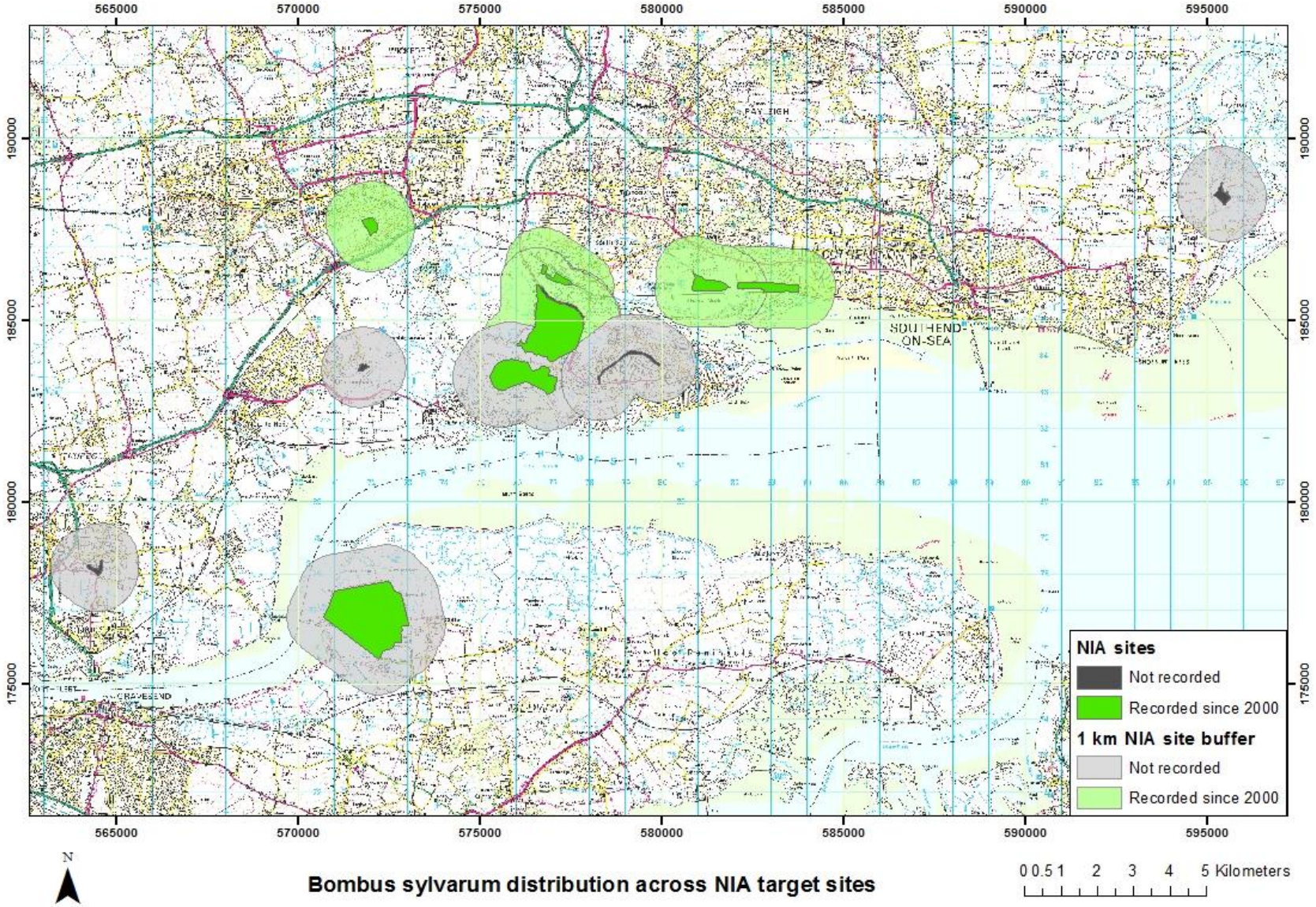
Roberts, J., Harvey, P. & Jones, R. (2006) *All of a Buzz in the Thames Gateway. Phase 1: Identification of the brownfield resource and preliminary assessment of the invertebrate interest.* Buglife – The Invertebrate Conservation Trust, available at: http://www.buglife.org.uk/Resources/Buglife/All%20of%20a%20Buzz%20phase%201%20Report.pdf.

Robins, J. & Henshall, S. (2012) The state of brownfields in the Thames Gateway. *The Essex Naturalist* **29**: 77-88

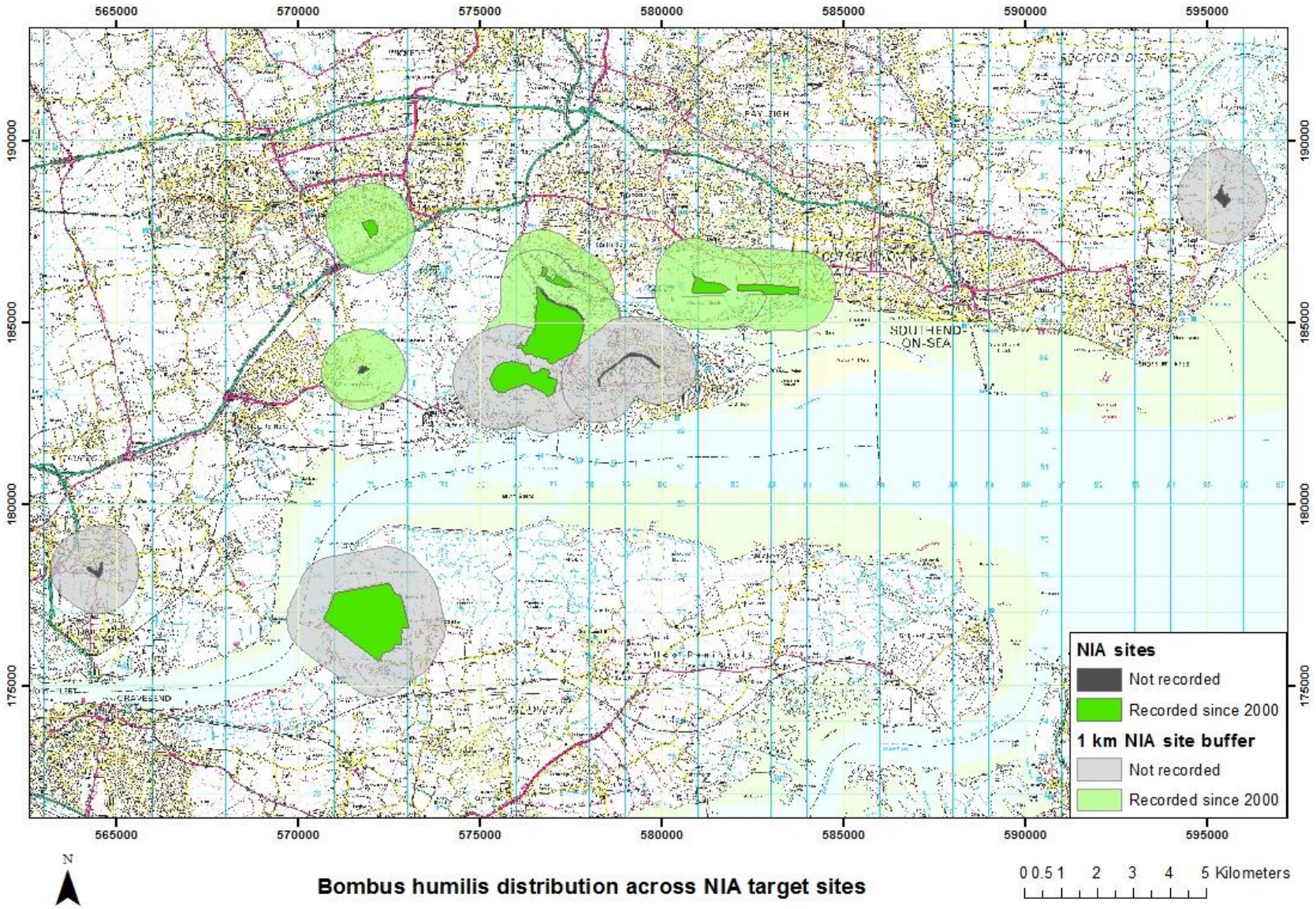
Saunders, P. (2008) *Bombus muscorum and Bombus humilis in the South West in 2008.* Hymettus Ltd, Midhurst.

Williams, P. (1982) The distribution and decline of British bumble bees (*Bombus* Latr.) *Journal of Apicultural Research* **21**: 236-245

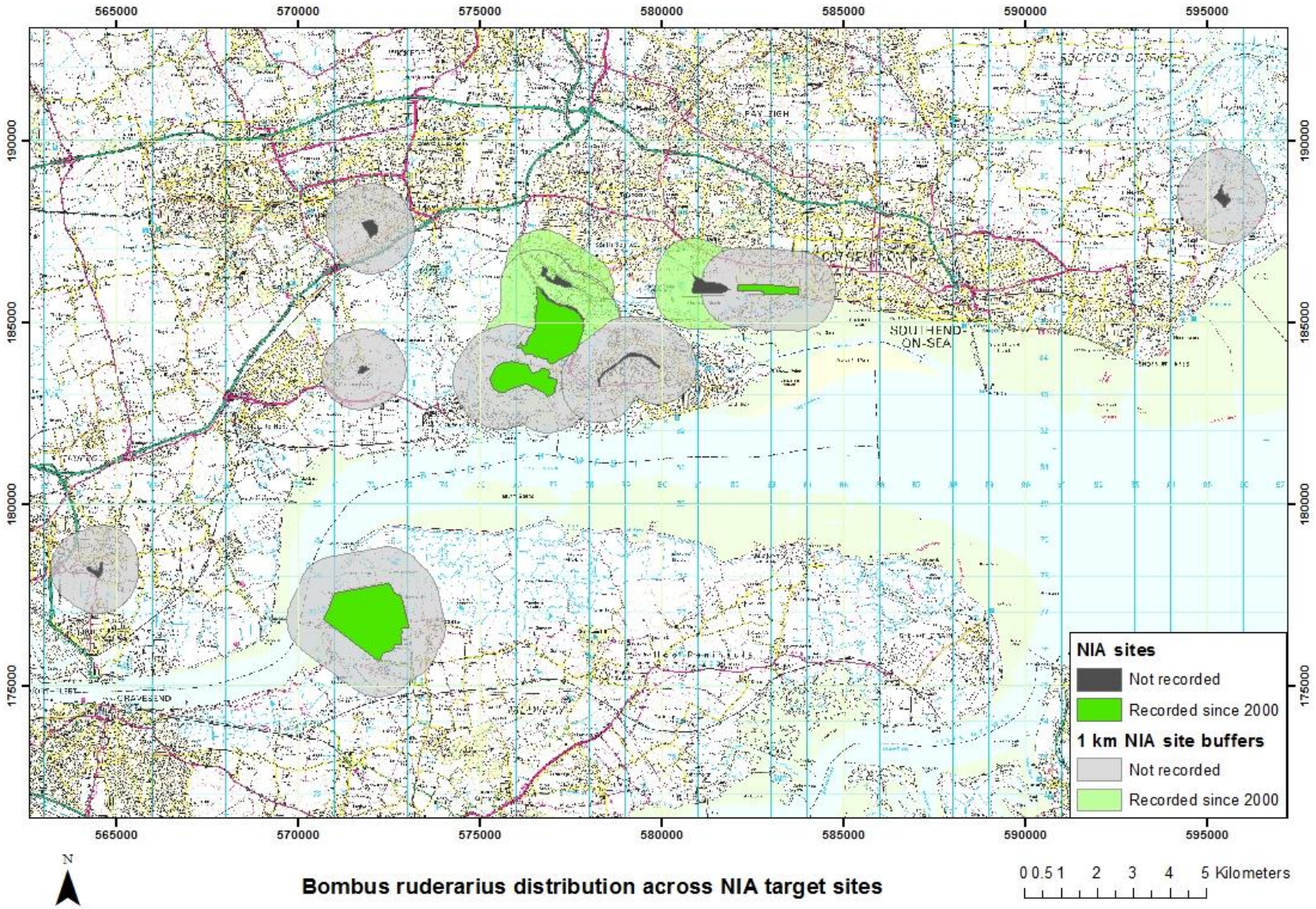
APPENDIX 1 - PRESENCE OF TARGET SPECIES. MAPS PREPARED BY STUART CONNOP.



Bombus sylvarum distribution across NIA target sites



Bombus humilis distribution across NIA target sites



Bombus ruderarius distribution across NIA target sites

APPENDIX 2 – MONITORING FRAMEWORK

Species	Group	Habitat requirements	Belton Hills			West Canvey Marshes			Fobbing Hill			Great Wakering			Hadleigh		
			On site	Nearby	Habitat Code	On site	Nearby	Habitat Code	On site	Nearby	Habitat Code	On site	Nearby	Habitat Code	On site	Nearby	Habitat Code
Aleucis distinctata	insect - moth	Woodland, scrub and hedgerows	0	0	1	0	0		0	0	1	0	0	0	0	1981	0
Anisodactylus poeciloides	insect - beetle (Coleoptera)	Saltmarsh, lagoon edges & transitional habitats	0	0	0	2006	2009	2	0	0	0	0	0	1	0	0	0
Aplasta ononaria	insect - moth	Calcareous grassland/ sandy areas	0	0	0	0	2003	0	0	0	0	0	0	0	0	0	1
Bombus humilis	insect - hymenopteran	Open wildflower grassland and thicker tussocky grassland	2005	2005	1	2006	2012	2	0	2005	1	0	0	1	2009	2012	1
Bombus muscorum	insect - hymenopteran	Open wildflower grassland and thicker tussocky grassland	0	0	1	0	0	2	0	0	0	0	0	1	0	0	1
Bombus ruderarius	insect - hymenopteran	Open wildflower grassland and thicker tussocky grassland	2001	0	1	2006	2006	2	0	0	1	0	0	1	0	2010	1
Bombus ruderatus	insect - hymenopteran	Open wildflower grassland and thicker tussocky grassland	0	0	1	0	0	2	0	0	1	0	0	1	0	0	1
Bombus sylvarum	insect - hymenopteran	Open wildflower grassland and thicker tussocky grassland	2005	2010	1	2006	2012	2	0	0	1	0	0	1	2009	2012	1
Campsicnemus magius	insect - true fly (Diptera)	Coastal levels/saltmarshes	0	0	0	0	2002	1	0	0	0	0	0	0	0	0	0
Cerceris quinquefasciata	insect - hymenopteran	Bare ground and wildflower resource	0	0	1	0	2012	1	1998	0	0	0	0	0	0	0	1
Colletes halophilus	insect - hymenopteran	Saltmarsh or bare ground and sea aster resource	0	0	0	0	2007	1	0	0	0	0	0	0	0	0	0
Doros profuges	insect - true fly (Diptera)	Calcareous grassland scrub edge	1949	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Dorycera graminum	insect - true fly (Diptera)	Rough grassland	0	2010	1	0	0	1	0	0	1	0	0	1	0	2010	1
Erynnis tages	insect - butterfly	Open, south-facing grasslands and slopes	0	0	1	0	0	1	0	0	1	0	0	1	0	1981	1
Melitaea athalia	insect - butterfly	Coppiced woodland	0	0	0	0	0	0	0	0	0	0	0	0	0	2010	0
Nemophora fasciella	insect - moth	Dry grassland	2001	1985	2	0	0	0	0	0	0	0	0	1	0	0	1
Odynerus melanocephalus	insect - hymenopteran	Grasslands and scrub on clayish soils	0	0	1	0	2001	1	0	0	0	0	0	1	0	1987	0
Paracolax tristalis	insect - moth	Oak woodland	0	0	0	0	2004	0	0	0	0	0	0	0	0	0	0
Pyrgus malvae	insect - butterfly	Unimproved grassland, woodland rides, downland	0	0	1	0	0	0	0	0	1	0	0	1	0	1981	0
Satyrium w-album	insect - butterfly	Elm on deciduous woodland edges	2006	1995	1	0	2011	0	0	1995	1	0	0	0	0	2011	0

Species			Hutts Hill			Southwick Dyke			Vange Hill			Cliffe Pools		
			On site	Nearby	Habitat Code	On site	Nearby	Habitat Code	On site	Nearby	Habitat Code	On site	Nearby	Habitat Code
Aleucis distinctata	insect - moth	Woodland, scrub and hedgerows	0	0	0	0	0	0	0	2006	1	0	0	1
Anisodactylus poeciloides	insect - beetle (Coleoptera)	Saltmarsh, lagoon edges & transitional habitats	0	0	0	0	0	0	0	0	0	0	0	1
Aplasta ononaria	insect - moth	Calcareous grassland/ sandy areas	0	0	0	0	0	0	0	0	1	0	0	1
Bombus humilis	insect - hymenopteran	Open wildflower grassland and thicker tussocky grassland	0	0	0	0	0	0	2003	2006	1	2012	0	2
Bombus muscorum	insect - hymenopteran	Open wildflower grassland and thicker tussocky grassland	0	0	0	0	0	0	0	0	1	2012	0	2
Bombus ruderarius	insect - hymenopteran	Open wildflower grassland and thicker tussocky grassland	0	0	0	0	0	0	0	0	1	2011	0	2
Bombus ruderatus	insect - hymenopteran	Open wildflower grassland and thicker tussocky grassland	0	0	0	0	0	0	0	0	1	2011	0	2
Bombus sylvarum	insect - hymenopteran	Open wildflower grassland and thicker tussocky grassland	0	0	0	0	0	0	2003	2007	1	2012	0	2
Campsicnemus magius	insect - true fly (Diptera)	Coastal levels/saltmarshes	0	0	0	0	0	0	0	0	0	0	0	1
Cerceris quinquefasciata	insect - hymenopteran	Bare ground and wildflower resource	0	0	0	0	0	0	0	0	1	2002	0	2
Colletes halophilus	insect - hymenopteran	Saltmarsh or bare ground and sea aster resource	0	0	0	0	0	0	0	0	0	2002	0	2
Doros profuges	insect - true fly (Diptera)	Calcareous grassland scrub edge	0	0	0	0	0	0	0	0	0	0	0	1
Dorycera graminum	insect - true fly (Diptera)	Rough grassland	0	0	0	0	0	0	2000	2007	2	0	0	1
Erynnis tages	insect - butterfly	Open, south-facing grasslands and slopes	0	0	0	0	0	0	0	0	1	0	0	0
Melitaea athalia	insect - butterfly	Coppiced woodland	0	0	0	0	0	0	0	0	0	0	0	0
Nemophora fasciella	insect - moth	Dry grassland	0	0	0	0	0	0	0	0	1	0	0	1
Odynerus melanocephalus	insect - hymenopteran	Grasslands and scrub on clayish soils	0	0	0	0	0	0	0	0	1	0	0	1
Paracolax tristalis	insect - moth	Oak woodland	0	0	0	0	0	0	0	0	0	0	0	0
Pyrgus malvae	insect - butterfly	Unimproved grassland, woodland rides, downland	0	0	0	0	0	0	0	1997	1	0	0	0
Satyrium w-album	insect - butterfly	Elm on deciduous woodland edges	0	0	0	0	2011	0	1995	2007	1	0	0	0

Key to code for site potential in terms of existing habitat/potential for habitat enhancement

0 = Unlikely to be supporting species currently as suitable habitat not present.

1 = Site may support species in low numbers and/or partially support the species' life cycle requirements as some suitable habitat present but not in favourable condition.

2 = Site known to be or likely to be supporting species in significant numbers and providing all life cycle requirements as suitable habitat is present.

In the absence of species focused surveys to assess site conditions, habitat values are based on:

* habitat assessment at the time of the NIA baseline survey;
* results of local searches;
* the experience and knowledge of the three Thames Terrace Invertebrate speciaists that carried out the baseline survey.

Due to the lack of understanding of the spatial dynamics of most of these target species and the reliance upon volunteer records which are not necessarily up-to-date for the local searches, the assessment of site habitat value does not include assessment of connectivity and likelihood of colonisation.