North Thames Estuary & Marshes Area – Saltmarsh NVC Survey, 2023

August 2024

Natural England Commissioned Report NECR568

www.gov.uk/natural-england

About Natural England

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

Further Information

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

Copyright

This publication is published by Natural England under the Open Government Licence v3.0 for public sector information. You are encouraged to use, and reuse, information subject to certain conditions.

Natural England images and photographs are only available for non-commercial purposes. If any other photographs, images, or information such as maps, or data cannot be used commercially this will be made clear within the report.

For information regarding the use of maps or data see our guidance on how to access Natural England's maps and data.

© Natural England 2024

Catalogue code: NECR568

Report details

Author

Richard Carter Director of RSK Environmental Limited

Natural England Project Manager

Jonathan Bustard, Senior Adviser Thames Estuary

Contractor

RSK Biocensus Ltd

Keywords

Saltmarsh, Thames Estuary, NVC, SSSI

Citation

RSK Biocensus Ltd. 2022. North Thames Area NVC Saltmarsh Survey. [NECR568]. Natural England.

Foreword

The North Thames Estuary & Marshes area was surveyed in 2023 to determine the extent and type of saltmarsh habitats present and collect evidence to assess the case for designation as a Site of Special Scientific Interest (SSSI). This report does not itself make a case for designation, rather it provides an objective record of survey findings to support Natural England's independent assessment of special interest. Natural England commission a range of reports from external contractors to provide evidence and advice to assist us in delivering our duties. The views in this report are those of the authors and do not necessarily represent those of Natural England.

Executive summary

1. Botanists from RSK Biocensus Ltd carried out phytosociological surveys of *c.*90 ha of inter-tidal saltmarshes (including adjacent terrestrial halophytic vegetation related to them) along the northern shore of the River Thames from the Thames Gateway Port to seaward in the east to the Tilbury Cruise terminal up-river to the south-west.
2. The surveys used the methods of the National Vegetation Classification (NVC) to identify and map the vegetation types of the saltmarshes to sub-community level. Natural England's normal approaches to vegetation complexity were adopted, allowing mapping polygons to be identified as standard NVC types and where necessary intermediate types or mosaics involving no more than two NVC types.
3. In relevant terrestrial vegetation, some clearly non-NVC vegetation types were identified, and five variants of the NVC type SM14 were described and mapped, each having amounts of a single species that were unusual for SM14.
4. Uncommon plant species were noted and various features of ecological interest were recorded in target-notes..
5. For the purposes of the report, the survey area was subdivided into 12 saltmarsh parcels ranging in size from *c.*0.5 to *c.*1.8 km of the shore. Though not always homogeneous, these each had distinctive characteristics.
6. The greater part of the North Thames shore, including its eastern and western parts, features rather narrow strips of long-established saltmarsh, more extensive in bays, but often fragmentary on exposed lengths of shore. However, the central part of *c.*2.5 km at the southern end of the north-south Lower Hope Reach has a much wider area of accreting marsh representing *c.*65% of the total saltmarsh area surveyed.
7. In the lower marsh, the principal NVC types were found to be 'SM6 *Spartina anglica* salt-marsh community' to seaward and 'SM11 *Aster tripolium* var. *discoideus* salt-marsh community' to landward. Communities with annual *Salicornia* species and *Suaeda maritima* were surprisingly uncommon. There was often confused 'SM10 Transitional low-marsh vegetation with *Puccinellia maritima*, annual *Salicornia* species and *Suaeda maritima*' at the ecotone between the lower marsh and the middle marsh.
8. In the middle marsh 'SM13a *Puccinellia maritima* salt-marsh community, sub-community with *Puccinellia maritima* dominant' was the only SM13 sub-community to be found in any quantity, and that was local. Most of the middle marsh was occupied by 'SM14a *Halimione portulacoides* salt-marsh community, sub-community with *Halimione portulacoides* dominant' or by variants of SM14 close to SM14a recognised as distinctive for the purposes of this report, with unusually large amounts of either *Tripolium panonnicum* var. *flosculosus* (towards the lower edge) or *Atriplex prostrata* or *Juncus gerardii* or *Juncus maritimus* or *Elymus athericus* (towards the upper edge).
9. At the lower edge of the middle marsh, stands of *Limbarda crithmoides* marked 'SM26a *Inula crithmoides* on salt-marshes, stands with *Puccinellia maritima*, *Salicornia* agg. and *Limonium vulgare*' which was frequent in the eastern and western parts of the survey area, and similarly 'SM26b *Inula crithmoides* on salt-marshes, stands with *Elymus pycnanthus*' was frequent at the upper edge.
10. In Mucking Creek and very locally and fragmentarily elsewhere the middle marsh was 'SM16a *Festuca rubra* salt-marsh community, *Puccinellia maritima* sub-community' more typical of saltmarshes in western Britain.
11. There were virtually no species-rich middle marsh lawns with abundant *Limonium vulgare* and *Armeria maritima* referable to the NVC type 'SM13c *Puccinellia maritima* salt-marsh community, *Limonium vulgare-Armeria maritima* sub-community' even though these are

characteristic of many Essex saltmarshes further north. Both the *Limonium* and the *Armeria* were found only rarely in the survey area.

12. The upper marsh was mostly ‘SM24 *Elymus pycnanthus* salt-marsh community’.
13. In some places various communities of halophytes and glycophytes on the landward side of the seawalls were described as non-NVC vegetation in the *Puccinellio-Spegularion* alliance. They contain scarce species including the grasses *Hordeum marinum*, *Polypogon monspeliensis*, *Puccinellia fasciculata* and *Puccinellia rupestris*.
14. In SSSI Unit 1 no saltmarsh vegetation was found in depressions that might have had some in the years immediately following the land reclamation. There remained only species-poor glycophytic swamp vegetation of the types ‘S4a *Phragmites australis* swamp and reed-beds, *Phragmites australis* sub-community’ and ‘S21a *Scirpus maritimus* swamp, sub-community dominated by *Scirpus maritimus’*.
15. The spectrum of NVC types in the North Thames area appears to be very typical of south-eastern UK saltmarshes with high prevalence of communities such as SM11 and SM14a that are generally scarce elsewhere, but low incidence of grassy western UK NVC types, especially SM16 sub-communities other than SM16a.
16. No rare species were recorded from inter-tidal marsh. Species of modest note in Essex were *Artemisia maritima*, *Cochlearia anglica*, *Limbarda crithmoides*, *Limonium* x *neumanni* and *Lysimachia maritima* (Sea-milkwort). Behind the seawall the many uncommon glycophytes included the England Red List VU species *Bupleurum tenuissimum* and *Hordeum marinum* and the NT *Puccinellia fasciculata*.
17. The saltmarshes of the survey area provide a large resource of vegetation types that are typical of and in a significant degree special to the inner Thames estuary, and more generally to the greater Thames estuary area.

Contents

Introduction

Purpose of the Report

This report presents the results of National Vegetation Classification (NVC) surveys of saltmarshes in the North Thames area along the northern (Essex) shore of the River Thames estuary from a north-eastern extreme just south of London Gateway Port heading south-westwards up-river (towards London) to a south-western extreme east of the Tilbury Cruise Terminal (and west of Tilbury Fort) as indicated in Figures 1 to 3 – a total length of shore of *c.*11 km, though up to about a third of this has no saltmarsh fringe.

The objective was in part to simply catalogue and map the incidence of different vegetation types using the NVC system. But there was also an objective to probe the characteristics of the vegetation and establish its nature conservation value in relation to that of other saltmarsh systems in the greater Thames estuary area (Suffolk, Essex, and Kent) and in the UK as a whole, and especially to identify any unusual or unique aspects of its value. A subsidiary objective was to record any noteworthy plant species, though there was no extensive listing of plants independent of the vegetation study.

The usual definition of saltmarshes is succinctly given by Waite (1998):

> "Saltmarshes may be defined as belts of higher plant vegetation which are periodically flooded by sea water, normally occurring between the mean high water neap tide level and mean high water. They require a supply of sediment and coastal conditions that promote accretion and protect building mudflats from erosion".

Intertidal saltmarshes of this kind are the main focus of this report. Nevertheless - leaving aside the minor complication of inland saltmarshes around salt-mining sites - many accounts of saltmarshes take a much wider view: thus Chatters (2017) states:

> "Saltmarshes occur wherever flowering plants grow in wetlands influenced by salt."

Rodwell (2000) does not attempt any such sweeping definition of saltmarshes, but though his preliminary discussion of saltmarsh vegetation is framed around intertidal vegetation, the SM-series of saltmarsh vegetation descriptions clearly includes communities of saline soils above the intertidal zone (and especially just behind seawalls). Rodwell (2000) therefore parcels the vegetation of non-intertidal saline soils according to physiognomic and phytosociological criteria, placing some types that are dominated by glycophytes into the SM-series, while placing swamps dominated by glycophytes into the S-series of swamp communities, and ruderal communities dominated by glycophytes into the MC-series of maritime cliff communities.

This survey therefore focussed on the SM-series of communities in the NVC but extended its scope to related communities of saline soils that might for one reason or another fall into other series in the NVC such as the swamp S-series, the maritime-cliff MC-series (marginally occurring on soft-coast strandlines), the mesotrophic grassland MG-series, or the ruderal OV-series. By related communities we mean non-intertidal but saline vegetation types wherever they might reasonably be viewed as elements in a habitat complex integral to nearby inter-tidal saltmarshes.

Totally unrelated communities of saline soils, e.g. central reservations on main roads, were not included.

In a few places fragments of scrub on earthworks in saltmarshes necessitated reference to the non-saline woodland and scrub W-series of communities.

In NVC surveys there is always a trade-off between on the one hand the simplicity of pigeonholing stands of vegetation into the published NVC communities and sub-communities of *British Plant Communities* (BPC) wherever possible, and on the other the complexity of addressing mosaics of NVC types, transitions between NVC types, intermediate NVC types, and non-NVC vegetation. The former approach - giving a simplified overview - is more useful to conservation managers who need tidy information about how much of each NVC type a survey area contains; and the latter approach – giving a more accurate but therefore potentially hard-to-interpret picture - may be more useful to those seeking to investigate the vegetation. Very understandably, the mapping specifications set by Natural England lean towards the former approach, but they allow the mapping of mosaics of NVC types and simple intermediate types (i.e. between no more than two of the published types). In this report we comply with this guidance, assigning stands of vegetation to single published NVC types wherever possible, but we have not avoided the mapping of mosaics and intermediate NVC types in many places. We have also mapped or discussed some non-NVC vegetation (mostly in saline areas behind seawalls rather than in the core inter-tidal saltmarshes). And finally, we have mapped and discussed a few non-published variants of common NVC types that we think will assist towards a correct understanding of the saltmarshes in the survey area, though there is no intention to suggest that these variants have any wider validity (i.e. we are not trying to propose additions to the existing framework of NVC types).

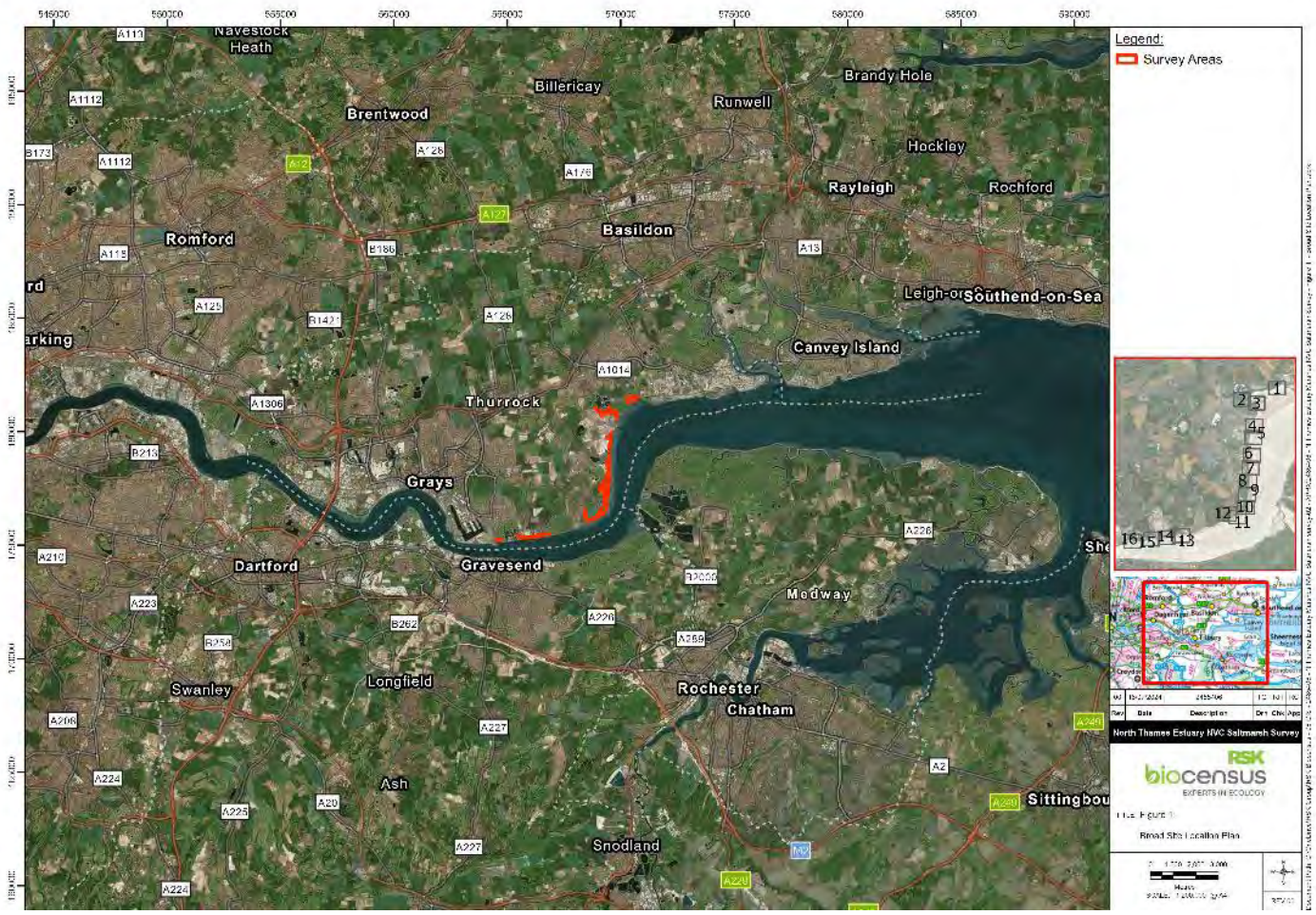

Figure 1: Broad site Location Plan.
Contains Contains Ordnance Survey data © Crown copyright and database right 2024.World Imagery (Clarity): This work is licensed under the Esri Master Licence Agreement.View Summary | View Terms of UseExport: This layer is not intended to be used to export tiles for offline. Data Collection and Editing: This layer may be used in various ArcGIS apps to support data collection and editing, with the results used internally or shared with others, as described for these use cases. Hybrid Reference Layer: Esri UK, Esri, TomTom, Garmin, Foursquare, MET/NASA, USGS. Word Imagery: Earthstar Geographics. OS Open Rasters: Contain OS data © Crown copyright and database right 2022.

The Survey Area

Notionally the River Thames is oriented east-west as one looks from the open sea up-river towards London (Figure 1), but it lies east-west in the Sea Reach in the north-eastern part of the survey area (as far west as Mucking Creek on the Essex Shore and Lower Hope Point on the Kent shore); then it turns north-south in the Lower Hope Reach (from Mucking Creek to Coalhouse Fort on the Essex shore and Cliffe Creek on the Kent shore); and finally it turns east-west again in the Gravesend Reach in the south-western part of the survey area. Throughout this report we order sites working up-river from north-east to south-west.

The survey area extends along the northern shore of the Thames estuary from London Gateway Port near Corringham in the ‘east’ (i.e. the relative east ignoring bends in the river) to the Tilbury Cruise Terminal area just west of Tilbury Fort. Before modern industrial and residential

development – say at the beginning of the 19th Century - the whole of this Essex shore would have been fringed by saltmarsh at around the mean high-water mark with intertidal mud to seaward and reclaimed land[1] to landward. It is likely that in the early part of the 19th century the entire shoreline had earthen seawalls separating the intertidal saltmarsh from the freshwater grazing-marshes, though so close to London there could have been arable too, as there is today. By the end of the 19th Century the walls were of a more-or-less standard construction described by Carey & Oliver (1918).

The 19th Century seawalls would have been high enough to protect against high spring tides (plus a bit – usually one foot above high spring tide level), but the land behind would have been somewhat below sea level. This was partly due to soils shrinking as they lost water and peat oxidised in inwalled fields or 'inclosures' (Dutch 'polders'). But, more importantly, the Essex coast has since at least 4000 BP been falling at a rate of *c*.2 mm per year due to isostatic fall – the fastest rate of anywhere in Great Britain (Shennan 1989) - so that sea level has risen at the same rate (Grieve 1959, Steers 1981, Shennan 1989). Inwalling an upper marsh fossilises the new inclosure at the sea-level of its reclamation date, while saltmarsh outside the seawall continues to accrete, thus increasing its height in line with increasing sea levels. For this reason, reclaimed lands in Essex are typically a metre or more below sea and saltmarsh levels after *c.*400 years. The oldest reclamations in the survey area are likely to be c.500 years old though there is good evidence for reclamations from the 13th Century onwards, and some evidence for the commencement of reclamations in Roman times. A further consequence of all this is that the newest inclosures just behind a seawall are only a little below sea level while the older inclosures inland are well below, making them hard to drain. Since the early 19th Century this has been dealt with by pumped drainage, but historically there may have been swamp vegetation in less well drained and managed areas, and some survives locally today.

In the later part of the 19th Century the seawalls were locally overtopped by rubbish tipping (as at the 'LTC4' / DHL-owned landfill site south of Coalhouse Fort and on the northern side of Mucking Creek) or else by the raised platforms of industrial sites (as at Tilbury Power Station east of Tilbury Fort). This process continued into the 20th Century with some extensive raised landfills as at the Thurrock Thameside Nature Park area. More recently a large bunded area north of Coalhouse Fort has been filled to a height just above current sea-levels with material suction-dredged from the river – this is now unit 1 of the Mucking Flats & Marshes Site of Special Scientific Interest (SSSI). There is no English name for this type of habitat, but it is well-known to Dutch ecologists as the 'opgespooten zandflakten' (transliterally 'sucked-up sand flats'). As a habitat type it is uncommon in Britain, though the Seal Sands Industrial Estate on Teesside is an extensive example of some

[1] Land historically won from the sea is correctly called reclaimed land and always has been. Some critics today protest that no land has been claimed from the sea twice. But 'reclaim' meaning claim again (i.e. 'claim' with prefix 're') is a modern word, dating from the mid- to late 19th Century. Prior to that, a much older English word 'reclaim' (direct from Latin *reclamare*) meant to tame (wild animals) or to bring into cultivation (land). The old and new meanings were both fully alive until at least the 1950s when P.J.O. Trist's book *Land Reclamation* catalogued the WW2 cultivation of the Essex thorn-scrub 'plotlands' by Italian prisoners-of-war. Today the older word is becoming obsolescent but not dead. It is still in OED and most middle-size dictionaries, and it survives in fossilised expressions from subjects as diverse as land-use and falconry. In the past the term reclaimed land could refer to scrub clearance, but it was consistently used for farmland created by the inwalling of saltmarshes, thus depicting quiet pastures tamed from the fury of the seas.

importance for nature conservation as well as industry. The semi-ruderal grasslands that develop on it are often surprisingly species-rich (as in the orchid-rich grassland of SSSI Unit 1) because the shell content makes the substrates calcareous. In many estuaries this effect is amplified by concrete and mortar wastes, though the Thames does not have the basic slag that makes the Teesside reclamations extremely calcareous.

Sand and gravel extraction has also altered some of the land behind the seawall, creating large water bodies, e.g. north of SSSI Unit 1 and in the Mucking Creek area. Most of this is no longer active and it appears to have been restored for wetland nature conservation. At the northern end of the survey area between Mucking Creek and London Gateway the seawalls have been manage realigned. The present-day Mucking Spit is in fact a seawall remnant. Its southern tip formerly turned north-eastwards enclosing a now-inter-tidal area roughly 700 m east-west and 400 m north-south between Mucking Creek and the saltmarsh area just west of London Gateway. A large new seawall has been constructed about 400 m to landward of the original wall.

Considerably less than 20% of the land behind the seawall in the survey area today retains any grazing-marsh character, and horse-grazed pastures east of Tilbury Fort are the only pristine example. But the seawalls that once bounded the grazing-marshes remain except in a very few places where the land is exceptionally high as at the Thurrock Thameside Nature Park. And in consequence it remains true that the saltmarsh zonations of the survey area are cut short abruptly in the middle-marsh, either by concrete-faced earthen seawalls or by land raising. Only limited grassy upper-marsh vegetation remains at the foot of the seawalls and the gradation of vegetation types from saline to terrestrial that might be expected at the top of a natural saltmarsh has long since disappeared.

The saltmarshes nevertheless reflect the historical and recent land-uses of the area. In some places the tidal channels of the river come close to the northern shore and there is no saltmarsh at all to seaward of the seawall (usually just rock armour with *Fucus* and mud) as along the Tilbury Fort frontage and several industrial frontages with jetties to the east, and along the length of the new wall of the managed retreat north of Mucking Creek. At the north-eastern extreme of the survey area, the saltmarsh just west of London Gateway Port also has a remnant of old seawall on its western side, and in recent years it must presumably have been affected by drastically altered patterns of water flow in the river.

At the other extreme, the reclamation at SSSI Unit 1 seems to have moved flows away from the northern shore and there is a *c.*200-300 m swathe of recent and accreting saltmarsh from *c.*500 m north of SSSI Unit 1 to *c.*500 m south of Coalhouse Fort. By area this probably represents about half of the saltmarsh total in the survey area.

Otherwise, the saltmarshes tend to form narrow strips from 10-50 m wide along the shore except in bays or sharp angles in the line of the seawall where they can be much wider. Very often the extent of these fragmentary marsh strips is locally determined by small topographical features such as the footings of old jetties, low banks formed by 19th Century rubbish tipping, and WW2 structures or raised paths leading to them.

As a generalisation, and anticipating the conclusions of this report, the marshes of the survey area are either accreting or affected by disturbance. Only in the saltmarsh just west of London Gateway Port are there anything like elaborate creek systems in the marshes (to a lesser extent also in and around Mucking Creek). Old marshes with species-rich and colourful lawns of Sea Lavender and Thrift are generally missing.

There are relatively few major creeks dissecting the survey area, but east of Tilbury Fort there is Bill Meroy Creek which extends *c.*500 m inland from the river edge as the crow flies (the meandering channel length is of course longer); and at the junction of the Sea Reach and the

Lower Hope Reach there is Mucking Creek which extends *c.*1100 m inland (again as the crow flies). Both have barriers and controlled outfalls but remain partially tidal throughout. Bill Meroy Creek has open aquatic habitat behind a now redundant seawall, while the inland parts of Mucking Creek have very extensive reed-swamp set in scrub.

Two other sites in the survey area are of importance as landmarks and the focus of valuable habitat complexes – these are the two historic artillery forts, Tilbury Fort, and Coalhouse Fort.

- Tilbury Fort at the south-western end of the survey area dates from the time of King Charles II and though it remained in military use during WWII it has not been much altered. It is now an English Heritage property and an ancient monument. With all its walls, ramparts, buildings, underground stores, outer earthworks, and water defences intact, it is rated as one of the finest surviving examples of 17th Century military engineering in the UK (Pattison 2004). Its ramparts support uncommon plants including annuals of drought-prone assemblages, while its moats support aquatic plant communities, and a saline lagoon aquatic invertebrate fauna, while the surrounding land supports uncommon grazing-marsh plants and vegetation types.
- Coalhouse Fort at East Tilbury (the junction of the Lower Hope Reach and the Gravesend Reach) is a Napoleonic-era artillery fort probably considerably modified in WWI and WWII and now apparently mothballed at the centre of a park run by Thurrock Council (there is no public access inside the fort). Though there are no pristine grazing-marsh habitats, there are vegetation-types characteristic of somewhat saline areas behind seawalls, and again they support uncommon plants. To the north the SSSI Unit 1 area supports species-rich calcicolous grassland with large populations of common orchid species such as *Anacamptis pyramidalis* and *Dactylorhiza fuchsii*.

Nomenclature and Terminology

Vascular plant nomenclature in this report follows the BSBI maps website which mostly follows Stace (2022) for native and naturalised species of vascular plant. Doubtful identifications may have ‘cf.’ before the specific epithet to mean that the plant cannot be distinguished from similar taxa with certainty. Nomenclature for mosses and liverworts follows Hill et al. (2008). Names of National Vegetation Classification (NVC) communities and subcommunities follow Rodwell (1991, 1992, 1995 x2000) and Rodwell et al. (2000) for proposed communities and sub-communities.

For conciseness, and because all native UK *Tripolium panonnicum* is Ssp. *pannonicum*, we have shortened *Tripolium panonnicum* ssp. *pannonicum* var. *flosculosus* to *Tripolium panonnicum* var. *flosculosus* in this report. We need to refer to these taxa because the non-rayed form of *Tripolium panonnicum* (i.e. Var. *flosculosus*) grows in one NVC community (SM11) and the rayed form grows in another (SM12b).

By ‘glycophyte’ we mean a halophyte that only tolerates low concentrations of salt. Plants growing in the inter-tidal are therefore straightforwardly halophytes, and inland plants that are completely intolerant of salt are non-halophytes, while plants occurring on strandlines, spray zones and brackish places are likely to be glycophytes (e.g. *Beta vulgaris* ssp. *maritima*, *Atriplex prostrata*, *Sonchus arvensis*). Many recent and non-specialist dictionary definitions of ‘glycophyte’ – especially those to be found on-line - speak only in terms of sodium ions, and only contrast halophytes (tolerant of high sodium) with glycophytes (only tolerant of low sodium), failing to distinguish glycophytes from non-halophytes. Recent usage of the term ‘glycophyte’ may or may not therefore be inconsistent across the wider literature, but we believe ours to be the established and salient usage.

By the greater Thames estuary, we mean the area thus referred to by the maritime community, i.e. Aldeburgh in Suffolk to the North Foreland in Kent. It should be noted that some put the south-eastern limit at Whitstable, beyond which reclaimed lands (and therefore habitats relevant to this report) are very uncommon on the Kent shore. By the inner Thames estuary, we mean the River Thames west of Leigh-on-Sea in Essex and the Medway estuary in Kent. By the North Thames area, we mean the general area along the Essex shore from Tilbury to the London Gateway Port so that it is more-or-less equivalent to the survey area. We therefore use the terms North Thames area and survey area more-or-less interchangeably in this report, but the former is nuanced towards the geographical area of interest and the latter is nuanced towards the actual area surveyed.

The term ‘noteworthy species’ is used to mean any species of interest or nature conservation importance for diverse reasons without specifying those reasons, thus avoiding unintentional reference to the precise meanings that attach to most alternatives, e.g. nationally scarce, threatened (has precise meanings in connection with Red Lists) etc.

We use the following acronyms widely:

- NVC – National Vegetation Classification.
- BPC – *British Plant Communities* (Rodwell 1990, 1991, 1995, 2000);
- DVVN – *De Vegetatie van Nederland* (Schaminée et al. 1998); and
- OS – Ordnance Survey.

In accordance with Natural England guidance, the following notation has been used to cover mosaics of NVC types and intermediates:

- SM6-SM11 means a mosaic of patches of good SM6 and good SM11 that are too small or complex to map; the proportions of each may follow as percentages.
- SM6/SM11 means vegetation intermediate in character between SM6 and SM11.

It should be noted that this reverses the normal typographical practice of newspapers and publishing houses, in which a dash means ‘from A to B’, and a slash means either A or B.

Saltmarsh Parcels in the Survey Area

In the survey brief, Natural England supplied mapping that divides the North Thames saltmarshes into four compartments: A (Mucking Wetlands, in the north-east), C (east of Enovert landfill), D (east and south of Walsh (East Tilbury) Quarry and F (inter-tidal between Coalhouse Point and Tilbury Cruise Terminal, in the south-west). For the purposes of this report these have been further divided into saltmarsh parcels of more-or-less distinctive character (though not always homogeneous) so that they can usefully be discussed in a report of this kind. They range in size from *c.*0.5 km to *c.*1.8 km of shore. They are shown in Figures 2a and 2b and named as follows.

- A1 – London Gateway Port Marsh
- A2 – Mucking Spit and foreshores
- A3 - Mucking Creek
- C1 – East of Enovert Landfill
- D1 – East Tilbury Marshes
- D2 – Mucking Flats Marshes
- D3 – SSSI Unit 1 and Coalhouse Fort

- D4 - LTC4 / DHL foreshore
- F1 - Tilbury Power Station foreshore
- F2 - Bill Meroy Creek
- F3 - Tilbury Fort
- F4 - Tilbury Cruise Terminal

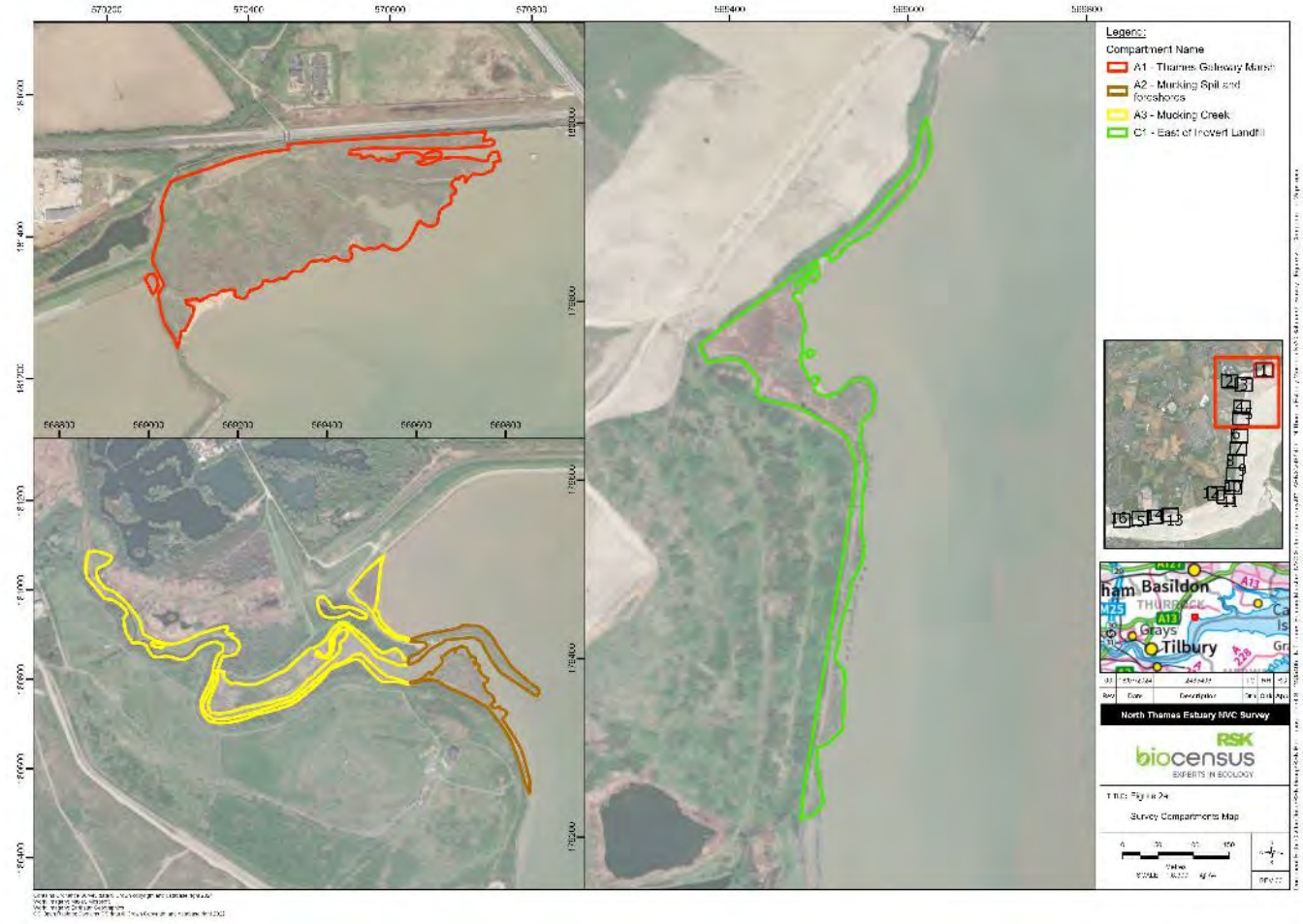

Figure 2a: Survey compartments map of A1, A2, A3, C1.
Contains Ordnance Survey data © Crown copyright and database right 2024. Word Imagery: Maxar, Microsoft. Word Imagery: Earthstar Geographics. OS Open Rasters: Contain OS data © Crown copyright and database right 2022

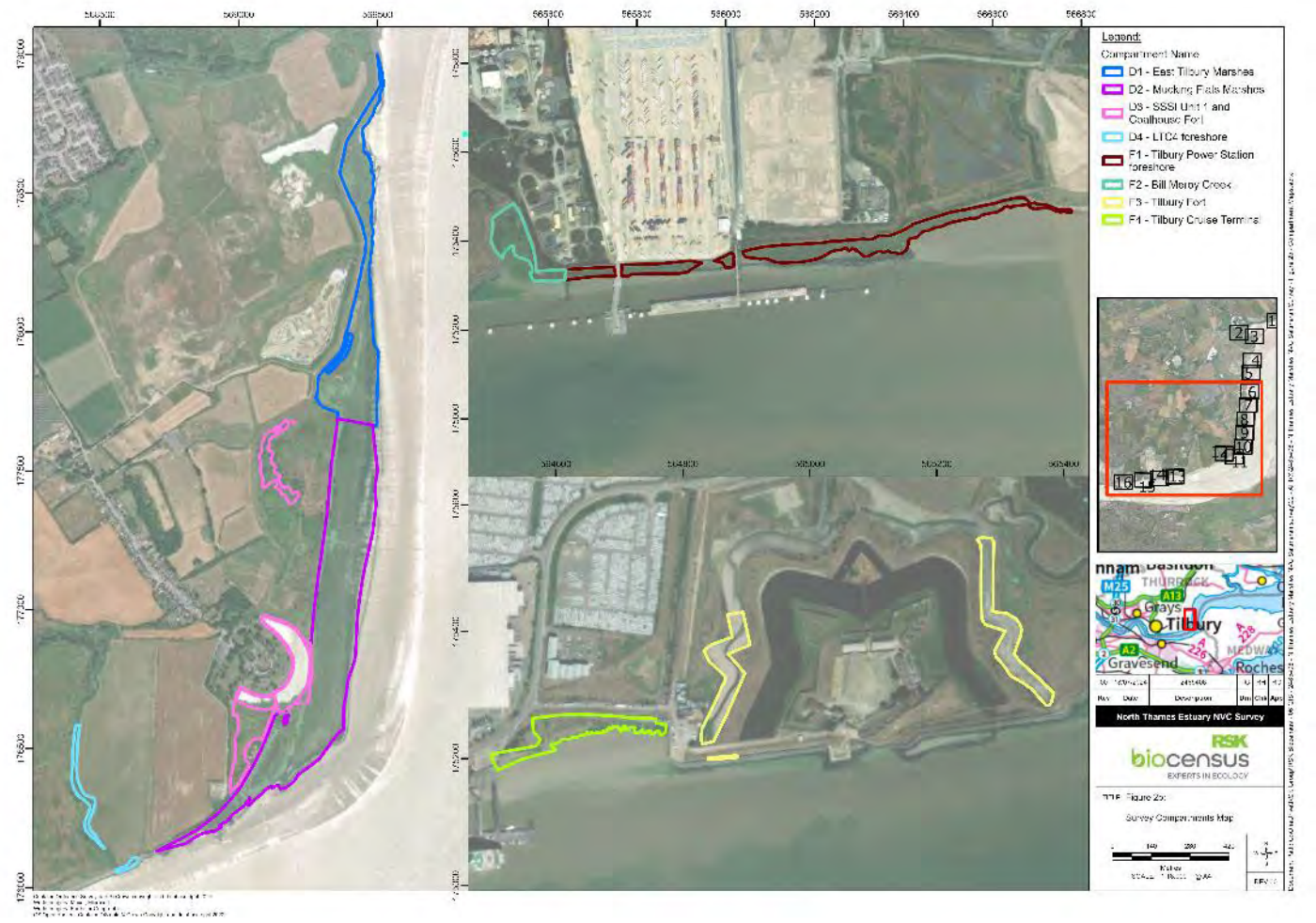

Figure 2b: Survey compartments map of D1, D2, D3, D4, F1, F2, F3, F4.
Contains Ordnance Survey data © Crown copyright and database right 2024. Word Imagery: Maxar, Microsoft. Word Imagery: Earthstar Geographics. OS Open Rasters: Contain OS data © Crown copyright and database right 2022

Non-standard NVC Variants - Coding

We have recognised and mapped non-standard variants of ‘SM14 *Halimione portulacoides* salt-marsh community’ (also one in ‘SM13 *Puccinellia maritima* salt-marsh community’) that differ from SM14 undifferentiated (and in most cases from ‘SM14a *Halimione portulacoides* salt-marsh community, sub-community with *Halimione portulacoides* dominant’) only in featuring one single species at levels of abundance not expected from the community descriptions and floristic tables in BPC. They are as follows>

- SM13Ap – an *Atriplex prostrata* variant of SM13 in the lower marsh.
- SM14Ea – and *Elymus athericus* variant of SM14 in the upper marsh.
- SM14Jg – a *Juncus gerardii* variant of SM14 in the middle marsh.
- SM14Jm – a *Juncus maritimus* variant of SM14 in the middle marsh.
- SM14Tp – a *Tripolium panonnicum* var. *flosculosus* variant of SM14 in the lower marsh.

Methods

Dates and Personnel

Field surveys were carried out by Dr Richard Carter, Mr Peter Flood, Mrs Sarah Harmer and Mr Jan Skuriat on 26 June 2023 in the Mucking Creek, Mucking Spit and Thames Gateway Marsh areas; by Jan Skuriat and Sarah Harmer between Tilbury Fort and the landfill site LTC4 / DHL on 27 June 2023; by Dr Carter with assistance from the Coalhouse Park warden, Ray Reeves at SSSI Unit 1 on 27 June 2023, by Dr Carter and Peter Flood in the area D2 Mucking Flats Marshes on 27 June 2023, by Peter Flood in the area east of the Enovert Landfill site on 27 June, by Dr Carter and Peter Flood at Coalhouse Fort and the DHL Landfill Site LTC4 on 29 June 2023; and by Dr Carter and Peter Flood at the Thurrock Thameside Nature Park area, the London Gateway Port Marsh area (including the new seawall to the west) and Mucking Spit on 30 June 2023. Some observations were also made by Dr Carter during an opportunistic visit to publicly accessible places at Tilbury Fort on 19 August 2023. For safety, general assistance and training, the lead surveyors were accompanied by RSK assistant ecologists Mr Joe Prodger and Mr Joe Prosser at various times. All the lead surveyors are employed by RSK Biocensus Ltd, either full-time as botanical consultants or regularly as independent subconsultants: Dr Carter and Mrs Sarah Harmer are directors of RSK Environment Limited; Mr Flood is a senior consultant; and Mr Skuriat is a subconsultant. All four are experienced botanists as follows:

- Dr Richard Carter has over 35 years' experience as an environmental consultant. He is a founder member of CIEEM and a Chartered Environmentalist. He set up the Vegetation Survey and Assessment M.Sc. course at the University of Reading and taught there part-time from 1995 to 2020. He is the BSBI recorder for VC28 (West Norfolk) and taxonomic referee for *Lactuca* and 'unclaimed' genera in the Tribe Cichorieae. He has a long-standing interest in seawall vegetation following a survey of Essex and north Kent seawalls under a BES small project grant in 1983 and he monitored Nationally Scarce species on the north Kent seawalls for the Environment Agency in the late 1990s to early 2000s. He lived in Essex from 1986 to 2007 and botanised widely on the coast, using Tollesbury for M.Sc. teaching.

- Mr Peter Flood is an experienced botanist and has three years' experience as an environmental consultant (following a career change). He is a member of CIEEM. He holds a FISC qualification (for plant identification) at Level 6 and is authorised to run the BSBI FISC examination.

- Mrs Sarah Harmer is an experienced botanist and has 27 years' experience as an environmental consultant (though working concurrently as a teacher for c.10 years). She is a member of CIEEM.

- Mr Jan Skuriat is an experienced botanist and animal ecologist and has over 20 years' experience as an environmental consultant. He is a member of CIEEM.

Species-search Survey

Target note locations, quadrat locations, and where appropriate notable plant species locations were recorded to 1-metre as 10-figure Ordnance Survey grid references, i.e. two letters (TQ) and five figures each for eastings and northings (or else six figures plus six if replacing TQ with 5/1). The grid references were obtained using a handheld GPS device, i.e. a Garmin GPSMAP 65s Multi-band model. Short of recourse to sub-metre GPS, this is among the more accurate handheld devices, using 3 satellite systems and optimised for rapid delivery of readings in places where views of the sky are restricted, e.g. woodland. On other seawall-survey projects in 2023, it has been RSK experience that readings have later plotted to roughly the correct place across the c.20 m width of the seawall habitat complex, e.g. outer face versus landward berm, suggesting an accuracy of c.2 m and certainly better than 5 m, but many factors can reduce accuracy at various times and places. We do not know whether blurring was ever being applied to GPS signals in June 2023 owing to the conflict in Ukraine.

It was not a requirement of the brief to produce exhaustive species lists for the sites, but non-exhaustive lists of the species seen during the surveys use subjective estimates of relative abundance on the DAFOR scale, which ranks species on a five-point - but effectively a four-point – scale as follows: D – dominant (seldom used), A – abundant, F – frequent, O – occasional, R – rare.

Quadrat Recording

The project brief requested the recording of quadrats in each of the principal NVC communities recorded. The methods of the National Vegetation Classification (NVC) were accordingly used to describe saltmarsh vegetation (Rodwell 1992, 2006). These methods centre on subjective recognition of homogeneous areas of vegetation (Rodwell 2006). NVC types were initially identified by observation and experience, but quadrat sampling was carried out to provide a more analytical description.

Quadrats were recorded from homogeneous stands of vegetation following the standard methods for identifying NVC types (Rodwell 2006). As usual in NVC sampling, the exact quadrat locations were non-randomly chosen to demonstrate the typical and key characteristics of the vegetation as understood by the surveyor (Rodwell 2006). The two-metre square (=4m^2) quadrat size recommended in Rodwell (2006) for short herbaceous vegetation was used. The cover of each species in each quadrat was estimated by eye and recorded on the Domin Scale (10 - over 90% cover, 9 - 76-90%, 8 - 51-75%, 7 - 34-50%, 6 - 26-33%, 5 - 11-25%, 4 - 4-10%, 3 - under 4% yet frequent, 2 - under 4% and occasional, 1 - under 4% and rare).

The data are presented as floristic tables following so far as possible the style of the definitive NVC tables in *British Plant Communities* (Rodwell 1990, 1991, 1995, 2000). Where five quadrats were recorded, species are ordered by their relative abundance, first by frequency class (class I – 0-20%, II – 21-40%, III -41-60%, IV – 61-80%, V – 81-100%), and then by maximum cover value on the Domin Scale, and then alphabetically for ties.

Stands of vegetation were identified to NVC type from quadrat data with the assistance of the computer-program MATCH (Malloch 1999), which computes similarity-coefficients between quadrat data and the published NVC tables in *British Plant Communities* (which define the NVC communities and sub-communities). This gives only an initial indication of which NVC types the data are most likely to have been drawn from – the highest coefficient does not necessarily

indicate a correct NVC diagnosis. It is always necessary to further identify the NVC type through careful consideration of the NVC descriptions and floristic tables in *British Plant Communities* (Rodwell 1992, 2000).

The absolute value of the matching coefficients produced by MATCH is not something usually interpreted when making NVC diagnoses. However, experience suggests that, in most vegetation types, good matches require coefficient values over *c.*45, and poor but acceptable matches can often attend coefficient values in the range 45 to 35. There is little chance of finding any satisfactory match when the highest coefficient is lower than *c.*35. Where the highest coefficient value is below *c.*30 it is usually obvious that the vegetation is non-NVC. However, stands of saltmarsh vegetation often contain very few species and this seems to give rise to coefficient values in the range 70 to 50 for acceptable matches and completely non-acceptable matches alike. The absolute values of matching coefficients are therefore of even less interpretative value than usual.

The programs MATCH and MAVIS perform very poorly when matching single quadrats as they do not use cover values in computing matching coefficients. MATCH however has the advantage over MAVIS because it can produce information on the extent to which cover values for each individual species in a quadrat diverge from those indicated in the BPC floristic table for each of the NVC types indicated by the top ten matching coefficients.

Constraints

Seasonality

Late June was generally a good time for the saltmarsh surveys, and it is unlikely that any significant areas of vegetation were missed on account of the survey date. It was a very good time for recording annual grass species associated with SM-series vegetation types of disturbed (rutted or trampled) saline areas to landward of the seawalls, e.g. *Hordeum marinum*, *Parapholis strigosa*, *Polypogon monspeliensis*, *Puccinellia distans* ssp. *distans*, *Puccinellia fasciculata* and *Puccinellia rupestris* – some of these might have been missed if surveys had been later. In the same habitat the noteworthy species *Bupleurum tenuissimum* was just coming into flower, but it may have been under-estimated or locally missed – the opportunistic visit to grazing-marsh at Tilbury Fort on 19 August 2024 revealed it in large amounts.

On the inter-tidal saltmarshes, however, several species are rather late-flowering, and some species could not be reliably identified to species level in late June as follows.

- *Limonium vulgare* – usually the abundant *Limonium* species on Essex saltmarshes – was not in flower making it hard to distinguish from *Limonium humile* and the hybrid (though several plants of *Limonium* × *neumanii* = *L. vulgare x L. humile* were in flower and therefore identifiable). No plants of the *Limonium binervosum* aggregate were seen, but these too would probably not have been identifiable at the time of the survey.
- The annual *Salicornia* species are not identifiable until October. Moreover, they have long been regarded as difficult to identify or even intractable (though improved accounts are changing this - there is an excellent French guide to the genus). Most botanists still simply record them as a single *Salicornia europaea* aggregate, and this almost certainly happened during sampling for

the NVC, so that identifying the annual *Salicornia* species would not help in identifying NVC types in an NVC survey.

- The annual *Suaeda maritima* was perhaps under-estimated as it too develops late.
- *Tripolium panonnicum* ssp. *pannonicum* is not flowering in June and it is impossible to distinguish between the non-rayed Var. *flosculosus* (Var. *discoideus* in older literature) and the rayed Var. *pannonicum*. We have generally presumed plants in the intertidal and especially in the lower marsh to be the non-rayed form, but plants in the upper marsh and especially behind seawalls are uncertain (except where they were later seen in mid-August).
- Two extremely rare species, *Atriplex pedunculata* and *Lactuca saligna* (listed on Schedule 8 of the Wildlife and Countryside Act 1988 as amended), grow at sites not far from the North Thames area (Foulness and Fobbing respectively). The former species is identified by its pendulous fruits in late summer (Chatters 2017) and the latter is July-August flowering. Neither would be easy to find in June. There is no particular reason to think they are present in the North Thames area, but suitable habitat is present, and the area may not have been searched for them at the right time of year.

Safety

At the suggestion of Natural England, Mr Ray Reeves, the long-serving warden at the Coalhouse Fort Park, was consulted about safety issues owing to his long experience of working in the intertidal zone within the survey area. The principal insight arising was that soft mud in the survey area can be exceptionally treacherous. In most Essex saltmarshes one can walk in the mud of creeks etc. because - despite sinking to almost knee-level -there is always firm footing below. Wildfowlers wearing waders routinely traverse the marshes using the creeks for cover. However, the industrial history of the Thames estuary and its use by boat traffic of diverse kinds has left areas of deep soft mud which look no different to the rest. Worst of all are ‘barge wallows’ where sailing barges or rafts of lighters have regularly rested on the mud creating pools of soft mud in which the unwary can simply disappear. For this reason, the surveys were carried out without setting foot on intertidal mud. This certainly limited surveys of the lower marsh vegetation, though good sight was usually available through binoculars, and as it turned out there were few if any places where much would have been learned by venturing out onto the intertidal mud.

The riverside strip (and cliff) at the DHL Landfill Site LTC4 presents extreme slopes, pits from 20th Century bottle-digging, uneven ground obscured by dense brambles and tall-herb vegetation, treacherous substrates underfoot (variously ashy, soft, unstable or noxious), and an abundance of broken glass and occasionally jagged metal exposed at the surface everywhere. Any small trip or fall would very probably be complicated by cuts which would be liable to contamination with ashy detritus. Hazards of this kind are not uncommon on brownfield sites, but this site is exceptionally hazardous. Similar conditions prevail on the northern side of Mucking Creek between the most seaward footbridge and Mucking Spit, and fragmentarily along the foreshore at the East Tilbury Marshes. The RSK team were properly informed of the risks by Natural England before the project commenced, **but for the benefit of future surveys we reiterate the severity of the problem here**.

Results

NVC Mapping

The mapping of NVC polygons across the survey area is presented in the several pages of Figure 3, i.e. Figure 3a to Figure 3q. Colour codes apply to NVC communities and sub-communities are indicated by the appropriate letters overlaid on the mapping. Thus, a letter 'a' positioned on a polygon that is colour coded as SM14 means SM14a.Not all polygons will necessarily have such letters, as not all the vegetation could be identified to sub-community level (i.e. it might for example be SM14 undifferentiated).

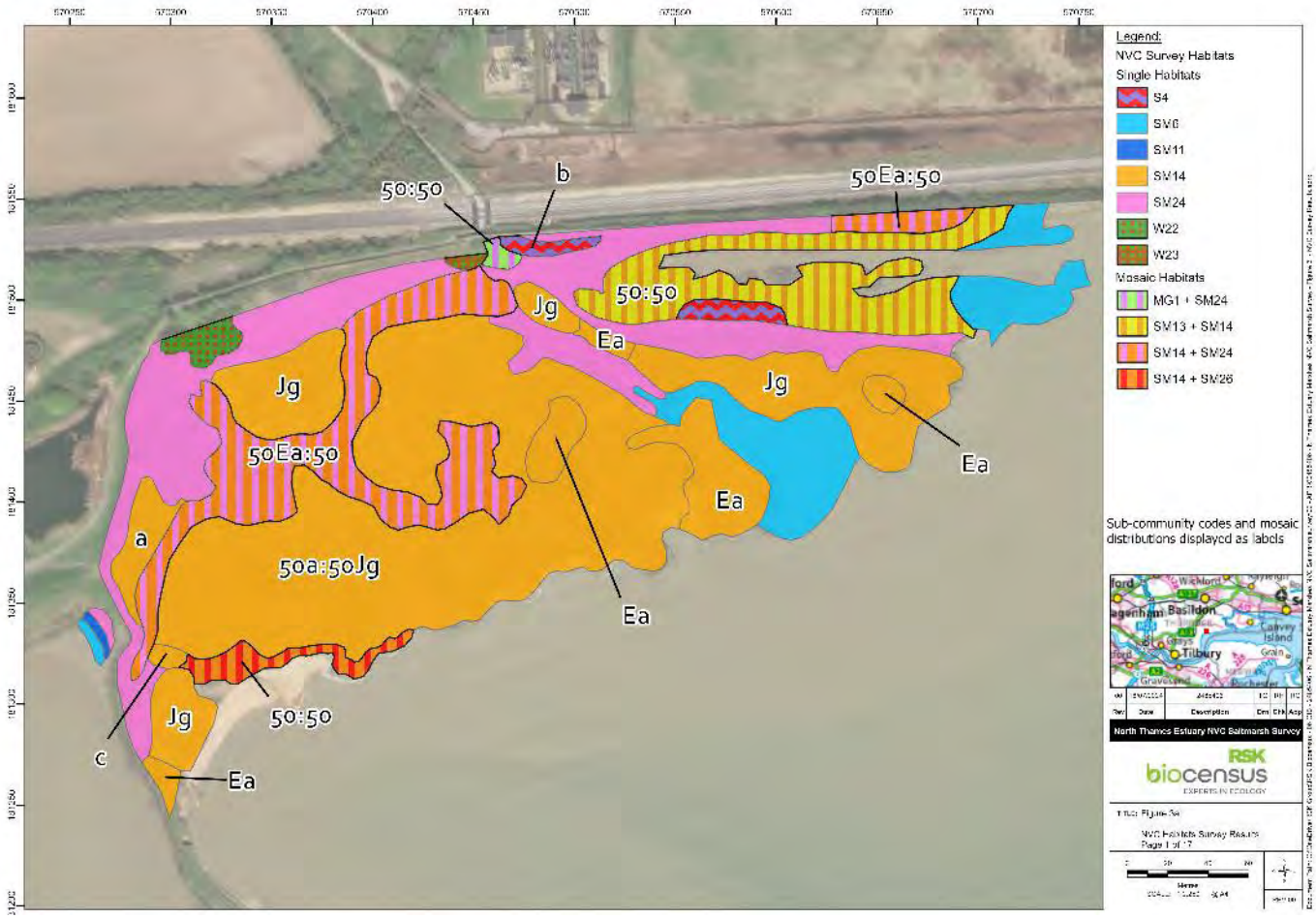

Figure 3a NVC Habitats Survey results.
Contains Ordnance Survey data © Crown copyright and database right 2024. Word Imagery: Maxar, Microsoft. Word Imagery: Earthstar Geographics. OS Open Rasters: Contain OS data © Crown copyright and database right 2022

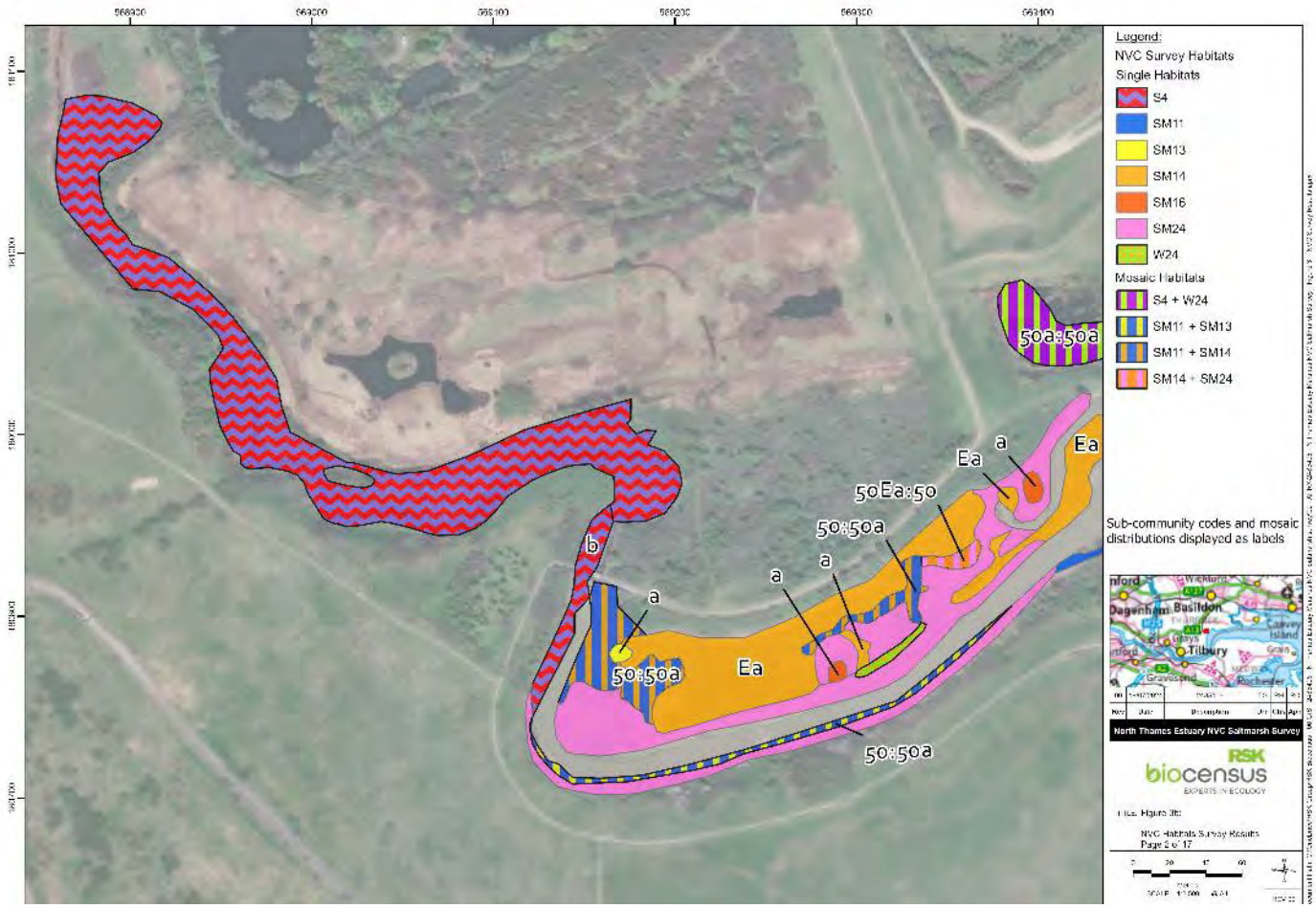

Figure 3b: NVC Habitats Survey results.
Contains Ordnance Survey data © Crown copyright and database right 2024. Word Imagery: Maxar, Microsoft. Word Imagery: Earthstar Geographics. OS Open Rasters: Contain OS data © Crown copyright and database right 2022

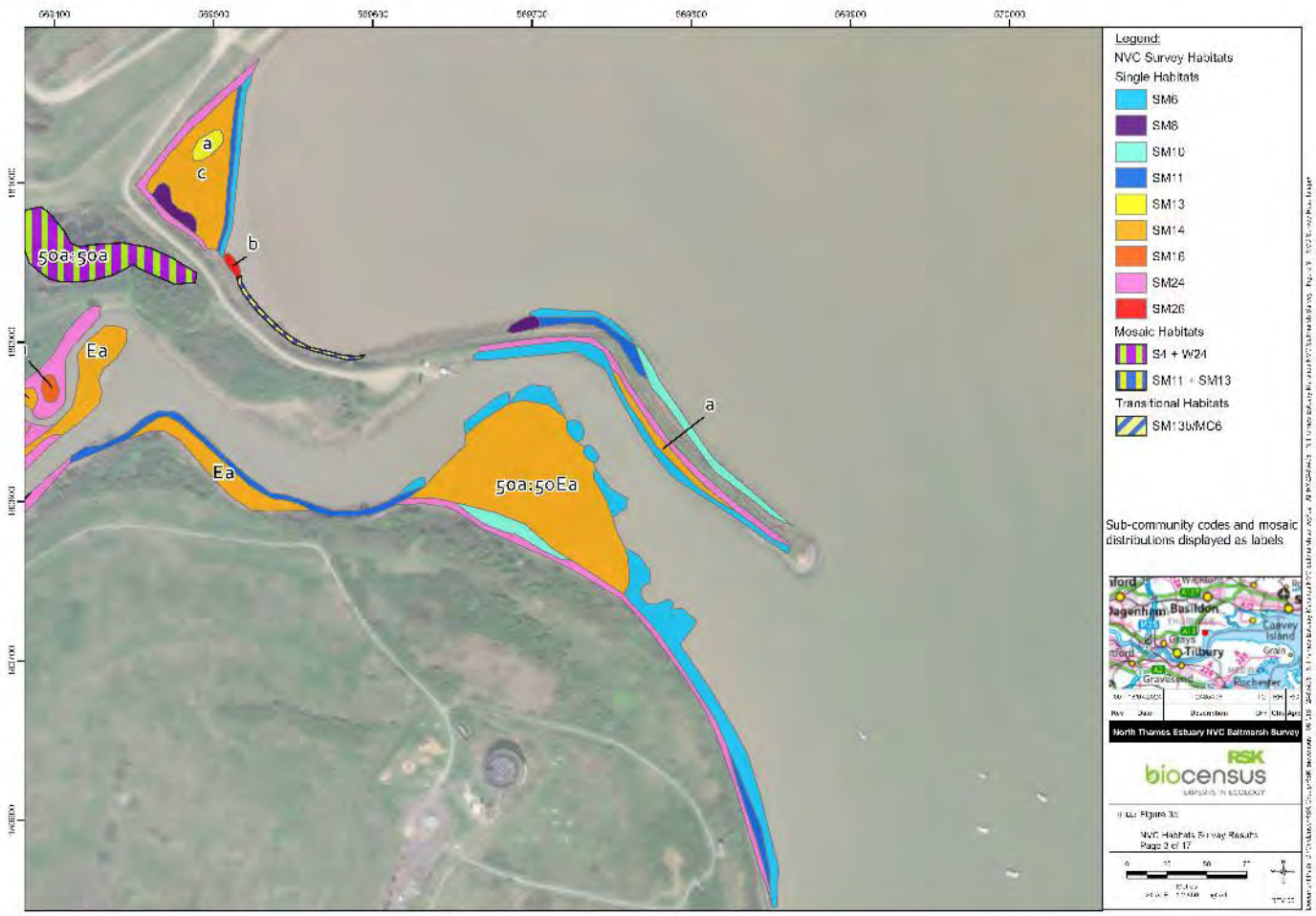

Figure 3c: NVC Habitats Survey results.
Contains Ordnance Survey data © Crown copyright and database right 2024. Word Imagery: Maxar, Microsoft. Word Imagery: Earthstar Geographics. OS Open Rasters: Contain OS data © Crown copyright and database right 2022

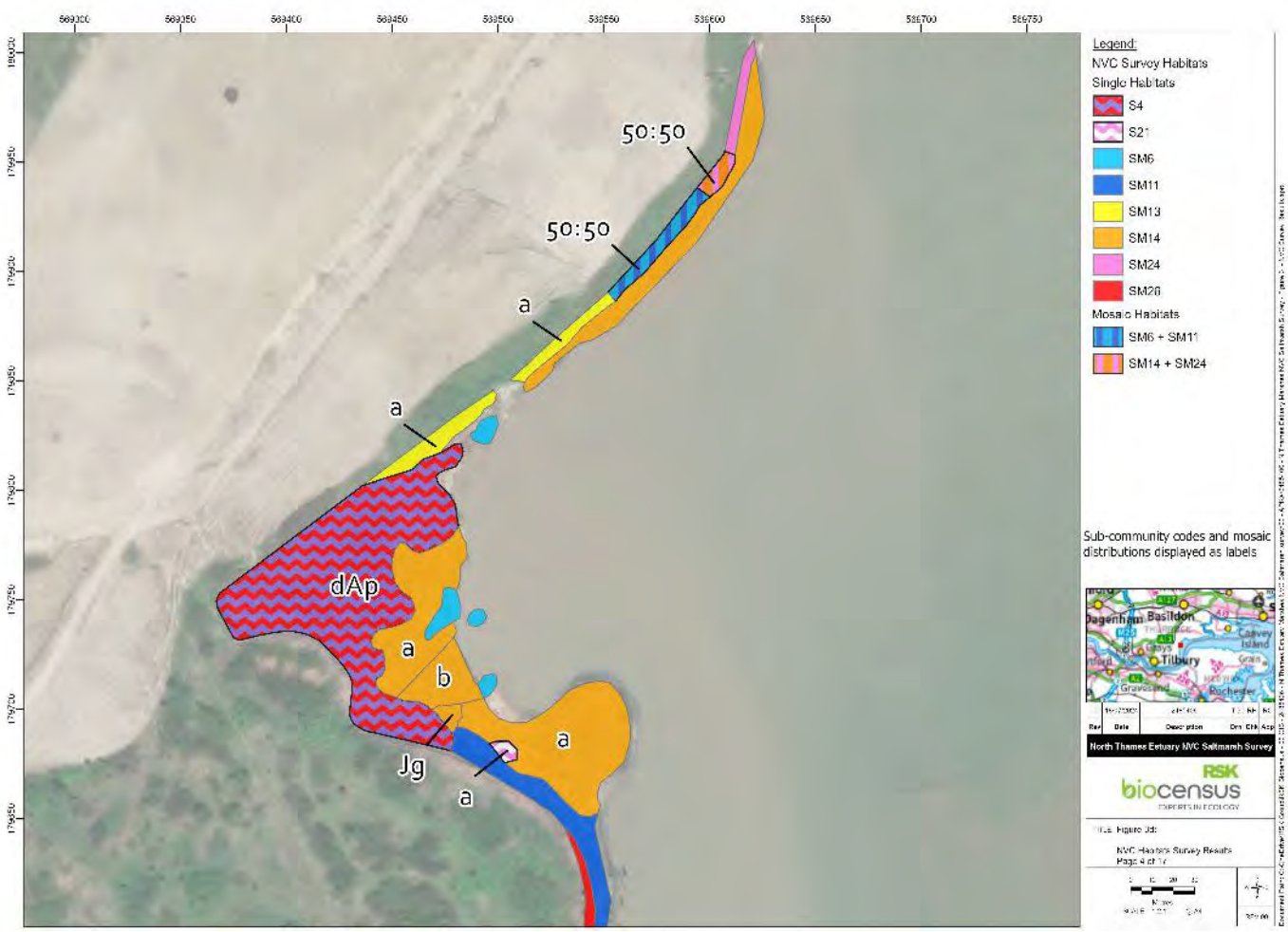

Figure 3d: NVC Habitats Survey results.
Contains Ordnance Survey data © Crown copyright and database right 2024. Word Imagery: Maxar, Microsoft. Word Imagery: Earthstar Geographics. OS Open Rasters: Contain OS data © Crown copyright and database right 2022

Figure 3e: NVC Habitats Survey results.
Contains Ordnance Survey data © Crown copyright and database right 2024. Word Imagery: Maxar, Microsoft. Word Imagery: Earthstar Geographics. OS Open Rasters: Contain OS data © Crown copyright and database right 2022

Figure 3f: NVC Habitats Survey results.
Contains Ordnance Survey data © Crown copyright and database right 2024. Word Imagery: Maxar, Microsoft. Word Imagery: Earthstar Geographics. OS Open Rasters: Contain OS data © Crown copyright and database right 2022

Figure 3g: NVC Habitats Survey results.
Contains Ordnance Survey data © Crown copyright and database right 2024. Word Imagery: Maxar, Microsoft. Word Imagery: Earthstar Geographics. OS Open Rasters: Contain OS data © Crown copyright and database right 2022

Figure 3h: NVC Habitats Survey results.
Contains Ordnance Survey data © Crown copyright and database right 2024. Word Imagery: Maxar, Microsoft. Word Imagery: Earthstar Geographics. OS Open Rasters: Contain OS data © Crown copyright and database right 2022

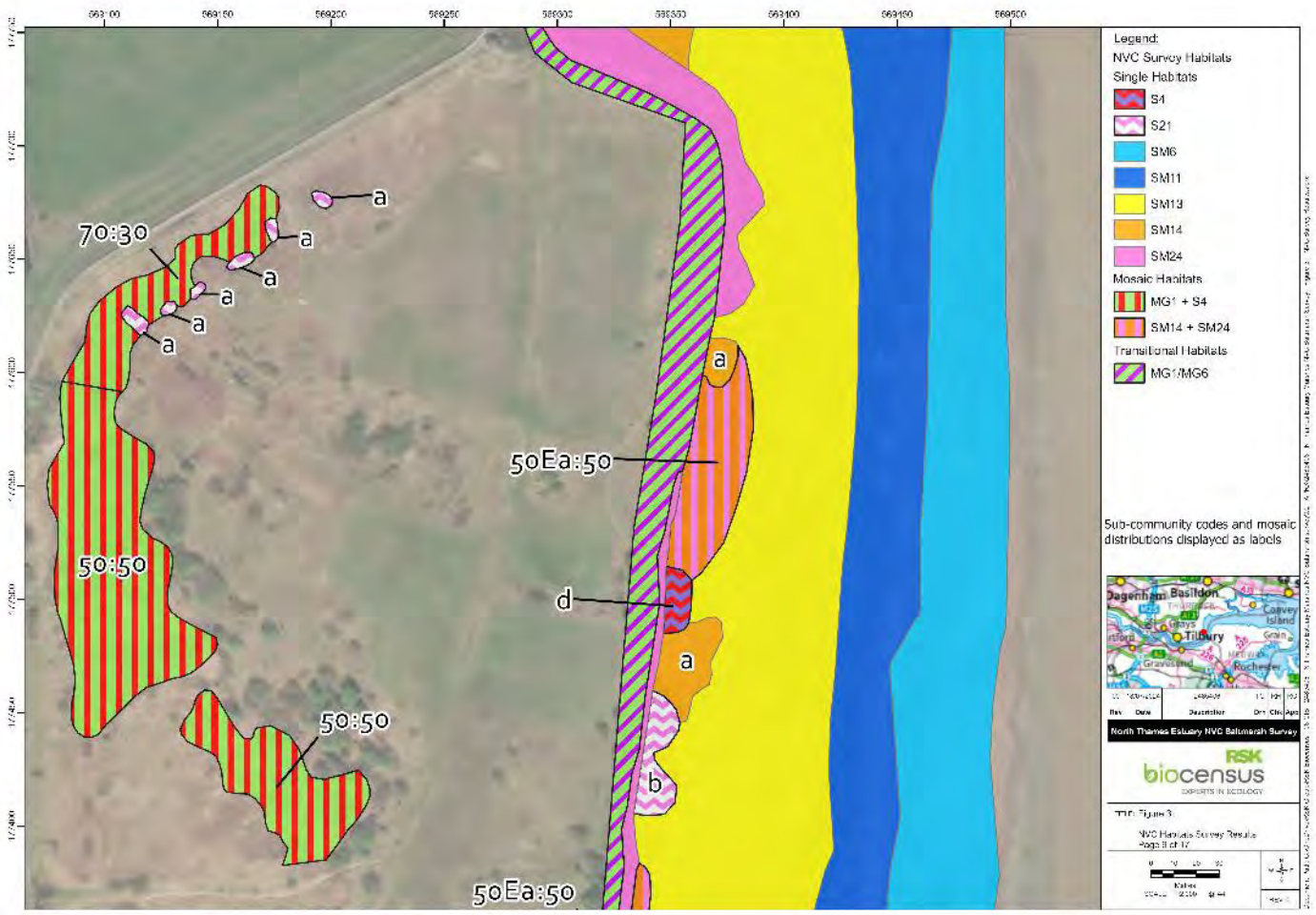

Figure 3i: NVC Habitats Survey results.
Contains Ordnance Survey data © Crown copyright and database right 2024. Word Imagery: Maxar, Microsoft. Word Imagery: Earthstar Geographics. OS Open Rasters: Contain OS data © Crown copyright and database right 2022

Figure 3j: NVC Habitats Survey results.
Contains Ordnance Survey data © Crown copyright and database right 2024. Word Imagery: Maxar, Microsoft. Word Imagery: Earthstar Geographics. OS Open Rasters: Contain OS data © Crown copyright and database right 2022

Figure 3k: NVC Habitats Survey results.
Contains Ordnance Survey data © Crown copyright and database right 2024. Word Imagery: Maxar, Microsoft. Word Imagery: Earthstar Geographics. OS Open Rasters: Contain OS data © Crown copyright and database right 2022

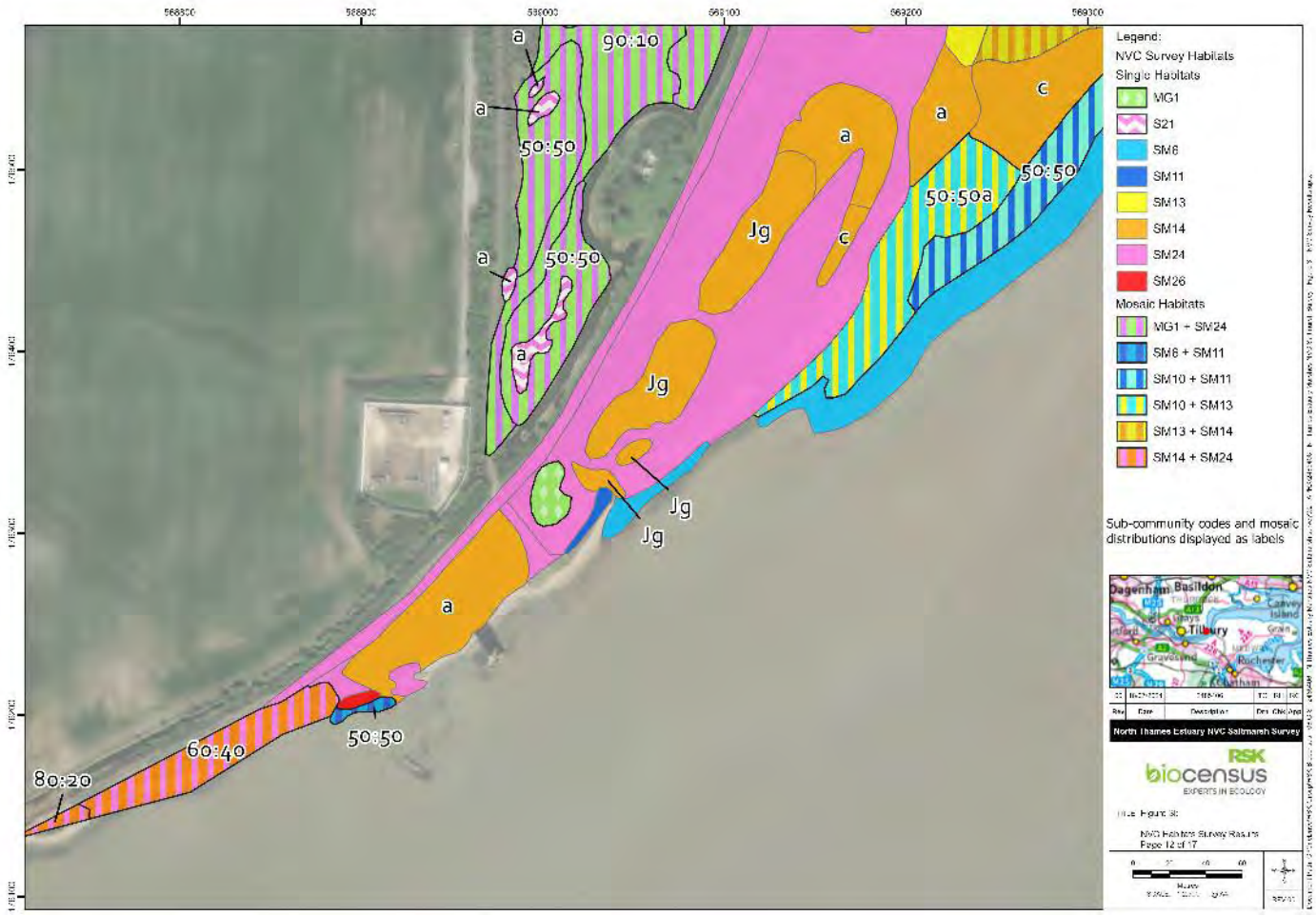

Figure 3l: NVC Habitats Survey results.
Contains Ordnance Survey data © Crown copyright and database right 2024. Word Imagery: Maxar, Microsoft. Word Imagery: Earthstar Geographics. OS Open Rasters: Contain OS data © Crown copyright and database right 2022

Figure 3m: NVC Habitats Survey results.
Contains Ordnance Survey data © Crown copyright and database right 2024. Word Imagery: Maxar, Microsoft. Word Imagery: Earthstar Geographics. OS Open Rasters: Contain OS data © Crown copyright and database right 2022

Figure 3n: NVC Habitats Survey results.
Contains Ordnance Survey data © Crown copyright and database right 2024. Word Imagery: Maxar, Microsoft. Word Imagery: Earthstar Geographics. OS Open Rasters: Contain OS data © Crown copyright and database right 2022

Figure 3o: NVC Habitats Survey results.
Contains Ordnance Survey data © Crown copyright and database right 2024. Word Imagery: Maxar, Microsoft. Word Imagery: Earthstar Geographics. OS Open Rasters: Contain OS data © Crown copyright and database right 2022

Figure 3p: NVC Habitats Survey results © Crown Copyright and database right 2022, 2024. Contains Ordnance Survey data © Crown copyright and database right 2024. Word Imagery: Maxar, Microsoft. Word Imagery: Earthstar Geographics. OS Open Rasters: Contain OS data © Crown copyright and database right 2022.

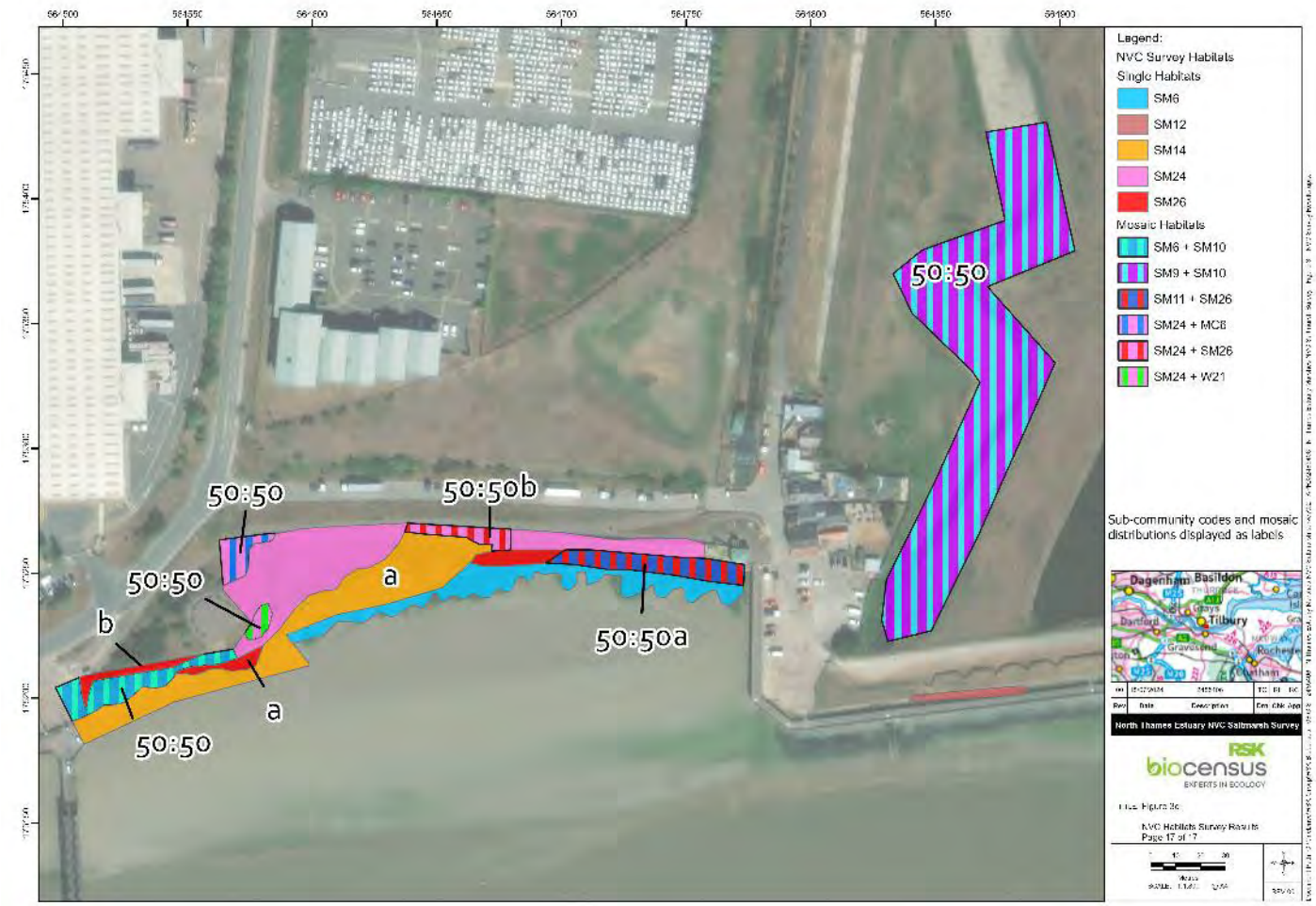

Figure 3q: NVC Habitats Survey results.
Contains Ordnance Survey data © Crown copyright and database right 2024. Word Imagery: Maxar, Microsoft. Word Imagery: Earthstar Geographics. OS Open Rasters: Contain OS data © Crown copyright and database right 2022

NVC Conspectus for the Survey Area

Introduction

This section addresses all the SM-series NVC communities and sub-communities, looking at whether the surveys reported here provide evidence for their occurrence in the survey area, and noting how usual or unusual their occurrence there is if they were recorded and how likely or unlikely if they were not. It also makes some general comment on the pattern of occurrence of NVC types in the survey area.

Detail of why stands of vegetation were identified as particular NVC types are addressed in the following major section, and then a further major section addresses the NVC profile of vegetation types occurring in the areas A1 to A3, C1, D1-D4 and F1 to F4.

SM1-SM3

No stands belonging to the NVC type ‘SM1 *Zostera* communities’ were noted during the surveys. In *British Plant Communities* (BPC) they are mapped on the Thames estuary only a little to the east of the survey area. According to Waite (1998) they were extensive to seaward of the survey area at the Maplin Sands in the past, but Waite (1998) addresses the greater Thames estuary, and it is not clear how much of what is said might apply to the survey area. As *Zostera* vegetation grows in the sub-littoral and eu-littoral zones of sand and mudflats, it can only be investigated using boat-work, and SM1 was from the outset beyond the purview of the surveys reported here. The same applies to stands of *Ruppia maritima* that might perhaps be growing in the same habitat, though stands of this kind discussed in BPC are Scottish and may not be represented in Essex.

No stands belonging to the NVC type ‘SM2 *Ruppia maritima* saltmarsh community’ were noted during the surveys. Sub-littoral forms of SM2 have been dismissed above, but behind seawalls the survey area does contain brackish water-bodies suitable for SM2, and the community is mapped from the survey area in BPC. Possible sites for SM2 are therefore widely scattered in the vicinity of the survey area. In particular, the shallow outer defence ditch on grazing-marsh east of Tilbury Fort (and other ditches in the Tilbury Fort to Bill Meroy Creek area) have aquatic species such as *Ranunculus baudotii* and *Stuckenia pectinata* that are mentioned as associates of dominant *Ruppia maritima* in typical stands of SM2 and may therefore deserve further investigation. So too may deeper defence ditches at Coalhouse Fort where water levels are far more stable. Brackish water bodies of this kind are often far distant from other SM-series vegetation types, and this is especially true of the survey area where seawalls generally make a sharp demarcation between saltmarsh vegetation and terrestrial vegetation. The ditches mentioned above were at least briefly checked during the surveys reported here, but more isolated examples may have been overlooked, and indeed many could be present in areas for which no access was requested (there being no matrix of SM-series vegetation to address).

It is unlikely that the NVC type ‘SM3 *Eleocharis parvula* saltmarsh community’ would occur in the survey area (known only from the Poole Harbour area and North Wales in the UK according to BPC). No *Eleocharis parvula* was recorded during the surveys.

SM4-SM6 Spartina communities

No stands belonging to the NVC type ‘SM4 *Spartina maritima* saltmarsh community’ were noted during the surveys, and neither was the key species *Spartina maritima* recorded anywhere. It follows that the NVC type ‘SM13f *Puccinellia maritima* saltmarsh community, *Puccinellia maritima-Spartina maritima* sub-community’ was not recorded either. In *British Plant Communities* (BPC) SM4 is not mapped on the inner Thames estuary while BPC is unclear concerning where SM13f might be found in the UK. However, SM4 is mapped in BPC in Essex northwards from the Blackwater estuary, where at Tollesbury *Spartina maritima* occurs in two distinct communities (or did until *c.*2010): first on the outer edges of middle-marsh lawns (close to mud-cliff marsh edges) it occurs with *Puccinellia maritima* and *Limonium vulgare* as an occasional species in ‘SM13c *Puccinellia maritima* saltmarsh community, *Limonium vulgare-Armeria maritima* sub-community’ or else in vegetation loosely referable to the NVC type SM13f; and second in muddy depressions in trampled yacht-berthing areas it occurs alone or with *Spartina anglica* in stands loosely referable to the NVC type SM4. Nothing like this was seen during the surveys reported here. Generally, the marshes of the survey area lack extensive *Puccinellia-Limonium* lawns and classic eroding cliff edges, so the conditions in which SM13f occurs at Tollesbury are seldom encountered, while the

marshes are little encroached on by foot-traffic making the niche in which SM4 occurs at Tollesbury similarly rare (though it could occur fragmentarily at Mucking Spit and towards the southern end of the survey area). *Spartina maritima* was more common in Essex in the past according to BPC, and it might have been overlooked in small quantity in these surveys (further comment under the heading Species of Note in the Conclusions section of this report) X, but it cannot be more than an occasional species in the survey area, and it seems unlikely that any of the NVC types determined by it were there in 2024 except perhaps as fragments too small to map.

It is unlikely that the NVC type 'SM5 *Spartina alterniflora* saltmarsh community' would occur in the survey area (it is now known only from Hampshire in the UK according to BPC). No *Spartina alterniflora* was recorded during the surveys.

Stands belonging to the NVC type 'SM6 *Spartina anglica* saltmarsh community' are abundant at the lowest levels of the marshes (and fragmentarily elsewhere) throughout the survey area (e.g. Plates A2.5, A2.7, C1.1, F4.1). Wide swathes of SM6 are especially prominent where accreting marsh extends out towards the fast-flowing open reaches of the River Thames, e.g. in the D2 Mucking Flats and Marshes area. In most of these stands – and especially in the more extensive ones fringing large areas of saltmarsh – *Spartina anglica* generally occurs in monoculture (so far as vascular plants go). Safety considerations (around working on intertidal mud) leave us unable to comment on the extent to which mud stability in such stands in the survey area might depend on algal mats or mud-dwelling ecads of *Fucus vesiculosus* (listed in the floristic table for SM6 in BPC).

Inevitably SM6 grades widely into other NVC types in the survey area, especially 'SM11 *Aster tripolium* var. *discoideus* saltmarsh community' which most commonly abuts it on the gradient from low marsh to middle marsh (e.g. Plate C1.2). In the next section we discuss in more detail (principally in dealing with SM10) how we have dealt with stands containing appreciable amounts of *Spartina anglica* together with other low-marsh species such as *Puccinellia maritima*, annual *Salicornia* species, *Suaeda maritima* and *Tripolium panonnicum* var. *flosculosus*. The floristic tables in BPC clearly allow these species to be present in SM6, and here we simply note that we have assigned to SM6 any stands where these species collectively achieve cover less than *c.*30% of that of *Spartina anglica*.

SM7-SM11 Other Low-marsh Communities

It will help to take 'SM11 *Aster tripolium* var. *discoideus* saltmarsh community' out of turn, as it is abundant and extensive in the low marsh throughout the survey area where it occupies a position immediately above 'SM6 *Spartina anglica* saltmarsh community' in the gradation towards the middle marsh (e.g. Plate 2.3). In the survey area it is usually rather sharply demarcated from the SM6 zone. Most SM11 stands, and especially the larger ones, are – in a similar fashion to SM6 stands – monocultures consisting in this case of *Tripolium panonnicum* var. *flosculosus* (e.g. Plate F1.18). As with SM6 and for the same reasons we are unable to comment on the role that algae might play in stabilising the mud. As for SM6, we discuss under SM10 how we have dealt with stands containing appreciable amounts of *Tripolium panonnicum* var. *flosculosus* together with other low-marsh species such as *Puccinellia maritima*, annual *Salicornia* species, *Spartina anglica* and *Suaeda maritima*, and we note here that we have assigned to SM11 any stands where these species collectively achieve cover less than *c.*30% of that of *Tripolium panonnicum* var. *flosculosus*.

No stands belonging to the NVC type 'SM7 *Arthrocnemum perenne* stands' were noted during the surveys, and neither was the key species *Sarcocornia perennis* recorded anywhere. In *British*

Plant Communities (BPC) SM7 is not mapped from the greater Thames estuary (it being mainly on the south coast and Norfolk in the UK). However, *Sarcocornia perennis* certainly grows in Essex and it would be plausible in the survey area. In BPC it is noted as an occasional but non-defining species in several SM-series NVC types. Thus, at Tollesbury on the Blackwater estuary in Essex for example, it occurs in species-rich middle-marsh lawns belonging to the NVC type 'SM13c *Puccinellia maritima* saltmarsh community, *Limonium vulgare-Armeria maritima* sub-community'. It might have been overlooked in small quantity in these surveys (further comment under the heading Species of Note in the Conclusions section of this report), but it cannot be more than an occasional species in the survey area, and it seems unlikely that the NVC type determined by it, i.e. SM7 was there in 2024.

Only a very few stands of the NVC type 'SM8 Annual *Salicornia* saltmarsh community' were noted during the surveys despite this being one of the commonest communities of UK saltmarshes generally. The key annual *Salicornia* species were recorded mainly as occasional species in other NVC types. Curiously SM8 is not mapped from the greater Thames estuary in BPC, and while that must primarily reflect a historical lack of survey coverage, it may be that it really does to some extent reflect a scarcity of SM8 relative to other parts of the UK.

The annual *Salicornia* species were lacking from the low marsh vegetation bordering the main reaches of the River Thames and instead they were largely confined to more protected inlets and fragmentary areas of marsh protected by 19th Century earthworks (mostly rubbish tips). In our mapping of the NVC types, it is nevertheless possible that SM8 may be under-represented, first because stands tend to be smaller than the minimum mappable unit, and second because some stands may not have been fully developed at the time of the survey in July – this especially applies at Tilbury Fort where shallow moats supporting aquatic A-series NVC types had dried out by September to support transient SM-series communities. However, it would not be correct to infer that SM8 is at all common in the survey area.

It was too early in the year to identify the annual *Salicornia* species, but given the pattern of their occurrence, it seems likely that low marsh types such as *Salicornia dolichostachya* are likely to be absent or rare (except perhaps in the few places where there are large creeks as in the A1 London Gateway Port marsh area and the D2 Mucking and Marshes area); the species seen in the surveys are therefore likely to be upper marsh types such as *Salicornia disarticulata* and *Salicornia ramosissima*. This is a contrast that might well deserve future recognition at sub-community level in the NVC, but it is hindered by the difficulty of *Salicornia* identification. The contrast could optionally be recognised in surveys carried out in October.

Again, despite it being common in UK saltmarshes, only a very few stands of the NVC type 'SM9 *Suaeda maritima* saltmarsh community' were noted during the surveys. Again, *Suaeda maritima* was recorded mainly as occasional species in other NVC types, though it was rather more frequent and widespread in the survey area than the annual *Salicornia* species.

Most of what has been said about SM8 above applies to SM9 as well. Though SM9 is likewise not mapped from the greater Thames estuary in BPC, the text of BPC states that SM9 is commonest in south-east England despite the mapping not showing it there, so that the discrepancy must be wholly attributable to a lack of sampling during the development of the NVC. The distribution pattern of *Suaeda maritima* within the survey area closely follows that of the annual *Salicornia* species, i.e. absent from the exposed outer marshes and occasional in sheltered inlets etc. At Tilbury Fort the shallower moats drying out in September supported very extensive stands of unequivocal SM9 (Plate F3.2) whereas SM8 may be fragmentary)

Stands loosely referable to the NVC type ‘SM10 Transitional low-marsh vegetation with *Puccinellia maritima*, annual *Salicornia* species and *Suaeda maritima*’ are scattered along the outer edges of marshes throughout the survey area, especially where the lowest belts of ‘SM6 *Spartina anglica* saltmarsh community’ and ‘SM11 *Aster tripolium* var. *discoideus* saltmarsh community’ are poorly developed or else in narrow strips of rather open vegetation between the SM11 zone and the middle marsh. The account of SM10 in BPC requires *Puccinellia maritima*, annual *Salicornia* species, and *Suaeda maritima* to be co-dominant in more-or-less equal amounts, but the floristic table in BPC suggests that *Spartina anglica* and *Tripolium panonnicum* var. *flosculosus* may at least approach them in abundance. Stands containing mixtures of low-marsh species such as *Puccinellia maritima*, annual *Salicornia* species, *Spartina anglica*, *Suaeda maritima* and *Tripolium panonnicum* var. *flosculosus* are common, and we simply note here that rather than positing unsatisfactory transitions between NVC types we have assigned to SM10 some stands with rather less *Salicornia* and *Suaeda maritima* and rather more *Spartina anglica* and *Tripolium panonnicum* than the account in BPC ideally suggests, perhaps stretching the definition of SM10 to its limits (e.g. Plates A2.1, C1.2).

We defer discussion of ‘SM12 Rayed *Aster tripolium* on saltmarshes’ to the section on NVC types characterised by glycophytes.

SM13-SM16 Middle-marsh Communities

Vegetation dominated by *Puccinellia maritima* is surprisingly uncommon throughout most of the survey area even though it is widespread as an occasional species in the middle marsh and locally contributes significantly to vegetation dominated by other species. It follows that stands belonging to the NVC type ‘SM13 *Puccinellia maritima* saltmarsh community’ are relatively uncommon despite being generally the commonest community of the middle marsh in other East-Anglian saltmarshes. However, in the D2 Mucking Flats and Marshes area there is a major exception to this picture, because there species-poor stands dominated by *Puccinellia maritima* form wide swathes of the seaward part of the middle marsh above the ‘SM11 *Aster tripolium* var. *discoideus* saltmarsh community’ zone (Plate D2.4). This vegetation belongs to the NVC type ‘SM13a *Puccinellia maritima* saltmarsh community, sub-community with *Puccinellia maritima* dominant’.

In the A2 Mucking Flats area a few *Puccinellia maritima* stands with abundant *Lysimachia maritima* are loosely referable to the NVC type ‘SM13b *Puccinellia maritima* saltmarsh community, *Glaux maritima* sub-community’ though they are probably not good examples. Being home to some glycophytes they almost better fit the description of ‘SM13d *Puccinellia maritima* saltmarsh community, *Plantago maritima-Armeria maritima* sub-community’ in BPC, but the absence of *Armeria maritima* militates against this conclusion. Also there may - in the few places where *Armeria maritima* and *Limonium vulgare* occur - be small remnants of old and now non-accreting saltmarsh belonging to the NVC type ‘SM13c *Puccinellia maritima* saltmarsh community, *Limonium vulgare-Armeria maritima* sub-community’ though mostly too small to map (Plates C1.10, F1.12). No stands belonging to the NVC types ‘SM13d *Puccinellia maritima* saltmarsh community, *Plantago maritima-Armeria maritima* sub-community’, ‘SM13e *Puccinellia maritima* saltmarsh community, *Puccinellia maritima*-turf fucoid sub-community’ or ‘SM13f *Puccinellia maritima* saltmarsh community, *Puccinellia maritima-Spartina maritima* sub-community’ were noted during the surveys, and there is no particular reason to expect their presence.

Otherwise SM13 undifferentiated has been rather widely recorded as a component in mosaics of middle-marsh vegetation where they probably represent points towards the SM13 end of transitions from other NVC types to SM13 types.

Throughout the survey area, most of the middle marsh is strongly dominated by *Atriplex portulacoides* and belongs to the NVC type 'SM14a *Halimione portulacoides* saltmarsh community, sub-community with *Halimione portulacoides* dominant' (e.g. Plates A1.8, C1.4, C1.6, D1.1, F1.3, F1.5) It tends to occupy the landward part of the marsh where it is often cut off by the seawall if upper marsh vegetation is lacking. The *Atriplex portulacoides* grows to a height of *c.*30-50 cm smothering other species among which *Puccinellia maritima* is usually present in small quantity. Otherwise the most widespread associates are *Plantago maritima* and *Triglochin maritimum* together with a scatter of low-marsh species especially *Tripolium panonnicum* var. *flosculosus*.

In the following section (on the use of quadrat data) we discuss in detail how the SM13, SM14 and SM16 communities have been dealt with. We simply note here that we have recognised and mapped stands where conspicuous amounts of an additional species differentiate stands that otherwise resemble SM14a. We have called these SM14Ap with *Atriplex prostrata*, SM14Ea with *Elymus athericus* (e.g. Plates A1.6, A1.7, A1.8, D2.1), SM14Jg with *Juncus gerardii* (e.g. Plates A1.4, A1.5, D2.3), SM14Jm with *Juncus maritimus* (Plate C1.5) and SM14Tp with *Tripolium panonnicum* var. *flosculosus* (e.g. Plates D2.6, F1.2). All of these are widespread throughout the survey area, though in any given place SM14Ea tends to occur towards the landward parts of the middle marsh while SM14Tp tends to occur towards seaward parts.

Juncus maritimus is widely scattered in species-poor vegetation dominated by *Atriplex portulacoides*. In BPC species-poor stands of SM14 with abundant *Juncus maritimus* and frequent *Plantago maritima* and *Triglochin maritimum* are assigned to the NVC type 'SM14b *Halimione portulacoides* saltmarsh community, *Juncus maritimus* sub-community' (Plate A1.2). It happens that *Plantago maritima* and *Triglochin maritimum* tend to be frequent throughout the SM14 of the survey area. The floristic table in BPC shows that the cover of *Juncus maritimus* in SM14b can be as low as *c.*5%, and on that basis a very few SM14 stands in the survey area have been mapped as SM14b, e.g. in the area C1 East of Enovert Landfill. Generally, however, *Juncus maritimus* seldom achieves cover exceeding Domin-scale 3 in the survey area and SM14b is scarce.

Where the cover of *Atriplex portulacoides* falls to 50% or less and *Puccinellia maritima* is abundant there are stands referable to the NVC type 'SM14c *Halimione portulacoides* saltmarsh community, *Puccinellia maritima* sub-community'. This too is widespread throughout the survey area though much less common than SM14a. In any given place it tends to occur towards the outer edge of the middle marsh (Plates A1.9, D2.4, D2.5).

No stands belonging to the NVC type 'SM15 *Juncus maritimus*-*Triglochin maritimum* saltmarsh community' were noted during the surveys, and the key species *Juncus maritimus* though present was never recorded as a dominant species (as in SM15). Judging from the account of SM15 in BPC there is no reason why it should not occur in the survey area, but dense stands of *Juncus maritimus* should be conspicuous, and nothing remotely resembling SM15 was seen.

The saltmarsh grass *Festuca rubra* ssp. *litoralis* is uncommon in the survey area but it does occur at modest levels of abundance in the A2 Mucking Spit and A3 Mucking Creek areas. Middle marsh vegetation in these areas mostly has *Puccinellia maritima* and *Atriplex portulacoides* at relatively high levels of abundance and even where *Festuca rubra* is present the stands look superficially like the prevalent SM13 and SM14 vegetation of the middle marsh throughout the survey area. But on closer examination the *Festuca rubra* is joined by scattered *Juncus gerardii* and *Lysimachia maritima* and this conjunction of species marks stands that can be assigned to the NVC type 'SM16a *Festuca rubra* saltmarsh community, *Puccinellia maritima* sub-community', which is the least species-rich of the SM16 sub-communities. Abundant *Puccinellia maritima* and constant

Triglochin maritimum in these stands is also consistent with SM16a (PlatesA3.3, A3.5). These stands lack high cover of *Atriplex portulacoides*, and where it increases the SM16a grades first into SM14c and ultimately into SM14a. All of the SM16 sub-communities are common on the western coasts of the UK and rare in the south-east according to BPC, but SM16a does occasionally occur there so that it is not surprising to find a little of it in parts of the survey area sheltered from the strong currents of the open reaches of the River Thames.

No stands belonging to the NVC type 'SM16b *Festuca rubra* saltmarsh community, sub-community with *Juncus gerardii* dominant' were noted during the surveys, even though this is the commonest form of SM16 in the south-east according to BPC. *Juncus gerardii* does) somewhat anomalously) occur in the middle marsh throughout the survey area, but it does not dominate anywhere in the intertidal zone. Small stands of SM16b dominated by *Juncus gerardi* would not be surprising in wet depressions in grassland behind the seawalls of the survey area, especially in the Coalhouse Fort area. None were seen in the surveys reported here, so they cannot be common, but it is possible that small stands were overlooked.

No stands of other SM16 sub-communities were noted during the surveys. They are mostly western in the UK and lacking or rare in the south-east. In the survey area it would be surprising to find 'SM16c *Festuca rubra* saltmarsh community, *Festuca rubra-Glaux maritima* sub-community', 'SM16d *Festuca rubra* saltmarsh community, sub-community with tall *Festuca rubra* dominant', or ''SM16f *Festuca rubra* saltmarsh community, *Carex flacca* sub-community'. The grassy sub-community 'SM16e *Festuca rubra* saltmarsh community, *Leontodon autumnalis* sub-community' is more characteristic of brackish grazing-marsh sites than intertidal saltmarsh sites of the kind prevailing in the survey area, but SM16e can occasionally occur in the south-east and stands could therefore be present in the North Thames area in places for which no access was requested (there being no matrix of SM-series vegetation to address). The grazing-marshes surrounding Tilbury Fort would be the most obvious place to look for it.

SM17-SM22 and SM24-SM26 Upper-marsh Communities

No stands belonging to the NVC type 'SM17 *Artemisia maritima* saltmarsh community' were noted during the surveys. A few plants of *Artemisia maritima* were recorded mostly among *Elymus athericus* swards on drift-lines at the base seawall, but they did not amount to stands of SM17. They were almost never associated with *Atriplex portulacoides* or *Festuca rubra* described as the usual associates of *Artemisia maritima* in the BPC account of SM17. The scarcity of *Artemisia maritima* in the survey area is surprising given how common it is in the upper zones of saltmarsh in north Essex and north Kent. It would not be surprising to find stands of SM17 in the survey area, and it is possible that small ones were overlooked, but none were seen and SM17 cannot be common in the survey area.

No stands belonging to the NVC type 'SM18 *Juncus maritimus* saltmarsh community' (including its three sub-communities) were noted during the surveys. *Juncus maritimus* is widely present in the survey area, but it was not seen as a dominant species anywhere, and neither was it seen growing in dense stands together with *Juncus gerardii* and an understorey of the glycophytes *Agrostis stolonifera* and *Festuca rubra* as described in the BPC account of SM18. According to BPC SM18 is mostly western in the UK and rare in the south-east where it may however occur on grazing-marshes. Small stands might occur in the North Thames area, but nothing like it was seen, and even if stands are present SM18 cannot be common in the survey area. A few plants of *Oenanthe lachenalii* were seen in SSSI Unit 1, and this is the key species for the NVC type 'SM18b *Juncus*

maritimus saltmarsh community, *Oenanthe lachenalii* sub-community' but the plants here were not associated with *Juncus maritimus* or any vegetation resembling SM18.

No stands belonging to the NVC types 'SM19 *Blysmus rufus* saltmarsh community' or 'SM20 *Eleocharis uniglumis* saltmarsh community' were noted during the surveys, and neither were the key species *Blysmus rufus* or *Eleocharis uniglumis* recorded anywhere. Both communities are of exclusively western distribution in UK saltmarshes according to BPC, and they would therefore be very surprising in the North Thames area.

No stands belonging to the NVC types 'SM21a *Suaeda vera-Limonium binervosum* saltmarsh community, typical sub-community', 'SM21b *Suaeda vera-Limonium binervosum* saltmarsh community, *Frankenia laevis* sub-community' or 'SM22 *Halimione portulacoides-Frankenia laevis* saltmarsh community' were noted during the surveys, and neither were the key species *Limonium binervosum* (agg.) or *Frankenia laevis* recorded anywhere. SM21 is a community of sandy saltmarshes in north Norfolk and Lincolnshire, while SM22 is confined to Sussex, and these communities would therefore be very surprising in the North Thames area.

Discussion of SM23 is deferred to the section dealing with SM-series communities dominated by glycophytes.

Overwhelmingly the most widespread and extensive upper-marsh community in the survey area is strongly dominated by *Elymus athericus* (e.g. Plates D1.1, D2.14, F1.1, F1.16). Stands belong to the NVC type 'SM24 *Elymus pycnanthus* saltmarsh community', which is at its most abundant in south-eastern England according to BPC, so that it is very much to be expected in the North Thames area. Often the *Elymus athericus* grows in a monoculture in the survey area, but there may be appreciable amounts of *Atriplex portulacoides* and *Beta vulgaris* ssp. *maritima* growing among it, and a wide range of semi-ruderal glycophyte species may occur in small quantity. SM24 may occupy wide swathes of the upper marsh and generally extends onto the foot of the seawall where vegetation that is clearly SM24 usually extends to a height of *c.*1m above the drift-line. Above that SM24 grades into maritime forms of 'MG1a *Arrhenatherum elatius* grassland, *Festuca rubra* sub-community' (or similar rough grasslands dominated by *Elymus repens*) that might deserve future recognition as a distinct sub-community of MG1 in the NVC system. In the survey area SM24 also often occurs on the middle marsh on slightly raised ground far away from the seawalls. In extensive middle-marsh stands of SM14 it seems that surface elevations of *c.*50 cm are sufficient to allow SM24 to replace SM14.

No stands belonging to the NVC type 'SM25 *Suaeda vera* drift-line community' were noted during the surveys, and neither was the key species *Suaeda vera* recorded anywhere. Since SM25 is a frequent drift-line community on north Essex seawalls around the Blackwater and Crouch estuaries, it is a little surprising that it seems to be absent from the North Thames area. However, *Suaeda vera* is a slow-growing perennial shrub, and may therefore tend to favour long-established and relatively undisturbed seawalls. If so, it may be that the seawalls of the survey area are either to recent in their construction or too disturbed by industrial activity to support it.

In the inner Thames estuary area (and beyond to the Swale in Kent and the Blackwater estuary in north Essex), *Limbarda crithmoides* is a frequent and even rather constant plant of seawalls and saltmarshes, albeit usually in small quantity. It is accordingly a frequent plant throughout the survey area and stands of vegetation that can be assigned to the NVC type 'SM26 *Inula crithmoides* on saltmarshes' are also therefore moderately common throughout. Although the

account of SM26 in BPC does not formally describe sub-communities, two are outlined in the floristic table, and both occur in the survey area.

One of the SM26 sub-communities occurs in a narrow strip marking the outer edge of the middle marsh below the prevalent 'SM14 *Halimione portulacoides* saltmarsh community' vegetation of the middle marsh together with 'SM13 *Puccinellia maritima* saltmarsh community' vegetation if it is extensive, and above the 'SM11 *Aster tripolium* var. *discoideus* saltmarsh community' zone in the upper part of the lower marsh. Thus 'SM26a *Inula crithmoides* on saltmarshes, stands with *Puccinellia maritima*, *Salicornia* agg. and *Limonium vulgare*' occurs at about the same place as stands of 'SM10 Transitional low-marsh vegetation with *Puccinellia maritima*, annual *Salicornia* species and *Suaeda maritima*' and confused transitions between middle marsh and lower marsh communities (e.g. Plates C1.4, C1.8, D4.1, F1.1, F2.6, F2.7). It often features frequent *Limbarda crithmoides* together with some *Atriplex portulacoides*, *Plantago maritima*, *Puccinellia maritima*, *Spartina anglica* and *Tripolium panonnicum* var. *flosculosus*. It is especially frequent where 19th Century rubbish tipping has left low banks of detritus at the outer edge of the marsh, e.g. in the area D1 East Tilbury marshes.

The other SM26 sub-community, i.e. 'SM26b *Inula crithmoides* on saltmarshes, stands with *Elymus pycnanthus*' occurs at the foot of the seawall in places where SM24 is transitional to SM14 so that *Elymus athericus* shares dominance with *Atriplex portulacoides* and other species including *Limbarda crithmoides* are frequent (e.g. Plates C1.6, C1.7, C1.12, F4.5, F4.6). It is less common in the survey area than SM26a but scattered throughout. Many SM26 stands in the survey area cannot be confidently assigned to either of these sub-communities, e.g. because they occupy depressions at the foot of the seawall where lower marsh species such as *Tripolium panonnicum* var. *flosculosus* are abundant. Many stands have therefore been mapped as SM26 undifferentiated.

S4 and S21 Swamp Communities

Pools in the upper marsh throughout the survey area are liable to contain fragmentary stands of swamp vegetation (e.g. Plates D2.2, F4.8). Where *Phragmites australis* is the dominant species, these belong to the NVC type 'S4 *Phragmites australis* swamp and reed-beds'. Usually they are monocultures that can be assigned to 'S4a *Phragmites australis* swamp and reed-beds, *Phragmites australis* sub-community' but in some places additional species such as *Atriplex prostrata*, *Puccinellia maritima* or *Triglochin maritimum* make it 'S4d *Phragmites australis* swamp and reed-beds, *Atriplex prostrata* sub-community'. No other S4 sub-communities were noted in saline habitats during the surveys. Some such as 'S4b *Phragmites australis* swamp and reed-beds, *Galium palustre* sub-community' may well occur in freshwater sites near the survey area, but they are not likely in saltmarsh sites within the remit of the surveys reported here.

S4a is the dominant and probably the only community occupying the extensive A2 Mucking Creek area to landward of the bridge on the coastal footpath (Plate A3.1). It tends to be embedded in scrub – mostly 'W21a *Crataegus monogyna-Hedera helix* scrub, *Hedera helix-Urtica dioica* sub-community' and 'W24a *Rubus fruticosus-Holcus lanatus* underscrub, *Cirsium arvense-Cirsium vulgare* sub-community' – on the surrounding higher ground. Traversing this area on foot would be not only difficult but hazardous, though survey by boat might be possible during the highs of spring tides. We cannot therefore rule out the presence of other S4 sub-communities, especially where W24a bramble scrub grades into S4 swamp through dense stands of scramblers such as *Calystegia sepium* ssp. *sepium* at the channel margin. There are also moderately extensive stands of S4a in shallow depressions in grassland in the D3 SSSI Unit 1 area (grading into species-rich

non-NVC rough grassland, W24a scrub and dubiously NVC willow scrub) and stands of both S4a and S4b in wet depressions and moats at Coalhouse Fort. Other stands of S4a or S4b occur along a ditch bordering the eastern side of the landfill site LTC4 and at Bill Meroy Creek east of Tilbury Fort.

Throughout the survey area, occasional stands of swamp dominated by *Bolboschoenus maritimus* belong to the NVC type 'S21a *Scirpus maritimus* swamp, sub-community dominated by *Scirpus maritimus'* or – where species such as *Atriplex prostrata* and *Triglochin maritimum* are present - 'S21b *Scirpus maritimus* swamp, *Atriplex prostrata* sub-community'. They are everywhere less common than stands of S4 in the survey area. They are nevertheless locally abundant in wet depressions and moat-edges at Coalhouse Fort and Tilbury Fort, and also occur in the D3 SSSI Unit 1 area where they may perhaps belong to the NVC type 'S21c *Scirpus maritimus* swamp, *Agrostis stolonifera* sub-community'.

SM12, SM23, SM27-28, MC6 and non-NVC Glycophyte Communities

At Tilbury Fort stands of similar vegetation at the foot of the seawall parapet beside the west gun line have abundant rayed *Tripolium panonnicum* var. *pannonicum* and clearly belong to the NVC type to 'SM12b Rayed *Aster tripolium* on saltmarshes, Inland stands of rayed *Aster tripolium*'. This NVC type only occurs very fragmentarily elsewhere in the survey area. The other sub-community 'SM12b Rayed *Aster tripolium* on saltmarshes, Coastal stands of rayed *Aster tripolium*' (which lacks the strong glycophyte element) was not encountered in the surveys.

Some vegetation on disturbed, damp and slightly saline soils – especially along trackways – behind the seawalls of the survey area may have loose affinities with the NVC type 'SM23 *Spergularia marina-Puccinellia distans* saltmarsh community'. Certainly some stands are as well assigned to SM23 as anything else if they contain *Spergularia marina*, but not *Spergularia media* and *Puccinellia distans* (but no other *Puccinellia* species) together with the grasses *Agrostis stolonifera*, diminutive *Elymus athericus* and *Lolium perenne* and such broad-leaved herbs tolerant of trampling as *Polygonum arenastrum* and *Plantago major* ssp. *major*. Some stands of this kind may contain small amounts of species of note including *Polypogon monspeliensis* and *Torilis nodosa* that are not listed in the floristic table for SM23 in BPC. These stands may occur anywhere along the coastal path, but they are commonest in the vicinity of Tilbury Fort, Coalhouse Fort and the new seawall between the A3 Mucking Spit area and the A1 London Gateway Port marsh area (Plates A1.12, A1.13).

Other non-NVC vegetation featuring *Spergularia marina* and having loose affinities with SM23 is widespread in the seawall habitat complex around the greater Thames estuary and the Hampshire Harbours area (Chichester Harbour to Southampton). Typically it occurs on disturbed, wet, and somewhat saline ground behind seawalls, most typically in rutted or hoof-poached depressions on seawall berms (between the landward slope and the borrow dyke on a typical seawall). Usually it has the annual glycophyte grass *Parapholis strigosa* together with *Spergularia marina* and various combinations of the uncommon grasses *Hordeum marinum*, *Puccinellia fasciculata* and *Puccinellia rupestris*. Also present may be *Bupleurum tenuissimum* (Plate F3.5) and *Trifolium squamosum*, and towards the edges of stands there is often *Agrostis stolonifera* and *Lotus tenuis*. Such vegetation used to be common on reclaimed land in the south-eastern areas discussed above (and extending to Great Yarmouth in the north and the Exe estuary in the south-west, but it has declined dramatically since the withdrawal of grazing from most seawalls around the 1990s. It is not noted as a proposed NVC type in Rodwell et al. (2000) but something very like it is described in *De Vegatatie van Nederland* (DVVN) - the Dutch equivalent of the NVC. There the combination of

Puccinellia distans ssp. *distans* and *Spergularia marina* defines a coenotaxon at the alliance level, namely the *Puccinellio-Spergularion salinae* alliance containing four associations as follows.

- The *Puccinellietum distantis* Feekes 1943 has the central features of the alliance. It is the commonest of the four associations in the Netherlands. It is probably equivalent to our SM23 except that DVVN recognises two sub-associations, a typical form and a *polygonetosum* rich in species such as *Polygonum arenastrum* and *Plantago major* ssp. *major* that are tolerant of trampling. It is possible that UK equivalents deserve future recognition in the NVC as sub-communities of SM23. Both types are likely to be present in the survey area (e.g. Plate A1.12).
- The *Puccinellietum fasciculatae* Beeftink 1965 has *Puccinellia fasciculata* as the character species. It is not described in the NVC but stands dominated by *Puccinellia fasciculata* certainly occur widely in the greater Thames estuary area. They occur locally in the survey area, e.g. in horse-trampled wet ground at Bill Meroy Creek (east of Tilbury Fort) and adjacent to moats in parkland at Coalhouse Fort. DVVN says that this association occurs in southern England. Such vegetation very probably deserves future recognition in the NVC, though whether it should be a separate community or a sub-community of SM23 or something else remains a matter for further study.
- The *Puccinellietum capillaris* Beeftink 1965 has *Puccinellia distans* ssp. *borealis* as the character species, and therefore has little relevance to the North Thames area.
- The *Parapholido strigosae-Hordeetum marini* Géhu et De Foucault 1978 has the character species *Hordeum marinum* (Plate D3.5) together with *Parapholis strigosa* (Plate D3.6). UK stands often have *Puccinellia fasciculata* (Plate D3.7) and *Puccinellia rupestris* (Plate D3.8) as well. Stands with abundant *Hordeum marinum* are not common in the survey area but there are some at Tilbury Fort (at the landward foot of the seawall parapet along the West Gun Line on the western approach to the Fort) and in grazing-marsh between the Fort and Bill Meroy Creek to the east. It also occurs fragmentarily at Coalhouse Fort. Again such vegetation very probably deserves future recognition in the NVC, though whether it should be a separate *Hordeum marinum-Parapholis strigosa* community or as a sub-community of SM23 or something else remains a matter for further study.

No stands belonging to the NVC type ‘SM27 Ephemeral saltmarsh vegetation with *Sagina maritima*’ were noted during the surveys, and neither was the key species *Sagina maritima* recorded anywhere, though it is inconspicuous and could have been missed. This vegetation normally occurs as fragmentary stands of ephemerals such as *Atriplex littoralis*, *Cochlearia danica* and *Plantago coronopus* and it may overlap the vegetation types discussed under SM23 above. It could occur in the survey area along path-sides and on waste ground, but nothing seen during the surveys really matched the admittedly very sketchy description in BPC where no floristic table is offered. In south Essex generally vegetation of this kind is probably now commonest along main roads owing to the influence of de-icing salt, and in that capacity, it could occur close to the survey area.

The coarse grass *Elymus repens* is abundant in the survey area both in typical form and in maritime forms – often glaucous – that are all too easily mistaken for *Elymus athericus* or the hybrid between the two. But it does not form the dense stands together with *Agrostis stolonifera* and *Atriplex prostrata* that characterise the exclusively northern NVC type ‘SM28 *Elymus repens* saltmarsh community’. No stands of SM28 were recorded during the surveys, and none are likely to occur in the North Thames area.

In some places there are assemblages consisting mainly of *Atriplex* species, especially *Atriplex prostrata* and *Atriplex littoralis*, together with *Beta vulgaris* ssp. *maritima* and other large

glycophyte ruderals such as *Rumex crispus*, *Sonchus arvensis* and *Tripleurospermum maritimum* (e.g. Plates D4.3, D4.4, D4.5). There is often a scatter of *Elymus athericus* as well. This vegetation best matches the NVC type 'MC6 *Atriplex prostrata-Beta vulgaris* ssp. *maritima* sea-bird cliff community', which - despite its placement in the maritime cliff MC-series of NVC communities - BPC allows as a strandline community on the soft coasts of south-eastern England. In the survey area it most conspicuously occurs at the eroding foot of the cliff formed by the edge of the landfill LTC4 south of Coalhouse Fort. No other vegetation other than patchy 'SM6 *Spartina anglica* saltmarsh community' occurs lower on this shore, and above it quickly grades into impenetrable tall-herb vegetation dominated by *Conium maculatum* and *Carduus tenuiflorus* together with *Rubus armeniacus* and *Rubus ulmifolius*. It also occurs in very similar situations at rubbish-cliffs in the A2 Mucking Creek and A3 Mucking Spit areas, and vegetation with *Atriplex littoralis* is frequent around Coalhouse Fort. Some of this may be non-NVC vegetation deserving of further research, but as the NVC stands there seems to be no better place to pigeonhole it for now than MC6.

Using Quadrat Data to Interpret the NVC Types

Throughout the survey area, the main lower marsh NVC types 'SM6 *Spartina anglica* saltmarsh community' and 'SM11 *Aster tripolium* var. *discoideus* saltmarsh community' were mostly monocultures of *Spartina anglica* and *Tripolium panonnicum* var. *flosculosus* respectively. These did not warrant any elucidation by means of quadrats. The two communities tended to be well demarcated, but where they meet one another there must be some intermediate vegetation containing both species.

Leaving aside moats drying out at Tilbury Fort in August to support extensive stands of late-developing 'SM9 *Suaeda maritima* saltmarsh community' and perhaps 'SM8 Annual *Salicornia* saltmarsh community', stands of SM8 and SM9 were so uncommon and fragmentary that they too were not significantly sampled by means of quadrats. Since the key species *Suaeda maritima* and the annual *Salicornia* species are recorded in the floristic tables in BPC from all lower and middle marsh NVC communities, it is not very clear whether any stands in the survey area really belong to SM8 or SM9 at all. But since stands with significant amounts of these key species are uncommon in the survey area, it seemed worthwhile to differentiate them in the NVC mapping, and potential stands of SM8 and SM9 were accordingly given the benefit of the doubt and mapped as such.

Where the upper limit of the 'SM11 *Aster tripolium* var. *discoideus* salt-marsh community' zone meets the middle marsh there is often confused and rather open vegetation (40-60% cover) in which the key SM8 and SM9 species, i.e. annual *Salicornia* species and *Suaeda maritima* may feature but only in small quantity. Also constant here there is *Puccinellia maritima* (Common Saltmarsh-grass) at less than 30% cover, together with variable amounts of *Plantago maritima*, *Spergularia media*, *Triglochin maritimum* and *Tripolium panonnicum* var. *flosculosus*, also more rarely *Cochlearia anglica*. Where *Puccinellia maritima* cover increases this grades into 'SM13a *Puccinellia maritima* salt-marsh community, sub-community with *Puccinellia maritima* dominant' but generally this vegetation is hard to handle using the published NVC types. Because the same few species appear in all of the possible NVC types, albeit in different amounts, there is often little to choose between calling this vegetation 'SM10 Transitional low-marsh vegetation with *Puccinellia maritima*, annual *Salicornia* species and *Suaeda maritima*', atypical 'SM13a *Puccinellia maritima* salt-marsh community, sub-community with *Puccinellia maritima* dominant' or SM13 undifferentiated, or a mosaic involving any or all of SM10, SM11 and SM13. Quadrat analysis in Appendix 1 fails to shed much light on the decisions here, or more correctly it demonstrates that there is no clearly correct decision, thereby justifying a pragmatic approach to assigning this vegetation to an NVC type. We have opted for SM10 where the vegetation is very open and mixed,

but we have leaned towards SM13a where *Puccinellia maritima* increases and it is informative to highlight the fact. Technically intermediate vegetation types involving SM8 and SM9 ought also to be options in the decisions, but we do not feel that it is helpful to posit transitions to NVC types that are not represented in any of the open intertidal marshes in the survey area.

The middle marshes are almost always unequivocally 'SM14 *Halimione portulacoides* salt-marsh community' in the survey area but stands with atypically large amounts of *Juncus gerardii* repeatedly caused consternation to surveyors in the field, and these stands have been heavily probed by quadrat sampling in Appendix 1. None of this probing justifies the idea that this vegetation is anything other than ordinary SM14 undifferentiated or 'SM14a *Halimione portulacoides* salt-marsh community, sub-community with *Halimione portulacoides* dominant'. As a precaution we have recognised and mapped a *Juncus gerardii* variant of SM14 for the purposes of this report. Similarly stands of SM14 with abundant *Elymus athericus* were probed by quadrat sampling. Here the seeming abundance of *Elymus athericus* was partly due to parallax, as flowering stems of *Elymus athericus* stick up above the *Atriplex portulacoides* canopy and look like a lot in side view even when cover is no more than *c.*5%. Again the quadrat analysis failed to support the idea that these stands are anything other than ordinary SM14 undifferentiated or SM14a. Again as a precaution we have recognised and mapped an *Elymus athericus* variant of SM14 for the purposes of this report. Though less conspicuously an issue in the field, we have probed SM14 stands with too much *Juncus maritimus* or *Tripolium panonnicum* var. *flosculosus* in Appendix 1, and we have recognised and mapped SM14 variants for these species. In the case of *Juncus maritimus* the quadrat analysis did show that a few stands could informatively be assigned to 'SM14b *Halimione portulacoides* salt-marsh community, *Juncus maritimus* sub-community'. And similarly the analysis of lower marsh stands with *Tripolium panonnicum* var. *flosculosus* and *Puccinellia maritima* showed that some stands could informatively be assigned to 'SM14c *Halimione portulacoides* salt-marsh community, *Puccinellia maritima* sub-community'.

The other area probed by quadrat sampling was around stands with *Limbarda crithmoides*. The analysis showed that many stands can informatively be assigned to 'SM26 *Inula crithmoides* on salt-marshes' but most are SM26 undifferentiated and usually there is little to choose between 'SM26a *Inula crithmoides* on salt-marshes, stands with *Puccinellia maritima*, *Salicornia* agg. and *Limonium vulgare*' and 'SM26b *Inula crithmoides* on salt-marshes, stands with *Elymus pycnanthus*' in the survey area. We have nevertheless sometimes mapped the sub-communities on the basis of their location at either the base of the seawall or the outer edge of the middle marsh, provided that the floristics give a degree of support to the differentiation.

Saltmarsh Compartment Descriptions

A1 London Gateway Port Marsh

Table A1. Areas (ha) of NVC types mapped in the saltmarsh compartment A1 (Figure 3a): columns 1 and 2 ordered by NVC-type name, columns 3 and 4 the same information ordered by area.

NVC type	Area (ha)	NVC type	Area (ha)
S4 undifferentiated	0.05	SM14a(50%) +SM14Jg(50%)	2.26

NVC type	Area (ha)	NVC type	Area (ha)
S4b	0.03	SM24	1.19
SM11	0.01	SM14Ea(50%) +SM24(50%)	0.87
SM13(50%) +SM14(50%)	0.61	SM14Jg	0.86
SM14(50%) +SM26(50%)	0.1	SM13(50%) +SM14(50%)	0.61
SM14a	0.1	SM26 undifferentiated	0.56
SM14a(50%) +SM14Jg(50%)	2.26	SM14Ea	0.37
SM14c	0.02	SM14(50%) +SM26(50%)	0.1
SM14Ea	0.37	SM14a	0.1
SM14Ea(50%) +SM24(50%)	0.87	W22	0.06
SM14Jg	0.86	S4 undifferentiated	0.05
SM24	1.19	S4b	0.03
SM26 undifferentiated	0.56	SM14c	0.02
MG1(50%) +SM24(50%)	0.02	MG1(50%) +SM24(50%)	0.02
W22	0.06	SM11	0.01
W23	0.01	W23	0.01

The A1 London Gateway Port Marsh area is a 7.11 ha triangle of marsh (*c.*500 m east-west and *c.*200 m north-south on its longest sides) protected by a remnant of seawall to the west. To the north operational railway runs immediately behind the seawall. See Plates A1.1 to A1.14.

It is mostly middle-marsh divided by several major creeks which branch to landward. There is little in the way of a stable mud-cliff at the outer edge, but the edge is nevertheless abrupt with a total of less than 0.6 ha of lower marsh communities forming narrow fringes locally – mostly 'SM6 *Spartina anglica* salt-marsh community' with a little 'SM11 *Aster tripolium* var. *discoideus* salt-marsh community'. Also towards the outer edge there is a scatter of 'SM13 *Puccinellia maritima* salt-marsh community' in the lower middle marsh though only in mosaic with other NVC types, and also a little 'SM14c *Halimione portulacoides* salt-marsh community, *Puccinellia maritima* sub-community', and again these total less than 0.6 ha. More interestingly, 'SM26 *Inula crithmoides* on salt-marshes' vegetation is especially well-developed in this compartment with a total area again

approaching 0.6 ha. So together the species-poor lower marsh and lower middle marsh NVC types account for only *c.*17% of this compartment, but SM26 with *Limbarda crithmoides* accounts for a further *c.*8%.

The greater part of the middle marsh is 'SM14 *Halimione portulacoides* salt-marsh community' vegetation dominated by *Atriplex portulacoides*. A lot is essentially 'SM14a *Halimione portulacoides* salt-marsh community, sub-community with *Halimione portulacoides* dominant' but *Juncus gerardii* is frequent throughout this compartment and a lot has been mapped as SM14Jg, i.e. our *Juncus gerardii* variant of SM14, or as mosaics of Sm14a and SM14 *Juncus gerardii*. In the lower part of the middle marsh appreciable amounts of SM14 have been mapped as mosaic with SM13, and in the upper part appreciable amounts have been mapped as mosaic with 'SM24 *Elymus pycnanthus* salt-marsh community' (0.87 ha of this 50:50 mosaic or *c.*12% of the total saltmarsh area) or as SM14Ea, i.e. our *Elymus athericus* variant of SM14. Taking all this into account SM14 vegetation of one kind or another accounts for *c.*4.25 ha or *c.*60% of this compartment. The SM14 vegetation is not species-rich, but it is rather constantly a modest range of associates that include *Elymus athericus*, *Plantago maritima*, *Puccinellia maritima*, *Suaeda maritima*, *Triglochin maritimum* and *Tripolium panonnicum* var. *flosculosus*. Other more occasional species including *Limbarda crithmoides* and *Cochlearia anglica* which is more common in this compartment than anywhere else in the survey area. Very small amounts of *Armeria maritima* and *Limonium vulgare* were recorded towards the eastern extreme of the marsh.

Species-poor upper marsh vegetation strongly dominated by *Elymus athericus* and referable to the NVC type 'SM24 *Elymus pycnanthus* salt-marsh community' occurs here not only to landward, but anywhere where the middle-marsh surface is elevated, seemingly by as little as *c.*0.5 m though we had no way of measuring this. SM24 in some form or other accounts for about 23% of this compartment.

Close to the seawall raised ground has tiny amounts of scrub belonging to the NVC types 'W22 *Prunus spinosa-Rubus fruticosus* scrub' and 'W23 *Ulex europaeus-Rubus fruticosus* scrub' while pools have scraps of reed-swamp belonging to the NVC types 'S4 *Phragmites australis* swamp and reed-beds'.

A2 Mucking Spit and Foreshores

Table A2. Areas (ha) of NVC types mapped in the saltmarsh compartment A2: columns 1 and 2 ordered by NVC-type name, columns 3 and 4 the same information ordered by area.

NVC type	Area (ha)	NVC type	Area (ha)
SM6	0.68	SM14Tp	1.03
SM8	0.01	SM14a(50%)+SM14Ea(50%)	0.74
SM10	0.12	SM6	0.68
SM11	0.2	SM24	0.46
SM13b/MC6	0.02	SM11	0.2
SM14a	0.04	SM10	0.12
SM14Tp	1.03	SM14a	0.04

SM14a(50%)+SM14Ea(50%)	0.74	SM13b/MC6	0.02
SM24	0.46	SM8	0.01

This compartment (Plates A2.1 to A2.7) has in total 3.31 ha of saltmarsh in narrow strips along the shore plus larger areas on the Thurrock Thameside Nature Park shore and at the base of Mucking Spit. Some of it has developed on geotextiles used to protect the spit from erosion following flooding of the managed retreat area to the east. Locally the area includes assemblages of saltmarsh plants that are less common in the survey area, especially *Lysimachia maritima* and glycophytes including *Polypogon monspeliensis*. It has been mapped as intermediate between 'SM13b *Puccinellia maritima* salt-marsh community, *Glaux maritima* sub-community' and 'MC6 *Atriplex prostrata-Beta vulgaris* ssp. *maritima* sea-bird cliff community' which conveys something of its character, but it is doubtfully NVC vegetation. This compartment is one of the few where tiny amounts of lower marsh were assigned to the NVC type 'SM8 Annual *Salicornia* salt-marsh community'.

Most of the lower marsh vegetation consists of *Spartina anglica* in monoculture referable to the NVC type 'SM6 *Spartina anglica* salt-marsh community'. At 0.68 ha this accounts for *c.*20% of the saltmarsh total in the compartment. The next most common lower marsh community is 'SM11 *Aster tripolium* var. *discoideus* salt-marsh community' and others are 'SM10 Transitional low-marsh vegetation with *Puccinellia maritima*, annual *Salicornia* species and *Suaeda maritima*' and 'SM8 Annual *Salicornia* salt-marsh community'. These bring the lower marsh total to *c.*30% of the total saltmarsh area in this compartment.

The middle marsh as usual is mostly dominated by *Atriplex portulacoides* and referable to the NVC type 'SM14 *Halimione portulacoides* salt-marsh community' Only 0.04 ha has been mapped as simple 'SM14a *Halimione portulacoides* salt-marsh community, sub-community with *Halimione portulacoides* dominant' but considerably more is mapped in 50:50 mosaic with variants of SM14. These are either SM14Tp, i.e. our *Tripolium panonnicum* var. *flosculosus* variant of SM14 in the lower part of the middle marsh, or SM14Ea, i.e. our *Elymus athericus* variant of SM14 in the upper part of the middle marsh. Together the various SM14 vegetation types account for 1.81 ha or *c.*55% of the total saltmarsh area in this compartment.

Species-poor upper marsh vegetation strongly dominated by *Elymus athericus* and referable to the NVC type 'SM24 *Elymus pycnanthus* salt-marsh community' occurs here mainly at the seawall or landward edge forming a wide swathe on the Thurrock Thameside Nature Park shore. SM24 accounts for 0.46 ha or *c.*14% of the total saltmarsh area in this compartment.

A3 Mucking Creek

Table A3. Areas (ha) of NVC types mapped in the saltmarsh compartment A3: columns 1 and 2 ordered by NVC-type name, columns 3 and 4 the same information ordered by area.

NVC type	Area (ha)	NVC type	Area (ha)
SM6	0.04	S4 undifferentiated	1.36
SM8	0.03	SM14Tp	1.03
SM11	0.12	SM14Ea	0.86
SM11(50%)+SM13a(50%)	0.09	SM24	0.86

NVC type	Area (ha)	NVC type	Area (ha)
SM11(50%)+SM14a(50%)	0.26	S4a(50%)+W24a(50%)	0.31
SM13a	0.03	SM11(50%)+SM14a(50%)	0.26
SM13b/MC6	0.02	SM11	0.12
SM14a	0.01	S4b	0.1
SM14Tp	1.03	SM11(50%)+SM13a(50%)	0.09
SM14Ea	0.86	SM6	0.04
SM14Ea(50%)+SM24(50%)	0.03	SM8	0.03
SM16a	0.02	SM13a	0.03
SM24	0.86	SM14Ea(50%)+SM24(50%)	0.03
SM26b	0.01	SM13b/MC6	0.02
S4 undifferentiated	1.36	SM16a	0.02
S4a(50%)+W24a(50%)	0.31	W24a	0.02
S4b	0.1	SM14a	0.01
W24a	0.02	SM26b	0.01

This compartment (Plates A3.1 to A3.7) has in total 3.45 ha of saltmarsh in the outer part of Mucking Creek and 1.77 ha or reed-swamp in the inland parts that were included in the compartment though there are large areas of the same further inland.

It was not possible to get close sight of much of the reed-swamp which has therefore been mapped as ‘S4 *Phragmites australis* swamp and reed-beds’ but it is mostly ‘S4a *Phragmites australis* swamp and reed-beds, *Phragmites australis* sub-community’ of which some has been mapped in mosaic with bramble scrub referable to the NVC type ‘W24a *Rubus fruticosus-Holcus lanatus* underscrub, *Cirsium arvense-Cirsium vulgare* sub-community’.

Lower marsh vegetation is mainly confined to the sides of the main channel where stands dominated by *Tripolium panonnicum* var. *flosculosus* and referable to the NVC type ‘SM11 *Aster tripolium* var. *discoideus* salt-marsh community’ are by far the commonest type. There are small amounts of ‘SM6 *Spartina anglica* salt-marsh community’, ‘SM8 Annual *Salicornia* salt-marsh

community' and 'SM13a *Puccinellia maritima* salt-marsh community, sub-community with *Puccinellia maritima* dominant' (mostly mapped in mosaic with SM11). Together these account for only 0.44 ha or *c.*13% of the total saltmarsh area (not counting reed-swamp) in this compartment.

The middle marsh as usual is mostly dominated by *Atriplex portulacoides* and referable to the NVC type 'SM14 *Halimione portulacoides* salt-marsh community' 1.3 ha has been mapped as 'SM14a *Halimione portulacoides* salt-marsh community, sub-community with *Halimione portulacoides* dominant' in 50:50 mosaic with SM11, and almost twice as much has been mapped as SM14 variants - either SM14Tp, i.e. our *Tripolium panonnicum* var. *flosculosus* variant of SM14 in the lower part of the middle marsh, or SM14Ea, i.e. our *Elymus athericus* variant of SM14 in the upper part of the middle marsh. Together the various SM14 types account for 2.95 ha or *c.*60% of the total saltmarsh area in this compartment.

Here the middle marsh also accounts for the only unequivocal examples of the NVC type 'SM16a *Festuca rubra* salt-marsh community, *Puccinellia maritima* sub-community' in the survey area, though only 0.02 ha were mapped as this.

C1 East of Enovert Landfill

Table C1. Areas (ha) of NVC types mapped in the saltmarsh compartment C1: columns 1 and 2 ordered by NVC-type name, columns 3 and 4 the same information ordered by area.

NVC type	Area (ha)	NVC type	Area (ha)
SM6	0.04	S4d	0.65
SM6(50%)+SM11(50%)	0.04	SM14a	0.42
SM11	0.21	SM24	0.32
SM13a	0.08	SM11	0.21
SM14 undifferentiated	0.18	SM14 undifferentiated	0.18
SM14a	0.42	SM14Jm	0.17
SM14Ea	0.05	SM13a	0.08
SM15Jg	0.01	SM14Ea	0.05
SM14Jm	0.17	SM6	0.04
SM24	0.32	SM6(50%)+SM11(50%)	0.04
SM24(50%)+SM14(50%)	0.02	SM26 undifferentiated	0.04
SM26 undifferentiated	0.04	SM26a	0.04
SM26a	0.04	SM24(50%)+SM14(50%)	0.02
S4d	0.65	SM14Jg	0.01
S21a	0.01	S21a	0.01

This compartment (Plates C1.1 to C1.12) has in total 1.63 ha of saltmarsh in a relatively narrow strip along the shore and 0.65 ha of reed-swamp.

Most of the lower marsh here is ‘SM11 *Aster tripolium* var. *discoideus* salt-marsh community’ though there are small amounts of ‘SM6 *Spartina anglica* salt-marsh community’ at the lowest levels and ‘SM13a *Puccinellia maritima* salt-marsh community, sub-community with *Puccinellia maritima* dominant’ in the transition from lower marsh to middle marsh. All lower marsh communities therefore account for 0.37 ha or *c.*23% of the total area of saltmarsh in this compartment.

As usual, species-poor ‘SM14a *Halimione portulacoides* salt-marsh community, sub-community with *Halimione portulacoides* dominant’ is the central NVC type of the middle marsh accounting for 0.42 ha, while a range of additional SM14 types account for a further 0.42 ha including including SM14 undifferentiated, SM14Ea, SM14Jg, i.e. our *Juncus gerardii* variant of SM14, SM14Jm, i.e. our *Juncus maritimus* variant of SM14, and SM14Ea, i.e. our *Elymus athericus* variant of SM14 in the upper part of the middle marsh, plus mosaics involving them. The SM14 types therefore account for *c.*52% of the total saltmarsh area in this compartment.

As usual, species-poor upper marsh vegetation here is dominated by *Elymus athericus* and referable to the NVC type ‘SM24 *Elymus pycnanthus* salt-marsh community’ of which 0.33 ha are mapped accounting for *c.*20% of the total saltmarsh area in the compartment. Miscellaneous communities such as ‘SM26 *Inula crithmoides* on salt-marshes’ in small quantity account for the rest of the saltmarsh area in this compartment.

D1 East Tilbury Marshes

Table D1. Areas (ha) of NVC types mapped in the saltmarsh compartment C1: columns 1 and 2 ordered by NVC-type name, columns 3 and 4 the same information ordered by area.

NVC type	Area (ha)	NVC type	Area (ha)
SM6	5.85	SM6	5.85
SM10	0.57	SM13a	5.28
SM11	3.19	SM11	3.19
SM13a	5.28	SM14a	2.47
SM13a(80%)+SM10(20%)	0.03	SM24	2.11
SM13(50%)+SM14(50%)	0.32	SM14a(50%)+SM14Ea(50%)	1.15
SM14Ea(50%)+SM13a(50%)	0.1	MG1/MG6	1.05
SM14a	2.47	SM10	0.57
SM14c	0.06	SM14(70%)+SM14Jg(30%)	0.55
SM14Ea	0.26	SM13(50%)+SM14(50%)	0.32
SM14Jg	0.14	SM14Ea	0.26
SM14Jm	0.03	SM14Jg	0.14
SM14Tp	0.05	SM14Ea(50%)+SM13a(50%)	0.1
SM14(70%)+SM14Jg(30%)	0.55	SM26b	0.09
SM14a(50%)+SM14Ea(50%)	1.15	SM14c	0.06
SM24	2.11	W24	0.06
SM26b	0.09	SM14Tp	0.05
S4b	0.01	SM13a(80%)+SM10(20%)	0.03
MG1/MG6	1.05	SM14Jm	0.03
W24	0.06	S4b	0.01

This compartment (Plates D1.1 to D1.2) has in total 22.24 ha of saltmarsh (discounting areas mapped as MG1/MG6, S4 and W24) in a shoreline strip of very variable width which locally reaches as much as *c.*150 m.

The lower marsh communities ‘SM6 *Spartina anglica* salt-marsh community’ and ‘SM11 *Aster tripolium* var. *discoideus* salt-marsh community’ form wide belts at the outer edge of the marsh.

They are near monocultures of *Spartina anglica* and *Tripolium panonnicum* var. *flosculosus* respectively and account for 5.85 ha and 3.19 ha respectively; together they therefore account for *c.*41% of the total saltmarsh area in this compartment.

A little higher on the shore confused vegetation with some *Spartina anglica* and *Tripolium panonnicum* var. *flosculosus* plus additional species including *Puccinellia maritima* are referable to the NVC types 'SM10 Transitional low-marsh vegetation with *Puccinellia maritima*, annual *Salicornia* species and *Suaeda maritima*' and 'SM13 *Puccinellia maritima* salt-marsh community' – mostly 'SM13a *Puccinellia maritima* salt-marsh community, sub-community with *Puccinellia maritima* dominant'. These cover the transition zone from lower marsh to middle marsh and form mosaics with middle-marsh NVC types. Together they cover *c.*6.09 ha accounting for *c.*27% of the total area of saltmarsh in the compartment.

In the middle marsh the vegetation is mostly species-poor and strongly dominated by *Atriplex portulacoides* so that it belongs to the NVC type SM14a of which 2.47 ha are mapped, while diverse variants and mosaics account for another 1.87 ha including SM14 undifferentiated, SM14Tp, i.e. our *Tripolium panonnicum* var. *flosculosus* variant of SM14, SM14Ea, SM14Jg, i.e. our *Juncus gerardii* variant of SM14, SM14Jm, i.e. our *Juncus maritimus* variant of SM14, and SM14Ea, i.e. our *Elymus athericus* variant of SM14 in the upper part of the middle marsh, plus mosaics involving them. Overall therefore SM14 NVC types account for *c.*4.34 ha or *c.*19% of the total area of saltmarsh in the compartment.

As usual, species-poor upper marsh vegetation here is dominated by *Elymus athericus* and referable to the NVC type 'SM24 *Elymus pycnanthus* salt-marsh community' of which 2.11 ha are mapped accounting for only *c.*9% of the total saltmarsh area in the compartment. Miscellaneous communities such as 'SM26 *Inula crithmoides* on salt-marshes' in small quantity account for the rest of the saltmarsh area in this compartment.

D2 Mucking Flats Marshes

Table D2. Areas (ha) of NVC types mapped in the saltmarsh compartment D2: columns 1 and 2 ordered by NVC-type name, columns 3 and 4 the same information ordered by area.

NVC type	Area (ha)	NVC type	Area (ha)
SM6	5.91	SM24	11.23
SM6(50%)+SM11(50%)	0.02	SM6	5.91
SM10(50%)+SM11(50%)	0.4	SM13a	5.32
SM10(50%)+SM13a(50%)	1.04	SM11	3.16
SM11	3.16	SM13a(50%)+SM14a(50%)	2.59

NVC type	Area (ha)	NVC type	Area (ha)
SM11(70%)+SM10(30%)	0.75	MG1/MG6	1.05
SM13a	5.32	SM10(50%)+SM 13a(50%)	1.04
SM13a(50%)+SM14a(50%)	2.59	SM14a	0.93
SM13Ap(50%)+SM14(50%)	0.15	SM14Jg	0.89
SM14(50%)+SM24(50%)	0.19	SM11(70%)+SM 10(30%)	0.75
SM14(60%)+SM24(40%)	0.28	SM10(50%)+SM 11(50%)	0.4
SM14(80%)+SM24(20%)	0.02	SM14c	0.4
SM14a	0.93	SM24(50%)+SM 14Ea(50%)	0.29
SM14c	0.4	SM14(60%)+SM 24(40%)	0.28
SM14Ea	0.26	SM14Ea	0.26
SM14Jg	0.89	MG1	0.2
SM24	11.23	SM14(50%)+SM 24(50%)	0.19
SM24(50%)+SM14Ea(50%)	0.29	SM13Ap(50%)+ SM14(50%)	0.15
SM26 undifferentiated	0.01	S21b	0.07
S21b	0.07	S4d	0.03

NVC type	Area (ha)	NVC type	Area (ha)
S4d	0.03	SM6(50%)+SM11(50%)	0.02
MG1	0.2	SM14(80%)+SM24(20%)	0.02
MG1/MG6	1.05	SM26 undifferentiated	0.01

This compartment (Plates D2.1 to D2.14) has in total 33.84 ha of saltmarsh (discounting areas mapped as beach S4, S21, MG1 and MG1/MG6) in a wide shoreline strip outside SSSI Unit 1; over the greater part of its length it has a width of at least *c.*150 m.

The lower marsh communities 'SM6 *Spartina anglica* salt-marsh community' and 'SM11 *Aster tripolium* var. *discoideus* salt-marsh community' form wide belts at the outer edge of the marsh. They are mostly near monocultures of *Spartina anglica* and *Tripolium panonnicum* var. *flosculosus* respectively and – including small amounts mapped as mosaics – they account for 5.92 ha and 3.19 ha respectively; together they therefore account for *c.*27% of the total saltmarsh area in this compartment, which is however very large – this is almost five times the total area of the C1 saltmarshes.

A little higher on the shore confused vegetation with some *Spartina anglica* and *Tripolium panonnicum* var. *flosculosus* plus additional species including *Puccinellia maritima* is referable to the NVC types 'SM10 Transitional low-marsh vegetation with *Puccinellia maritima*, annual *Salicornia* species and *Suaeda maritima*' while here there are extensive swards dominated by *Puccinellia maritima* – generally a very common thing on south-eastern saltmarshes but less so in the North Thames area - and these belong to 'SM13 *Puccinellia maritima* salt-marsh community' – mostly 'SM13a *Puccinellia maritima* salt-marsh community, sub-community with *Puccinellia maritima* dominant'. These communities cover what is here a wide transition zone from lower marsh to middle marsh forming mosaics with middle-marsh NVC types in places. Together they cover *c.*7.97 ha accounting for *c.*23% of the total area of saltmarsh in the compartment.

As *Puccinellia* lawns are more extensive in the middle marsh here (as compared with elsewhere in the survey area), so vegetation dominated by *Atriplex portulacoides* and referable to the NVC type 'SM14 *Halimione portulacoides* salt-marsh community' is less extensive than usual. All SM14 types account for only *c.*3.56 ha or 11% of the total area of saltmarsh in this compartment, including SM14 undifferentiated, 'SM14a *Halimione portulacoides* salt-marsh community, sub-community with *Halimione portulacoides* dominant', 'SM14c *Halimione portulacoides* salt-marsh community, *Puccinellia maritima* sub-community', SM14Jg, i.e. our *Juncus gerardii* variant of SM14, and SM14Ea, i.e. our *Elymus athericus* variant of SM14 in the upper part of the middle marsh, plus mosaics involving all of these and other NVC communities.

Species-poor upper-marsh vegetation strongly dominated by *Elymus athericus* and referable to the NVC type 'SM24 *Elymus pycnanthus* salt-marsh community' forms an exceptionally wide belt close to the seawall in this compartment. Including small amounts mapped as mosaics, SM24 accounts for 11.48 ha or 34% of the total area of saltmarsh in this compartment. In additional, small amounts of mesotrophic 'MG1 *Arrhenatherum elatius* grassland' were mapped on raised ground at the

seawall edge of the site, and small amounts of 'S4 *Phragmites australis* swamp and reed-beds' and 'S21 *Scirpus maritimus* swamp' swamp vegetation were mapped in pools.

D3 SSSI Unit 1 and Coalhouse Fort

Table D3. Areas (ha) of NVC types mapped in the saltmarsh compartment D3: columns 1 and 2 ordered by NVC-type name, columns 3 and 4 the same information ordered by area.

NVC type	Area (ha)	NVC type	Area (ha)
Ex SM23	0.17	SM13a(50%)+SM14a(50%)	2.1
MG1	0.15	SM24	1.44
MG1(50%)+S4(50%)	0.9	MG1(90%)+SM24(10%)	1.03
MG1(70%)+S4(30%)	0.21	SM13a	0.29
MG1(90%)+SM24(10%)	1.03	SM14(50%)+SM24(50%)	0.23
S21a	0.11	MG1(70%)+S4(30%)	0.21
SM13a	0.29	Ex SM23	0.17
SM13a(50%)+SM14a(50%)	2.1	MG1	0.15
SM14(50%)+SM24(50%)	0.23	S21a	0.11
SM24	1.44	MG1(50%)+S4(50%)	0.9
SM24(50%)+MG1(50%)	0.94	SM24(50%)+MG1(50%)	0.94

This compartment (Plates D3.1 to D3.10) has in total *c.*4.8 ha of SM-series saltmarsh communities in a relatively narrow strip along the shore towards its southern end. The inland parts of the compartment at Coalhouse Fort Park and SSSI Unit 1 have fragmentary stands of glycophyte vegetation embedded in terrestrial vegetation, but there are no extensive stands of saltmarsh vegetation as such.

This compartment has only negligible amounts of lower marsh vegetation in patches below the minimum size for mapping. There are likely to be small amounts of 'SM6 *Spartina anglica* salt-marsh community' and 'SM11 *Aster tripolium* var. *discoideus* salt-marsh community' at the top of the intertidal mud along the shore.

In the middle marsh 'SM13a *Puccinellia maritima* salt-marsh community, sub-community with *Puccinellia maritima* dominant' accounts for 1.34 ha or 28% of the total area of the saltmarsh in the compartment. Rather less abundant are 'SM14 *Halimione portulacoides* salt-marsh community'

communities, mainly SM14 undifferentiated and ‘SM14a *Halimione portulacoides* salt-marsh community, sub-community with *Halimione portulacoides* dominant’. They account for 1.16 ha or 24% of the total area of the saltmarsh in the compartment.

Species-poor upper marsh vegetation dominated by *Elymus athericus* and referable to the NVC type ‘SM24 *Elymus pycnanthus* salt-marsh community’ is more extensive and as mapped it accounts for 2.13 ha or 44% of the total area of the saltmarsh in the compartment. This may be an over-estimate since the SM24 grades into mesotrophic ‘MG1a *Arrhenatherum elatius* grassland, *Festuca rubra* sub-community’ and it is hard to know whether the *Elytrigia* in such situations is *Elymus athericus* or maritime forms of *Elymus repens* (i.e. not SM24). Extensive stands of this confusing grassland south of Coalhouse Fort have glycophye swamps with *Bolboschoenus maritimus* referable to the NVC type ‘S21a *Scirpus maritimus* swamp, sub-community dominated by *Scirpus maritimus’*, and species of note including abundant *Carex divisa*. Along the edges of trampled paths and heavily visited moat edges abutted by the amenity turf of the park there are assemblages of glycophytes including the annual grasses *Hordeum marinum*, *Parapholis strigosa*, *Polypogon monspeliensis*, *Puccinellia distans* ssp. *distans*, *Puccinellia fasciculata* and *Puccinellia rupestris* together with such glycophytes as *Spergularia marina* and plts tolerant of trampling such as *Polygonum arenastrum*. A few plants of *Bupleurum tenuissimum* were seen. This vegetation has been mapped as ‘ex SM23’ because it had affinities with ‘SM23 *Spergularia marina-Puccinellia distans* salt-marsh community’ but clearly is not simply that. This *Puccinellio-Spergularion salinae* alliance vegetation has already been discussed.

In SSSI Unit 1 there was a question as to whether saltmarsh vegetation of any kind might yet survive in shallow but wet depressions, especially in the northern part. However, no convincing saltmarsh vegetation was found. There are extensive stands of ‘S4a *Phragmites australis* swamp and reed-beds, *Phragmites australis* sub-community’ and some ‘S21a *Scirpus maritimus* swamp, sub-community dominated by *Scirpus maritimus’*. These are suggestive of very slight salinity, but they are embedded in rough mesotrophic grassland, bramble scrub and willow scrub – much of it dominated by impenetrable tangles of *Vicia villosa* to a height of *c.*1.5 m – and none of this shows any tendency towards saltmarsh vegetation or even to favouring glycophyte species.

D4 LTC4 / DHL Foreshore

Table D4. Areas (ha) of NVC types mapped in the saltmarsh compartment D4: columns 1 and 2 ordered by NVC-type name, columns 3 and 4 the same information ordered by area.

NVC type	Area (ha)	NVC type	Area (ha)
SM14a	0.09	S4	0.78
SM24	0.03	SM14a	0.09
SM26	0.02	SM24	0.03
S4	0.78	SM26	0.02
Ex SM23 not mapped	-	Ex SM23 not mapped	-
MC6 no mapped	-	MC6 no mapped	-

This compartment (Plates D4.1 to D4.5) has in total *c.*0.14 ha of SM-series saltmarsh communities in a short stretch of shore at the south-eastern corner of the DHL-owned landfill site LTC4 as indicated in the table. The southern edge of the arable field to the east has in recent years been disturbed by sea wall repairs (acting as the access track from a compound at the south-eastern corner of DHL / LTC4) and now has ephemeral vegetation in which *Polypogon monspeliensis* is prominent. This again is *Puccinellio-Spergularion salinae* alliance vegetation.

The eroding cliff at the southern edge of DHL / LTC4 stands above a non-vegetated beach in the intertidal zone. Non-NVC tall herb vegetation dominated by *Carduus tenuiflorus, Conium maculatum*, *Rapistrum rugosum* and *Rubus fruticosus* agg. on the cliff has loose affinities with the NVC community 'OV25 *Urtica dioica-Cirsium arvense* community' and several thistly brownfield communities proposed in Rodwell et al. (2000), but does not obviously conform to any of them. At its foot there are assemblages of glycophyte 'chenopods' including *Atriplex littoralis*, *Atriplex portulacoides*, *Atriplex prostrata*, *Beta vulgaris* ssp. *maritima* and *Suaeda maritima* that are loosely referable to the NVC type 'MC6 *Atriplex prostrata-Beta vulgaris* ssp. *maritima* sea-bird cliff community' already discussed in this report. Rare species recorded here in the past including *Chenopodium vulvaria* and *Marrubium vulgare* were not found in 2024.

F1 Tilbury Power Station Foreshore

Table F1. Areas (ha) of NVC types mapped in the saltmarsh compartment F1: columns 1 and 2 ordered by NVC-type name, columns 3 and 4 the same information ordered by area.

NVC type	Area (ha)	NVC type	Area (ha)
SM6	0.09	SM14a	1.42
SM11	0.28	SM14a(70%)+SM14(30%)	0.39
SM13	0.27	SM11	0.28
SM13(60%)+SM14c(40%)	0.12	SM13	0.27
SM14 undifferentiated	0.06	SM14(50%)+SM13(50%)	0.17
SM14(50%)+SM13(50%)	0.17	SM13(60%)+SM14c(40%)	0.12
SM14a	1.42	SM6	0.09
SM14a(70%)+SM14(30%)	0.39	SM14 undifferentiated	0.06
SM24	0.8	SM26a	0.06
SM26a	0.06	S4	0.05
S4	0.05	SM24	0.8

This compartment (Plates F1.1 to F1.18) has in total 3.64 ha of saltmarsh (discounting areas mapped as beach S4) in a long but narrow shoreline strip with industrial sites to landward.

There is some ‘SM6 *Spartina anglica* salt-marsh community’ but the lower marsh vegetation is mostly ‘SM11 *Aster tripolium* var. *discoideus* salt-marsh community’. The two communities account for 0.37 ha or *c.*10% of the total area of saltmarsh in this compartment. Vegetation dominated by *Puccinellia maritima* at the transition from lower marsh to middle marsh vegetation is mostly ‘SM13 *Puccinellia maritima* salt-marsh community’ undifferentiated and accounts for 0.41 ha or *c.*11% of the total area of saltmarsh in this compartment.

Most of the middle marsh is species-poor vegetation dominated by *Atriplex portulacoides* and referable to the NVC type ‘SM14a *Halimione portulacoides* salt-marsh community, sub-community with *Halimione portulacoides* dominant’ though small amounts have been mapped as SM14 undifferentiated or ‘SM14c *Halimione portulacoides* salt-marsh community, *Puccinellia maritima* sub-community’. All types of SM14 (including mosaics) account for 1.91 ha or *c.*51% of the total area of saltmarsh in this compartment.

Species-poor upper marsh vegetation dominated by *Elymus athericus* and referable to the NVC type ‘SM24 *Elymus pycnanthus* salt-marsh community’ accounts for 0.80 ha or *c.*22% of the total area of saltmarsh in this compartment.

F2 Bill Meroy Creek

Table F2. Areas (ha) of NVC types mapped in the saltmarsh compartment F2: columns 1 and 2 ordered by NVC-type name, columns 3 and 4 the same information ordered by area.

NVC type	Area (ha)	NVC type	Area (ha)
SM6	0.21	SM14a	0.49
SM10	0.02	SM24	0.46
SM11	0.16	SM6	0.21
SM13a	0.02	SM11	0.16
SM14a	0.49	SM24(90%)+SM26(10%)	0.05
SM24	0.46	W24(70%)+W21(30%)	0.04
SM24(90%)+SM26(10%)	0.05	SM10	0.02
SM26 undifferentiated	0.01	SM13a	0.02
W24(70%)+W21(30%)	0.04	SM26 undifferentiated	0.01

This compartment (Plates F2.1 to F2.12) has in total 1.42 ha of saltmarsh (discounting areas mapped as W21 or W24 in a bay at the mouth of Bill Meroy Creek.

As usual the lower marsh vegetation was mainly ‘SM6 *Spartina anglica* salt-marsh community’ and ‘SM11 *Aster tripolium* var. *discoideus* salt-marsh community’ together accounting for 0.37 ha or *c.*26% of the total area of saltmarsh in this compartment. The transition from lower marsh to middle marsh vegetation has only small amounts of ‘SM10 Transitional low-marsh vegetation with *Puccinellia maritima*, annual *Salicornia* species and *Suaeda maritima*’ and ‘SM13a *Puccinellia maritima* salt-marsh community, sub-community with *Puccinellia maritima* dominant’ together accounting for 0.04 ha or *c.*3% of the total area of saltmarsh in this compartment.

The middle marsh has only species-poor vegetation strongly dominated by *Atriplex portulacoides* and referable to the NVC type ‘SM14a *Halimione portulacoides* salt-marsh community, sub-community with *Halimione portulacoides* dominant’ accounting for 0.49 ha or *c.*35% of the total area of saltmarsh in this compartment.

The upper marsh has species-poor vegetation strongly dominated by *Elymus athericus* and referable to the NVC type ‘SM24 *Elymus pycnanthus* salt-marsh community’ together with small amounts of more species-rich ‘SM26 *Inula crithmoides* on salt-marshes’ undifferentiated. Together they account for 0.52 ha or *c.*37% of the total area of saltmarsh in this compartment.

F3 Tilbury Fort

Table F3. Areas (ha) of NVC types mapped in the saltmarsh compartment F3: columns 1 and 2 ordered by NVC-type name, columns 3 and 4 the same information ordered by area.

NVC type	Area (ha)	NVC type	Area (ha)
SM9	0.71	SM9	0.71
SM9(50%)+SM10(50%)	0.63	SM9(50%)+SM10(50%)	0.63
SM12	0.01	SM12	0.01

This compartment (Plates F3.1 to F3.5) has in total 1.35 ha of saltmarsh vegetation, much of which is unusual in being highly seasonal. The moat east of the fort contained aquatic vegetation dominated by *Ranunculus baudotii* in June 2023. But by mid-August it had dried out and open vegetation dominated by ephemeral halophytes had germinated and developed. It mostly consisted of *Suaeda maritima* and was therefore referable to the NVC type ‘SM9 *Suaeda maritima* salt-marsh community’ but there were annual *Salicornia* species and it is possible that there may have been patches referable to the NVC type ‘SM8 Annual *Salicornia* salt-marsh community’. Another water body west of the fort had similar but more mixed vegetation that probably included *Puccinellia maritima* (binocular survey only). This may be a tidal or at least a controlled water body with less seasonal vegetation. It probably contains ‘SM8 Annual *Salicornia* salt-marsh community’, ‘SM9 *Suaeda maritima* salt-marsh community’, ‘SM10 Transitional low-marsh vegetation with *Puccinellia maritima*, annual *Salicornia* species and *Suaeda maritima*’ and perhaps ‘SM11 *Aster tripolium* var. *discoideus* salt-marsh community’ in mosaic and transition.

The landward foot of the seawall parapet along the southern side of the West Gun Line (Pattison 2004) between the Water Gate to the fort and the (former) World’s End public house has patches of non-NVC vegetation dominated by fine stands of *Hordeum marinum* and *Parapholis strigosa*. This again is *Puccinellio-Spergularion salinae* alliance vegetation, in this case probably the *Parapholido strigosae-Hordeetum marinae* association of DVVN. There is also rather similar

glycophyte vegetation dominated by rayed *Tripolium panonnicum* var. *pannonicum* that is clearly referable to the NVC type 'SM12b Rayed *Aster tripolium* on salt-marshes, Inland stands of rayed *Aster tripolium*'.

Other stands of *Puccinellio-Spergularion salinae* alliance vegetation occur in the pristine grazing-marsh surrounding the fort, where they depend on the trampling of wet ground by horses. Generally the area supports extensive stands of the proposed *Hordeum secalinum* sub-community of 'MG6 *Lolium perenne-Cynosurus cristatus* grassland' (or possibly a similar south-eastern sub-community) with abundant *Ranunculus sardous* and other characteristic species including *Bupleurum tenuissimum*, *Lepidium latifolium*, *Lotus tenuis*, *Sison segetum* and *Torilis nodosa.* Wherever there are low earthworks in this sward, and especially along the Covered Way between the Inner Moat and the Outer Moat *Hordeum marinum* is abundant and there are transitions from MG6-*Hordeum secalinum* to the *Parapholido strigosae-Hordeetum marinae*. Wetter trampled soils in the moats and especially along Bill Meroy Creek have stands of different *Puccinellio-Spergularion salinae* alliance vegetation variously dominated by *Puccinellia distans* ssp. *distans*, *Puccinellia fasciculata* and *Puccinellia rupestris* typically with chenopods such as *Atriplex prostrata*.

F4 Tilbury Cruise Terminal

Table F4. Areas (ha) of NVC types mapped in the saltmarsh compartment F4: columns 1 and 2 ordered by NVC-type name, columns 3 and 4 the same information ordered by area.

NVC type	Area (ha)	NVC type	Area (ha)
SM6	0.11	SM14a	0.22
SM6(50%)+SM10(50%)	0.05	SM24	0.22
SM11(50%)+SM26a(50%)	0.06	SM6	0.11
SM14a	0.22	SM11(50%)+SM26a(50%)	0.06
SM24	0.22	SM6(50%)+SM10(50%)	0.05
SM24(50%)+MC6(50%)	0.02	SM24(50%)+MC6(50%)	0.02
SM24(50%)+W21(50%)	0.01	SM26 undifferentiated	0.02
SM26 undifferentiated	0.02	SM26b	0.02
SM26a	0.01	SM26b(50%)+SM24(50%)	0.02

SM26b	0.02	SM24(50%)+W21(50%)	0.01
SM26b(50%)+SM24(50%)	0.02	SM26a	0.01

This compartment (Plates F4.1 to F4.10) has in total *c.*0.76 ha of disturbed saltmarsh vegetation at rather high level on a beach occupying a short, sheltered stretch of foreshore set back from the stretches on either side.

Lower marsh vegetation is mostly ‘SM6 *Spartina anglica* salt-marsh community’ with just a little ‘SM10 Transitional low-marsh vegetation with *Puccinellia maritima*, annual *Salicornia* species and *Suaeda maritima*’ and ‘SM11 *Aster tripolium* var. *discoideus* salt-marsh community’. Together these account for 0.19 ha or *c.*25% of the total area of saltmarsh in this compartment.

Middle marsh vegetation is confined to species-poor ‘SM14a *Halimione portulacoides* salt-marsh community, sub-community with *Halimione portulacoides* dominant’ accounting for 0.22 ha or *c.*29% of the total area of saltmarsh in this compartment.

Upper marsh vegetation is mostly species-poor or in some places semi-ruderal ‘SM24 *Elymus pycnanthus* salt-marsh community’ e.g. with *Lepidium draba*, but there are small amounts of more species-rich vegetation with *Limbarda crithmoides*. Together these account for *c.*0.32 ha or *c.*42% of the total area of saltmarsh in this compartment.

Conclusions

Saltmarsh Characteristics in the Survey Area

Extent

In total the survey area contains *c.*90 ha of vegetation that would conventionally be regarded as belonging to intertidal saltmarsh communities mostly in the SM-series. Exact totals will depend on how glycophyte community types outside the SM-series are counted (e.g. 'S4 *Phragmites australis* swamp and reed-beds', 'S21 *Scirpus maritimus* swamp' 'SM12b Rayed *Aster tripolium* on salt-marshes, Inland stands of rayed *Aster tripolium*' and stands in the *Puccinellio-Spergularion salinae* alliance) and on how fragments of terrestrial vegetation located in the intertidal zone are counted (e.g. 'W21 *Crataegus monogyna-Hedera helix* scrub', 'W24 *Rubus fruticosus-Holcus lanatus* underscrub' and 'MG1 *Arrhenatherum elatius* grassland'), but with the possible exception of S4 the total amounts of such marginal communities are very small, and will not significantly affect the overall total area of SM-series vegetation. Given defined criteria, exact areas for different sets of NVC types can be extracted from the GIS product upon which this report is based.

Around 65% (*c.*58.6 ha) of the saltmarsh vegetation in the survey area lies within just 2.5 km of the North Thames shoreline in the Lower Hope Reach, i.e. within the D1 East Tilbury Marshes and D2 Mucking Flats Marshes areas. Here the accreting saltmarsh extends out from the line of the seawalls and into the channel of the river to a distance of *c.*150 m over long stretches. Though of great extent this is relatively species-poor saltmarsh vegetation confined to the core NVC types of the survey area. The other 35% is scattered in thin strips and a few larger local concentrations (as at the A1 London Gateway Port Marsh area and the A1/A2 Mucking Creek areas) over a total distance of *c.*8.3 km along the shoreline. There are large saltmarsh gaps in areas such as that to the west of the DHL / LTC4 landfill site. In these stretches, much of the saltmarsh is remnant middle and upper marsh in narrow strips with relatively small proportions of lower marsh NVC types. Though of lesser extent the more unusual saltmarsh types of the survey area are here, especially the bulk of the 'SM26 *Inula crithmoides* on salt-marshes'.

Morphology

From this snapshot we are unable to comment on whether saltmarsh in the survey area is being lost to erosion. But we can be confident that saltmarsh is accreting in the Lower Hope Reach, presumably because tidal flows have shifted towards the Kent shore. It has been plausibly suggested that this followed upon the relatively recent inwalling and infilling of the SSSI Unit 1 polder, but we do not have published references to support this or permission to present the idea as an attributed personal communication.

The inner estuary location of the survey area means that the saltmarshes do not have to withstand energy inputs from wave action (as marshes on the Dengie coast to the north do for example). But they do have to withstand energy inputs from the tidal prism, though on the open river frontage these are unlikely to be magnified by resonance effects (as happens in many North Essex saltmarshes, e.g. at Tollesbury). They must also withstand energy inputs from the flow of the river. Judging from the creek-system theory set out by Pethick (1992), the minimal creek systems here suggest that the saltmarshes are comfortably at equilibrium with these energy inputs. Some

creeks, e.g. those at the A1 London Gateway Port Marsh, branch to dissipate tidal energy, but they still stop before the reaching the seawall, and no convoluted creeks (as at Tollesbury in Essex) were seen. At the upper edge of the saltmarsh in 2024, we saw no sign of the creek-head erosion pools that were a common sight in the 1980s when saltmarsh loss in Essex was rapid.

In the narrow strips of remnant middle and upper marsh, ongoing disturbance and historical topography (banks often less than 0.5 m high from remains of jetties, wharves, paths, gun platforms, rubbish tips, buildings etc.) are probably important factors in determining the exact shapes of the present-day marsh fragments.

The Core NVC Types of the Survey Area

The spectrum of saltmarsh NVC types in the survey area is quintessentially that of non-barrier saltmarsh systems[2] on muddy substrates in south-eastern England. As such it features abundant 'SM11 *Aster tripolium* var. *discoideus* salt-marsh community' in the lower marsh, abundant 'SM14 *Halimione portulacoides* salt-marsh community' in the middle marsh, and abundant 'SM24 *Elymus pycnanthus* salt-marsh community' in the upper marsh (Rodwell 2000). Conversely 'SM16 *Festuca rubra* salt-marsh community' – commonly the dominant NVC type in western UK saltmarsh systems – is rare, as are other NVC types headquartered in or confined to the west, e.g. 'SM19 *Blysmus rufus* salt-marsh community' and 'SM20 *Eleocharis uniglumis* salt-marsh community'. Also missing are south-eastern saltmarsh communities typical of sandy saltmarshes mostly in Norfolk, e.g. 'SM21a *Suaeda vera-Limonium binervosum* salt-marsh community, typical sub-community' and 'SM21b *Suaeda vera-Limonium binervosum* salt-marsh community, *Frankenia laevis* sub-community'.

On intertidal mud at the very lowest levels for saltmarsh vegetation, the main NVC type throughout the survey area is 'SM6 *Spartina anglica* salt-marsh community' consisting of *Spartina anglica* in monoculture or nearly so. This is widespread and not especially distinctive of saltmarshes in any given geographical area. Immediately above it in the saltmarsh zonation there is 'SM11 *Aster tripolium* var. *discoideus* salt-marsh community', which is more typically south-eastern. In the Lower Hope Reach these two communities form bands clearly distinguishable at distances of a kilometre or so, so that they are landscape features rather than cryptic phytosociological detail.

Over much of the UK and even in some parts of the south-eastern sector, e.g. the north Norfolk saltmarshes, the usual lower marsh communities are 'SM8 Annual *Salicornia* salt-marsh community' and 'SM9 *Suaeda maritima* salt-marsh community' but these are rare in the survey area being found mostly in pools in the upper marsh or brackish water bodies inland (as at Tilbury Fort), perhaps because that is the only place where they are protected from the incessant currents of the River Thames.

Above the SM11 zone there tends to be confused vegetation with small amounts of annual *Salicornia* species and *Suaeda maritima* (despite the absence of SM8 and SM9) together with scattered *Puccinellia maritima*, *Tripolium panonnicum* var. *flosculosus* and *Plantago maritima*. Where the cover of *Puccinellia maritima* is low it is referable to the NVC type 'SM10 Transitional

[2] Open to the sea being unprotected by fringing sand dunes, shingle bars, spits etc.

low-marsh vegetation with *Puccinellia maritima*, annual *Salicornia* species and *Suaeda maritima*' and where it is higher it grades into 'SM13a *Puccinellia maritima* salt-marsh community, sub-community with *Puccinellia maritima* dominant' which is generally of small extent in the survey area but locally extensive in the Lower Hope Reach D1 and D2 areas.

Above that the middle marsh throughout the survey area is dominated by *Atriplex portulacoides* and referable to the NVC type 'SM14 *Halimione portulacoides* salt-marsh community'. Where it is species-poor, as it often is, this is the 'SM14a *Halimione portulacoides* salt-marsh community, sub-community with *Halimione portulacoides* dominant' but small amounts of 'SM14b *Halimione portulacoides* salt-marsh community, *Juncus maritimus* sub-community' and 'SM14c *Halimione portulacoides* salt-marsh community, *Puccinellia maritima* sub-community' have been mapped, and four variants have been mapped for the purposes of this report with *Tripolium panonnicum* var. *flosculosus* in the lower marsh, with *Juncus gerardii* or *Juncus maritimus* in the middle marsh, and with *Elymus athericus* in the upper marsh. We strongly doubt that these local quirks in species occurrence warrant general recognition in the NVC, but we nevertheless felt it important to map them lest they turn out to be embryonic states of distinct NVC types that might become better differentiated as the saltmarshes of the survey area develop.

The upper marsh is dominated by species-poor stands of *Elymus athericus* referable to the NVC type 'SM24 *Elymus pycnanthus* salt-marsh community' and this too is characteristic of saltmarsh systems in south-eastern England. On the seawalls this grades into more species-rich vegetation having affinities with 'MG1 *Arrhenatherum elatius* grassland' though it is probably distinctive enough to warrant further investigation as a potential new NVC type. Typically it has an understorey of small dicotyledonous herbs, especially *Geranium dissectum*, *Medicago arabica* and *Torilis nodosa*, in a sward of *Arrhenatherum elatius*, *Elymus athericus* and maritime forms of *Elymus repens* together with larger and mostly glycophyte ruderals including *Beta vulgaris* ssp. *maritima*, *Carduus tenuiflorus*, *Lepidium draba*, and *Tragopogon porrifolius* among others.

A special feature of the survey area is the abundance of *Limbarda crithmoides* in amounts sufficient to recognise the NVC type 'SM26 *Inula crithmoides* on salt-marshes' in both its lower and upper marsh forms, i.e. 'SM26a *Inula crithmoides* on salt-marshes, stands with *Puccinellia maritima*, *Salicornia* agg. and *Limonium vulgare*' and 'SM26b *Inula crithmoides* on salt-marshes, stands with *Elymus pycnanthus*' though many stands are SM26 undifferentiated. SM26 is least abundant in the Lower Hope Reach D1 and D2 areas, but very frequent elsewhere within the survey area.

In Mucking Creek, some middle marsh stands have rather less *Atriplex portulacoides* than usual and they have *Festuca rubra* and *Juncus gerardii* in varying abundance, and *Lysimachia maritima* as an extra species. This is the closest the vegetation of the survey area comes to the western 'SM16 *Festuca rubra* salt-marsh community'. It is 'SM16a *Festuca rubra* salt-marsh community, *Puccinellia maritima* sub-community' which Rodwell (2000) identifies as the intermediate between typical SM16 and south-eastern SM14.

In other places we have discussed grazing-marsh vegetation at Tilbury Fort and stands of ephemeral glycophyte vegetation belonging to the *Puccinellio-Spergularion salinae* alliance of DVVN. Floristically these are especially diverse and unusual.

Species of Note

No exceptionally uncommon species were recorded from the inter-tidal saltmarshes of the survey area. Species of modest note in Essex – judging from the county Floras (Gibson 1862, Jermyn 1974) - are *Artemisia maritima* (Sea Wormwood), *Cochlearia anglica* (English Scurvygrass), *Limbarda crithmoides* (Golden-samphire), *Limonium* x *neumanni* (a hybrid Sea-lavender) and *Lysimachia maritima* (Sea-milkwort). There is also some potential for the following species even though they were not seen in the 2023 surveys.

- *Likely* – it would perhaps be surprising if the survey area did not contain at least a few plants of *Limonium humile* (Lax-flowered Sea-lavender), *Sarcocornia perennis* (Perennial Glasswort) and perhaps some of the less ubiquitous annual *Salicornia* species, e.g. *S. fragilis* (Yellow Glasswort).
- *Possible* – though they could truly be absent, it would not be surprising to find *Spartina maritima* (Small Cord-grass), *Spartina* × *townsendii* (Townsend's Cord-grass) or *Suaeda vera* (Shrubby Sea-blite).
- *Unlikely* – there is just a remote possibility that *Atriplex pedunculata* (Pedunculate Sea-purslane) could be overlooked in the survey area, especially as it requires autumn survey.

Among glycophytes behind the seawall there are several species of note including the England Red List VU (vulnerable) *Bupleurum tenuissimum* (Slender Hare's-ear) and *Hordeum marinum* (Sea Barley) and the England Red List NT (near-threatened) *Puccinellia fasciculata* (Borrer's Saltmarsh-grass) – see Stroh et al. (2014), all of which are at both Tilbury Fort and Coalhouse Fort. On the outer side of the seawall west of the A1 London Gateway Port Marsh area there was X *Agropogon lutosus* (Hybrid Beard-grass) with both parents (*Agrostis stolonifera* and *Polypogon monspeliensis*). Similar species of more modest note at these sites and elsewhere are *Apera spica-venti* (Loose Silky-bent), *Carduus tenuiflorus* (Slender Thistle), *Carex divisa* (Divided Sedge) *Lepidium latifolium* (Dittander), *Lathyrus nissolia* (Grass Vetchling) in natural populations[3], *Lotus tenuis* (Narrow-leaved Bird's-foot-trefoil), *Oxybasis chenopodioides* (Saltmarsh Goosefoot) which we were shown at Coalhouse Fort by the Park warden Ray Reeves, *Polypogon monspeliensis* (Annual Beard-grass), *Puccinellia rupestris* (Stiff Saltmarsh-grass), *Ranunculus baudotii* (Brackish Water-crowfoot), *Ranunculus sardous* (Hairy Buttercup), *Sison segetum* (Corn Parsley),*Silybum marianum* (Milk-thistle) and *Trifolium squamosum* (Sea Clover).

The scarce plants of Tilbury Fort are discussed in greater detail in Carter & RSK (2023).

In SSSI Unit 1 there is species-rich calcicolous but semi-ruderal grassland of extremely obscure NVC status. In places the orchids *Anacamptis pyramidalis* (Pyramidal Orchid) and *Dactylorhiza fuchsii* (Common Spotted-orchid) are hugely abundant together with other calcicolous species such as *Blackstonia perfoliata* (Yellow-wort). It is hard to see how these could have been artificially

[3] The UK distribution of this species used to be headquartered on seawalls and reclaimed land in south-eastern England, but it is now widespread owing to its frequent and ongoing inclusion in wild-flower seed mixtures. Also – and perhaps more significantly – it was somehow included as a major constituent in grass mixtures for use on new major roads around the 1970s and for many years there were huge populations on the M5 motorway in Gloucestershire, on the A46 around Coventry, and elsewhere.

introduced, but the presence of *Rhinanthus minor* does suggest interventions with a wild-flower seed mixture. Other species of note in the Essex content here include *Oenanthe lachenalii* (Parsley Water-dropwort). There are plausible reports of *Bupleurum tenuissimum* (Slender Hare's-ear) and *Medicago polymorpha* (Toothed Medick).

Conservation Significance of Saltmarshes of the Survey Area

For the moment leaving aside the *Puccinellio-Spergularion salinae* alliance of DVVN in sites behind the seawall, the intertidal saltmarsh NVC communities of the survey area have nature conservation value in the following respects.

- Their size – this satisfies criteria for nature conservation evaluation in relation to various kinds of designated sites etc.
- The way in which they exemplify the typical NVC spectrum of south-eastern UK saltmarshes on open coasts and muddy substrates.
- The exceptionally high incidence of 'SM26 *Inula crithmoides* on salt-marshes' which is locally frequent in the inner Thames estuary area, but less common across the rest of the greater Thames estuary area, and much less common elsewhere in the UK, i.e. it is not uncommon in the general vicinity of the survey area, but more generally it is uncommon, and it needs conserving here because this is where it is headquartered.
- The very high incidence of accreting marsh in an area where historically there has been alarming saltmarsh loss, especially around the 1980s (Doody 1992, Hughes and Paramor 2004).
- The occasional hints of transition to western SM16 saltmarsh.

In short, the saltmarshes of the survey area provide a large resource of vegetation types that are typical of and in a significant degree special to the inner Thames estuary, and more generally to the greater Thames estuary area.

In addition the grazing-marsh and seawall habitat complex at Tilbury Fort represent a splendid resource of uncommon plant species and distinctive vegetation types virtually all of which are inadequately covered in the NVC. These species and vegetation types – originally brought to attention by Gray (1977) - have declined catastrophically in the greater Thames estuary where historically they reached their optimum, the decline being largely due to the removal of grazing from seawalls especially and many grazing-marsh sites as well, though other lesser factors have doubtless played a part. The fact that the vegetation is not recognised in the NVC must have contributed to its undervaluation, since it is hard to write a conservation agenda for something that doesn't officially exist. It does not help that conserving the grazing-marsh plants and vegetation types runs counter to a strong agenda of managed retreat. The importance of the Tilbury Fort grazing-marshes has been discussed at greater length in Carter & RSK (2023).

References

Carey, A.E. & Oliver, F.W. (1918). *Tidal Lands: A Study of Shore Problems*. Blackie, London.

Carter, R.N. & RSK Biocensus (2024). *Notable Plant Species at Three Sites in the North Thames Estuary & Marshes Area.* Natural England Commissioned Report.

Chatters, C. (2017). *Saltmarsh*. British Wildlife Collection 5. Bloomsbury, London.

Doody, J.P. (1992). The conservation of British saltmarshes. In J.R.L Allen & K. Pye (Eds.), *Saltmarshes: Morphodynamics, Conservation and Engineering Significance*, Pp. 80-114. Cambridge University Press, Cambridge.

Gibson, G.S. 1862. *The Flora of Essex*. William Pamplin, London.

Gray, A.J. (1977). Reclaimed land. In R.S.K. Barnes (Ed.), *The Coastline,* Pp. 253-270. Wiley, Chichester,

Gray, A.J. (1992). Saltmarsh plant ecology: zonation and succession revisited. In In J.R.L Allen & K. Pye (Eds.), *Saltmarshes: Morphodynamics, Conservation and Engineering Significance*, Pp. 63-79. Cambridge University Press, Cambridge.

Grieve, H. (1959). *The Great Tide: The Story of the 1953 Flood Disaster in Essex.* County Council of Essex, Chelmsford.

Hill, M.O., Blackstock, T.H., Long, D.G. & Rothero, G.P. 2008. *A Checklist and Census Catalogue of British and Irish Bryophytes*. British Bryological Society, Middlewich.

Hughes, R.G. & Paramor, O.A.L. (2004). On the loss of saltmarshes in south-east England and methods for their restoration. *Journal of Applied Ecology*, **41**, 440-448.

Jermyn, S.T. 1974. *Flora of Essex*. Essex Naturalist's Trust Limited, Colchester.

Malloch, A.J.C. 1999. Vespan III. *A Computer Package to Handle and Analyse Multivariate and Species Data for WINDOWS NT and WINDOWS 95*. University of Lancaster, Lancaster.

Pattison, P. (2004). *Tilbury Fort*. English Heritage, London.

Pethick, J.S. (1992). Saltmarsh geomorphology. In In J.R.L Allen & K. Pye (Eds.), *Saltmarshes: Morphodynamics, Conservation and Engineering Significance*, Pp. 41-62. Cambridge University Press, Cambridge.

Rodwell, J.S. 1991. *British Plant Communities 1: Woodlands and Scrub.* Cambridge University Press, Cambridge.

Rodwell, J.S. 1992. *British Plant Communities 3: Grasslands and Montane Communities*. Cambridge University Press, Cambridge.

Rodwell, J.S. 1995. *British Plant Communities 4: Aquatic Communities, Swamps and Tall-herb Fens*. Cambridge University Press, Cambridge.

Rodwell, J.S. 2000. *British Plant Communities 5: Maritime Communities and Vegetation of Open Habitats*. Cambridge University Press. Cambridge.

Rodwell, J.S. 2006. *National Vegetation Classification: User's Handbook*. Joint Nature Conservation Committee, Peterborough.

Rodwell, J.S., Dring, J.C., Averis, A.B.G., Proctor, M.C.F., Malloch, A.J.C., Schaminee, J.H.J. & Dargie, T.C.D. 2000. *Review of Coverage of the National Vegetation Classification*. Joint Nature Conservation Committee, Peterborough.

Schaminée, J.H.J, Weeda, E.J. & Westhoff 1998. *De Vegetatie van Nederland, Deel 4: Plantengemeenschappen van de kust en van binnenlandse pioniermilieus.* Opulus Press, Uppsala.

Shennan, I. (1989). Holocene crustal movements and sea-level changes in Great Britain. *Journal of Quaternary Science*, **4**, 77-89.

Stace, C.A. (2022). *Concise Flora of the British Isles*. C & M Floristics, Middlewood Green.

Steers, J.A. (1981). Essex and Lancashire. In *Coastal Features of England and Wales*, Pp. 89-106. Oleander Press, Cambridge.

Stroh, P.A., Leach, S.J., August, T.A., Walker, K.J., Pearman, D.A., Rumsey, F.J., Harrower, C.A., Fay, M.F., Martin, J.P., Pankhurst, T., Preston, C.D. & Taylor, I. 2014. *A Vascular Plant Red List for England*. Botanical Society of Britain and Ireland, Bristol.

Waite, S. (1998). The Thames Estuary saltmarsh plant and seagrass communities. In Atrill, M.J. (Ed.), *A Rehabilitated Estuarine Ecosystem*, Pp. 169-188. Kluwer, London.

Appendix 1 – Quadrat Data

Quadrat Tables (Sets of 5 Quadrats in Homogeneous Vegetation)

Quadrat Table A1.1 – SM14Jg. Two-metre square quadrats recorded in middle marsh at the A1 London Gateway Port Marsh area on 30 June 2023.

Species name	Q1	Q2	Q3	Q4	Q5	Freq.	Cover
Atriplex portulacoides	7	9	9	8	9	V	07-Sep
Juncus gerardii	8	1	5	4	5	V	01-Aug
Tripolium panonnicum	2	2	4	3	4	V	02-Apr
Puccinellia maritima	3	3	1	4	1	V	01-Apr
Elymus athericus	3	1	5	-	5	IV	01-May
Juncus maritimus	-	4	-	-	-	I	4
Plantago maritima	-	-	-	2	-	I	2
Suaeda maritima	-	-	1	-	-	I	1
Triglochin maritimum	-	1	-	-	-	I	1
Bare ground	0	0	0	0	0	-	-
Algal mat	0	0	0	0	0	-	-
Sward height (cm)	25	25	25	25	25	-	-
Easting	70306	70306	70307	70308	70309	-	-
Northing	81283	81287	81295	81300	81304	-	-

Matching coefficients. SM14 undifferentiated 60.6, SM14a 59.1, SM25 55.2, SM14c 53.7, SM11 52.4, SM14b 49.5, SM24 48.5, SM7 47.2, SM13f 44.1, SM26b 41.9

Diagnosis. The dominance of *Atriplex portulacoides* ensures that this vegetation must be 'SM14 *Halimione portulacoides* saltmarsh community'. Constant *Puccinellia maritima* at low levels of cover are entirely consistent with 'SM14a *Halimione portulacoides* saltmarsh community, sub-community with *Halimione portulacoides* dominant' but constant *Elymus athericus*, *Juncus gerardii* and *Tripolium panonnicum* at moderate to high levels of cover are not. For that reason SM14 undifferentiated is a preferable conclusion, as suggested by the highest matching coefficient. The small amounts of *Elymus athericus* and *Tripolium panonnicum* might suggest transition to upper marsh in the first case, and lower marsh in the second, cancelling one another out. These species are probably a distinctive feature of the SM14 marsh in this locality (Parcel 1), but they are not significantly outside the expected range of SM14 floristic composition. On the other hand, the abundance of *Juncus gerardii* – which motivated the selection of these quadrat locations – might suggest transition towards 'SM16a *Festuca rubra* saltmarsh community, *Puccinellia maritima* sub-community'; but it is the only species to do so, and in the absence of such SM16 character species as *Agrostis stolonifera*, *Festuca rubra* and *Lysimachia maritima* these quadrats doubtfully support the idea of transition to SM16. The fact that SM16 does not appear among the top ten matching coefficients while several instantly dismissible matches do (e.g. 'SM7 *Arthrocnemum perenne* stands', 'SM11 *Aster tripolium* var. *discoideus* saltmarsh community' and 'SM26 *Inula crithmoides* on saltmarshes') confirms that there is no significant degree of transition towards SM16 in these quadrats. However, since *Juncus gerardii* is distinctive here (i.e. in saltmarsh Parcel 1) there may be a case for this NVC study of the North Thames saltmarshes to recognise and map a *Juncus gerardii* variant of SM14 undifferentiated.

Quadrat Table A1.2 – SM14Jg. Two-metre square quadrats recorded in middle marsh at the A1 London Gateway Port Marsh area on 30 June 2023.

Species name	Q1	Q2	Q3	Q4	Q5	Freq.	Cover
Atriplex portulacoides	8	8	8	9	9	V	08-Sep
Juncus gerardii	7	8	7	3	4	V	03-Aug
Puccinellia maritima	4	4	5	5	5	V	04-May
Tripolium panonnicum	3	4	4	3	4	V	03-Apr
Elymus athericus	3	-	-	1	-	II	01-Mar
Limbarda crithmoides	-	-	-	-	1	I	1
Triglochin maritimum	-	-	1	-	-	I	1
Bare ground	0	0	0	0	0	-	-
Algal mat	0	0	0	0	0	-	-
Sward height (cm)	26	26	26	26	26	-	-
Easting	70424	70431	70439	70446	70456	-	-
Northing	81383	81381	81378	81376	81375	-	-

Matching coefficients. SM14a 60.0, SM14 undifferentiated 57.4, SM11 49.5, SM14c 47.5, SM7 47.0, SM25 undifferentiated 44.5, SM13f 43.7, SM14b 43.1, SM10 40.5, SM26 37.0

Diagnosis. The diagnosis for Quadrat Table 1.1 applies equally here in virtually every detail, except that *Elymus athericus* is less abundant and there is a trace of *Limbarda crithmoides* accounting for a very low matching coefficient with 'SM26 *Inula crithmoides* on saltmarshes' undifferentiated. These quadrats can be regarded as a possible *Juncus gerardii* variant of 'SM14 *Halimione portulacoides* saltmarsh community' undifferentiated.

Quadrat Table A1.3 – SM14Jg-SM14a. Two-metre square quadrats recorded in middle marsh at the A1 London Gateway Port Marsh area on 30 June 2023.

Species name	Q1	Q2	Q3	Q4	Q5	Freq.	Cover
Atriplex portulacoides	8	8	9	8	10	V	08-Oct
Puccinellia maritima	2	3	5	3	5	V	03-May
Juncus gerardii	7	8	6	7	-	IV	06-Aug
Elymus athericus	5	4	4	3	-	IV	03-May
Tripolium panonnicum	2	3	1	2	-	IV	01-Mar
Bare ground	0	0	0	0	0	-	-
Algal mat	0	0	0	0	0	-	-
Sward height (cm)	18	18	20	16	18	-	-
Easting	7030	7029	7030	7031	7031	-	-
Northing	8135	8136	8137	8136	8134	-	-

Matching coefficients. SM14a 55.2, SM14 undifferentiated 52.3, SM25 undifferentiated 51.6, SM7 48.8, SM24 48.0, SM11 47.3, SM14c 45.5, SM26b 44.3, SM13f 41.7, SM14b 41.0

Diagnosis. The diagnosis for Quadrat Table 1.1 applies equally here in virtually every detail, except that *Atriplex portulacoides* is more abundant making 'SM14a *Halimione portulacoides* saltmarsh community, sub-community with *Halimione portulacoides* dominant' a more plausible conclusion. These quadrats can be regarded as a possible *Juncus gerardii* variant of 'SM14 *Halimione portulacoides* saltmarsh community' embedded in vegetation that is mainly SM14a.

Quadrat Table A1.4 – SM14Jg. Two-metre square quadrats recorded in middle marsh at the A1 London Gateway Port Marsh area on 30 June 2023.

Species name	Q1	Q2	Q3	Q4	Q5	Freq.	Cover
Juncus gerardii	9	10	9	8	7	V	07-Oct
Atriplex portulacoides	4	5	4	4	5	V	04-May
Puccinellia maritima	3	2	3	3	4	V	02-Apr
Tripolium panonnicum	2	4	3	3	4	V	02-Apr
Juncus maritimus	4	-	2	2	5	IV	02-May
Limbarda crithmoides	-	1	-	5	3	III	01-May
Suaeda maritima	1	-	-	-	1	II	1
Plantago maritima	-	-	-	3	-	I	3
Elymus athericus	-	-	-	-	1	I	1
Tripleurospermum maritimum	-	-	1	-	-	I	1
Bare ground	0	0	0	0	0	-	-
Algal mat	0	0	0	0	0	-	-
Sward height (cm)	20	15	15	15	25	-	-
Easting	7034	7033	7035	7034	7034	-	-
Northing	8130	8136	8137	8135	8134	-	-

Matching coefficients. SM14 undifferentiated 58.9, SM14a 58.3, SM11 52.3, SM14c 50.3, SM14b 49.5, SM7 47.4, SM26 undifferentiated 44.5, SM26a 44.3, SM25 undifferentiated 41.0, SM13f 41.5

Diagnosis. The abundance of *Juncus gerardii* in this vegetation suggests that this it ought to be some form of 'SM16 *Festuca rubra* saltmarsh community', but in the absence of *Festuca rubra* and *Lysimachia maritima* SM16 does not appear among the matching coefficients. The constant *Atriplex portulacoides* is nowhere near sufficiently dominant for 'SM14a *Halimione portulacoides* saltmarsh community, sub-community with *Halimione portulacoides* dominant' while *Puccinellia maritima* though constant has very low cover making 'SM14c *Halimione portulacoides* saltmarsh community, *Puccinellia maritima* sub-community' seem unsatisfactory, especially in the presence of so much *Juncus gerardii*. Similarly there is not enough *Juncus maritimus* for 'SM14b *Halimione portulacoides* saltmarsh community, *Juncus maritimus* sub-community' nor enough *Limbarda crithmoides* for 'SM26 *Inula crithmoides* on saltmarshes'. This stand is therefore – as suggested by the top matching coefficient - best assigned to an atypical variant of SM14 undifferentiated distinguished by an unusual abundance of *Juncus gerardii*.

Quadrat Table A3.1. SM16a. Two-metre square quadrats recorded in creek-head marsh at the A3 Mucking Creek area on 26 June 2023.

Species name	Q1	Q2	Q3	Q4	Q5	Freq.	Cover
Juncus gerardii	9	7	9	8	8	V	07-Sep
Triglochin maritimum	2	3	5	4	5	V	02-May
Atriplex portulacoides	3	2	3	4	3	V	02-Apr
Puccinellia maritima	4	2	3	1	1	V	01-Apr
Lysimachia maritima	-	8	1	6	7	IV	01-Aug
Festuca rubra	-	6	2	4	4	IV	02-Jun
Tripolium panonnicum	2	2	3	-	3	IV	02-Mar
Plantago maritima	1	1	-	2	2	IV	01-Feb
Parapholis strigosa	4	3	3	-	-	III	03-Apr
Spergularia media	-	1	1	-	2	III	01-Feb
Juncus maritimus	-	-	2	4	-	II	02-Apr
Suaeda maritima	-	1	-	-	2	II	01-Feb
Elymus athericus	-	-	-	4	-	I	4
Bare ground	0	0	0	0	0	-	-
Algal mat	0	0	0	0	0	-	-
Sward height (cm)	22	29	26	22	24	-	-
Easting	6921	6920	6921	6926	6930	-	-
Northing	8076	8077	8078	8078	8081	-	-

Matching coefficients. SM16a 62.9, SM17 56.9, SM13c 55.2, SM13d 54.7, SM16c 54.2, SM14c 54.0, SM15 53.9, SM14 undifferentiated 53.5, SM16b 53.1, SM16 undifferentiated 52.3. Diagnosis. This stand is clearly intermediate in general character between the typical *Puccinellia maritima* and *Atriplex portulacoides* dominated 'SM13 *Puccinellia maritima* saltmarsh community' and 'SM14 *Halimione portulacoides* saltmarsh community' stands of the the middle marsh in the survey area on the one hand, and 'SM16 *Festuca rubra* saltmarsh community' marsh with constant and abundant *Festuca rubra*, *Juncus gerardii* and *Lysimachia maritima* on the other. That is exactly how BPC describes 'SM16a *Festuca rubra* saltmarsh community, *Puccinellia maritima* sub-community' and the top match with SM16a is therefore acceptable for this vegetation.

Quadrat Table A2.1. SM14c. Two-metre square quadrats recorded in middle marsh at the A2 Mucking Spit and Foreshore area on 26 June 2023.

Species name	Q1	Q2	Q3	Q4	Q5	Freq.	Cover
Puccinellia maritima	8	8	8	6	6	V	06-Aug
Atriplex portulacoides	6	4	6	7	6	V	04-Jul
Tripolium panonnicum	5	4	5	6	7	V	04-Jul
Spergularia media	2	-	1	3	3	IV	01-Mar
Plantago maritima	4	-	-	1	1	III	01-Apr
***Salicornia* agg.**	-	-	1	4	1	III	01-Apr
Suaeda maritima	-	3	3	2	-	III	02-Mar
Spartina anglica	-	4	4	-	-	II	4
Elymus athericus	2	-	-	-	-	I	2
Triglochin maritimum	-	-	-	2	-	I	2
Bare ground	0	5	5	5	5	-	-
Algal mat	0	0	0	0	0	-	-
Fucoid litter	5	0	0	10	15		
Sward height	34	28	30	30	26	-	-
Easting	6950	6949	6950	6950	6950	-	-
Northing	8103	8102	8102	8104	8105	-	-

Matching coefficients. SM14 undifferentiated 76.3, SM11 75.5, SM14c 74.4, SM12 72.8, SM14a 71.0, SM7 62.3, SM13a 61.5, SM10 60.8, SM13f 60.6, SM26 60.1

Diagnosis. The high constancy and cover of *Atriplex portulacoides* is consistent only with 'SM14 *Halimione portulacoides* saltmarsh community' and would make this an atypical example of any other NVC community, with the possible exception of 'SM13c *Puccinellia maritima* saltmarsh community, *Limonium vulgare-Armeria maritima* sub-community' from which this vegetation differs

radically in lacking *Armeria maritima* and *Limonium vulgare* (as well as structurally since this is taller and rougher vegetation than the lawns of typical SM13c). At the same time, the high constancy and abundance of *Tripolium panonnicum* is only consistent with 'SM11 *Aster tripolium* var. *discoideus* saltmarsh community' but that is a much less species-rich pioneer community, and seldom if ever closed like this vegetation, so that the match with SM11 can confidently be rejected. The large contribution of *Tripolium panonnicum* does however explain why SM14 undifferentiated has a higher matching coefficient than any sub-community of SM14. It also means that this is SM14 at its transition to lower marsh communities (also evidenced by the presence of annual *Salicornia* species). Nevertheless, the combination of *Atriplex portulacoides* and *Puccinellia maritima* at high constancy and cover together with a modest range of associates including *Plantago maritima*, *Spergularia media* and *Triglochin maritimum* is suggestive of 'SM14c *Halimione portulacoides* saltmarsh community, *Puccinellia maritima* sub-community'. Whether to call this vegetation SM14 undifferentiated or SM14c is therefore a finely balanced decision. SM14c as described in *BPC* has some species suggesting middle- to upper-marsh affinities, e.g. *Festuca rubra*, *Limonium vulgare*, which are lacking here, but as they are not constants the point is inconclusive. On balance therefore it seems more informative to reject SM14 undifferentiated in favour of SM14c albeit atypical in the high abundance of *Tripolium panonnicum* var. *flosculosus*. Though it is undoubtedly in some degree transitional to SM11 it is not sufficiently so to identify or map as intermediate, but it may perhaps be usefully regarded as a distinctive *Tripolium panonnicum* variant of SM14c.

Quadrat Table A2.2 – SM13b/MC6. Two-metre square quadrats recorded in upper marsh at the A2 Mucking Spit and Foreshore area on 30 June 2023.

Species name	Q1	Q2	Q3	Q4	Q5	Freq.	Cover
Spergularia media	7	8	8	8	7	V	07-Aug
Puccinellia maritima	7	7	7	6	7	V	06-Jul
Polypogon monspeliensis	5	5	5	1	5	V	01-May
***Salicornia* species**	3	4	3	4	4	V	03-Apr
Atriplex prostrata	2	4	2	4	3	V	02-Apr
Suaeda maritima	2	2	3	2	4	V	02-Apr
Sonchus arvensis	2	1	2	2	1	V	01-Feb
Tripolium panonnicum	1	2	2	1	1	V	01-Feb
Helminthotheca echioides	1	1	1	1	-	IV	1
Lysimachia maritima	-	2	-	5	4	III	02-May
Plantago major	-	2	1	4	-	III	02-Apr
Phragmites australis	-	-	2	3	-	II	02-Mar

Beta vulgaris* ssp. *maritima	-	-	-	-	1	I	1
Limonium* x *neumanii	1	-	-	-	-	I	1
Ranunculus sardous	-	-	-	-	1	I	1
Bare ground (%)	5	5	5	5	10	-	-
Algal mat (%)	0	0	0	0	0	-	-
Sward height (cm)	4	4	6	10	4	-	-
Easting	69516	69526	69541	69561	69589	-	-
Northing	80931	80920	80909	80900	80896	-	-

Matching coefficients. SM10 49.0, SM12 47.0, SM13a 46.5, SM13 undifferentiated 40.9, SM13b 39.8, SM13c 39.3, SM23 37.2, SM11 35.7, SM13d 35.6, SM14c 35.5

Diagnosis. This high-water mark vegetation (growing through geo-textile netting) does not conform to any single NVC type, and the relatively low numerical values of the highest matching coefficients reflect this. The highest matching coefficient with 'SM10 Transitional low-marsh vegetation with *Puccinellia maritima*, annual *Salicornia* species and *Suaeda maritima*' can be dismissed because the three character species (in the name) are here joined by many other species, some glycophytes, that are never found in this species-poor community of muddy lower marshes. The second highest matching coefficient with 'SM12 Rayed *Aster tripolium* on saltmarshes' can similarly be dismissed. The matches with 'SM13 *Puccinellia maritima* saltmarsh community' make more sense since *Puccinellia maritima* is at least co-dominant with other species, and the anomalously abundant *Spergularia media* is characteristic of inter-tidal SM13, while lower marsh species such as *Suaeda maritima* and *Tripolium panonnicum* do occur in SM13. But *Puccinellia maritima* is insufficiently dominant for 'SM13a *Puccinellia maritima* saltmarsh community, sub-community with *Puccinellia maritima* dominant' to be the best match, and in the absence of *Armeria maritima*, *Limonium vulgare* and other middle-marsh lawn species the same applies to 'SM13c *Puccinellia maritima* saltmarsh community, *Limonium vulgare-Armeria maritima* sub-community'. SM13 undifferentiated is a better conclusion, but the presence of *Lysimachia maritima* suggests that this vegetation is closer to 'SM13b *Puccinellia maritima* saltmarsh community, *Glaux maritima* sub-community' than to any other SM13 sub-community. However, the constant presence of semi-ruderal glycophytes such as *Atriplex prostrata*, *Beta vulgaris* ssp. *maritima*, *Plantago major*, *Polypogon monspeliensis* and *Sonchus arvensis* means that this vegetation cannot in fact be SM13 even if it has affinities with it. These strandline species suggest the *Atriplici-Betetum maritimae* or 'MC6 *Atriplex prostrata-Beta vulgaris* ssp. *maritima* sea-bird cliff community' which sometimes occurs in habitats other than sea-bird cliffs according to Rodwell (2000). If *Spergularia media* were replaced with *Spergularia marina* seldom found in the intertidal, there might also be affinities with 'SM23 *Spergularia marina-Puccinellia distans* saltmarsh community' or with 'SM12 Rayed *Aster tripolium* on saltmarshes, inland stands sub-community' though *Polypogon*

monspeliensis does not occur in the floristic table for SM23 or SM12b[4] in Rodwell (2000), it suggests communities of south-eastern seawall habitat complexes close to SM23 but not as yet described in the NVC, especially featuring species such as *Hordeum marinum*, *Polypogon monspeliensis*, *Puccinellia fasciculata* and *Trifolium squamosum*. This vegetation is therefore probably best regarded as intermediate between SM13b on the one hand and MC6 on the other (but MC6 transitional to non-NVC vegetation containing *Polypogon monspeliensis*).

Quadrat Table C1.1 – SM13c (transitional to SM26a). Two-metre square quadrats recorded in the East of Enovert Landfill area on 26 June 2023.

Species name	Q1	Q2	Q3	Q4	Q5	Freq.	Cover
Puccinellia maritima	4	8	4	5	2	V	02-Aug
Tripolium panonnicum	2	3	5	5	4	V	02-May
Armeria maritima	5	5	-	7	9	IV	05-Sep
Parapholis strigosa	4	8	-	6	8	IV	04-Aug
Juncus gerardii	3	-	9	4	-	III	03-Sep
Limbarda crithmoides	7	3	-	2	-	III	02-Jul
Atriplex portulacoides	5	-	4	-	2	III	02-May
Plantago maritima	5	2	-	2	-	III	02-May
Spergularia media	1	1	-	2	-	III	01-Feb
Lysimachia maritima	-	1	-	1	-	II	1

[4] In *British Plant Communities,* the two SM12 sub-communities 'SM12a Rayed *Aster tripolium* on salt-marshes, Coastal stands of rayed *Aster tripolium*' and 'SM12b Rayed *Aster tripolium* on salt-marshes, Inland stands of rayed *Aster tripolium*' are not formally described under these names in the text of the very brief section covering SM12. Moreover that section includes no floristic table for SM12 following the text as in the vast majority of community desciptions including the similarly unusual and therefore comparable case of 'SM26 *Inula crithmoides* on salt-marshes'. But as a trap for the unwary the SM12 sub-communities are included in the floristic table for SM11 which is positioned at the end of the section covering SM11, and this is where the sub-community names above derive from.

Species name	Q1	Q2	Q3	Q4	Q5	Freq.	Cover
Limonium vulgare	-	-	-	4	-	I	4
Elymus athericus	-	-	2	-	-	I	2
Bare ground (%)	2	2	2	2	2	-	-
Algal mat (%)	0	0	0	0	0	-	-
Sward height (cm)	22	24	24	20	20	-	-
Easting	6952	6952	6951	6951	6951	-	-
Northing	7938	7937	7936	7934	7933	-	-

Matching coefficients. SM13 undifferentiated 53.7, SM26a 51.7, SM13a 51.4, SM22 50.5, SM14 undifferentiated 50.3, SM13c 49.0, SM13b 48.9, SM17 48.6, SM21 47.6, SM26 undifferentiated 47.0

Diagnosis. This very mixed vegetation shows constant *Puccinellia maritima* with only occasional *Atriplex portulacoides* suggesting that the highest matching coefficient with 'SM13 *Puccinellia maritima* saltmarsh community' is likely to be acceptable. The local abundance of *Parapholis strigosa* is anomalous (i.e. not a feature of any middle marsh vegetation in *BPC*) and has no diagnostic significance, but it may have weakened all the matches with described NVC communities and sub-communities. Several of the matches can easily be dismissed: 'SM14 *Halimione portulacoides* saltmarsh community' because *Atriplex portulacoides* is insufficiently abundant; 'SM22 *Halimione portulacoides-Frankenia laevis* saltmarsh community' because *Frankenia laevis* is not present (and this is a very different type of saltmarsh); 'SM17 *Artemisia maritima* saltmarsh community' because *Artemisia maritima* is not present 'SM21 *Suaeda vera-Limonium binervosum* saltmarsh community' because this is not drift-line marsh with *Suaeda vera*; and SM26 because *Limbarda crithmoides* is not constant, though there may be quite strong affinities with 'SM26 *Inula crithmoides* on saltmarshes, lower marsh sub-community'. That leaves SM13 sub-communities. This is not 'SM13a *Puccinellia maritima* saltmarsh community, sub-community with *Puccinellia maritima* dominant' because *Puccinellia maritima* is not strongly dominant. And it is not 'SM13b *Puccinellia maritima* saltmarsh community, *Glaux maritima* sub-community' because *Lysimachia maritima* is not co-dominant with *Puccinellia maritima* (in fact very rare). Because there are so many anomalies in this vegetation SM13 undifferentiated would be a perfectly reasonable conclusion, but the abundance of *Armeria maritima* plus very occasional *Limonium vulgare* in relatively species-rich middle marsh leads us to conclude that this is best regarded as somewhat atypical 'SM13c *Puccinellia maritima* saltmarsh community, *Limonium vulgare-Armeria maritima* sub-community' perhaps transitional in some degree towards 'SM26a

Inula crithmoides on saltmarshes, stands with *Puccinellia maritima*, *Salicornia* agg. and *Limonium vulgare*' but not worth treating as intermediate.

Quadrat Table D1.1. SM14Jg. Two-metre square quadrats recorded in middle marsh at the D1 East Tilbury Marshes area on 27 June 2023.

Species name	Q1	Q2	Q3	Q4	Q5	Freq.	Cover
Atriplex portulacoides	8	6	7	7	9	V	06-Sep
Triglochin maritimum	5	6	4	4	1	V	01-Jun
Tripolium panonnicum	5	5	5	4	3	V	03-May
Puccinellia maritima	1	3	1	1	2	V	01-Mar
Juncus gerardii	3	6	-	6	7	IV	03-Jul
Plantago maritima	-	4	7	7	1	IV	01-Jul
Elymus athericus	3	-	1	1	4	IV	01-Apr
Festuca rubra	-	-	-	2	1	II	01-Feb
Bare ground (%)	0	0	0	0	0	-	-
Algal mat (%)	0	0	0	0	0	-	-
Sward height (cm)	18	26	22	22	22	-	-
Easting	6941	6941	6941	6941	6940	-	-
Northing	7864	7864	7863	7862	7862	-	-

Matching coefficients. SM14c 55.6, SM14 undifferentiated 55.3, SM14b 54.8, SM25 undifferentiated 53.1, SM16a 52.2, SM13c 51.3, SM17 49.1, SM14a 48.0, SM24 47.6, SM15 47.0

Diagnosis. The consistently high cover of *Atriplex portulacoides* ensures that this vegetation must be identified as 'SM14 *Halimione portulacoides* saltmarsh community'. The presence of atypical species such as *Juncus gerardii* explains why SM14 undifferentiated has a higher matching coefficient than any SM14c sub-community, but the constancy of *Puccinellia maritima* together with *Plantago maritima* and *Triglochin maritimum* suggests that 'SM14c *Halimione portulacoides*

saltmarsh community, *Puccinellia maritima* sub-community' is a more acceptable conclusion. Admittedly the cover of *Puccinellia maritima* is low for typical SM14c but the high cover of *Plantago maritima* and *Triglochin maritimum* additionally suggests SM14c rather than any other SM14 sub-community. The match with 'SM16a *Festuca rubra* saltmarsh community, *Puccinellia maritima* sub-community' is suggested by the presence of *Juncus gerardii* and there must be some transition from SM14c towards SM16a, but *Juncus gerardii* alone is insufficient to warrant identifying this as intermediate vegetation. It may however be usefully regarded as a *Juncus gerardii* variant of SM14c. Other matching coefficients can in each case be dismissed owing to the absence of character species, e.g. *Suaeda vera* in the case of 'SM25 *Suaeda vera* drift-line community' or *Artemisia maritima* (Sea Wormwood) in the case of 'SM17 *Artemisia maritima* saltmarsh community'.

Quadrat Table D2.1 – SM14a Jg. Two-metre square quadrats recorded in middle marsh at the D2 Mucking Flats Marshes area on 27 June 2023.

Species name	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Freq.**	**Cover**
Juncus gerardii	8	10	9	9	9	V	08-Oct
Atriplex portulacoides	8	5	8	5	8	V	05-Aug
Plantago maritima	3	2	-	6	-	III	02-Jun
Tripolium panonnicum	4	6	-	-	-	II	04-Jun
Elymus athericus	1	-	-	-	-	I	1
Bare ground (%)	0	0	0	0	0	-	-
Algal mat (%)	0	0	0	0	0	-	-
Sward height (cm)	25	25	25	25	25	-	-
Easting	6910	6911	6912	6913	6914	-	-
Northing	7643	7645	7648	7649	7650	-	-

Matching coefficients. SM14 undifferentiated 45.1, SM14a 45.0, SM14c 42.8, SM24 39.2, SM14b 37.7, SM16b 36.8, SM25a 36.0, SM17 35.1, SM16 undifferentiated 33.9, SM25 undifferentiated 33.8

Diagnosis. Despite the dominance of *Juncus gerardii*, the abundance of *Atriplex portulacoides* leaves little option but to assign this vegetation to ‘SM14 *Halimione portulacoides* saltmarsh community’. The tiny amount of *Elymus athericus* is insufficient to make it transitional towards ‘SM24 *Elymus pycnanthus* saltmarsh community’. The only community in which *Juncus gerardii* is characteristic is ‘SM16 *Festuca rubra* saltmarsh community’ so the abundance of *Juncus gerardii* might suggest that this vegetation is intermediate between SM14 and SM16, but other than *Juncus gerardii* it has no SM16 characteristics whatsoever. Because the abundance of *Juncus gerardii* would be anomalous for any SM14 sub-community it would be perfectly reasonable to call this SM14 undifferentiated, but without the *Juncus* it would clearly be ‘SM14a *Halimione portulacoides* saltmarsh community, sub-community with *Halimione portulacoides* dominant’ and this vegetation is best regarded as SM14a that is atypical in accommodating a large amount of *Juncus gerardii*.

Quadrat Table D2.2. SM11. Two-metre square quadrats recorded in lower marsh at the D2 Mucking Flats Marshes area on 27 June 2023.

Species name	Q1	Q2	Q3	Q4	Q5	Freq.	Cover
Tripolium panonnicum	9	9	8	5	5	V	05-Sep
Puccinellia maritima	-	5	4	7	8	IV	04-Aug
Atriplex portulacoides	4	-	5	4	6	IV	04-Jun
***Salicornia* species**	5	1	1	2	-	IV	01-May
Suaeda maritima	1	1	2	5	-	IV	01-May
Spartina anglica	1	1	1	2	-	IV	01-Feb
Atriplex prostrata	-	-	-	7	5	II	05-Jul
Plantago maritima	-	-	5	-	-	I	5
Bare ground (%)	2	2	2	2	2	-	-
Algal mat (%)	0	0	0	0	0	-	-
Sward height (cm)	30	30	30	30	30	-	-
Easting	6932	6918	6918	6924	6923	-	-
Northing	7643	7644	7645	7647	7651	-	-

Matching coefficients. SM11 78.7, SM9 67.9, SM14a 66.8, SM6 66.0, SM10 63.7, SM12 undifferentiated 63.2, SM13f 62.1, SM14 undifferentiated 61.7, SM7 60.7, SM14c 60.4. Diagnosis. The abundance and constancy of *Tripolium panonnicum* var. *flosculosus* suggest that the top match with 'SM11 *Aster tripolium* var. *discoideus* salt-marsh community' is the best diagnosis for this vegetation. It is a little atypical in the range and abundance of associated species, but key species such as *Atriplex portulacoides*, *Puccinellia maritima*, *Spartina anglica* and *Suaeda*

maritima are insufficiently abundant for this to be ‘SM14 *Halimione portulacoides* salt-marsh community’, ‘SM13 *Puccinellia maritima* salt-marsh community’ ‘SM6 *Spartina anglica* salt-marsh community’ or ‘SM9 *Suaeda maritima* salt-marsh community’ respectively.

Quadrat Table D2.3. SM13a/SM11. Two-metre square quadrats recorded in lower marsh at the D2 Mucking Flats Marshes area on 27 June 2023.

Species name	Q1	Q2	Q3	Q4	Q5	Freq.	Cover
Puccinellia maritima	8	9	8	9	10	V	08-Oct
Tripolium panonnicum	4	3	5	6	6	V	03-Jun
Atriplex prostrata	4	4	5	4	1	V	01-May
Spartina anglica	-	3	6	2	3	IV	02-Jun
Atriplex portulacoides	6	3	-	-	-	II	03-Jun
Triglochin maritimum	5	3	-	-	-	II	03-May
***Salicornia* species**	1	-	-	-	-	I	1
Bare ground (%)	7	7	18	18	18	-	-
Algal mat (%)	0	0	0	0	0	-	-
Sward height (cm)	25	60	55	55	50	-	-
Easting	6925	6926	6927	6927	6928	-	-
Northing	7663	7665	7665	7668	7669	-	-

Matching coefficients. SM11 61.9, SM12 undifferentiated 57.0, SM6 50.5, SM14 undifferentiated 50.1, SM13f 49.7, SM14a 48.9, Sm10 47.7, SM13 undifferentiated 47.3, SM14c 46.0, Sm13a 44.9.
Diagnosis. The matching coefficients in this case are hard to understand. It may be that the somewhat anomalous presence of *Atriplex prostrata* in the lower marsh is confusing the matching process. Vegetation so strongly dominated by *Puccinellia maritima* is likely to be ‘SM13a *Puccinellia maritima* salt-marsh community, sub-community with *Puccinellia maritima* dominant’ even though the matching coefficient for this sub-community is exceeded by nine others. Besides having *Atriplex prostrata* the vegetation is atypical for SM13a in the constancy and abundance of lower marsh species including *Tripolium panonnicum* var. *flosculosus* and *Spartina anglica*. The

vegetation is therefore best regarded as transitional from SM13a to SM11 though closer to SM13a than SM11.

Quadrat Table F4.1. SM14/SM26 Two-metre square quadrats recorded in lower marsh at the F4 Tilbury Cruise Terminal area on 27 June 2023.

Species name	Q1	Q2	Q3	Q4	Q5	Freq.	Cover
Atriplex portulacoides	8	8	8	9	8	V	08-Sep
Limbarda crithmoides	6	8	5	5	7	V	05-Aug
Tripolium panonnicum	2	3	3	1	-	IV	01-Mar
Plantago maritima	2	-	5	-	-	II	02-May
Triglochin maritimum	5	1	-	-	-	II	01-May
***Salicornia* species**	-	3	3	-	-	II	3
Spergularia media	2	-	-	-	-	I	2
Suaeda maritima	-	1	-	-	-	I	1
Bare ground (%)	7	7	18	18	18	-	-
Algal mat (%)	0	0	0	0	4	-	-
Sward height (cm)	20	30	35	30	40	-	-
Easting	6471	6470	6469	6469	6467	-	-
Northing	7526	7526	7526	7526	7526	-	-

Matching coefficients. SM14 undifferentiated 65.7, SM14c 61.3, SM14a 61.0, SM26 undifferentiated 60.7, SM26a 56.1, SM14b 52.3, SM13a 51.7, SM13 undifferentiated 50.7, SM26b 47.4, SM12 undifferentiated 47.2.

Diagnosis. The abundance of *Atriplex portulacoides* in combination with a wide range of associates at moderate levels of abundance but little suggests that the top match with 'SM14 *Halimione portulacoides* saltmarsh community' undifferentiated is acceptable. The match with 'SM14c *Halimione portulacoides* saltmarsh community, *Puccinellia maritima* sub-community' is not acceptable in the absence of *Puccinellia maritima* and *Atriplex portulacoides* is insufficiently dominant for 'SM14a *Halimione portulacoides* saltmarsh community, sub-community with *Halimione portulacoides* dominant'. However, the high constancy and abundance of *Limbarda crithmoides* suggests that the lower marsh form of 'SM26 *Inula crithmoides* on saltmarshes' might deserve consideration. For 'SM26a *Inula crithmoides* on saltmarshes, stands with *Puccinellia maritima*, *Salicornia* agg. and *Limonium vulgare*' the key associates are all lacking so this stand is probably better assigned to SM26 undifferentiated despite its lower marsh location. This stand might therefore be regarded as intermediate between SM14 undifferentiated and SM26 undifferentiated.

Single Quadrats

Quadrat D1.2 ex Target Note D1.1 – SM26b, TQ 6951 7892, 27 June 2023. Bare ground (rock) 40%, algal mat 0, sward height 20.0 cm, *Limbarda crithmoides* 8, *Atriplex portulacoides* 5, *Plantago maritima* 5, *Elymus athericus* 3. Matching coefficients SM26b 70.4, SM26 undifferentiated 54.2, SM25a 49.5, SM24 47.5, SM25 undifferentiated 44.1, SM26a 43.1. Diagnosis – as suggested by the exceptionally high matching coefficient, this is clearly 'SM26b *Inula crithmoides* on saltmarshes, stands with *Elymus pycnanthus*' with *Elymus athericus* as an associate and no lower marsh species.

Quadrat D1.3 ex Target Note 6.2 – SM26a, TQ 6951 7890, 27 June 2023. Bare ground 15%, algal mat 0, sward height 20.0 cm, *Atriplex portulacoides* 6, *Limbarda crithmoides* 6, *Plantago maritima* 5, *Puccinellia maritima* 4, *Spartina anglica* 4, *Spergularia media* 2, *Lysimachia maritima* 1. Matching coefficients SM26a 55.1, SM26 undifferentiated 50.5, SM13b 50.4, SM14 undifferentiated 50.2, SM14a 50.1, SM13d 46.5. Diagnosis – from the high cover of *Limbarda crithmoides* this must be 'SM26 *Inula crithmoides* on saltmarshes'. It cannot be 'SM13b *Puccinellia maritima* saltmarsh community, *Glaux maritima* sub-community' since *Elymus athericus* is lacking while middle-marsh species such as *Puccinellia maritima* and lower marsh species such as *Spartina anglica* are abundant. Other than its atypical location at the foot of the seawall, there is no floristic reason to reject the highest matching coefficient with 'SM26a *Inula crithmoides* on saltmarshes, lower marsh sub-community', which is therefore preferable to SM26 undifferentiated as the conclusion. In relatively narrow belts of fringing marsh like this, it is not uncommon for pioneer saltmarsh vegetation to occur close to the seawall.

Quadrat D2.4 – SM6-MC6, TQ 6938 7730, 27 June 2023. Bare ground 0, algal mat 0, sward height 60.0 cm, *Atriplex prostrata* 9, *Spartina anglica* 6, *Puccinellia maritima* 5, *Bolboschoenus maritimus* 1, *Suaeda maritima* 1, *Triglochin maritimum* 1. Matching coefficients S21b 63.7, S21 undifferentiated 51.4, SM12 48.3, S21c 47.8, SM6 46.0, SM10 43.3, SM14 undifferentiated 41.5, S21a 41.1, SM14a 39.9, SM14c 39.0. Diagnosis – the few plants of *Bolboschoenus maritimus* are insufficient to warrant calling this 'S21 *Scirpus maritimus* swamp' or even transition towards it. Neither is this 'SM12 Rayed *Aster tripolium* on saltmarshes'. That leaves lower marsh species such as *Puccinellia maritima*, *Spartina anglica* and *Suaeda maritima* suggesting 'SM6 *Spartina anglica* saltmarsh community' or 'SM10 Transitional low-marsh vegetation with *Puccinellia maritima*, annual *Salicornia* species and *Suaeda maritima*' and *Atriplex prostrata* suggesting the strandline form of 'MC6 *Atriplex prostrata-Beta vulgaris* ssp. *maritima* sea-bird cliff community'. The amounts of *Puccinellia maritima* and *Suaeda maritima* are not inconsistent with SM6 and in the absence of *Tripolium panonnicum* it is accordingly possible to dismiss SM10. This vegetation is therefore best regarded as intermediate between SM6 and MC6 or perhaps a compressed mosaic of the two.

Quadrat D2.5 – SM10, TQ 6926 7649, 27 June 2023. Bare ground 40%, algal mat 0, sward height 55.0 cm, *Atriplex prostrata* 6, *Puccinellia maritima* 6, *Suaeda maritima* 6, *Spartina anglica* 4, *Tripolium panonnicum* 3, *Salicornia* species 2. Matching coefficients SM11 73.4, SM10 69.7, SM6 61.6, SM12 61.2, SM9 61.1, SM13f 57.2, SM8 56.3, SM7 48.9, SM14c 45.5, SM14 undifferentiated 44.5. Diagnosis – though 'SM11 *Aster tripolium* var. *discoideus* saltmarsh community' is undoubtedly abundant nearby, the key species *Tripolium panonnicum* is not sufficiently abundant in this lower marsh vegetation to support a conclusion of SM11. Moreover, in Rodwell (2000) a single floristic table combines SM11 and 'SM12 Rayed *Aster tripolium* on saltmarshes', and it is to be feared that the abundance of *Atriplex prostrata* is affecting the matching coefficients, the point being that *British Plant Communities* records *Atriplex prostrata* from brackish stands of SM12 above the inter-tidal and not from low-marsh SM11. In the case of a single quadrat there might be a case for calling it any of the low marsh communities 'SM6 *Spartina anglica* saltmarsh community', 'SM8 Annual *Salicornia* saltmarsh community' or 'SM9 *Suaeda maritima* saltmarsh community' since they all share the same lower marsh associates (in varying proportions), but on balance the shared abundance of *Puccinellia maritima* and *Suaeda maritima* suggests that this

quadrat is best regarded as ‘SM10 Transitional low-marsh vegetation with *Puccinellia maritima*, annual *Salicornia* species and *Suaeda maritima*’.

Quadrat D2.6 – SM11/SM26a, TQ 6892 7621, 27 June 2023. Bare ground 5%, algal mat 40%, sward height 12.0, *Tripolium panonnicum* 8, *Atriplex portulacoides* 7, *Limbarda crithmoides* 5, *Spergularia media* 5, *Suaeda maritima* 4, *Cochlearia anglica* 3, *Plantago maritima* 2, *Salicornia* species 1, *Spartina anglica* 1. Matching coefficients SM26a 55.7, SM11 53.3, SM26 undifferentiated 51.7, SM12 49.9, SM9 46.8, SM14c 46.5, SM14 undifferentiated 45.3, SM6 45.2, SM10 44.9, SM14a 44.0. Diagnosis – the abundance of *Tripolium panonnicum* suggests that ‘SM11 *Aster tripolium* var. *discoideus* saltmarsh community’ may well be a correct conclusion, but several of the middle-marsh associates are more abundant than they should be in SM11, especially *Atriplex portulacoides*. On the other hand, the abundance of *Limbarda crithmoides* suggests that ‘SM26 *Inula crithmoides* on saltmarshes’ might be correct, but *Tripolium panonnicum* is much too abundant. The lower matching coefficients are altogether less satisfactory, so the only possible conclusion is that this vegetation is intermediate between SM11 on the one hand and ‘SM26a *Inula crithmoides* on saltmarshes, lower marsh sub-community’ on the other.

Quadrat F1.1 – SM14a, TQ 6637 7541, 27 June 2023. Bare ground 0, algal mat 0, litter 20%, sward height 30.0, *Atriplex portulacoides* 8, *Elymus athericus* 4, *Plantago maritima* 3, *Triglochin maritimum* 3, *Tripolium panonnicum* 1. Matching coefficients SM14b 49.4, SM14c 46.7, SM24 45.7, SM14 undifferentiated 45.0, SM25a 44.9, SM25a 44.9, SM25 undifferentiated 42.9, SM26b 40.9, SM14a 39.0, SM17 37.0, SM26 undifferentiated 33.1. Diagnosis – matches with ‘SM17 *Artemisia maritima* saltmarsh community’, ‘SM25 *Suaeda vera* drift-line community’ and ‘SM26 *Inula crithmoides* on saltmarshes’ can be dismissed in the complete absence of the character species, *Artemisia maritima*, *Suaeda vera* and *Limbarda crithmoides* respectively. No vegetation with cover of *Atriplex portulacoides* massively exceeding that of *Elymus athericus* can well be regarded as ‘SM24 *Elymus pycnanthus* saltmarsh community’. The matches with ‘SM14 *Halimione portulacoides* saltmarsh community’ are therefore the only ones likely to be acceptable. The top two matches with ‘SM14b *Halimione portulacoides* saltmarsh community, *Juncus maritimus* sub-community’ and ‘SM14c *Halimione portulacoides* saltmarsh community, *Puccinellia maritima* sub-community’ can be dismissed in the absence of the character species *Juncus maritimus* and *Puccinellia maritima* respectively (these species would need to be present at appreciable levels of abundance). Given the strong dominance of *Atriplex portulacoides* ‘SM14a *Halimione portulacoides* saltmarsh community, sub-community with *Halimione portulacoides* dominant’ is probably the best diagnosis despite the relatively low matching coefficient. The vegetation may be marginally atypical for SM14a in the abundance of *Atriplex portulacoides* and there is undoubtedly a degree of transition towards ‘SM24 *Elymus pycnanthus* saltmarsh community’ so that it would not be unreasonable to prefer the match with SM14 undifferentiated, but here the character of the vegetation is better conveyed by accepting SM14a.

Quadrat F1.2 – SM14c, TQ 6644 7544, 27 June 2023. Bare ground 0, algal mat 0, litter 5%, sward height 25.0, *Atriplex portulacoides* 8, *Plantago maritima* 5, *Triglochin maritimum* 4, *Parapholis strigosa* 3, *Tripolium panonnicum* 1. Matching coefficients SM14c 50.3, SM14b 49.4, SM13c 44.4, SM17 43.8, SM16b 43.3, SM13d 42.1, SM16a 42.0, SM14 undifferentiated 41.7m SM16c 41.5, SM14a 39.0. Diagnosis – see Quadrat 13.3.

Quadrat F1.3 – SM14c, TQ 6650 7545, 27 June 2023. Bare ground 0, algal mat 0, litter 5%, sward height 25.0, *Plantago maritima* 7, *Triglochin maritimum* 6, *Puccinellia maritima* 5, *Tripolium panonnicum* 5, *Spergularia media* 3, *Parapholis strigosa* 2, *Puccinellia distans* 1. Matching coefficients SM14c 60.1, SM13c 58.5, SM14b 56.2, SM12 54.4, SM14 undifferentiated 54.3, SM13d 52.3, SM14a 50.1, SM17 48.4, SM13a 48.3, SM13b 48.0. Diagnosis for Quadrats 13.2 and 13.3 considered together as *Atriplex portulacoides* vegetation rich in *Plantago maritima* and *Triglochin maritimum* - matches with ‘SM17 *Artemisia maritima* saltmarsh community’ can be dismissed in the absence of the character species *Artemisia maritima*, while a match with ‘SM12 Rayed *Aster tripolium* on saltmarshes’ can be dismissed owing to the lack of glycophytes (though *Parapholis strigosa* and *Puccinellia distans* might be considered as such). Matches with ‘SM13 *Puccinellia maritima* saltmarsh community’ are harder to dismiss, but *Puccinellia maritima* is not

sufficiently abundant to favour SM13 over 'SM14 *Halimione portulacoides* saltmarsh community'. Matches with 'SM14a *Halimione portulacoides* saltmarsh community, sub-community with *Halimione portulacoides* dominant' can be dismissed as *Atriplex portulacoides* is not constantly dominant (though it is locally) and other saltmarsh plants are too common, while the same largely applies to 'SM14b *Halimione portulacoides* saltmarsh community, *Juncus maritimus* sub-community' especially in the absence of *Juncus maritimus*. However 'SM14c *Halimione portulacoides* saltmarsh community, *Puccinellia maritima* sub-community' does have abundant *Plantago maritima* and *Triglochin maritimum* according to the definitive tables in *British Plant Communities* and this vegetation is therefore best regarded as SM14c albeit somewhat atypical in the low cover of *Puccinellia maritima*.

Quadrat F1.4 – SM14 undifferentiated, TQ 6577 7534, 27 June 2023. Bare ground 7%, algal mat 0, sward height 20.0, *Atriplex portulacoides* 9, *Plantago maritima* 3, *Spartina anglica* 2, *Spergularia media* 2, *Tripolium panonnicum* 2, *Limbarda crithmoides* 1 *Puccinellia maritima* 1, *Triglochin maritimum* 1. Matching coefficients SM12 undifferentiated 61.8, SM14c 57.9, SM13c 56.9, SM14 undifferentiated 54.8, SM14b 54.4, SM26a 53.6, SM14a 51.1, SM13d 51.0, SM26 undifferentiated 49.2, SM13a 47.2. Diagnosis – the obvious NVC conclusion for a stand with 90% cover of *Atriplex portulacoides* is 'SM14a *Halimione portulacoides* saltmarsh community, sub-community with *Halimione portulacoides* dominant' yet this appears low among the matching coefficients owing presumably to the wide range of associated species present only at low levels of abundance. Matches with 'SM13 *Puccinellia maritima* saltmarsh community' can confidently be dismissed on the simple basis that *Puccinellia maritima* is insufficiently abundant and *Atriplex portulacoides* is far too abundant. Matches with 'SM26 *Inula crithmoides* on saltmarshes' are understandable owing to the occasional presence of *Limbarda crithmoides*, and some small degree of transition towards SM26 may be acknowledged, but it is probably not helpful to call this vegetation SM26 on such a slender basis. Matches with 'SM14b *Halimione portulacoides* saltmarsh community, *Juncus maritimus* sub-community' and 'SM14c *Halimione portulacoides* saltmarsh community, *Puccinellia maritima* sub-community' can be dismissed in the absence of *Juncus maritimus* and low incidence of *Puccinellia maritima* respectively. If the species associated with the dominant *Atriplex portulacoides* are just regarded as 'noise' consequent upon historically disturbed conditions on the industrial foreshore then this vegetation is best regarded as modified and therefore slightly atypical 'SM14a *Halimione portulacoides* saltmarsh community, sub-community with *Halimione portulacoides* dominant'; while if - regardless of the reasons for their presence - they are regarded as intrinsic to the vegetation, then it is best regarded as SM14 undifferentiated. We marginally favour the latter option in the basis that it seems unlikely that this was ever pristine SM14a that got modified, but rather an assemblage that has developed *in situ* in a foreshore with a chequered history.

Quadrat F1.5 – SM14 undifferentiated, TQ 6610 7533, 27 June 2023. Bare ground 3%, algal mat 0, sward height 15.0, *Atriplex portulacoides* 8, *Plantago maritima* 7, *Puccinellia maritima* 5, *Limonium vulgare* 4 *Spartina anglica* 2. Matching coefficients SM14 undifferentiated 62.5, SM14b 62.5, SM14c 60.1, SM14a 58.5, SM26a 57.4, SM13c 52.1, SM6 49.3, SM17 47.9, SM7 46.2, SM26 undifferentiated 45.7. Diagnosis – matches with 'SM7 *Arthrocnemum perenne* stands', 'SM17 *Artemisia maritima* saltmarsh community' and 'SM26 *Inula crithmoides* on saltmarshes' can be dismissed in the absence of the character species *Sarcocornia perennis*, *Artemisia maritima* and *Limbarda crithmoides* respectively; and 'SM7 *Arthrocnemum perenne* stands' can be dismissed in the absence of dominant *Spartina anglica*. The preponderance of *Atriplex portulacoides* over *Puccinellia maritima* suggests that matches with 'SM13 *Puccinellia maritima* saltmarsh community' are less acceptable than matches with 'SM14 *Halimione portulacoides* saltmarsh community'. Though *Puccinellia maritima* is moderately abundant, the greater abundance associates such as *Plantago maritima* and the presence of additional associates such as *Limonium vulgare* suggests that 'SM14c *Halimione portulacoides* saltmarsh community, *Puccinellia maritima* sub-community' is a less acceptable match than either 'SM14b *Halimione portulacoides* saltmarsh community, *Juncus maritimus* sub-community' or SM14 undifferentiated. The abundance of associates such as *Limonium vulgare* and *Plantago maritima* is consistent with SM14b, but in the absence of the character species *Juncus maritimus* SM14 undifferentiated appears to be the best conclusion in this case.

Quadrat F1.6 – SM14c, TQ 6611 7537, 27 June 2023. Bare ground 0, algal mat 0, litter 20%, sward height 30.0, *Plantago maritima* 6, *Triglochin maritimum* 6, *Atriplex portulacoides* 5, *Puccinellia maritima* 4, *Tripolium panonnicum* 4, *Spergularia media* 3, *Limonium vulgare* 2, *Lysimachia maritima* 2. Matching coefficients SM13c 68.3, SM14c 64.2, SM16a 64.1, SM14b 63.4, SM13d 61.3, SM13b 60.7, SM17 56.5, SM14 undifferentiated 56.3, SM13a 56.2, SM13 undifferentiated 55.6. Diagnosis – the match with 'SM17 *Artemisia maritima* saltmarsh community' can be dismissed in the absence of *Artemisia maritima*, as can that with 'SM16 *Festuca rubra* saltmarsh community' in the absence of several character species including *Festuca rubra* and *Juncus gerardii* (though the presence of *Lysimachia maritima* probably explains this match). Since the vegetation is dominated by *Plantago maritima* and *Triglochin maritimum* with moderate amounts of both *Puccinellia maritima* and *Atriplex portulacoides*, it is hard to choose between 'SM13 *Puccinellia maritima* saltmarsh community' and 'SM14 *Halimione portulacoides* saltmarsh community'. This vegetation does not have the general character of a species-rich middle-marsh lawn with *Armeria maritima* and *Limonium vulgare* (even though the latter is present), and therefore the highest matching coefficient with 'SM13c *Puccinellia maritima* saltmarsh community, *Limonium vulgare-Armeria maritima* sub-community' can be dismissed. The absence of *Armeria maritima* makes several other options such as 'SM13d *Puccinellia maritima* saltmarsh community, *Plantago maritima-Armeria maritima* sub-community' unattractive. There is however no strong disagreement with the description of 'SM14c *Halimione portulacoides* saltmarsh community, *Puccinellia maritima* sub-community' in *British Plant Communities.* As SM14c this vegetation is atypical in having more *Plantago maritima* and *Triglochin maritimum* than *Atriplex portulacoides* and *Puccinellia maritima*, but the discrepancy is not great. SM14c therefore is the best conclusion though a case could be made for regarding this vegetation as transitional between say SM13c and SM14 undifferentiated.

Quadrat F1.7 – SM14a/(SM26 undifferentiated), TQ 6611 7537, 27 June 2023. Bare ground 7%, algal mat 0, sward height 50.0, *Atriplex portulacoides* 9, *Juncus gerardii* 3, *Limbarda crithmoides* 3, *Triglochin maritimum* 1, *Tripolium panonnicum* 1. Matching coefficients SM16b, SM16a 42.8, SM16c 41.5, SM26b 40.9, SM14c 39.5, SM14a 39.0, SM14 undifferentiated 36.8, SM26 undifferentiated 35.9, SM13c 35.7, SM16 undifferentiated 35.4. Diagnosis – the various matches with sub-communities of 'SM16 *Festuca rubra* saltmarsh community' have probably benn triggered by the presence of *Juncus gerardii*, but in the absence of character species such as *Festuca rubra* and *Lysimachia maritima* they are not acceptable. Neither is there any strong case for regarding this stand as transitional towards SM16, since *Juncus gerardii* occurs extensively in 'SM14 *Halimione portulacoides* saltmarsh community' vegetation in the survey area. In the absence of *Puccinellia maritima* neither 'SM13c *Puccinellia maritima* saltmarsh community, *Limonium vulgare-Armeria maritima* sub-community' nor 'SM14c *Halimione portulacoides* saltmarsh community, *Puccinellia maritima* sub-community' would be helpful diagnosis. The strong dominance of *Atriplex portulacoides* (cover over 90%) suggests that 'SM14a *Halimione portulacoides* saltmarsh community, sub-community with *Halimione portulacoides* dominant' is the best conclusion. However, the presence of *Limbarda crithmoides* among the so few associated species suggests that this vegetation is at least in some degree transitional towards some form of 'SM26 *Inula crithmoides* on saltmarshes'.

Quadrat F4.2 – SM14a/(SM26 undifferentiated), TQ 6474 7526, 27 June 2023. Bare ground 30%, algal mat 0, sward height 30.0, *Tripolium panonnicum* 8, *Atriplex portulacoides* 4, *Plantago maritima* 4, *Salicornia* species 4, *Cochlearia anglica* 3, *Spergularia media* 3, *Limbarda crithmoides* 2, *Suaeda maritima* 2. Matching coefficients SM26a 57.3, SM26 undifferentiated 53.1, SM11 51.3, SM14c 47.5, SM14 undifferentiated 46.3, SM10 45.9, SM14a 45.0, SM13f 44.5, SM7 44.3, SM9 44.0. Diagnosis – this rather mixed vegetation lacks *Puccinellia maritima* and has little *Atriplex portulacoides* suggesting that it is something other than the prevalent 'SM13 *Puccinellia maritima* saltmarsh community' or 'SM14 *Halimione portulacoides* saltmarsh community' of the wider survey area. In the absence of *Sarcocornia perennis* the match with 'SM7 *Arthrocnemum perenne* stands' can be dismissed, and the small amounts of annual *Salicornia* species and *Suaeda maritima* are insufficient to warrant acceptance of matches with low marsh NVC types such as 'SM9 *Suaeda maritima* saltmarsh community' or 'SM10 Transitional low-marsh vegetation with *Puccinellia*

maritima, annual *Salicornia* species and *Suaeda maritima*'. The high cover of *Tripolium panonnicum* is too high for straightforward 'SM26 *Inula crithmoides* on saltmarshes' does suggest that 'SM11 *Aster tripolium* var. *discoideus* saltmarsh community' might be a correct diagnosis, but the range and cover of associated species is too great.

Appendix 2 – Target Notes

Target Note A1.1 – TQ 70221 81381, 30 June 2023. A large stand of *Lepidium latifolium* among terrestrial (non-SM) vegetation types including MG1b and W24a.

Target Note A1.2 - TQ 70256 81358. The western end of berm grassland vegetation with *Polypogon monspeliensis* described in Target Note 1.X.

Target Note A1.3 – TQ 70306 81283, 30 June 2023. SM14 with *Juncus gerardii* at exceptionally high cover of more than 50% in a *c.*7 m patch too small to map. Quadrat data are given in column 1 of Quadrat Table 1.2.

Target Note A1.4 – TQ 70321 81319, 30 June 2023. Vegetation featuring *Limbarda crithmoides* at moderate levels of abundance and otherwise dominated by *Atriplex portulacoides* or *Elymus athericus* in mosaic and transition at a patch-scale too small to map. Lower marsh species such as *Tripolium panonnicum* and *Plantago maritima* are present in small quantity. *Elymus athericus* should not occur in 'SM26a *Inula crithmoides* on saltmarshes, lower marsh sub-community' while lower marsh species should not occur in 'SM26b *Inula crithmoides* on saltmarshes, stands with *Elymus pycnanthus*' and therefore this has been mapped as SM14-SM26 undifferentiated.

Target Note A1.5 – TQ 70402 81393. A creek-side area where *Cochlearia anglica* is locally frequent in SM14Ea and SM24 in mosaic and transition. Though it is not common in the North Thames saltmarshes, its presence does not affect any NVC diagnosis.

Target Note A3.1. Though the saltmarsh edge zonation here is mapped as strips of SM6 and SM11 dominated by *Spartina anglica* and *Tripolium panonnicum* var. *flosculosus* respectively with SM14c dominated by *Atriplex portulacoides* in the middle marsh, the edge zone is locally quite confused and locally open (cover *c*.60%) with diverse mixtures of low marsh species including *Puccinellia maritima*, *Spartina anglica*, *Suaeda maritima* and *Tripolium panonnicum* might be assigned to 'SM10 Transitional low-marsh vegetation with *Puccinellia maritima*, annual *Salicornia* species and *Suaeda maritima*' were they not also confused with relatively abundant *Atriplex portulacoides*.

Target Note A3.2. Vegetation at the foot of the seawall in which *Limbarda crithmoides* is abundant together with *Elymus athericus* and *Beta vulgaris* ssp. *maritima*. A few species more typical of the inter-tidal are present including *Lysimachia maritima*.

Target Note A2.3. Very unusual vegetation with *Polypogon monspeliensis* on geotextile netting protecting a narrow zone of saltmarsh at the foot of the seawall. It is more fully explained in Quadrat Table 3.1, and it has affinities with additional community types not indicated in the map codes.

Target Note A2.4. Sparse and fragmentary lower marsh vegetation with *Spartina anglica* and *Tripolium panonnicum* not sufficient to map as a unit.

Target Note A2.5. The foreshore towards the outer end of the spit has a 1-metre cliff below SM24 vegetation dominated by *Elymus athericus* on the seawall. *Limbarda crithmoides* is locally abundant (not mapped). Below this there is a narrow zone of sparse lower marsh plants including *Salicornia* species, *Spartina anglica* and *Tripolium panonnicum* that might be regarded as a

mosaic of many communities including *Spartina maritima*^, *Spartina maritima**, SM10 and SM11 but for simplicity mapped as SM10.

Target Note A2.6. Confused patches of lower marsh plants on mud, including *Spartina anglica* and *Tripolium panonnicum* not easily mapped.

Target Note D1.1 - TQ 6951 7892. The vegetation on the outer face of the seawall shows strong vertical zonation. Starting *c.*4 m below average high tide level there is a *c.*2m-wide belt of *Fucus* species, then (working upwards) a *c.*2m-wide belt of rock (probably ragstone), then a *c.*1-m wide belt of open SM26 (*c.*60% cover) in which *Limbarda crithmoides* is prominent together with a limited range of upper marsh species (Quadrat 6.1), then a *c.*2 to 3-m wide belt of SM24 strongly dominated by *Elymus athericus* reaching to the top of the wall where it grades into rough grassland, probably MG1 that is slightly maritime in character. The SM24 has small amounts of *Artemisia maritima* insufficient to warrant recording as SM17.

Target Note D1.2 - TQ 6951 7890. Zoned seawall vegetation that is similar to that described in Target Note 6.1 but here with a wider belt of SM26 on a berm *c.*2-3 m wide (Quadrat 6.2).

Target Note D1.3 – TQ 6943 7872. Open strandline vegetation at the foot of the seawall mostly consists of scattered *Atriplex littoralis*, *Beta vulgaris* ssp. *maritima* and *Suaeda maritima*. The *Suaeda* creates some affinities with SM9 to which it cannot be assigned on account of the other species. It has closer affinities with the *Atriplici-Betetum maritimae* or 'MC6 *Atriplex prostrata-Beta vulgaris* ssp. *maritima* sea-bird cliff community' which sometimes occurs on strandline debris according to Rodwell (2000). Such mixtures of *Atriplex* species and *Beta* occur where strandlines are nutrient-rich owing to accumulations of organic debris, a requirement that is indeed met along the North Thames shore. Closed vegetation immediately above the strandline is variously dominated by *Atriplex portulacoides* and *Elymus athericus* and therefore belongs to SM14 and SM24 in mosaic and transition, giving way higher on the seawall slope to pure SM24.

Target Note D1.4 – TQ 6943 7849. Middle-marsh vegetation dominated by by *Atriplex portulacoides* and referable to SM14Jm with a dense stand of *Juncus maritimus* and scattered *Juncus maritimus* and *Juncus gerardii* over a *c.*50 m radius.

Target Note D1.5 – Bare mud and *Fucus* cf. *vesiculosus*.

Appendix 3

Table 1: Notable species recorded during survey. Species in bold where Red List risk status is VU or higher.

Scientific name	Common name	Threat Status on England Red List	Notes on Rarity
Althaea officinalis	Marshmallow	NT Eng, NS	
Anacamptis morio	Green-winged Orchid	VU	
Artemisia absinthium	Wormwood	LC	Historic Decline
Artemisia maritima	Sea Wormwood	NT	
Asplenium adiantum-nigrum	Black Spleenwort	LC	Essex Listed
Asplenium ruta-muraria	Wall-rue	LC	Essex Listed
Blitum bonus-henricus	Good-King-Henry	VU	Archaeophyte, Essex Listed
Bupleurum tenuissimum	Slender Hare's-ear	VU (A2c) NS GB	Stroh et al., 2013
Carex divisa	Divided Sedge	VU (A2c) NS GB	Stroh et al., 2013
Carlina vulgaris	Carline Thistle	NT	Essex Listed
Catapodium marinum	Sea Fern-grass	LC	Essex Listed
Cerastium semidecandrum	Little Mouse-ear	LC	Essex Listed
Chenopodiastrum murale	Nettle-leaved Goosefoot	EN	
Chenopodium vulvaria	Stinking Goosefoot	EN	Rare
Cochlearia anglica	English Scurvygrass	LC	Essex Listed
Clinopodium nepeta	Lesser Calamint	LC, NS	
Crepis biennis	Rough Hawk's-beard	LC	Essex Listed
Cynoglossum officinale	Hound's-tongue	NT	Essex Listed
Dactylorhiza x *grandis*	A hybrid orchid	Not listed	Essex Listed
Dactylorhiza incarnata	Early Marsh-orchid	WL	Historic Decline
Erophila verna	Common Whitlowgrass	NT	
Galium parisiense	Wall Bedstraw	VU	native/alien NS
Geranium rotundifolium	Round-leaved Crane's bill	LC	Essex Listed
Hippophae rhamnoides	Sea buckthorn	LC, NS	probable introduction at Essex sites
Hordeum marinum	Sea barley	YU, NS GB	Stroh et al., 2013
Inula conyzae	Ploughman's-spikenard	LC	Essex Listed
Jacobaea aquatica	Marsh Ragwort	NT	Essex Listed
Lepidium latifolium	Dittander	LC	Formerly NS now on roads due to de-icing salt
Limbarda crithmoides	Golden-samphire	LC, NS GB	Stroh et al., 2013
Limonium vulgare	Common Sea-lavender	NT	

Scientific name	Common name	Threat Status on England Red List	Notes on Rarity
Logfia minima	Small Cudweed	NT	
Lotus angustissimus	Slender Bird's-foot-trefoil	NT, NS	not in Essex Floras
Lotus tenuis	Narrow-leaved Bird's-foot-trefoil	LC	
Marrubium vulgare	White Horehound	LC, NS GB	Stroh et al., 2013
Medicago polymorpha	Toothed Medick	LC, NS	
Moenchia erecta	Upright Chickweed	VU	
Myosotis discolor	Changing Forget-me-not	LC	Essex Listed
Myosotis ramossisima	Early Forget-me-not	LC	Essex Listed
Oenanthe lachenalii (Parsley Waterdropwort) NT Eng (LC UK)	Parsley Waterdropwort	NT Eng (LC UK)	
Origanum vulgare	Wild Marjoram	LC	Essex Listed
Oxybasis glauca	Oak-leaved Goosefoot	VU	NS Page 15 of 25
Oxybasis chenopodioides	Saltmarsh Goosefoot	LC, NS GB	Stroh et al., 2013
Parapholis incurva	Curved Hardgrass	LC, NS GB	Stroh et al., 2013
Poa bulbosa	Bulbous Meadowgrass	LC, NS	
Polycarpon tetraphyllum	Four-leaved Allseed	LC, NS	
Polypogon monspeliensis	Annual Beardgrass	LC, NS GB	Stroh et al., 2013
Potentilla argentea	Hoary Cinquefoil	NT	
Puccinellia fasciculata	Borrer's Saltmarsh-grass	NT Eng (VU UK), NS	
Ranunculus sardous	Hairy Buttercup	LC	
Rumex hydrolapathum	Water Dock	LC	Essex Listed
Rumex maritimus	Golden Dock	LC, NS GB	Stroh et al., 2013
Rumex pulcher	Fiddle Dock	LC	Essex Listed
Salicornia fragilis	Yellow Glasswort	LC, NS	
Salvia verbenaca	Wild Clary	NT	Essex Listed
Sarcocornia perennis	Perennial Glasswort	LS, NS	
Saxifraga granulata	Meadow Saxifrage	LC	Historic Decline
Saxifraga tridactylites	Rue-leaved Saxifrage	LC	Essex Listed
Scilla autumnalis	Autumn Squill	LC, NS	
Spiranthes spiralis	Autumn Lady's-tresses	NT, NS	
Stellaria pallida	Lesser Chickweed	LC	Essex Listed
Stratiotes aloides	Water Solider	LC	Native/alien NS GB Stroh et al., 2013
Trifolium fragiferum	Strawberry Clover	VU Eng (LC UK)	
Trifolium squamosum	Sea Clover	LC	49% decline since 1987
Valerianella locusta	Common Cornsalad	LC	
Verbena officinalis	Vervain	LC	

Appendix 4 – Species lists

Table 2: Vascular plant species recorded in the North Thames survey areas (Figure 2) between 26 and 30 June 2023 (also 9 August 2023). Relative abundance: A – abundant, F – frequent, O – occasional, R – rare. Ecological notes: as stated SM – intertidal saltmarsh, SWA seawall and grazing-marsh habitat complex, WoPD – weed of path-sides and disturbance, ODS – open disturbed saline soils.

Species name	Relative abundance	Ecological notes
X*Agropogon lutosus* (an *Agrostis* × *Polypogon* hybrid)	R	SWA
Agrostis stolonifera (Creeping Bent)	A	Widespread
Anacamptis pyramidalis (Pyramidal Orchid)	LF	SSSI Unit 1
Apera spica-venti (Loose Silky-bent)	R	WoPD
Armeria maritima (Thrift)	R	SM
Arrhenatherum elatius (False Oat-grass)	A	Widespread
Armeria maritima (Thrift)	R	SM
Atriplex littoralis (Grass-leaved Orache)	O	ODS
Atriplex portulacoides (Sea-purslane)	A	SM
Atriplex prostrata (Spear-leaved Orache)	O	ODS
Beta vulgaris ssp. *maritima* (Sea Beet)	F	SWA
Bolboschoenus maritimus (Sea Club-rush)	O	SWA
Carex divisa (Divided Sedge)	LA	SWA
Cochlearia anglica (English Scurvygrass)	O	SM
Dactylorhiza fuchsii (Common Spotted-orchid)	LF	SSSI Unit 1
Daucus carota ssp. *carota* (Wild Carrot)	LF	Widespread
Elymus athericus (Sea Couch)	R	SM
Elymus repens (Common Couch)	A	SWA
Festuca rubra ssp. *littoralis* (Red Fescue)	R	SM

Species name	Relative abundance	Ecological notes
Festuca rubra (Red Fescue)	A	Widespread
Helminthotheca echioides (Bristly Oxtongue)	F	Widespread
Hordeum marinum (Sea Barley)	LA	ODS
Hordeum secalinum (Meadow Barley)	O	SWA
Juncus bufonius (Toad Rush)	O	Widespread
Juncus gerardii (Saltmarsh Rush)	LA	SM
Juncus maritimus (Sea Rush)	LF	SM
Lactuca serriola (Prickly Lettuce)	LA	WoPD
Lactuca virosa (Great Lettuce)	LF	WoPD
Lathyrus nissolia (Grass Vetchling)	O	SWA
Lepidium draba (Hoary Cress)	O	WoPD
Lepidium latifolium (Dittander)	O	SM
Limbarda crithmoides (Golden-samphire)	F	SM
Limonium x *neumannii* (a hybrid Sea-Lavender)	R	SM
Limonium vulgare (Common Sea-lavender)	R	SM
Lotus tenuis (Narrow-leaved Bird's-foot-trefoil)	LF	SWA
Lysimachia maritima (Sea-milkwort)	O	SM
Oenanthe lachenalii (Parsley Water-dropwort)	R	SSSI Unit 1
Oxybasis chenopodioides (Saltmarsh Goosefoot)	VR	SWA
Parapholis strigosa (Hard-grass)	LA	ODS
Phragmites australis (Common Reed)	LA	Moats
Picris hieracioides (Hawkweed Oxtongue)	LF	WopD, SSSI Unit 1
Plantago lanceolata (Ribwort Plantain)	F	Widespread
Plantago major ssp. *major* (Greater Plantain)	F	WoPD

Species name	Relative abundance	Ecological notes
Plantago maritima (Sea Plantain)	LA	SM
Polygonum arenastrum (Equal-leaved Knotgrass)	LA	WopD
Polypogon monspeliensis (Annual Beard-grass)	R	WoPD
Poa trivialis (Rough Meadow-grass)	F	Widespread
Puccinellia maritima (Common Saltmarsh-grass)	A	SM
Puccinellia distans (Reflexed Saltmarsh-grass)	O	ODS
Puccinellia fasciculata (Borrer's Saltmarsh-grass)	R	ODS
Puccinellia rupestris (Stiff Saltmarsh-grass)	R	ODS
Ranunculus baudotii (Brackish Water-crowfoot)	LA	Moats
Ranunculus sardous (Hairy Buttercup)	A	Grazing-marsh
Rapistrum rugosum (Bastard Cabbage)	A	Alien ruderal
Rhinanthus minor (Yellow-rattle)	LF	SSSI Unit 1
Rumex crispus (Curled Dock)	LF	Grazing-marsh
Salicornia europaea agg. (Glasswort)	LF	Moats
Silybum marianum (Milk-thistle)	R	Alien ruderal
Sison segetum (Corn Parsley)	R	SWA
Sonchus arvensis (Perennial Sow-thistle)	O	WoPD
Spartina anglica (Common Cord-grass)	A	SM
Spergularia marina (Lesser Sea-spurrey)	O	ODS
Spergularia media (Greater Sea-spurrey)	R	ODS
Suaeda maritima (Annual Sea-blite)	LF	Moats
Taraxacum species (Dandelion)	F	Amenity turf, WoPD
Torilis nodosa (Knotted Hedge-parsley)	LA	SWA
Tragopogon porrifolius (Salsify)	R	SWA

Species name	Relative abundance	Ecological notes
Trifolium campestre (Hop Trefoil)	LF	SSSI Unit 1
Trifolium dubium (Lesser Trefoil)	LF	Widespread
Trifolium pratense (Red Clover)	O	Widespread
Trifolium repens (White Clover)	LF	Amenity turf
Trifolium squamosum (Sea Clover)	F	Grazing-marsh, ODS
Triglochin maritimum (Sea Arrowgrass)	F	SM
Tripleurospermum inodorum (Scentless Mayweed)	LA	Grazing-marsh, WoPD
Tripolium panonnicum var. *flosculosus* (Sea Aster)	F	Moats
Tripolium panonnicum var. *tripolium* (Sea Aster)	O	ODS
Vicia villosa (Fodder Vetch)	A	Alien ruderal

Appendix 5 – Plates

In the legends A1, C1, D2, F4 etc. are the survey areas referred to in the methods section of the main report. The plates have been prepared from photographs taken by the following: Richard Carter - Plates A1.2-A1.3, A1.5-A1.9, A1.11-A14, A2.1-2.6, A3.1, A3.3-A3.6, D1.1, D3.1-D3.3, D3.5-D3.10, D4.3-D4.5, F3.2-F3.5; Pete Flood - Plates A1.1, A1.4, A1.10, A2.7, A3.7, C1.1-C1.12, D1.2, D2.1-D2.14, D3.4; Sarah Harmer - Plates A3.2, D4.1-D4.2, F1.1-F1.18, F2.1-F2.12, F3.1, F4.1-F4.10.

A1 – London Gateway Port Marsh

Plate A1.1. View east across A1 showing a mosaic of SM14a, SM14Jg (browner parts) and SM14Ea (parts with emergent glaucous grass) in the fore- and middle-ground.

Plate A1.2. Mosaic of SM14Ea, SM14b (with dark green *Juncus maritimus*), and SM14c in the eastern part of A1 (the spit of an old seawall on the eastern boundary of A1 shows in the background).

Plate A1.3. Mosaic of SM14a, SM14Jg, SM14Ea and fragmentary SM14b in the eastern part of A1 (the spit of an old seawall on the eastern boundary of A1 shows in the background).

Plate A1.4. Extensive SM14Jg in the central part of A1 (several other NVC types in the background) looking north to the new seawall.

Plate A1.5. Detail of SM14Jg in the central part of A1. This example has some *Puccinellia maritima* which is not always present in this variant.

Plate A1.6. Detail of the transition from SM14Ea to SM24 in the eastern part of A1.

Plate A1.7. SM14Ea at the outer edge of the marsh in the eastern part of A1 looking east.

Plate A1.8. Detail of SM14Ea in A1. From a short distance the cover of emergent *Elymus athericus* appears very high making such vegetation hard to distinguish from SM24, but here the *Elymus* is growing through 100% cover of *Atriplex portulacoides*.

Plate A1.9. Looking east, a mosaic of SM14a and SM14c at the outer edge of the marsh ends in clay cliffs in the central part of A1.

Plate A1.10. Looking east, a mosaic of SM14a and SM14c at the outer edge of the marsh ends in clay cliffs in the western central part of A1.

Plate A1.11. The central part of A1 contains a few typical saltmarsh creeks, which are otherwise rare in the North Thames area – here they are surrounded by SM14a and SM14Ea with SM14Jg in the background.

Plate A1.12. *Puccinellio-Spergularion* vegetation, probably closest to the *Puccinellietum distantis* but with abundant *Polypogon monspeliensis* on the lower berm of the south-facing seawall west of A1 and east of A3.

Plate A1.13. Dense stands of *Polypogon monspeliensis* in *Puccinellio-Spergularion* vegetation on the lower berm of the south-facing seawall west of A1 and east of A3.

Plate A1.14. The inter-generic hybrid grass X *Agropogon lutosus* (*Polypogon monspeliensis* × *Agrostis stolonifera*) in *Puccinellio-Spergularion* vegetation on the lower berm of the south-facing seawall west of A1 and east of A3.

A2 – Mucking Spit and foreshores

Plate A2.1. Above a narrow fringe of SM10, non-NVC vegetation dominated by *Spergularia marina* grows on geotextile laid along parts of the seaward side of Mucking Spit below mixed rough grassland and bramble scrub on the old seawall.

Plate A2.2. Detail of non-NVC vegetation on geotextile laid along parts of the seaward side of Mucking Spit. It is here dominated by *Parapholis strigosa* and *Spergularia marina* with occasional *Polypogon monspeliensis* and *Suaeda maritima* suggesting affinities with *Puccinellio-Spergularion* vegetation.

Plate A2.3. The seaward edge of the outer end of Mucking Spit showing a compressed zonation with *Fucus* and SM6 to seaward, SM11 and fragmentary SM14 along the high-tide line, and SM24 above.

Plate A2.4. The hybrid sea-lavender *Limonium* × *neumanii* (*L. humile* × *L. vulgare*) on the seaward side of Mucking Spit.

Plate A2.5. Saltmarsh edge zonation at Mucking Spit with SM6 with *Spartina anglica* to seaward, and SM11 with *Tripolium panonnicum* var. *flosculosus* plus confused SM10 above.

Plate A2.6. Saltmarsh zonation at Mucking Spit with SM11 to seaward, confused SM14 with *Limonium* × *neumanii* in the middle, and SM24 on the old seawall.

Plate A2.7. Colonising *Spartina anglica* forming SM6 on mud in A2.

A3 - Mucking Creek

Plate A3.1. Looking north across the upper part of Mucking Creek with extensive stands of S4a strongly dominated by *Phragmites australis* among scattered bramble and thorn scrub on the adjacent rising ground.

Plate A3.2. The main channel of Mucking Creek to seaward of the coastal path bridge, variously overhung by S4a or S4b, SM11 and SM14a.

Plate A3.3. The middle marsh at Mucking Creek to seaward of the coastal path bridge is flanked by the main channel (right of picture) and a raised 19th or early 20th century rubbish tip (left of picture). It is mostly grassy SM16a dominated by *Festuca rubra* but the plate also shows pans and surrounding *Juncus maritimus*.

Plate A3.4. The middle marsh at Mucking Creek to seaward of the coastal path bridge is here mostly SM16a strongly dominated by *Festuca rubra* with occasional patches of *Juncus maritimus*. The old landfill cliff behind has ruderal vegetation dominated by *Carduus tenuiflorus* and *Conium maculatum* – it is a hazardous area with steep slopes, loose ashy soils and abundant broken glass and jagged metal.

Plate A3.5. Detail of middle-marsh SM16a at Mucking Creek with abundant *Festuca rubra* and occasional *Puccinellia maritima*, *Triglochin maritimum* and *Tripolium panonnicum* var. *flosculosus*.

Plate A3.6. Detail of middle-marsh SM16a at Mucking Creek with locally abundant *Lysimachia maritima*.

Plate A3.7. Detail of middle-marsh SM16a at Mucking Creek with locally abundant *Limbarda crithmoides*.

C1 – East of Enovert Landfill

Plate C1.1. SM6 colonising on mud at the northern tip of D1.

Plate C1.2. A narrow strip of confused SM6, SM10 and SM11 below ruderal vegetation dominated by *Conium maculatum* on the seawall in the northern part of D1.

Plate C1.3. Looking north towards Thames Gateway Port across SM14a and SM14*Juncus gerardii* in the northern part of D1.

Plate C1.4. SM14a in the northern part of D1 with *Limbarda crithmoides* on the edge of a clay cliff perhaps amounting to fragmentary SM26a.

Plate C1.5. Detail of SM14Jm in D1.

Plate C1.6. View of SM14a strongly dominated by *Atriplex portulacoides* grading into SM26b with *Limbarda crithmoides* at the upper edge of the marsh in D1.

Plate C1.7. A narrow strip of SM26b below bramble scrub on the seawall at the disused wharfage in D1.

Plate C1.8. South of the disused wharfage in D1 looking south across a wide strip of SM26a grading into relatively species-rich SM14 perhaps transitional to SM13c in the middle marsh and SM14Ea in the upper marsh.

Plate C1.9. Detail of relatively species-rich SM14 with abundant *Armeria maritima* - generally rare in the North Thames area - perhaps transitional to SM13c in the middle marsh of D1 south of the disused wharfage.

Plate C1.10. Detail of relatively species-rich SM14 with abundant *Armeria maritima* – generally rare in the North Thames area – in the centre of D1.

Plate C1.11. SM26b with both *Limbarda crithmoides* and *Artemisia maritima* (generally rare in the North Thames area) abundant in the centre of D1.

D1 – East Tilbury Marshes

Plate D1.1. Zonation near the disused wharfage in D1 showing SM24 in the upper marsh, SM14a in the middle marsh and SM11 to seaward.

Plate D1.2. View north from the southern tip of D1 looking across SM14 in the foreground though SM13 is probably extensive beyond.

D2 – Mucking Flats Marshes

Plate D2.1. Looking north-east across extensive saltmarsh in D2 and D1 with SM24 and SM14Ea in the foreground.

Plate D2.2. Patchy swamp vegetation – S21b in foreground and S4b in background – on the upper edge of the intertidal marsh in D2 outside SSSI Unit 1.

Plate D2.3. Extensive SM14Jg in D2 near Coalhouse Fort with SM14Ea in background to landward.

Plate D2.4. Looking towards Coalhouse Fort from the seaward part of D2 across extensive SM13a and SM14c in mosaic and transition.

Plate D2.5. Looking to seaward in D2 near Coalhouse Fort across extensive SM13a and SM14c in mosaic and transition.

Plate D2.6. Looking towards Coalhouse Fort in D2 with abundant *Tripolium panonnicum* var. *flosculosus* in SM14Tp perhaps grading into SM11 out of picture.

Plate D2.7. The seaward part of D2 near Coalhouse Fort showing gradation from SM11 through SM14Tp to SM14Ea.

Plate D2.8. *Tripolium panonnicum* var. *flosculosus* – the usual taxon in the intertidal marsh – in D2.

Plate D2.9. Rayed Sea-aster *Tripolium panonnicum* var. *pannonicum* occurs in SM12 but very occasionally occurs sparingly in the intertidal marsh as here in D2.

Plate D2.10. In SM13 in D2 *Puccinellia maritima* is the dominant grass.

Plate D2.11. *Triglochin maritimum* in D2.

Plate D2.12. Low marsh at the southern end of D2 with extensive SM11 and SM10 towards the middle marsh where here there is an abrupt switch to SM14Ea on slightly higher ground.

Plate D2.13. Annual *Salicornia* – in low marsh perhaps *Salicornia dolichostachya* – is seldom prominent in the North Thames area but occurs locally in SM10 at the southern end of D2.

Plate D2.14. Owing to modified topography there are swathes of upper marsh SM24 across the marsh at the southern end of D2 near the WWII anti-aircraft tower.

D3 – SSSI Unit 1 and Coalhouse Fort

Plate D3.1. S21a in foreground and S4a in background in the north-western part of SSSI Unit 1

Plate D3.2. S21a strongly dominated by *Bolboschoenus maritimus* in the north-western part of SSSI Unit 1

Plate D3.3. Large parts of D3 in SSSI unit 1 are dominated by the alien *Vicia villosa*.

Plate D3.4. A fringe of *Puccinellio-Spegularion* vegetation alongside the outer moat at Coalhouse Fort in D3.

Plate D3.5. A stand of *Hordeum marinum* in *Puccinellio-Spegularion* vegetation alongside the outer moat at Coalhouse Fort in D3.

Plate D3.6. A stand of *Parapholis strigosa* in *Puccinellio-Spegularion* vegetation alongside the outer moat at Coalhouse Fort in D3.

Plate D3.7. *Puccinellia fasciculata* in *Puccinellio-Spegularion* vegetation at Coalhouse Fort in D3.

Plate D3.8. *Puccinellia rupestris* in *Puccinellio-Spegularion* vegetation at Coalhouse Fort in D3.

Plate D3.9. SM21a swamp strongly dominated by *Bolboschoenus maritimus* grading into maritime mesotrophic grassland loosely referable to the NVC type MG1 but featuring maritime forms of *Elymus repens* in D3 south of Coalhouse Fort.

Plate D3.10. *Oxybasis chenopodioides* with *Atriplex prostrata* in a winter-flooded pan in SM21 in D3 south of Coalhouse Fort.

D4 - LTC4 / DHL foreshore

Plate D4.1. Confused saltmarsh including SM26a in D4 just east of the LTC4 /DHL foreshore.

Plate D4.2. A field corner in D4 with a population of *Polypogon monspeliensis* and other species characteristic of *Puccinellio-Spergularion* vegetation (though too open to identify as any particular type) below the (raised) coastal path just east of the landfill site.

Plate D4.3. Strandline vegetation at D4 with *Elymus athericus* and diverse Amaranthaceae below ruderal vegetation dominated by *Rapistrum rugosum* on the 19th or early 20th century landfill site.

Plate D4.4. Detail of strandline vegetation in D4 with *Elymus athericus*, *Beta vulgaris* ssp. *maritima*, *Suaeda maritima*, *Atriplex littoralis*, *Atriplex prostrata* (or *Atriplex glabriuscula* from which it cannot be distinguished without fruits) and *Chenopodium album*.

Plate D4.5 Detail of the smaller strandline plants in D4 with *Suaeda maritima*, *Atriplex littoralis*, *Atriplex prostrata* (or *Atriplex glabriuscula* from which it cannot be distinguished without fruits) and *Chenopodium album*.

F1 - Tilbury Power Station foreshore

Plate F1.1. The eastern end of F1 with SM24 to landward, SM14 in the middle marsh, and SM26a giving way directly to Fucus at the outer edge.

Plate F1.2. The eastern tip of F1 showing extensive SM14Tp in the lower part of the middle marsh.

Plate F1.3. The eastern part of F1 showing SM14a with a few large plants of *Limbarda crithmoides* behind an abrupt outer edge along a line of masonry blocks.

Plate F1.4. Looking west in F1 towards the easternmost of three jetties, with SM24 adjacent to the seawall, SM14Ea and SM14a in the middle marsh and variously abrupt edges related to artificial features of the shoreline including accretions of boulders.

Plate F1.5. The abrupt edge to SM14a middle marsh in F1 looking west towards the easternmost of three jetties, with scattered plants of *Limbarda crithmoides* and patches of SM6 to seaward.

Plate F1.6. Complex mosaics of SM6, SM11, SM14a, SM14Ea and SM24 in F1 near the easternmost of three jetties.

Plate F1.7. Detail of SM14a and perhaps SM14Ea at the easternmost of three jetties in F1.

Plate F1.8. Extensive SM14, mostly SM14a, east of the central of three jetties and looking east in F1, with a narrow strip of SM24 at the base of the seawall.

Plate F1.9. Extensive SM14, mostly SM14a, and SM11 at the marsh edge looking west from the central of three jetties in F1.

Plate F1.10. Gap in fringing saltmarsh just west of the central of three jetties in F1.

Plate F1.11. Older-style block facing on the seawall in the central part of F1 with *Atriplex portulacoides*, *Plantago maritima* and *Spartina anglica* in the joints.

Plate F1.12. SM14 in F1 with *Limonium vulgare* – generally very uncommon in the North Thames area – and *Triglochin maritimum*.

Plate F1.13. Detail of SM13 in the central part of F1.

Plate F1.14. The western end of F1 with SM11, SM14a and SM24.

Plate F1.15. Detail of SM14Tp in F1.

Plate F1.16. The western end of F1 with SM24 grading straight into SM11.

Plate F1.17. The marsh edge at the western end of F1 with Fucus, SM11 and a narrow transition into middle marsh SM14a.

Plate F1.18. Detail of SM11 and *Fucus* at the marsh edge at the western end of F1.

F2 - Bill Meroy Creek

Plate F2.1. Looking from F1 into the eastern part of F2 with a broad strip of SM24, SM14Ea and SM14a.

Plate F2.2. The eastern end of F2 looking east with SM24, SM14a and SM11.

Plate F2.3. Detail of SM14a at the eastern end of F2.

Plate F2.4. Confused SM24 and SM14 at the eastern side of the mouth of Bill Meroy Creek in F2.

Plate F2.5. Looking across the mouth of Bill Meroy Creek in F2.

Plate F2.6. Detail of SM26a on the eastern side of Bill Meroy Creek in F1.

Plate F2.7. SM26a, SM14a and SM24 on the eastern side of Bill Meroy Creek in F1.

Plate F2.8. General view of the eastern side of Bill Meroy Creek in F1 with SM24, SM14Ea, SM14a, and SM26a.

Plate F2.9. Extensive SM14a and some SM11 at the head of Bill Meroy Creek in F1.

Plate F2.10. Detail of SM14a in Bill Meroy Creek in F1.

Plate F2.11. A large patch of colonising *Puccinellia maritima* on mud in Bill Meroy Creek in F1.

Plate F2.12. SM14a and SM11 on the western side of Bill Meroy Creek in F1.

F3 – Tilbury Fort

Plate F3.1. The Tilbury Fort foreshore in F3 with concrete, boulders and *Fucus* but no saltmarsh.

Plate F3.2. Ephemeral saltmarsh vegetation, mostly SM9 with *Suaeda maritima*, in the seasonally dry outer moat east of Tilbury Fort on 19 August 2024. In June the same moat had shown *c.*30 cm depth of water and populations of *Ranunculus baudotii*.

Plate F3.3. Mixed saltmarsh vegetation in the outer moat west of Tilbury Fort on 19 August 2024.

Plate F3.4. Grazing marsh east of Tilbury Fort with *Lepidium latifolium*.

Plate F3.5. *Bupleurum tenuissimum* in grazing-marsh east of Tilbury Fort on 19 August 2024.

F4 - Tilbury Cruise Terminal

Plate F4.1. SM6 and SM11 in the eastern corner of F4.

Plate F4.2. Looking west across F4 with SM6 on mud to seaward of a low relic wall and SM11 to landward.

Plate F4.3. SM11 in F4 with fragmentary SM24 in the joints between concrete blocks in an older style of seawall.

Plate F4.4. Detail of SM24 on a concrete block wall in F4.

Plate F4.5. The central part of F4 with relatively extensive SM14 plus some SM26a at the lower edge of the marsh and SM26b at the upper edge.

Plate F4.6. Detail of SM26b at the base of the seawall in F4.

Plate F4.7. SM24 and SM14 in the central part of F4.

Plate F4.8. A patch of S4 *Phragmites australis* swamp in the western part of F4.

Plate F4.9. View across F4 from the west.

Plate F4.10. Ruderal SM24 with *Elymus athericus* plus *Lepidium draba* in F4.

www.gov.uk/natural-england