CENTRE FOR ECOLOGY AND HYDROLOGY

(NATURAL ENVIRONMENT RESEARCH COUNCIL)

CEH Project C02936 DE Contract no. LSS53099

Vegetation and Habitat Survey of the Fingringhoe Ranges

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31 January 2006

Executive summary

I. A vegetation survey of the Fingringhoe Ranges (Essex) was carried out in August 2005, complemented by a contemporary remote-sensing habitat survey, focussing on *ca* 680ha of salt marsh, grazing marsh, reed-bed, ditches, agricultural grassland and scrub.

II. The aim of the vegetation survey was to provide accurate and consistent information on the composition, location and extent of the different vegetation types and habitats present. This survey was carried out using a very slightly modified form of the standard methodology described by the *National Vegetation Classification* (*NVC*) and successfully implemented previously on other training areas managed by Defence Estates.

III. The Fingringhoe Ranges comprise some 28 different *NVC* communities, together with a range of sub-communities, mosaics and assemblages that are not readily classified within the *NVC*. The occurrence, extent and distribution of these vegetation types are determined principally by the degree of tidal inundation, hydrology and management practices. These vegetation types were characterised within the CEH survey using 243 sample quadrats distributed through 45 sampling units (fields, woodlands and blocks of salt-marsh).

IV. The site has considerable conservation interest due in large part to the lack of public pressure on its salt-marshes and coastal grasslands. The structural diversity of the habitats also represents an important biodiversity resource. The Fingringhoe Ranges contain significant populations of 10 Nationally Scarce plant species (9 of which were recorded during the survey), and several local rarities within a total recorded flora of *ca* 300 species.

V. In terms of area and the designated species that it holds, the most important broad habitat at Fingringhoe is salt-marsh, accounting for *ca* 35% of the area. Good examples of 9 distinct *NVC* communities were identified and mapped, with at least 5 further component sub-communities. In addition, fragmentary stands of 4 other *NVC* types (**SM12**, **SM16**, **SM23** and **SM26**) were located, though their cover was negligible. The salt-marsh communities showed a marked differentiation between areas that had previously been reclaimed (but subsequently reverted) and areas of essentially natural salt-marsh. In the former area (Fingringhoe Marsh), **SM6** *Spartina anglica*, **SM8** Annual *Salicornia* and **SM11** *Aster tripolium* var *discoideus* were all frequent, growing generally at lower levels than **SM13** *Puccinellia maritima* and **SM14** *Halimione portulacoides*. In the Geedon Saltings **SM13** and **SM14** formed a mosaic, with **SM24** *Elymus pycnanthus* at the highest levels.

VI. Grassland covered 46.6% of the Ranges – excluding the tidal grasslands of *Puccinellia* and *Elytrigia atherica*. Most of this grassland is mesotrophic, but very locally (*ca* 10ha) the sward had a higher proportion of *Agrostis capillaris* or *Holcus lanatus*/*Festuca rubra* and were better classified as maritime (**MC9**) or calcifuge (**U4**) grasslands. These dry grasslands are sheep-grazed and have a low cover of *Lolium perenne*.

VII. Mesotrophic grassland communities occupy much of the inland portion of the Fingringhoe Ranges behind the sea-walls, but variation in management (mainly grazing, but some mowing) and, to a lesser extent, water regime led to the occurrence of 7 distinct communities with 8 sub-communities. However, patterns in management were somewhat confounded with elevation and soil-moisture. Sheep-grazed grasslands (*ca* 90ha) occurred principally on higher lying and well-drained sites, whilst lightly-grazed (semi-managed) grasslands were generally on reclaimed salt-marsh and some were prone to winter-flooding (*ca* 228 ha).

VIII. The lightly-grazed grasslands primarily comprise **MG1** *Arrhenatherum elatius* grassland, though frequently in mosaics with disturbed vegetation (**OV28**), swamps (**S21** or, more rarely, **S4**) or coarse brackish grassland (**SM24**/**SM28**). Nearer the fleets and ditches, the composition of the **MG1** very locally gives way to **MG10** *Holcus lanatus*-*Juncus effusus* rush-pasture or **MG13** *Agrostis stolonifera*-

Alopecurus geniculatus inundation grassland. The grazed swards are overwhelmingly **MG6** *Lolium perenne-Cynosurus cristatus* grasslands (sub-communities) reflecting the relatively intense grazing but without any evidence of reseeding. Where frequent cutting rather than sheep-grazing was the management regime, there were small areas of **MG7** *Lolium perenne* grassland. The richest swards were on steeper slopes, with drier shallower soils, and in a few very restricted places were closest to the **MG5** *Cynosurus cristatus-Centaurea nigra* grassland.

IX. Most of the grasslands were closed swards, where either thick litter (**MG1**) or frequent defoliation and tillering (**MG6**) limited the extent of bare ground and soil disturbance. In some fields, where the soil was disturbed (*e.g.* through scrub-clearance), the grassland became thistle-infested and referable to the **OV25** *Urtica dioica-Cirsium arvense* community. Where flooding and/or trampling created the open soil, the resultant vegetation was **OV28** *Agrostis stolonifera-Ranunculus repens* community. Other ruderal communities were present in small patches. The total extent of such land on the Ranges was *ca* 15.5-17.5ha.

X. Swamp vegetation covered about 20-25ha of the Ranges, and comprised just two communities (**S4** and **S21**) but with 5 sub-communities. Reed swamp (**S4**) was largely in a single block near Langenhoe Point, but with significant areas by fleets further west and covered ca 18ha. Swamp dominated by *Bolboschoenus maritimus* (**S21**) was more widespread, but tended to occur as smaller patches in a mosaic with grassland or lining watercourses, especially where the water was more brackish. In addition to the sampling of fields and marshes, the CEH survey covered ditches, fleets and pools on the Ranges. **S4** and **S21** were again the most important communities, but there was considerable local variation depending on water depth, whether these water-bodies were grazed or dredged at the margins, and whether the water was brackish or fresh. Very small areas of a further nine *NVC* communities of fresh-water were found (in addition to **S4** and **S21**), with the brackish-water *Ruppia maritima* community (**SM2**) being found in borrow-dykes and lagoons.

XI. Scrub and woodland were localised at Fingringhoe, but covered some 56ha of the Ranges, all of which was on the higher-lying ground. Most of this was scrub, including areas derived from old hedges and included both hawthorn (**W21**) and blackthorn scrub (**W22**), with the latter being more invasive of grassland. Hedges were especially extensive in the north and often included tall standard trees of oak, ash and maple. Between the scrub patches (or hedges) and grassland, there were local zones of bramble underscrub (**W25**). Tall woodland was confined to three blocks, all toward the western fringe of the ranges and comprising two rectangles of planted conifers and a strip of deciduous woodland (Grimps Grove) along a stream gully. None of these woodland blocks fitted well with a named *NVC* type. The conifer stands being closest to thorn scrub (**W21**/**W22**) on the basis of their understorey, whereas Grimps Grove showed some relationship to both **W8** (ash-maple) and **W6** (alder-willow) depending upon the dominant trees.

XII. In addition to the characterisation and mapping of vegetation types, the survey made an inventory of all the species present in each area of the Ranges (Defence Estate Unit, DE Compartment or CEH division) and assessed the whole flora in terms of their rarity. Ten nationally scarce plant species were observed during the CEH survey, all of which were wholly or mainly found in salt-marshes (especially in **SM24**). Six other species were noted that were thought to be rare or local in northeast Essex, although two of these were invasive alien aquatic species that are now known to be more frequent in this area. The total recorded flora was *ca* 300 species, and was especially rich in grassland, salt-marsh and ruderal species.

XIII. The results of the two approaches (field survey and remote sensing) were summarised as two vegetation maps with accompanying tables that detailed the extent (in hectares) of each land cover class and *NVC* type. A further table allowed the two approaches to be cross-referenced. The use of field survey and remote sensing is discussed. Taken together the two maps provide both an accurate portrayal of the vegetation variation on the Fingringhoe Ranges (down to the 2m x 2m pixel scale) and also a workable framework for characterising the biodiversity value of Defence Estates Units and Compartments.

XIV. The overall nature conservation interest of the Ranges was assessed and discussed by major habitat and uncommon species, together with an outline of the management approaches most likely to conserve

or enhance the existing value. The Fingringhoe Ranges were shown to be an important site for botanical diversity, and especially for the conservation of salt-marshes and for potential ecological rehabilitation of the grasslands. The landscape diversity of the site adds significant value for a wide range of vertebrates, especially birds and herptiles, and would repay study of the invertebrate fauna.

XV. The report is accompanied by two appendices. The first provides examples of all the field data-sheets used during the survey. The second appendix includes maps of the Ranges, identifying management units and divisions employed by CEH during the field survey. Further figures include both CASI and LiDAR images of the Ranges, together with vegetation maps and data-tables derived from remote sensing and from field survey. Following receipt and acceptance of the contract report, CEH will provide DE with a database of vegetation and maps, together with summaries of the mean vegetation heights, management and disturbance information for each DE unit and component communities.

Contents

1. Background

Over the past ten years, the Ministry of Defence (MoD) has sought to prepare Integrated Land Management Plans (ILMPs) for several of its training areas in the UK. The aim of ILMPs has been to enable the optimum amount of military training to be conducted in the most consistent, economic and environmentally acceptable way. The ILMP process provides a structured framework for local training estate management teams to identify and resolve potential conflicts in a consistent manner *e.g.* between training requirements on the one hand, and nature conservation, public access, amenity and archaeological interests.

This approach has led to detailed appraisals of the vegetation and habitats in a number of training areas (Pywell *et al.* 1997, 1998, 1999a, 1999b). In 2005, the NERC Centre for Ecology and Hydrology (Monks Wood) was commissioned by Defence Estates (DE) to conduct a comparable appraisal of the vegetation and habitats of the Fingringhoe Ranges, and the present report details the results of the vegetation survey and associated characterisation of the habitats.

1.1 Aims and Objectives

The overall aim of the survey was to provide accurate and consistent information on the composition, location and extent of the different vegetation types and habitats present within the Fingringhoe Ranges. To that end, the survey had certain specific objectives:

- To supply an inventory and description of the habitats, vegetation communities and species present within the ranges.
- To accurately map the location and extent of these habitats, communities and species.
- To identify species and communities of conservation importance in terms of their:
  - ⇒ *protected status and rarity*;
  - ⇒ *susceptibility to specific impacts*; and
  - ⇒ *where possible, use by other species (fauna)*.
- To provide a baseline from which to monitor change in composition, structure and extent of these habitats and communities.

2. Methodology

2.1 Vegetation survey

The survey approach followed at Fingringhoe closely followed that used in previous CEH (ITE) surveys of military training areas (*e.g.* Pywell and Walker 1997). The following account of the methodology is based directly on the approach outlined for Castlemartin AFTC (Pywell *et al.* 1999b). Such consistency of approach is intended not only to allow valuable comparison between training areas, but also to facilitate future monitoring.

2.1.1 *The National Vegetation Classification*

The *National Vegetation Classification* (*NVC*) provides a standard methodology for the survey and description of British plant communities (Rodwell 1991a, 1991b, 1992, 1995, 2000). It is based on the classification of over 35,000 quadrat samples covering virtually all vegetation types within the UK –

the main gaps being in highly disturbed and artificial situations, sites with a strong component of neophytes or where the vegetation comprises a very intimate mosaic or concatenation of types (Mountford in press). The resultant groupings have been interpreted using other environmental data, such as soil type, management, aspect and hydrology, to produce described communities that are ecologically meaningful. This classification is now the standard framework used by the conservation agencies *etc* for the production of inventories and maps of vegetation for areas of biodiversity value. The great advantages of the *NVC* are in allowing a consistent comparison between sites and an estimation of biodiversity value against a common standard, itself derived from a survey of the best examples of natural and semi-natural vegetation. The *NVC* should not be used, however, to derive fixed goals for nature conservation management, especially considering the role of global environmental change.

2.1.2 *Previous surveys of Fingringhoe*

The present survey is the first comprehensive inventory of the flora and habitats of the Fingringhoe Ranges. Nonetheless, some earlier indication of the flora can be gained by examining the species maps and other information presented in the most recent of the local floras (Tarpey and Heath 1990). Many species were mapped on a 1km square basis, allowing records to be confidently ascribed to the MoD land – seven 1km squares being wholly or overwhelmingly within the Fingringhoe Ranges. A list of the likely Range flora was derived from this source, and formed the basis of the species checklists used in the recording cards for *NVC* communities and watercourses (see Appendix 1). In addition, there is considerable ongoing activity to study and protect the wildlife of the ranges, conducted by both the range wardens and volunteers, with particular attention paid to birds, reptiles and amphibians (C. Duncan *pers. comm.*).

2.1.3 *The current vegetation survey*

The vegetation survey of the Fingringhoe Ranges was conducted using essentially the standard *NVC* methodology (Pywell and Walker 1997), although in some coarse and very species-poor vegetation types, frequently only 3 quadrats were used (rather than 5 or more). Common recording cards for the terrestrial vegetation (including salt-marshes) were closely derived from those used in previous CEH surveys, to ensure consistency of results between sites (see Appendix 1). The only important departure from previous surveys was the use (where necessary) of a recording card designed specifically for drainage channels (see also Appendix 1), where the approach and data recorded follows procedures long accepted as standard (Alcock and Palmer 1985; Mountford in press). The great bulk of the vegetation survey took place whilst the ranges were closed, from 1-12 August 2005, and was completed on the 16th August. A further visit on the 23rd September was with the express purpose of taking digital photographs of the main habitat types and areas.

2.1.4 *Vegetation mapping*

The Fingringhoe Ranges occupy a wedge of land between the estuaries of the River Colne and the Pyefleet Channel (which separates Mersea Island from the mainland). The Geedon Creek and its tributaries divide the ranges almost in half. The ranges thus comprise:

- a southern peninsula (to Langenhoe Point) including Langenhoe and Wick Marshes;
- a north-eastern peninsula comprising the Geedon Saltings;
- a central peninsula – Fingringhoe Marsh; and
- the hinterland connecting these peninsulas from Wick farm, via the Range Offices to South House Farm and the southern boundary of Fingringhoe Wick nature reserve.

After completion of the field survey, Defence Estates provided CEH with a 1:5,000 map on which were marked management units (Figure A2.1 in Appendix 2). This division into five major Defence Estates Units and 26 Compartments was produced specifically for the present survey and does not represent the management units normally employed by the Range staff. For greater precision, CEH produced its own map of compartments in advance of the survey, recognising 45 potential management units on the basis of existing boundaries such as fences, tracks and tidal creeks (Figure A2.2 in Appendix 2). In the vast majority of instances, these CEH divisions either correspond directly to the DE Compartments or represent further sub-divisions of these DE Compartments. Where there is a discrepancy between the two maps, and where this might cause confusion, this fact is drawn attention to in the report. The database holding the field data includes a cross-reference between the two systems to ensure compatibility.

The vegetation survey covered all of the Fingringhoe Ranges, except the Geedon Creeks (North and South) below mean high-water (DE Unit 3) and Rat Island. Pewit Island (immediately south of the Langenhoe peninsula) is outwith the Ranges and was also omitted from the survey. This stratification into 45 basic survey areas (CEH divisions) ensured that there was a relatively uniform sampling effort across the whole site. Within each DE Unit, the location and extent of homogeneous stands of vegetation, together with mosaics and ecotones (Box 2.1), were mapped onto paper 1:5000 OS base maps. Mapping accuracy was enhanced by the use of a differential Global Positioning System (GPS) for vegetation blocks, as well as to locate samples (see 2.1.5).

Box 2.1 *Mosaics and Ecotones*

Mosaics: = 2 communities forming a complex patchwork, which is impossible to map accurately. In such cases the composition and scale of the mosaic were noted, and each component sampled separately.

Ecotone or transition: where one vegetation type gradually passing into another. In these cases the transitional zone was also mapped.

The use of remote sensing (Sections 2.11-2.12) integrated with the vegetation sampling revealed several DE Units where the vegetation largely comprised complex mosaics – see sections **4**-**9**.

2.1.5 *Vegetation sampling*

Information relating to each vegetation stand (community, mosaic/ecotone or watercourse) was recorded on a standard recording sheet (see Appendix 1). The composition of each vegetation unit was described at two scales. Firstly, an inventory was made of all species present and their overall abundance, described using the DAFOR scale (Box 2.2). Secondly, a number of sample quadrats were recorded at random within representative areas of each homogeneous vegetation stand. The composition and scale of any vegetation mosaics/transitions was described and quadrats recorded in each component. For watercourses, an inventory of the whole ditch/fleet was made, together with a detailed characterisation of a representative 20m sample length.

Box 2.2 *The DAFOR cover abundance scale*

D = Dominant **A = Abundant** **F = Frequent** **O = Occasional** **R = Rare**

Scores were given for both the local (L) and widespread (W) distribution of each species, thus providing a more accurate description of the relative abundance of those species with highly clustered distributions.

The number of sample quadrats and their size was dependent upon the scale and structure of the vegetation community (Box 2.3). Typically five quadrats were recorded in botanically diverse or highly variable stands of vegetation, and fewer samples were taken in species-poor vegetation.

Box 2.3 *Rationale for size and number of quadrats recorded in each vegetation type in the Fingringhoe Ranges*

Vegetation type	Quadrat size (m)	Quadrat number
Short inland grassland	1x1	5
Coarse inland grassland	2x2	Typically 5, but 3 in very species-poor communities
Salt-marsh vegetation (*Atriplex portulacoides, Puccinellia, Limonium etc*)	2x2	5 but 3 in very species-poor communities
Club-rush swamp (*Bolboschoenus maritimus*)	2x2	5 but 3 in very species-poor communities
Reed-swamp (*Phragmites*)	4x4	5 but 3 in very species-poor communities
Scrub and underscrub	5x5	Typically 5, but 3 in very species-poor communities
Plantation woodland	5x5	Typically 3

Percentage cover of all vascular plants and bryophytes was estimated as a vertical projection onto the ground, and then recorded as Domin values (Box 2.4).

Box 2.4 *Domin-Krajina cover-abundance scale - interpretation*

Domin	Meaning	Domin	Meaning
+	Present	5	11-25% cover
1	Few individuals (insignificant cover)	6	25-33% cover
2	Very scattered (small cover - <1%)	7	34-50% cover
3	Scattered (cover - <1-4%)	8	51-75% cover
[Thence any number of individuals]		9	76->90% cover
4	4-10% cover	10	Complete cover

Cover values took account of layering of the vegetation, which was especially important in scrub and woodland communities. In addition to the species, the cover of the following features was recorded (where relevant) within each quadrat or watercourse sample:

- Algae;
- Bare (tidal) mud;
- Bare soil;

- Bryophyte and lichen cover (where not ascribed to named species);
- Plant litter (distinguishing litter deposited by the tide); and
- Open water

Each sample (quadrat or watercourse record) was assigned a unique number and its position recorded to a high degree accuracy using a differential GPS. Such data were subsequently digitised and transferred to the Geographic Information System.

2.2 Vegetation structure

Random drop-disk measurements (to the nearest centimetre) were used to gain an indication of the vegetation structure for each NVC community. The disk used was made of compressed hard board, measuring 300mm in diameter, 3mm thick and with a weight of *ca* 80g, and provided a combined measure of vegetation height and density. A total of 10 (-20) measurements were typically made for each community along a random walk. Four additional drop-disk measurements were made within each quadrat, depending on quadrat size. In swamp, tall scrub and woodland, vegetation heights were estimated or (where practical) directly measured.

2.3 Rare plant species

The distribution and population size of Nationally Scarce and Rare plants were recorded during the survey, together with other species of local conservation interest or which might prove invasive (*e.g*. *Crassula helmsii*). Significant populations were marked on the 1:2500 OS base maps.

2.4 Topography, geology and soils

General notes on geology, soil and topography were made for each site and for some vegetation communities. The geological survey map published as part of the standard county flora (Jermyn 1974) was used to provide information on solid and drift geology, and the national soil map of England and Wales consulted to classify the main soil types (Anon 1983). Considerations of safety and staff-time resources prevented excavation of soil pits or the extraction of core samples at any of the sites. Three broad soil categories were present (see Section 3.1):

1. Unripened salt-marsh soils.
2. Groundwater gley soils (within reclaimed marsh); and
3. Surface-water gley soils on the higher-lying land.

2.5 Management

The type, intensity and pattern of management evident at the time of survey were recorded for each *NVC* community, using a tick-box recording framework devised during the Salisbury Plain *NVC* survey (Pywell *et al*. 1997, 1998 – see also Appendix 1 of the present report), and shown to be useful through testing in all subsequent similar surveys. The following variables were recorded:

- Type of management (nil, grazed, cut, other [*e.g*. burning])
- Grazer (rabbit, sheep, cattle, other [*e.g*. deer])
- Intensity of grazing or cutting (light, moderate, heavy); and
- Pattern within the *NVC* community (uniform, random, clustered, mixed).

2.6 Disturbance

Similarly, an assessment was made of the type, age, intensity and pattern of any disturbance evident within each *NVC* community (see Appendix 1), *i.e.*:

- Type of disturbance (nil, vehicle, shell impact, excavation, other)
- Age (recent, old, mixed)
- Intensity (slight, moderate, heavy)

- Pattern within *NVC* community (linear, random, clustered, mixed)
- Salt spray

2.7 Habitats of conservation interest

As a complement to the 1:5000 annotated OS maps, a sketch map of each DE Unit, Compartment and CEH division was made, identifying all features of interest and any clear patterns in the vegetation cover. This sketch map was accompanied by a summary site description which, as well as explaining or commenting upon the mapped information, listed those species and habitats of conservation importance or otherwise notable. This compartment appraisal was expanded by specific descriptions and assessments of all the component vegetation types and, where appropriate, of the adjacent watercourses.

2.8 Fauna

No formal recording of the fauna took place during this survey, and indeed most vertebrate groups are already the subject of detailed monitoring organised through the Range Wardens. However, during the course of the vegetation survey, incidental records were made especially of birds, reptiles and amphibians. This information was appended to the relevant compartment record, but is not presented in this report.

2.9 Nomenclature

The nomenclature of the vascular plants conformed to Stace (1997), whilst that of the bryophytes followed Hill *et al.* (1991-1994). However, it should be noted that the vegetation community names used by the *NVC* conform to the nomenclature of *Flora Europaea* (Tutin *et al.* 1964 *et seq*.). Five anomalies caused by the different nomenclatures are noted in Box 2.5.

Box 2.5 Correspondence of species nomenclature as used for community names in the *NVC* with accepted modern nomenclature (as used elsewhere in this report)

Nomenclature as used in the *NVC*	**Accepted name (after Stace 1997)**
Arthrocnemum perenne (as in *NVC* community **SM7** – section 4.2)	*Sarcocornia perennis*
Elymus pycnanthus (as in *NVC* community **SM24** – section 4.8)	*Elytrigia atherica*
Elymus repens (as in *NVC* community **SM28** – section 4.11)	*Elytrigia repens*
Halimione portulacoides (as in *NVC* community **SM14** – section 4.6)	*Atriplex portulacoides*
Scirpus maritimus (as in *NVC* community **S21** – section 8.2)	*Bolboschoenus maritimus*

2.10 Data analysis

Homogeneous vegetation stands, and the components of mosaics and ecotones were provisionally assigned to an *NVC* community or, where possible, a sub-community in the field. This classification was then checked against the descriptions, constancy tables and keys in the published *NVC* (Rodwell 1991-2000). Finally, the relationship of these vegetation types (usually sub-communities) was further tested by running each stand (as a constancy table), community list and quadrat or watercourse sample through TABLEFIT (Hill 1996). Unknown 'variant' communities were also assigned a unique code, and their composition is described in the text of this report.

2.11 Remote sensing – Methods and data gathered

The habitats of coastal landscapes such as Fingringhoe are not only determined by their land cover (*e.g.* species and community composition), but crucially by their elevation relative to tidal inundation regime and management policies of defended areas. The remote sensing approach used for this survey allowed the possibility of 3-dimensional habitat mapping. The NERC aircraft can gather data on surface composition and elevation synoptically over large areas, via:

(i) **Optical sensors** that measure surface reflectance highlight species and community composition and patterns; and

(ii) **Light Detection and Ranging** (**LiDAR**) that measures surface elevation and indicate surface roughness and the presence of surface features such as embankments, buildings, ditches and woody vegetation.

Together with suitable ground reference data (i.e. the vegetation survey and digital photography), the information derived from airborne remote sensing provided comprehensive and reliable habitat maps. Optical image data were collected for the site concurrent with the field survey (4th August 2005) and were acquired with a Compact Airborne Spectrographic Imager (CASI) and an Airborne Thematic Mapper (ATM) which, when combined, can give detailed information in the visible and near infrared as well as useful information on both the shortwave and thermal parts of the spectrum.

The CASI data consisted of 12 flightlines, some of which contained small amounts of cloud and cloud shadow. An almost completely cloud-free composite image was compiled from seven of the flightlines and used both for display and classification. The spatial resolution gave 2 metre pixels *i.e.* each picture element represented 2 x 2 m of the ground surface. An ATM composite image was also compiled for display purposes.

2.12 Remote sensing – Data processing and analysis

Digital remote sensing instruments record surface reflectance in a number of wavebands (regions of the spectrum) for each pixel. The original bandset (***BIOTA+***, see Table 2.1) contained 15 wavebands from the visible and near-infrared part of the spectrum.

Table 2.1: Wavebands and their description from the ***BIOTA+*** bandset

Band No.	NERC BIOTA+ Wavelength (nm)	Centre (nm)	Description / Usage	Actual Centre (nm)	Half-width (nm)
1	435 – 450	440	Blue 1 plant pigment response	443.08	9.5
2	485 – 495	490	Blue 2 plant pigment response	489.82	7.7
3	500 – 520	510	Blue 3 plant pigment response	509.54	12.4
4	535 – 545	540	Blue/Green plant pigment response	539.66	6.8
5	547 – 557	552	Green 1 pigment reflectance peak	552.87	6.8
6	603 – 613	608	Green 2 pigment vegetation absorption	607.78	6.8
7	647 – 657	652	Red 1 vegetation absorption	651.53	6.8
8	665 – 676	670	Red 2 maximum chlorophyll absorption	670.60	6.8
9	680 – 685	682.5	Chlorophyll fluorescence	682.06	4.9
10	705 – 715	710	Red-Edge	710.74	6.8
11	747 – 753	750	Red-Edge NIR shoulder	750.03	5.9
12	759 – 764	762	Atmospheric oxygen absorption	761.54	4.0

13	775 – 785	780	NIR plateau vegetation reflec. maximum	779.80	6.9
14	870 – 890	880	NIR plateau	879.98	12.7
15	937 - 947	942	Atmospheric water vapour absorption	941.80	6.9

Of these, bands 1, 12 and 15 were "noisy" and excluded from the classification process *i.e.* a 12-band image was compiled for classification. This 12-band image (**fing_c_class.img**) is displayed for the classification procedure using b11, b8, b1 (*i.e.* original bands 13, 9, 2) in an RGB display (a high contrast false-colour version of Figure A2.3). This approach accentuates the reflectance in the near-infrared where there is greatest divergence between cover types with vegetation – varying shades of red indicate the relative density of vegetated cover.

The approach used a supervised classification, *i.e.* it required demarcation of 'training areas' -polygons of known land cover that are spectrally uniform and typical of that land cover type. *Maximum Likelihood Classification* (a Bayesian maximum likelihood classifier - Schowengerdt 1983) in Erdas Imagine was used in an iterative procedure. Samples from 'training areas' were used to calculate the statistical properties for the reflectances of different surfaces and thereby identify the 'spectral signatures' of the different cover types. Training areas were based on information derived from:

(i) the ground-based *NVC* survey;
(ii) an additional field visit in which hard copy versions of airborne imagery were annotated;
(iii) conventional aerial photographs (taken contemporaneously with the digital imagery); and
(iv) displays of the digital datasets themselves.

The process of training and classification involved preliminary classification, inspection of results, comparison with reconnaissance data, editing or addition of training subclasses, then reclassification - through several cycles before completion of a final cover map (Figure A2.5). The initial classification was refined by tightening spectral extents of the classes as much as possible and thus reducing the overlap and ambiguity between classes with similar spectral signatures.

The classification was limited to an area confined by a) the perimeter of MoD land (as given in an Arc shapefile, **MOD_boundary.shp**, supplied by the MOD) and b) adjacent estuarine intertidal areas and water. This area was divided into two zones, Terrestrial and Maritime, which were classified separately (**fing_T_zone.shp** and **fing_M_zone.shp**). The dividing line between these zones ran along the seaward base of the seawall.

Many cover types at Fingringhoe required subdivision into a number of spectral subclasses (Kershaw and Fuller, 1992). An example of many spectral subclasses within a final Land Cover Class (LCC) is seen in "intertidal mud", which is an amalgamation of five spectral subclasses ranging from very light to dark in appearance on the display image. The spectra of the vegetated LCCs exhibit a gradation of reflectance in the near-infrared from low (sparsely vegetated semi-natural grassland) to high (productive managed grassland, deciduous woodland and *Phragmites* reedbeds). The species names of plants used in LCC names and spectral subclasses are listed in Box 2.6):

Box 2.6: Species (with vernacular names) used in naming LCCs and spectral subclasses

Agrostis capillaris (Common Bent)
Agrostis stolonifera (Creeping Bent)
Arrhenatherum elatius (False Oat-grass)
Atriplex portulacoides (Sea Purslane)
(aka *Halimione p.* – see **Box 2.5**)
Bolboschoenus maritimus (Sea Club-rush)
Elytrigia atherica (Sea Couch)
Elytrigia repens (Common Couch)
Festuca rubra (Red Fescue)
Limonium vulgare (Sea Lavender)
Holcus lanatus (Yorkshire Fog)
Hordeum secalinum (Meadow Barley)

(aka *Scirpus maritimus* – see **Box 2.5**)	*Lathyrus pratensis* (Meadow Vetch)
Cirsium arvense (Field Thistle)	*Lolium perenne* (Perennial Rye-grass)
Cirsium palustre (Marsh Thistle)	*Phragmites australis* (Reed)
Cynosurus cristatus (Crested Dog's-tail)	*Puccinellia maritima* (Saltmarsh-grass/ Sea Poa)
Dactylis glomerata (Cock's-foot)	*Salicornia europaea agg.* (Glasswort)

2.12.1 *Validation*

The CASI-derived class map was validated against the ground-based quadrat data and a cross-comparison matrix compiled in which the CASI LCCs were arrayed against *NVC* classes (allocated according to TABELFIT - Hill 1996) for each quadrat surveyed (Table A2.3). During the field survey, the position of each quadrat had been located by a GPS device (to within 10m) and the LCC allocated to that quadrat was the majority class within a 4 x 4 pixel square centred on that location. The results were expressed as a percentage of the quadrats where there is an acceptable agreement of LCC and *NVC* classes. Most discrepancies between classes occur in the salt-marsh vegetation where the habitats are intermixed in an intricate mosaic.

2.12.2 *LiDAR*

Figure A2.4 shows a display of the LiDAR image, coloured to emphasise differences in height above sea-level, which includes two small patches where data have had to be interpolated to fill areas obscured by cloud. The final image contains digital elevation data (with a vertical accuracy of +/- 15cm) at a spatial resolution of 0.5m pixels but a 2m pixel version was compiled for amalgamation with the CASI data (see below).

2.12.3 *Additional classifications of remotely sensed data*

The training areas used for the Maximum Likelihood Classification of the CASI data were then used to repeat the classification of:

i) A composite CASI-LiDAR dataset in which the 2m LiDAR image was amalgamated with the 12-band CASI image as an additional layer to give a pseudo-13-band image for classification.

ii) The ATM dataset (omitting band 1 [noisy signal] and band 11 [thermal infrared not usually used for classification]).

The resulting class maps were then validated as for the original CASI class map. The inclusion of LiDAR data produced a slight enhancement to the classification, but for the purposes of the present study the CASI image is entirely suitable. These additional classifications are not discussed further in this report and may be analysed in a possible future scientific publication.

2.13 Data organisation

2.13.1 *Production of NVC maps*

In the field, the positions of all vegetation communities and other land use types were mapped onto paper 1:2500 scale Ordnance Survey (OS) maps. All datasets were subsequently referenced to 1:5000 scale digital landline map data provided by DE under OS license number GD03189G001 (Contract LS53099). OS MasterMap files of the area covering the Fingringhoe Ranges were imported into ArcMap version 9 so that a digital map (Figure A2.6) could be produced showing the findings of the *NVC* survey (as multiple layers of spatially referenced data in a GIS). The shape and location of the different *NVC* communities mapped in the field were digitised to confer complete polygon coverage (see Section 11). The OS data ensured the accurate positioning of the polygons and

provided additional information on the extent of some vegetation types, notably wooded and tidal areas. Each polygon was labelled with a unique identifier code, to enable linkage to the relevant quadrat and *NVC* community information held in the database to be provided to DE (section 2.13.2). The construction and content of the map are outlined in more detail below.

Specifically, the final Fingringhoe map consists of six different layers: three of the layers depict the loci of the *NVC* communities identified, the quadrats surveyed and the 20 metre channel samples. The remaining three layers depict boundaries, buildings and water.

***NVC* Communities:** Each of the *NVC*/mosaic communities identified by the survey was assigned an individual colour by which they are represented in the digital map (Figure A2.6). The *NVC* layer also had an associated attributes table containing the following information:

- Shape area = Area in m² of each sample unit
- CEH division ID = Identity code for the sample units used by the surveyors during the survey.
- MoD ID = Identity code for the sample units used by the MoD.
- *NVC* = *NVC* community type or mosaic of *NVC* communities.
- % Cover = Percentage cover of *NVC*/mosaic communities.
- Species = Showing four most abundant plant species of the *NVC* type or mosaic.
- Number of Quadrats = Number of quadrats recorded in each sample unit.

In order to view this information, the user must select the information icon (ⓘ) in ArcMap and click on one of the sample units. The relevant information will then appear as a "pop-up" table.

Quadrat locations: The approximate locations of all the quadrats were recorded in the field using hand held GPS, and these grid references are shown on the map as green squares. The associated attribute data table contains the following information:

- X = The X coordinate recorded by hand held GPS.
- Y = The Y coordinate recorded by hand held GPS
- Mwood id = CEH code assigned to the quadrat, indicated on the survey recording form (Appendix 1).

In order to view this information the user must select the information icon (ⓘ) in ArcMap and click on one of the green squares. Again, the quadrat information will appear as a "pop-up" table.

20m Channel samples: The approximate location of the 20m samples are shown on the map as blue squares, and the associated attribute table contains the following information:

- Id = The CEH code assigned to the channel sample, indicated on the survey recording form (Appendix 1).
- Species = Four most dominant plant species recorded in the sample.
- Length = Approximate overall length of the channel sampled.
- Width = Approximate width of the channel.
- Depth = Approximate maximum depth of the channel.

Boundaries, buildings and water: These three layers and their associated attribute tables do not contain any data collected by the survey.

2.13.2 *Production of database tables and data organisation*

All information relating to each *NVC* community was transferred from the recording sheets to Excel spreadsheets. These data will then be incorporated into database tables to be provided to DE with

documentation following the report. Each community described in the field will be assigned a unique numeric reference code, which will enable linkage both of the different database tables, and thence to the spatially referenced vegetation map and quadrat location map. The data organisation for this project is essentially that employed in previous training area studies, with slight modifications to account for additional quadrats recorded and range of species with each *NVC* community. The raw (Box 2.7) and processed data (Database tables; spatially referenced polygon maps; and spatially referenced point maps) will be supplied separately on compact disk in three basic formats, and should follow the approach used at Castlemartin (Pywell *et al* 1999b).

Box 2.7 *Raw data from the vegetation survey*

File name	Description	Type	File format
Comp_desc.txt*	Description of compartment attributes	Flat database table	ASCII (comma separated values - CSV)
Community.txt	Descriptions of *NVC* community attributes	Flat database table	ASCII (comma separated values - CSV)
Disturbance.txt	*NVC* community disturbance data	Flat database table	ASCII (comma separated values - CSV)
Management.txt	*NVC* community management data	Flat database table	ASCII (comma separated values - CSV)
Habitat.txt	Habitats of conservation interest present within *NVC* community	Flat database table	ASCII (comma separated values - CSV)
Flora_record.txt	CEH Biological Record Centre plant species name look-up table	Flat database table	ASCII (comma separated values - CSV)
Quadrat_record.txt	*NVC* community DAFOR and quadrat data	Flat database table	ASCII (comma separated values - CSV)
CMNVC.shp	Vegetation map	Labelled polygon coverage (Raster)	ARCVIEW shape file
CMrare.shp	Rare & scarce species locations	Labelled point coverage	ARCVIEW shape file
CMphoto.shp	Photograph locations	Labelled point coverage	ARCVIEW shape file
CMquad.shp	Quadrat locations	Labelled point coverage	ARCVIEW shape file

3. Overview of the vegetation of the Fingringhoe Ranges

3.1 Topography, geology and soil

The Fingringhoe Ranges occupy an area of 680ha on the Essex coast southeast of Colchester. The ranges largely comprise level ground at or slightly above mean high-water, including active saltmarsh and reclaimed marsh within the seawall. The ranges rise gradually to the west to over 10m, but more steeply along the northern margin to *ca* 20m AOD. The active saltmarsh is dissected by creeks, and relict creeks and fleets (some engineered for conservation purposes) occur in the reclaimed marsh. Two minor valleys cut through the higher ground: a) a stream valley (shallow in section) feeding into the South Geedon Creek; and b) a more steep-sided gulley north of the Range Offices passing through Grimps Grove to join the borrow dyke behind the seawall adjacent to the north bank of the South Geedon Creek.

The whole area is underlain by Eocene London Clay but for much of the Fingringhoe Ranges this solid geology is overlaid by superficial deposits (Jermyn 1974). The Geedon Saltings and Fingringhoe Marsh, as well as the tip of Langenhoe Point outwith the seawall, are covered in modern tidal flat deposits (marine alluvium) that give rise to unripened gley soils. The reclaimed marshes of Langenhoe, Wick and the area west and SW of Fingringhoe Marsh have pelo-alluvial gley soils (groundwater gleys) derived from marine alluvium. Around the Range offices and along the western boundary of the Ranges on higher lying land, the London Clay is exposed and produces a pelo-stagnogley soil (surface water gley). The northern boundary of the Ranges is marked by a sudden rise to an area of glacial sands and gravels with the Fingringhoe Wick nature reserve, but no soils derived from this material seem to occur on MoD land. Thus, the three main soils types mapped are (Anon 1983):

- **Unripened gley soils**: Soils of variable texture flooded at high tides – many are soft and unripened, though some at higher levels in the marsh may be firmer and ripened. Such soils are frequently calcareous.
- **Pelo-stagnogleys of the Windsor soils association**: Slowly permeable seasonally waterlogged clayey soils derived from Tertiary clay, and mostly with brown subsoils. Includes variants that are fine loamy over clayey or fine silty over clayey and (locally on slopes) clayey soils with only slight seasonal waterlogging.
- **Pelo-alluvial gley soils of the Wallasea 1 soil association**: These soils are deep and clayey, but either non-calcareous or calcareous. Soils locally have humose or peaty surface horizons. Typically occur on flat land where the groundwater is controlled by ditches and pumps, and where there is a slight risk of flooding.

3.2 Vegetation

This section provides a brief synopsis of the vegetation of the Fingringhoe Ranges, with individual vegetation communities recorded by the CEH survey described in detail in the following sections (4 to 9). In this section (and sections 4-10 that detail the *NVC* communities of broad habitats) information on the distribution of particular *NVC* types (including mosaics) is partly derived from the summary map of communities (Figure A2.6) and partly from the CASI MLC thematic map (Figure A2.5). In this account, all community names follow the *NVC* (Rodwell 1991-2000), and the community codes from the *NVC* are indicated in bold-faced type – thus **MG1a**, **S21c**, **SM14** *etc*. The area of vegetation surveyed by CEH in 2005 comprised almost the full 680ha of the Ranges, with only the main tidal creek areas omitted – for reasons of safety and practicality, and because there was no evidence of any *Zostera*-dominated vegetation (**SM1**: Rodwell 2000) present. The older county flora (Jermyn

1974) records all three *Zostera* species for the Colne Estuary in National Grid square TR01, but Tarpey and Heath (1990) were unable to find them and there are no post-1970 records in the modern national atlas of the British flora (Preston *et al.* 2002). During 2005, 28 *NVC* community types were distinguished, together with 23 *NVC* sub-communities and 31 combinations or mosaics of these communities. These were described from 243 sample quadrats distributed through 45 sampling units (fields, woodlands and blocks of salt-marsh). Approximately 300 plant species were recorded during the survey, this variety reflecting a wide range of habitat conditions (Hill *et al.* 2004).

Maritime vegetation at Fingringhoe is almost entirely salt-marsh, although some of the drier grasslands are sub-maritime in character and most closely approach the swards typical of maritime cliffs in composition (Rodwell 2000). Salt-marsh occupies the northeastern portion of the ranges, as well as forming a strip outwith the seawall around the Langenhoe peninsula. The total area of salt-marsh on MoD land here is 210-240ha. Over the greater part of this area, the different communities are generally well developed but frequently occur in mosaics reflecting slight differences in surface elevation or drainage. Thus the Geedon Saltings (DE Unit 4 – CEH divisions 26 and 30) are a mosaic of **SM13** *Puccinellia maritima* and **SM14** *Halimione portulacoides* saltmarsh (and their sub-communities), with the latter occurring principally at higher levels and along creek banks. Toward the landward edge of the saltings, and along ridges and hummocks, was a clear zone of **SM24** *Elymus pycnanthus* salt-marsh, with some local variation due to drainage and grazing *etc*.

The Fingringhoe Marsh was altogether more heterogeneous, in part reflecting its distinct management history. Most of this block of marsh between the North and South Geedon Creeks (DE Unit 5 – CEH divisions 23-25 and 27-29) was reclaimed in the last quarter of the 18th Century and enclosed by seawalls, although the southwestern portion (CEH divisions 23 and 24) was not reclaimed until the early decades of the 19th Century. During the 19th century, this DE Unit was under extensive grazing, except for CEH division 23, which was ploughed and under arable cultivation (relict ridges and furrows are still clearly visible). The seawalls for the whole Marsh were breached in *ca* 1897 and tidal salt-marsh re-established, together with a deep wide creek system. The salt-marshes here are generally wetter than those of the Geedon Saltings, with some significant areas of **SM6** *Spartina anglica* and **SM8** Annual *Salicornia* salt-marsh in addition to the typical mosaic of **SM13**/**SM14** and **SM24** on the sea-walls.

The remaining area of salt-marsh lines the Langenhoe peninsula, though there is a larger area at the Point. Most of this peninsula is bounded by **SM14** marsh, especially the *Puccinellia maritima* sub-community (**S14c**), though on the bank of the Pyefleet Channel there is rather greater diversity, with **SM6** and **SM13** (represented by both **SM13**a and **SM13c** sub-communities). Within the seawalls, some areas of coarser grassland at lower altitudes are essentially halophytic in nature, including both **SM24** and **SM28** *Elymus repens* salt-marsh. The maritime influence extends to some of the swamp communities (**S21** see below), which are typical of brackish water situations.

Most grassland on the Fingringhoe ranges is mesotrophic in nature, but several grazed fields with better drainage showed some trend toward other grassland types. However, in all cases observed these drier sward types occurred within mosaics or transitions to mesotrophic communities. The most wide-ranging of these variants was **U4b** *Festuca ovina-Agrostis capillaris-Galium saxatile* grassland (*Holcus lanatus-Trifolium repens* sub-community). Patches approaching this type were a frequent part of sheep-grazed and mown fields south and southeast of South House Farm, where *A. capillaris* was often prominent in the sward, possibly most often where the sand/gravel fraction in the soil is somewhat greater. Similar fields further south (CEH divisions 34 and 35) have some areas that approach **MC9** *Festuca rubra-Holcus lanatus* maritime grassland, which normally occurs on maritime cliffs. This apparent maritime influence may be related to the fact that these fields were

once reclaimed from the valley of the upper South Geedon Creek. Finally, very locally at the far eastern end of Langenhoe Marsh are dry grassy patches with a composition related to that of semi-fixed dunes (**SD7e** *Ammophila arenaria-Festuca rubra – Elymus pycnanthus* sub-community), but these fragments represent an extreme variant of **SM24**.

Mesotrophic grassland communities occupied most of the Fingringhoe ranges within the seawalls, and were variable - often occurring in mosaics related to grazing pressure, cutting regime, slope and soil drainage. In total, such grasslands occupied *ca* 280-315ha of the site. Within this variation, however, two main communities were overwhelmingly dominant. **MG1** *Arrhenatherum elatius* grassland (especially **MG1a** *Festuca rubra* sub-community) dominates the south and east parts of DE Unit 1 (notably south of the Grimps Grove stream) and is overwhelmingly the main cover in Langenhoe and Wick Marshes, except in more low-lying parts, and amongst the scrub nearer Wick Farm. This grassland is cut annually, lightly grazed or (on Langenhoe peninsula) largely unmanaged. Where grazing is prolonged or cutting intense, the chief community is the **MG6** *Lolium perenne-Cynosurus cristatus* grassland, almost always in its *Trisetum flavescens* sub-community (**MG6c**). Such more intensively managed swards occupy the west and north of the higher ground, from east of South House Farm to Grimps Grove and south to the short-mown fields around the main track east from the Range Offices. Another variant of this community is found mainly along the west fringes of the Ranges south from the Langenhoe (public) road to the southern stream valley. Here the swards have a poorer range of grass species and are closest to **MG6a** (typical sub-community).

Other mesotrophic grassland types occur very locally, mainly as minor elements in mosaics. From the perspective of botanical richness, the best grasslands are on the steeper slopes at the north edge of DE Compartment 1.01 (CEH division 38), where **MG5** *Cynosurus cristatus-Centaurea nigra* grassland is sparingly present. The far northeast of DE Compartment 1.04 (CEH division 11) has a very mixed assembly of grasslands, some of which are relatively poorly drained, have prominent *Juncus* and are best placed in **MG10a** *Holcus lanatus-Juncus effusus* rush-pasture. The same area has some more tightly grazed damp swards that approach **MG11** *Festuca rubra-Agrostis stolonifera-Potentilla anserina* grassland, a community that also occurs in a modified form amongst the grazed butts of CEH division 7 and (as the *Lolium perenne* sub-community **MG11a**) in a mosaic with **MG6c** around the Range Offices. A reconnaissance had suggested that **MG13** inundation grassland might be frequent in the lowest lying parts of the ranges immediately behind the seawalls and near the fleets. The survey revealed the *Agrostis stolonifera-Alopecurus geniculatus* community to be very local and mainly in fields by the east end of the Grimps Grove stream (CEH divisions 16 and 19).

In place of **MG13** occurred a floristically related community typical of frequently inundated and trampled sites – the **OV28** *Agrostis stolonifera-Ranunculus repens* community. Such vegetation often occurred in a mosaic with patches of **MG13**, **S21** and areas of open exposed mud, and was most extensive in CEH divisions 15, 18 and 19, as well as sparingly in CEH division 34. All these fields lay adjacent to the fleets and brackish creeks near the South Geedon Creek. The other Open Habitat community represented (**OV25** *Urtica dioica-Cirsium arvense*) was very different and found in the drier disturbed or neglected parts of the Ranges. Such vegetation was especially prevalent where rough grassland occurred mixed with strips or patches of scrub and where the soil had been recently disturbed *e.g.* the western part of DE Compartment 2.03 (CEH divisions 36 and 37). Related vegetation was found along rough margins of fields in DE Unit 1, where the presence of **OV25a** *Holcus lanatus-Poa annua* sub-community indicated some trend toward the adjacent mesotrophic swards.

Swamp communities were restricted in their distribution and limited in their number, but often extensive where they did occur. In terms of overall extent **S4** *Phragmites australis* swamps and reedbeds

were most important, with a total cover of 24.23ha. Most of this reedbed was within DE Compartment 2.07 (CEH division 31) with its lagoon, where it occurred in both **S4a** *Phragmites australis* and **S4d** *Atriplex prostrata* sub-communities. Elsewhere there were quite large typical reedbeds (**S4a**) by fleets in Langenhoe Marsh (especially DE Compartments 2.03, 2.04 and 2.06). Smaller patches of reed, mostly in the **S4f** *Atriplex prostrata-Agrostis stolonifera* sub-community, were found by dykes marking the landward edge of the Geedon Saltings and by a wide brackish part of the stream that empties into the South Geedon Creek (DE Compartment 1.06). The other major type was **S21** *Scirpus maritimus* swamp, almost always in a coarse mosaic with **MG1** grassland and **MG13**/**OV28** inundation swards, and as such represented by **S21c** *Agrostis stolonifera* sub-community. **S21c** was extensive near creeks and fleets in DE Compartments 1.03 and 1.04, and occurred in similar sites (but with more uniformly coarse grassland of **MG1** and **SM28**) in the Langenhoe Marsh. In the main reedbed area (DE Compartment 2.07), *Bolboschoenus maritimus* was also common, forming beds along dykes and around lagoons, but in a more species-poor sub-community (**S21a**).

Local areas of standing or slow-flowing water (ditches, fleets etc) supported patches of **S4** and **S21**, as well as more diverse swamp assemblages in excavated pools within certain fields *e.g.* CEH division 33 (**S12** *Typha latifolia* swamp) and CEH division 45 (**S13** *Typha angustifolia* swamp). Where the emergent species thinned out, the ditches might be dominated by floating and submerged macrophytes, but well-marked Aquatic communities were very uncommon on the Ranges. A ditch in DE Compartment 1.04 supported **A9** *Potamogeton natans* and **A2** *Lemna minor* communities, whilst the borrow-dyke by the same DE Compartment was locally dominated by *Ruppia maritima* (closest to **SM2** *Ruppia maritima* salt-marsh of mud-flats). The ditches around Langenhoe Marsh were locally full of *Potamogeton pectinatus* (occasionally with *Myriophyllum spicatum*) in what was mostly **A12**, but with some trend toward the **A11** community. Extensive patches of *Crassula helmsii* occurred amongst **S21c** in DE Compartments 1.03 and 1.04, forming an amphibious community that is not dealt with in the published *NVC*.

Scrub was generally not extensive on the Ranges (total area of scrub and woodland 56ha), although in the area east of Wick Farm there were large patches of and strips of **W21** *Crataegus monogyna-Hedera helix* and **W22** *Prunus spinosa-Rubus fruticosus* scrub, often in a mosaic (CEH divisions 32, 36 and 37). More typical **W22** occurred as patches eastward onto the Langenhoe Marsh. Two smaller blocks of **W21** occurred in the middle of field in DE Compartments 1.01 and 1.04 (CEH divisions 13 and 38), where it gave way to a **W24** *Rubus fruticosus-Holcus lanatus* underscrub around the edges (**W24a** *Cirsium arvense-Cirsium vulgare* sub-community). Such complexes of tall scrub, underscrub, coarse grassland and weedy vegetation were locally present along field boundaries in the western part of the ranges, sometimes with prominent elm. However the main woody cover in the higher-lying parts of the Ranges comprised overgrown hedges of elm, hawthorn and blackthorn, with tall trees of *Acer campestre* and *Quercus robur*. Such spreading hedges were especially common toward the northern edge of the Ranges. The only block of apparently semi-natural woodland was Grimps Grove, whose trees (oak, ash maple) seemed to indicate **W8** *Fraxinus excelsior-Acer campestre-Mercurialis perennis* woodland, but the lack of *Mercurialis* and the presence of a large grove of *Salix fragilis* near the stream fitted best with **W6** *Alnus glutinosa-Urtica dioica* woodland. Finally two rectangular blocks of conifer plantation toward the west edge of the ranges (CEH divisions 40 and 43) did not fit well with any described community. The understorey of hawthorn and blackthorn resulted in some fit with **W21**/**W22** scrub communities.

4. Salt-marsh Communities

The CEH survey of maritime communities focussed on the salt-marshes that occupy almost all of DE Units 4 and 5, as well as the shoreline of DE Unit 2 (and potentially as *Zostera* communities in DE Unit 3 also). Within this area, the quadrats recorded were not distributed evenly (see Figure A2.6). Safety considerations meant that within the Geedon Saltings (for example), most samples were located along a central axis accessible from the path to the point. However, despite these limitations, comparison with maps prepared from remote sensing data (Figure A2.5) strongly suggests that the vegetation survey succeeded in covering all important vegetation types within these compartments.

4.1 **SM6** *Spartina anglica* salt-marsh community

4.1.1 *Composition*

A distinctive species-poor community that was not common at Fingringhoe, **SM6** typically had over 75% cover of *Spartina anglica* and no other constant species. Indeed the total species-list for good examples of this community on the ranges was only 7 and the mean number of species per sample is 3.6. Where this community occurs adjacent to other salt-marsh communities (notably **SM13** and **SM14**), the dominants from those vegetation types may be present at up to *ca* 20% cover, especially *Salicornia* agg., *Limonium vulgare* and *Aster tripolium*. Poorer examples of *S. anglica* marsh may have as much as 20% cover of *Puccinellia maritima*, but such stands are really transitional in nature. There was often some standing water present within the *S. anglica*, even at low tide levels. No species of particular conservation interest occurred within this community at Fingringhoe.

4.1.2 *Location, habitat and management*

SM6 was most extensive and characteristic toward the seaward fringes of marshes (especially along the shores of the Pyefleet Channel) though locally it occurred on creek sides and in old pans within the higher marsh. Most interestingly, **SM6** frequently occurred as quite small patches within the salt-marsh mosaic in the Fingringhoe Marsh (DE Unit 5), an area which had been reclaimed and farmed during the 19th century. On the much-less disturbed Geedon Saltings, which have never been reclaimed, *S. anglica* was rare or uncommon and the individual tufts did not coalesce into **SM6** stands. The habitat of **SM6** on the ranges does not receive any controlled management as such, though this history of disturbance is of note. The greater abundance of *S. anglica* in Fingringhoe Marsh may be a function of the poor drainage capacity of soils developed over reclaimed substrates. Crooks (1999) found that, in other abandoned reclamations in Essex, the former land claim surface underlying regenerated marshes consisted of an over-consolidated horizon that acted as a barrier to water movement and hindered sub-surface drainage of the developing marsh above. The abundance of *S. anglica* in this compartment may also be a result of its introduction to the area at a time when the vegetation of the developing marsh was more open. *S. anglica* was first recorded in the region in 1924 where it was planted to stabilise eroding saltmarsh (Jermyn 1974). This was at a time when the reactivated Fingringhoe marshes would have been relatively immature, characterised by a more open vegetation and bare mud - ideal conditions for invasion by *S. anglica*. In contrast, the mature Geedon Saltings marshes would probably have been much as they are today, where competition from more established species restricts the spread of *S. anglica*. The presence of **SM6** appears to be partly determined by tolerance of inundation (typically up to 6 hours submersion per day at spring tides) but

modified by exposure to physical damage from tides and waves. **SM6** can tolerate grazing, as witnessed by the presence of moderate stands in CEH division 23, where sheep have easy access.

4.1.3 *Zonation and succession*

The best examples of this community at Fingringhoe were in two situations: a) on the lower shore of the main channels, where *S. anglica* gave way above to **SM13** and **SM14**; and b) in a mosaic with these two communities within disturbed marsh, where **SM6** occupied the depressions and furrows. Stands of **SM6** by the channels may be relatively stable, but those within the main body of the marsh may be more dynamic. Accumulation of silts and de-watering of sediments might be predicted to favour succession to **SM13** and eventually to **SM14**. Alternatively, *S. anglica* is known to drastically alter the sedimentary and drainage characteristics of its surroundings, leading to the creation of water logged and anaerobic soils, the consequences of which may be a relatively static or extended **SM6**. Transitions between **SM6** and other salt-marsh types were moderately abrupt, though some mosaics in the Fingringhoe Marsh were quite intimate/fine-grain.

4.2 **SM7** *Arthrocnemum perenne* stands

4.2.1 *Composition*

No extensive areas of the Fingringhoe Ranges were allotted to this community, although *Sarcocornia perennis* was a frequent plant (at low cover values) throughout much of the site in vegetation that corresponded best to **SM14**, or more rarely to **SM13**. However in a very few stands, the cover of *S. perennis* approached 10% and the correspondence to **SM7** was good – although the very few samples of this community described by Rodwell (2000) do not include an Essex site. *S. perennis* grew in a closed community of *Limonium vulgare* and *Puccinellia maritima*, with *Atriplex portulacoides* locally important and scattered plants of *Suaeda maritima*. *Sarcocornia perennis* is itself a nationally scarce plant (Stewart *et al.* 1994) and thus these larger Fingringhoe populations are of some national biodiversity significance (see Section 10).

4.2.2 *Location, habitat and management*

Noted by Rodwell (2000) and Stewart *et al* (1994) as occurring at many levels in salt-marshes, the best Fingringhoe populations were generally in somewhat more open upper marsh where competition from *L. vulgare* and *Puccinellia maritima* was reduced, and where the marine alluvium was mixed with some gravel and other coarser material. **SM7** in the strict sense was found only on the Geedon Saltings, though related vegetation was found around the shores of the Langenhoe Peninsula. *S. perennis* was almost absent from the Fingringhoe Marsh, suggesting that it may be slow to colonise reverting salt-marsh of this type. Apart from tidal and wave impacts and occasional sheep grazing (Fingringhoe Marsh – where the plant is rare), S**M7** received no management at Fingringhoe.

4.2.3 *Zonation and succession*

The presence of the community proper is so sparse that the samples allocated to **SM7** are probably best considered as extreme examples of a mosaic of **SM14** sub-communities. The habitat range of *S.*

perennis is quite wide and, when taken together with the rarity of true **SM7**, it was not possible to make a distinctive case for the zonation and succession of **SM7** other than as part of the mid-/upper-marsh mosaic of **SM13**/**SM14** (see sections 4.6 and 4.7).

4.3 **SM8** Annual *Salicornia* salt-marsh community

4.3.1 *Composition*

Vegetation ascribable to **SM8** differed from other adjacent salt-marsh types principally in the abundance (cover *ca* 33-75%) of annual *Salicornia* species, the importance of surface water in the stands (even at low stages of the tide) and the large amount of open bare mud. Species accompanying *Salicornia* included locally co-dominant *Aster tripolium* and *Limonium vulgare*, and less extensive *Spartina anglica* and *Puccinellia maritima*. In stands transitional to other communities (mainly **SM6** and **SM12a**), *S. anglica* and *A. tripolium* were, respectively, more common (cover *ca* 50%). The stands are quite species-poor - only 4 species/quadrat (*i.e.* 4m^2).

4.3.2 *Location, habitat and management*

Although small stands of this community were observed elsewhere in the surveyed salt-marshes, the only important stands were all within Fingringhoe Marsh (DE Unit 5) and especially in DE Compartment 5.04 (CEH divisions 23 and 24). Here **SM8** was frequent not only on the muddy terraces of the main creeks (a habitat where it occurred in the Geedon Saltings *etc*), but also in more open, wet areas within the main body of the marsh. By the creeks **SM8** is subject to marked physical impact from tidal flow, and *Salicornia* agg. is known to tolerate up to 600 flooding tides per year (Rodwell 2000). *Salicornia* can also tolerate the sheep grazing that is an occasional feature of these blocks of salt-marsh on Fingringhoe Marsh.

4.3.3 *Zonation and succession*

As discussed by Rodwell (2000), **SM8** at Fingringhoe generally occupied the zone that might best be labelled "lower marsh", although changes in sea-level have resulted in some talking of this zone being "squeezed" on the east coast of the UK. However the Essex evidence is does not support his contention. Although it was predicted that sea-level rise would "drown" mid- and upper-marsh communities and result in their replacement by **SM8,** quite the opposite seems to be happening. There is now very little pioneer marsh left in Essex, whereas the extensive **SM13** and **SM14** appears to be continuing to accrete vertically, keeping pace with sea-level rise. There are, however, signs of lateral erosion in Essex examples of these communities. The erosion of Fingringhoe Marsh may mean that the open wet mud suitable for this community is moving upward with **SM8** colonising and even replacing more continuous salt-marsh cover of **SM13**/**SM14**. However, the evidence of the CEH survey suggested a dynamic mosaic with vegetation of SM8 succeeding to **SM13**/**SM14** in some areas, and replacing *Atriplex portulacoides* and *Puccinellia maritima* in others.

4.4 **SM11** *Aster tripolium* var *discoideus* salt-marsh community

4.4.1 *Composition*

During the CEH survey, the rayed and non-rayed varieties of *Aster tripolium* were not always systematically distinguished, mainly because most plants observed were not yet in flower. However, the ancillary notes made during the survey suggest that much the greater part of the tidal Aster vegetation held var. *discoideus*. In such stands, the cover of *Aster* varies between 10-<50%, with *Puccinellia maritima* (2-30% cover) and *Spartina anglica* (5-75% cover) the other constants in a rather open vegetation with 25-75% bare mud and often with abundant annual *Salicornia* (often around 50% cover). Other species (*e.g. Limonium vulgare* and *Suaeda maritima*) are frequent but at low cover, and some examples have a great deal of surface water. Transitional examples of this community tend to have more *Puccinellia maritima* and approach **SM13**, though some more open stands with abundant *Salicornia* are closer to **SM8**. The nationally scarce *Sarcocornia perennis* was recorded in one of these atypical stands of **SM11**. The mean number of species per sample was 5.5.

4.4.2 *Location, habitat and management*

SM11 was almost confined to the wetter Fingringhoe Marsh (DE Unit 5) where it formed a mosaic with **SM**8 in the muddier parts of the marsh, and with **SM13** in the somewhat drier higher-lying areas. No convincing stands of **SM11** were found on the Geedon Saltings but a few atypical patches were observed on the shores of the Pyefleet Channel. The association of this community with lower marsh and creek sides at Fingringhoe is consistent with its described preferences (Rodwell 2000). In such habitats, it tends to be slightly higher up the shore than **SM8**, being most typical of *ca* 350 submergences/year and very rare at >500 submergences/year. The history of disturbance and the erosion of this marsh may account for its apparent preference for DE Unit 5 rather than 4. Within DE Unit 4, **SM11** was much more common in those wetter areas where grazing sheep were less likely to forage.

4.4.3 *Zonation and succession*

In general terms, the classic zonation of **SM11** above the *Salicornia* (**SM8**) and giving way above to *Puccinellia maritima* and *Atriplex portulacoides* (**SM13**/**SM14**) was maintained at Fingringhoe, though at a local level fairly complex mosaics were observed reflecting marsh micro-topography and the management history. As with other communities of the Fingringhoe Marsh, the history of reclamation, abandonment and current erosion means that present succession is highly variable.

4.5 **SM12** Rayed *Aster tripolium* on salt-marshes

4.5.1 *Composition*

Use of *NVC* keys and especially of TABLEFIT suggested that this community was quite frequent at Fingringhoe, especially as its coastal sub-community (**SM12a**). However, as discussed above, all the quadrat samples examined appeared to be better placed in **SM11**. In a few places, rayed *Aster tripolium* was observed mixed with *Spartina anglica* and *Puccinellia maritima*, and especially with *Bolboschoenus maritimus*, but none of these stands were in tidal salt-marsh.

4.5.2 *Location, habitat and management*

Rayed *A. tripolium* was most common in *Bolboschoenus maritimus* swamp (**S21** – see section 8.2), and as such widely scattered on the Langenhoe peninsula (DE Unit 2 – especially CEH divisions 22 and 30). The ecology of these habitats is discussed in the context of **S21** swamp. Those few places where rayed *A. tripolium* grew with *S. anglica etc* tended to be by old borrow dykes at the upper edge of the saltmarsh near Fingringhoe Wick nature reserve.

4.5.3 *Zonation and succession*

As with their location, habitat and management, those few areas with rayed *A. tripolium* are best dealt with under club-rush swamp (**S21**) and do not fit into a discussion of tidal salt-marsh.

4.6 **SM13** *Puccinellia maritima* salt-marsh community

4.6.1 *Composition*

This widespread lower-middle level salt-marsh community is dominated by *Puccinellia maritima* (cover typically 50-75%) with quite a wide variety of associated species, though none of them are constant. *Limonium vulgare* is locally sub-dominant, with sparse *Suaeda maritima*. The vegetation is generally closed, with little bare mud or surface water at low tide. Atypical or stands that are transitional to **SM14** have abundant *Atriplex portulacoides* co-dominant with the salt-marsh grass. The nationally scarce *Sarcocornia perennis* is very occasional in this community. Stands of **SM13** that cannot be ascribed to a particular sub-community are species-poor (5 species/quadrat).

4.6.1.1 **SM13a** Sub-community with *Puccinellia maritima* dominant

This sub-community differs principally in having a slightly richer flora (mean number of species per sample = 6.7) and, although *A. portulacoides* was found in almost all samples, its cover was rarely more than 5%. Several other species typically grew with the dominant *Puccinellia maritima*, though normally at low cover: *Aster tripolium, Limonium vulgare, Salicornia* agg., *Spartina anglica* and *Suaeda maritima*. Compared to other sub-communities of **SM13**, the cover of bare mud is quite high (5-10%). *Sarcocornia* is present in *ca* 15% of samples, but with sparse cover.

4.6.1.2 **SM13c** *Limonium vulgare-Armeria maritima* sub-community

A distinctive species-rich variant of **SM13** (*ca* 9 species/quadrat), this sub-community has a markedly lower cover of *Puccinellia maritima* (*ca* 10-25%) with *Limonium vulgare* (cover usually >50%) replacing *P. maritima* as the typical dominant. Other constant species include *Aster tripolium, Salicornia* agg. and, most characteristically, *Triglochin maritimum* – although all these normally have low cover (<10%), *Aster* especially so. Other species that are notably frequent in **SM13c** include *Armeria maritima, Spergularia media* and *Sarcocornia perennis* – the latter is commonest in this sub-community (other than those extreme examples of **SM13** that approach **SM7** – see section 4.2).

4.6.1.3 **SM13f** *Puccinellia maritima-Spartina maritima* sub-community

The presence of this sub-community at Fingringhoe could not be unequivocally demonstrated, although *Spartina maritima* is scattered through the Geedon Saltings and on the shores of the Langenhoe

peninsula. A very small number of samples showed some trend toward this type, which differed mainly in the presence of *S. maritima* amongst the matrix of *Puccinellia* and *Limonium.*

4.6.2 *Location, habitat and management*

SM13 is the most extensive salt-marsh community on the Fingringhoe Ranges, accounting for over 50% of the Geedon Saltings. In the Fingringhoe Marsh and around the Langenhoe peninsula, **SM13** is rather less common, being partially replaced by **SM6**/**SM8**/**SM11** in the wetter DE Unit 4, and by **SM14** on the quite steeply shelving shore of DE Unit 2. Almost 60% of this *Puccinellia* dominated marsh can be allocated to the **SM13a** sub-community, with 25% of samples classified as the more species-rich **SM13c** and the remainder showing no particular trend to one sub-community within **SM13**. Within these salt-marshes, **SM13a** (and **SM13** in the broad sense) tends to occupy the lower-middle levels of the marsh *i.e.* immediately above the pioneer communities outlined in sections 4.1, 4.3 and 4.4. Its lower limit may be where the marsh surface receives up to 350 submergences per year and the core of its distribution appears to be at *ca* 220 submergences/year (Rodwell 2000). This community is favoured by grazing, either of stock, rabbits or wildfowl.

The more herb-rich **SM13c** is found particularly at rather higher marsh-levels, though the very flat topography of the Geedon Saltings results in no perceptible geographical trend within DE Unit 4. There is a reported association between high organic content in the topsoil and the occurrence of **SM13c** (Rodwell 2000), though this trend could not be confirmed from the CEH survey. However, **SM13c** was always close by pools of standing water (termed "splashes" by wildfowlers) on the Geedon Saltings, and other CEH research on the Essex salt-marshes indicates that **SM13c** is actually created and maintained by wildfowl (Wigeon and Brent Geese) and possibly by hares *i.e.* wildfowl land and roost in the splashes and then graze the neighbouring turf. This focus of grazing animals would also contribute to the reported high organic content of the top soil. Finally, if **SM13f** does indeed occur at Fingringhoe, this sub-community would be expected to occur in small depressions in the mid-marsh and to occupy patches of just a few square metres.

4.6.3 *Zonation and succession*

Over much of the Fingringhoe salt-marshes, especially in DE Units 4 and 5, **SM13** occurs in an intimate mixture with **SM14**, with *Atriplex portulacoides* vegetation replacing *Puccinellia maritima* swards at slightly higher elevations and on the banks of creeks and levées. The classic zonation referred to above (4.6.2) can be observed throughout the Fingringhoe salt-marshes, and succession appears to be mainly toward the most closely allied variant of *Atriplex portulacoides* marsh - the **SM14c** *Puccinellia maritima* sub-community.

4.7 **SM14** *Halimione portulacoides* salt-marsh community

4.7.1 *Composition*

This community can be recognised from a distance by the overwhelming preponderance of the greyish sub-shrub *Atriplex portulacoides* (synonym: *Halimione portulacoides*). In typical stands of this community, the cover of *A. portulacoides* is at least 50%, and usually 60-100% (mean *ca* 80%). The community in the broad sense is species-poor, with *ca* 4 species/quadrat. The only frequent

associated species are *Puccinellia maritima* (cover *ca* 15%) and *Suaeda maritima* (cover *ca* 2%), with scattered individuals of *Aster tripolium.*

4.7.1.1 **SM14a** Sub-community with *Halimione portulacoides* dominant

A very few samples of **SM14** were markedly species-poor, with *Puccinellia maritima* having negligible cover. Such samples were allocated to the **SM14a** sub-community.

4.7.1.2 **SM14c** *Puccinellia maritima* sub-community

Two-thirds of the **SM14** vegetation at Fingringhoe is clearly placed in a grassier facies of the community that somewhat approaches **SM13** in overall composition. The **SM14c** sub-community is markedly more species-rich (6.9 species/quadrat), with *Limonium vulgare, Puccinellia maritima, Salicornia* agg. and *Suaeda maritima* all having high constancy. The cover of *A. portulacoides* thins out somewhat (mean 65-70%), and the interstices are filled mainly by *P. maritima* and *L. vulgare*. Within the Fingringhoe ranges, this vegetation was the main locus for the nationally scarce *Spartina maritima*, and *Sarcocornia perennis* was present as scattered plants in nearly 40% of samples.

4.7.2 *Location, habitat and management*

To some extent, the distribution of **SM14** is the reciprocal of that for the "wetter marsh" types (**SM6**, **SM8** and **SM11**), occurring mainly in the Geedon Saltings (especially the slightly higher-lying northern portion) and around the Langenhoe peninsula, where it is the main community on the shore of the Geedon Creek. In the Fingringhoe Marsh, **SM14** is absent from the western portion (DE Compartment 5.04 and landward part of 5.03 *i.e.* CEH division 25) but sparsely represented in the east. As described by Rodwell (2000) and others, **SM14** at Fingringhoe was found on creek levees, low ridges and higher-lying marsh. Its distribution appears to be related to well-drained and aerobic sites (possibly for germination) and possibly to higher inputs of nutrients along the creeks. The pH in **SM14** stands ranges between 7.0 and 8.0. **SM14** is intolerant of sheep grazing, which (together with history of disturbance and wetter conditions) may explain its absence from the west fringe of DE Unit 5. The light grazing of rabbits, wildfowl *etc* that the other salt-marshes receive poses no restriction on *A. portulacoides* vegetation.

4.7.3 *Zonation and succession*

As noted by Rodwell (2000), **SM14** can occur above or below the *Puccinellia* swards (**SM13**) and "boundaries between the two associations can be marked by mosaics". The representation of **SM14** by its grassy sub-community **SM14c** on the Ranges makes the zonation of **SM13** and **SM14** less clear locally. This sub-community might be formed either by *A. portulacoides* invading **SM13**, or conversely by *Puccinellia* colonising aging stands of *A. portulacoides*. Despite these uncertainties, in most of Fingringhoe, **SM14** occupied a consistent zone between **SM13** below and **SM24** above.

4.8 **SM16** *Festuca rubra* salt-marsh community

4.8.1 *Composition*

The presence of this salt-marsh type on the Fingringhoe Ranges was not absolutely confirmed by the CEH survey, and those areas where vegetation might be ascribed to **SM16** were very limited in extent

and not entirely typical. The most typical stands, where a mixed sward of *Festuca rubra* and *Juncus gerardii* was accompanied by *Glaux maritima* and *Plantago maritima*, were extremely local. What appeared to be a variant of this community, with coarse tall *Festuca rubra* (cover *ca* 65%), *Agrostis capillaris* but no true halophytes was found within the seawall but close to the upper edge of the salt-marshes proper. Such vegetation was placed in **SM16d** (sub-community with tall *Festuca rubra* dominant) but may better be dealt with in **MC9** (see section 5.1) or as an extreme variant of **MG1a** (see section 6.1.1.1).

4.8.2 *Location, habitat and management*

SM16 may be present sparsely at Fingringhoe, especially along the northern (landward) fringe of the Geedon Saltings where trampling (and grazing) suppresses *Elytrigia atherica*. The record of **SM16d** is more likely to be aberrant mesotrophic grassland and was found in Compartment 2.01 – within the reclaimed area, but <300m from the South Geedon Creek.

4.8.3 *Zonation and succession*

The best instances of **SM16** occurred at the highest level of the marsh immediately abutting stands of **SM13c** (*Limonium vulgare-Armeria maritima* sub-community of the *Puccinellietum maritimae*), where it is probably kept in place by grazing. Removal of grazing animals and further restrictions on walkers using the path along the north edge of DE Unit 4 would probably lead to succession through to **SM24** *Elymus pycnanthus* salt-marsh (see section 4.9).

4.9 **SM24** *Elymus pycnanthus* salt-marsh community

4.9.1 *Composition*

A very species-poor (mean species/quadrat = 3) community with only the dominant grass *Elytrigia atherica* (*Elymus pycnanthus*) constant, **SM24** is the main vegetation type marking the upper edge of the tidal effect at Fingringhoe. The cover of E. *atherica* is always in excess of 50%, and typically over 75% (mean *ca* 87%). The coarse grass often emerges from a thick mat of its own litter, and in several instances this was supplemented by drift-line deposition of tidally-borne litter. There is some variation in composition, with a few samples having halophytes like *Atriplex portulacoides*, whilst others have *Elytrigia repens* as a subsidiary grass. Annual *Chenopodiaceae* are occasional (*Atriplex littoralis* and *A. prostrata*), especially where the sward is enriched by tidally-borne litter. Transitional samples have much *Festuca rubra*, together with a scattering of species normally absent from salt-marshes, and approach **SM16d**. **SM24** was the main native habitat on the Ranges for the nationally scarce Dittander (*Lepidium latifolium*), where it occurred close to the Fingringhoe Wick nature reserve. Other scarce species were found in related vegetation on the Langenhoe Marsh (described in section 4.12).

4.9.2 *Location, habitat and management*

This community has a very distinctive distribution at Fingringhoe, forming a band at the upper tidal limit along the north side of the Geedon Saltings, as well on old sea-walls throughout DE Units 4 and 5 and on the raised pathway from near Fingringhoe Wick to the point at the south end of the Saltings. One interesting location for **SM24** is a "Red Hill", a mound within the **SM13**/**SM14** marsh of DE Unit 4. There are over three hundred such Red Hills, the remains of prehistoric and Roman salt-making sites found along the Essex coast. At these sites, the sun would evaporate sea-water trapped in open pans cut into the impermeable clays of the marsh. The concentrated brine was then boiled in rough ceramic vessels until all the water was removed and only salt remained. These vessels, along with the burning process, resulted in the red soils and mounds of debris that can still be seen today. Although not distinguished as a sub-community, the samples of **SM24** where *Elytrigia repens* is also prominent are confined to the reclaimed marsh of Compartment 2.07, where it occurs in drier more elevated areas. Related vegetation is found in a handful of other places on the Langenhoe and Wick Marshes (CEH division 22), though most of these stands are probably better placed in **SM28**, since *E. repens* much outstrips *E. atherica* in these non-tidal reclaimed grasslands. This vegetation is too generally avoided by stock, but it is suggested (Rodwell 2000) that *E. atherica* may not establish well under more intensive grazing, and this contention is supported by the rarity of *E. atherica* and the absence of **SM24** where sheep have direct access along the landward edge of DE Unit 5.

4.9.3 *Zonation and succession*

At Fingringhoe, as typically throughout Britain, this community marks the upper limit of the salt-marsh zonation. Rodwell suggests that some of these **SM24** stands may have developed from *Atriplex portulacoides* salt-marsh (**SM14**). The occasional tidal inundation, coupled to the thick mat of litter, mean that succession through to scrub is slow or prevented altogether. No natural transition between **SM24** and non-halophytic communities really exists at Fingringhoe, other than locally to *Phragmites* and to *Elytrigia repens* swards.

4.10 **SM25** *Suaeda vera* drift-line community

4.10.1 *Composition*

SM25 is another species-poor community (3 species/quadrat), represented at Fingringhoe by a very few small patches of the **SM25a** *Elymus pycnanthus* sub-community. Floristically **SM25a** is closely allied to **SM24** and differs principally in the presence of the national scarce *Suaeda vera*, and of the higher representation of *Atriplex portulacoides* than is typical of Sea Couch salt-marsh (**SM24**). Some areas adjacent to the **SM25a** were transitional to reedbed (**S4f**), having *Phragmites australis* and *Triglochin maritimum.*

4.10.2 *Location, habitat and management*

Although odd plants of *Suaeda vera* were found elsewhere on the drift-line, the only indisputable example of this community was at the northern tidal limit of the Geedon Saltings close to the Fingringhoe Wick nature reserve. Here a mixture of *Elytrigia atherica* and *A. portulacoides* was covered in tidally-borne litter and a few bushes of *S. vera* were present. This vegetation may be able to tolerate up to 120 tidal submergences/year (Rodwell 2000). This community may also be present as fragments on the silty ridge that bears the path to the Geedon Saltings point. This community does not appear to undergo any management or anthropogenic disturbance at Fingringhoe.

4.10.3 *Zonation and succession*

At Fingringhoe, **SM25a** marks a transition from the upper marsh of **SM14** to both **SM24** salt-marsh and non-halophytic vegetation. Where *A. portulacoides* becomes commoner at slightly lower levels, a transitional zone of the **SM25b** *Halimione portulacoides* sub-community might be expected.

4.11 **SM26** *Inula crithmoides* on salt-marshes

4.11.1 *Composition*

Vegetation approaching **SM26** was observed several times during the CEH survey and the characteristic *Inula crithmoides* (a Nationally Scarce species) was scattered on the salt-marshes of the ranges, but no quadrat samples showed a high goodness-of-fit with **SM26** in TABLEFIT (Hill 1996). In all instances where *I. crithmoides* was seen at Fingringhoe, it was closely associated with

abundant *Atriplex portulacoides*, either with sub-dominant *Puccinellia maritima* (stands possibly allocated to **SM26a**) or co-dominant *Elytrigia atherica* (related to **S26b**).

4.11.2 *Location, habitat and management*

No unambiguous stands of this type were mapped, but *I. crithmoides* is most frequent on the Geedon Saltings, with occasional sites around the eastern margin of the Fingringhoe Marsh and on the Langenhoe peninsula. The habitat characteristics *etc* of these sites were similar to **SM24.**

4.11.3 *Zonation and succession*

I. crithmoides was most frequent at the upper marsh edge near the limit of tidal influence and any small patches that approach **SM26** occur in the same zone.

4.12 **SM28** *Elymus repens* salt-marsh community

4.12.1 *Composition*

Stands dominated by couch (*Elytrigia repens*) can be difficult to classify in vegetation surveys. Use of *NVC* keys or the TABLEFIT procedure tend to place such coarse species-poor grasslands in **SM28** but none of the Fingringhoe examples had any markedly halophytic species and all but a few samples were within the seawalls. Rodwell (2000) suggest that there might be a distinct ecotype of *E. repens* that dominates some salt-marshes and which is morphologically. However, in the survey of Fingringhoe, this ecotype was not distinguished and consequently all vegetation classification took place at the species level. In addition the TABLEFIT goodness-of-fit values were relatively low (50-65). Nonetheless, the overall floristic composition was quite typical of **SM28**, with dominant *E. repens* (mean cover *ca* 60%, but frequently >75%), frequent *Festuca rubra* and *Agrostis stolonifera*, and a mixture of other species at low cover (*e.g. Cirsium arvense* and *Poa pratensis*). This coarse grassland is quite species-poor (5.6 species/quadrat) and, like **SM24**, often has a thick litter mat.

4.12.2 *Location, habitat and management*

Although almost confined to areas within the seawalls, **SM28** was most typical of low-lying ground on pelo-alluvial gleys that had been reclaimed from salt-marsh proper. The most extensive stands formed a mosaic with **MG1a** (see section 6.1) in the largely unmanaged Langenhoe and Wick marshes, being commoner in hollows within the varied micro-topography. The other main area lay within the valley of the stream draining Grimps Grove, especially toward the sea-wall by South Geedon Creek (CEH divisions 4, 14, 19, 20 and 33). Here too, *E. repens* marsh tended to form pure swathes within depressions, but the fields were liable to intermittent sheep-grazing. Related vegetation, which did not fit especially well with any *NVC* type, was observed on old sea-walls within Compartment 5.04 (Fingringhoe Marsh).

4.12.3 *Zonation and succession*

Except for the ambiguous Fingringhoe Marsh samples, no **SM28** was seen at the upper edge of the salt-marsh zonation – the typical habitat according to Rodwell (2000). These stands seemed much similar to the kinds of *Elytrigia repens* grassland, belonging to the *Elymo-Rumicion crispi* alliance, that are frequent in neglected grassland and reverting arable well away from the tidal influence (*e.g.* Mountford *et al.* 1992).

4.13 Other halophytic vegetation

4.13.1 *Composition*

Some samples gathered during the CEH survey did not equate well with any described *NVC* type or were apparently aberrant variants of other communities. Two interesting examples are worthy of mention either because they represent quite extensive cover in some areas, or because they contain species assemblages of nature conservation interest. A species-poor type with *Spergularia marina* the main species (cover up to *ca* 35-40%) was locally important, with dwarfed plants of *Chenopodium rubrum*, scattered shoots of *Bolboschoenus* and very occasional *Agrostis stolonifera*. A third or more of these areas was bare mud, and in one or two places the invasive alien *Crassula helmsii* was present and, where this vegetation gave way to **S21** swamp, the uncommon dock *Rumex maritimus* was locally abundant. This vegetation seems to represent an atypical variant of **SM23** *Spergularia marina-Puccinellia distans* salt-marsh.

The other notable halophytic vegetation appeared to be unrepresentative, more species-rich form of **SM24** *Elymus pycnanthus* (Sea Couch) salt-marsh. The cover of Sea Couch was only *ca* 15%, and instead other maritime (often annual) grasses dominated. The most important of these was the Nationally Scarce *Hordeum marinum* (cover *ca* 40%) though *Parapholis strigosa* was frequent and *Puccinellia fasciculata* (also Nationally Scarce) was present, as well as the more ubiquitous *Festuca rubra*. In very similar vegetation nearby (no quadrat recorded), there were many plants of a third nationally scarce species, *Bupleurum tenuissimum*.

4.13.2 *Location, habitat and management*

The variant of **SM23** occurred in patches totalling as much as 1-2ha immediately behind the sea-wall in DE Compartments 1.03 and 1.04. Its presence appeared to be determined by a combination of factors - where low-lying, winter-wet land was subject to sheep grazing, poaching and dunging, and where proximity to brackish fleets introduced salts that became concentrated as the water receded, forming a quite saline crust on the soil surface.

The annual-rich variant of **SM24** was found in a distinctive zone around the mown inner edge of the seawall in DE Unit 2, from the head of the South Geedon Creek to the seawall separating DE Compartment 2.07 from the remainder of the Langenhoe Peninsula. Its occurrence was most obvious where *H. marinum* was frequent, but although well-scattered in this band, the total area of the type could not be more that *ca* 250-500 m^2. The presence of this assemblage appeared to be determined partly by the mowing of the sea-wall and adjacent trackside (the rest of this compartment being essentially unmanaged) and partly by probable seepage of saline water through the sea-wall (or salt-spray deposition).

4.13.3 *Zonation and succession*

The **SM23** variant occurred in a mosaic with **S21c**, **MG13** and occasional low hummocks bearing **MG1**. Relaxation of the sheep-grazing (with consequently reduced poaching and nutrient input) might allow **MG13** or **S21c** to spread at the expense of this open saline community. Both this community and the **SM24** variant depend on a balance of perturbations preventing succession to coarser

vegetation types. For the annual-rich Sea Couch sward, reduced mowing and salt input would allow the spread of *Elytrigia atherica*, whilst more intensive disturbance might provide more areas where these scarce annuals could grow.

5. Dry non-mesotrophic grassland communities

5.1 **MC9** *Festuca rubra-Holcus lanatus* maritime grassland

5.1.1 *Composition*

As described by Rodwell (2000), this community is typical of sheltered parts of maritime cliffs, to be rather rank and tussocky and confined to the west and north coasts of Britain. The Fingringhoe examples are somewhat atypical (TABLEFIT goodness-of-fit values generally <65) and although dominated by *Festuca rubra* and *Holcus lanatus*, the swards were much shorter than described, *Dactylis* is absent and the community is species poor (7.75 species/sample rather than the 14 that Rodwell reports). At Fingringhoe, *H. lanatus* predominates (cover approaching 50%) with subsidiary *F. rubra* (cover *ca* 25-35%). The turf is forb-poor, and the only other frequent species (all at low cover) were *Agrostis capillaris*, *Hordeum secalinum* and *Poa pratensis*.

5.1.1.1 **MC9e** *Anthoxanthum odoratum* sub-community

Most of the Fingringhoe examples corresponded slightly better to this sub-community than **MC9** in the broad sense, partly on the basis of the abundance of *H. lanatus* with *A. capillaris* and with rather more forbs and bryophytes than other samples.

5.1.2 *Location, habitat and management*

All but a few samples were confined to two fields between the South Geedon Creek and the Range Offices (CEH divisions 34 and 35), where this community dominated the sward. Most of these fields had been sheep-grazed, but not in the weeks prior to the survey. Other fields with **MC9** were subject to regular mowing, since the grassland surrounded shooting butts, and with signs of soil disturbance. All sites were fairly well-drained and usually south-facing.

5.1.3 *Zonation and succession*

As discussed above, the samples allotted to this vegetation type were not typical of the described community or its situation. Examination of the survey results suggests that the **MC9** fields were related to the much more widespread **MG6**, but were less intensively grazed and less fertile, with more *Lolium* and *Cynosurus* (both very rare in **MC9**). Hence, the **MC9** fields may represent a particular combination of conditions that are drier than those that support **S21**/**MG13**, more grazed/mown than **MG1** fields but not so intensively as those fields further north and west in the Ranges that support **MG6** *Lolium perenne-Cynosurus cristatus*.

5.2 **U4** *Festuca ovina-Agrostis stolonifera-Galium saxatile* grassland

5.2.1 *Composition*

Many of the sheep-grazed grasslands at Fingringhoe were dominated by a common group of grasses – *Agrostis capillaris, Cynosurus cristatus, Festuca rubra, Holcus lanatus, Hordeum secalinum* and *Lolium perenne* – growing with *Trifolium repens*. Where *F. rubra* and *H. lanatus* dominate, with

little *L. perenne* or *C. cristatus*, the composition fits best with **MC9** (section 5.1). Where *L. perenne* and *C. cristatus* are prevalent, the community is **MG6** (section 6.3). However, in those areas where *A. capillaris* is sub-dominant, or locally co-dominant, and *C. cristatus/L. perenne* again sparse, the grassland matches with the **U4** calcifuge grassland – represented throughout Fingringhoe by the *Trifolium repens* sub-community (**U4b**).

5.2.1.1 **U4b** *Holcus lanatus-Trifolium repens* sub-community

Distinguished from other Fingringhoe grasslands by *A. capillaris* cover of *ca* 20% or more, **U4b** also has abundant *H. lanatus* (*ca* 30% cover) and *H. secalinum* (*ca* 15-20%), with constant but limited *F. rubra* and *Trifolium repens* in a closed turf with 9.5 species/quadrat. Atypical samples tend to be little more species-rich with more *L. perenne* and are transitional to **MG6** grassland.

5.2.2 *Location, habitat and management*

U4b turf is a component of grassland mosaics throughout DE Unit 1, but only becomes extensive on the higher-lying land near the Range Offices and especially toward the north edge of the Ranges near South House Farm. In such situations, it occurred principally in drier short sheep-grazed fields with little military disturbance, although some samples were found under intensive mowing and close to butts.

5.2.3 *Zonation and succession*

As discussed above, the grassland mixture on the north and west of the Ranges includes some areas best placed in **U4b** and **MC9**, largely set within a matrix of **MG6**. The factors controlling this pattern appear to be grazing (and dung/urine input), disturbance and possibly soil type (particle size and drainage). Slight changes in these factors can alter the composition toward one element of the mosaic, and relaxation/elimination of the grazing leads to the establishment of **MG1a** grassland.

6. Mesotrophic grassland communities

6.1 **MG1** *Arrhenatherum elatius* grassland

6.1.1 *Composition*

False-oat grassland is one of the most widely-spread communities on the Fingringhoe Ranges, but the variant present is species-poor (*ca* 7.1 species/quadrat), unvaried and lacking in scarce or uncommon species. The overwhelming dominant is *Arrhenatherum elatius* itself (usual cover *ca* 50-90%) in a coarse tussocky community, with *Elytrigia repens* and *Holcus lanatus* often sub-dominant over a thick litter thatch. No forbs achieve better than constancy III, with *Lathyrus pratensis* the most frequent and *Cirsium arvense* locally important. The uncommon neophyte *Tragopogon porrifolius* (Salsify) was found in several **MG1** fields, but did not occur in any of the sample quadrats.

6.1.1.1 **MG1a** *Festuca rubra* sub-community

This sub-community is the most species-poor variant of the *Arrhenatheretum elatioris* and the bulk of **MG1** samples from Fingringhoe are best classified here. *F. rubra* is indeed quite frequent, but in none of the fields here was it more than sub-dominant. Over 50 species were recorded in examples of the False-oat grassland, but the majority occurred in <5 quadrats. Most of these additional species were coarse forbs, tall grasses or climbing legumes.

6.1.2 *Location, habitat and management*

MG1 and **MG6** together account for the bulk of the grassland vegetation within the sea-walls. **MG1** is the dominant community in the Langenhoe and Wick Marshes, together with the higher-lying land toward Wick Farm itself, as well as the eastern (less-grazed) fields of DE Unit 1, and the rank swards in the valley of the stream draining Grimps Grove. Although some of these fields were lightly (often unintentionally) sheep-grazed, the best development of the community lay where there was no recent management. **MG1** grew on relatively well-drained soils that were deep and moderately fertile. The community was tolerant of some salt input, though where conditions were clearly saline, Elytrigia atherica became dominant.

6.1.3 *Zonation and succession*

At a field scale, there was clear evidence that the **MG1** grasslands were being invaded by thorn scrub communities, especially close to field boundaries and in DE Unit 2. However, within the quadrats, woody species were almost absent and it is likely that the thick litter layer may arrest succession to scrub unless it is removed through burning or other disturbance (as in DE Compartments 2.01 and 2.03). **MG1** areas were often fairly distinct from those fields dominated by **MG6**, which depended on sheep-grazing to suppress the tall False-oat. Where **MG1** occurred in a more intimate mosaic within fields under the same management, it was usually mixed with a coarse weedy community of **OV25** *Urtica dioica-Cirsium arvense* – the latter occur in patches formed through vegetative spread. Where **MG1** and **MG6** did exist in the same "management unit", this was clearly due to two management regimes being applied within the same area *e.g.* CEH divisions 5 (part of DE Compartment 1.01) and 35 (part of DE Compartment 1.02) – unmanaged zone and intensively-mown area around butts and firing positions.

6.2 **MG5** *Cynosurus cristatus – Centaurea nigra* grassland

6.2.1 *Composition*

The most species-rich of the grassland assemblages at Fingringhoe was represented by 2 samples only, both with TABLEFIT goodness-of-fit values <60. This poor correspondence was due to the absence of a number of the normal constants for **MG5**: *Anthoxanthum odoratum, Centaurea nigra, Dactylis glomerata, Plantago lanceolata* and *Trifolium pratense*. The sward had no clear dominant – *Agrostis capillaris, Cynosurus cristatus, Festuca rubra, Holcus lanatus* and *Lotus corniculatus* all had a cover value of *ca* 20%. The most characteristic features of these samples were the higher proportions of mosses and forbs than was found elsewhere at Fingringhoe, and especially the high species complement – 22 and 16 species for the two samples. None of the nationally scarce species were found in these samples, but the presence of *Linum catharticum* is indicative of old and unimproved grasslands, and indeed Tarpey and Heath (1990) recorded this in only four sites in the whole of Northeast Essex.

6.2.2 *Location, habitat and management*

The **MG5** samples were confined to a distinctive part of DE Compartment 1.01 close to the northern edge of the Ranges. Here there was a moderately steep slope up from Grimps Grove gulley toward some plantation woodland outwith the MoD property. The soil was shallow and the area moderately grazed by sheep, but with little disturbance associated with the Range activity itself. Related grasslands (classified as more herb-rich variants of **MG6**) were found further south and east within the same DE Compartment. The **MG5** could be picked out from the surrounding **MG6** matrix by its combination of mosses, *Prunella, Linum,* abundant *Lotus* and *Potentilla reptans*.

6.2.3 *Zonation and succession*

The presence of **MG5** within the otherwise dominant **MG6** appeared to be related to soil fertility, related to the steepness of the slop, shallowness of the soil and somewhat reduced inputs of dung and urine from the sheep. Transitional samples to **MG6** were found on the steep banks of dry ditches and other places where the soil was shallow. It is possible that this vegetation type would be commoner through all the Ranges on steeper slopes, were the prevailing grazing to be less intensive, but not abandoned (which would lead to the development of a rank **MG1** community).

6.3 **MG6** *Lolium perenne-Cynosurus cristatus* grassland

6.3.1 *Composition*

Although named by the *NVC* as the *Lolium-Cynosurus* grassland, at Fingringhoe this community was dominated by a mixture of *Agrostis capillaris, Holcus lanatus* and *Hordeum secalinum*, with *L. perenne* and *C. cristatus* constant but with mean cover values of only *ca* 5% each. In addition, *Festuca rubra* has a constancy of IV but a cover of <10%. **MG6** not only has a more complex grass composition than **MG1**, but is also more species-rich (*ca* 11 species/quadrat). Most of this species

complement is made up *Poaceae*, with *Trifolium repens* the only frequent forb throughout the samples. The overall frequencies of the two grassland types at Fingringhoe are comparable, but **MG6** is generally more variable and at least three sub-communities are present.

6.3.1.1 **MG6a** Typical sub-community
This variant contained between 8 and 14 species per quadrat (mean 10.9), and differed principally from the other sub-communities in the lower cover of both *Agrostis capillaris* and *Phleum bertolonii*, as well as rather more moss (*Brachythecium rutabulum*).

6.3.1.2 **MG6b** *Anthoxanthum odoratum* sub-community
This sub-community may be present at Fingringhoe though, where the TABLEFIT procedure suggested **MG6b**, the goodness-of-fit values were slightly lower than for other **MG6** sub-communities. The composition of this sub-community tends toward **U4b** (see section 5.2), with more extensive *Agrostis capillaris*, and there is some indication of a somewhat more species-poor composition although the number of samples is very small.

6.3.1.3 **MG6c** *Trisetum flavescens* sub-community
The commonest variant of the *Lolio-Cynosuretum* grassland at Fingringhoe is **MG6c**, accounting for two-thirds of the samples of this community. The quadrats had 8-15 species/quadrat (mean 11.3), and some 32 species were recorded overall in these samples. The composition of the sward differed somewhat in having consistently more *Phleum bertolonii* and a greater frequency of forbs, with *Cerastium fontanum* and *Ranunculus acris* occurring in *ca* 65% of samples, in addition to the more usual *Trifolium repens*.

6.3.2 *Location, habitat and management*

MG6 is the most common grassland type in the west and north parts of DE Unit 1, where sheep-grazing or, more locally, frequent mowing are the main management techniques. Within the sub-communities, **MG6a** is largely confined to the fields along the west margin of the ranges south of the access road from Langenhoe village, whereas **MG6c** is the chief cover north of this road and as far as South House Farm. The closest approach to **MG6b** is in the same area as the *Trisetum flavescens* sub-community. The great majority of these fields are quite intensively sheep-grazed, although the frequently mown fields immediately by the Range Offices have comparable vegetation (CEH divisions 1 and 2). The mowing here is intense not only for to maintain a neat and tidy surrounding to the buildings, but also to provide amenity grassland. There is no indication of fertiliser application, and the distinction between **MG6** and **MG1** where sheep were present appears to be entirely related to the normal stocking rate with the fields.

6.3.3 *Zonation and succession*

This semi-improved grassland was largely demarcated on the basis of its management, though there is some evidence of other factors leading to a mosaic of sward-types (see section 5). The clear distinction from MG1 and from the scrub and salt-marsh communities was evident from the ground survey and from the remote-sensing.

6.4 **MG7** *Lolium perenne* leys and related grasslands

6.4.1 *Composition*

6.4.1.1 **MG7e** *Lolium perenne–Plantago lanceolata* grassland

There is no evidence on the Fingringhoe Ranges of reseeding in recent decades, and the presence and abundance of *Lolium perenne* appears to be entirely related to the nutrient input from sheep-grazing and other disturbance. Hence no typical **MG7** swards occurred on the site, and those where there was a fair goodness-of-fit represent extreme variants of the **MG6** sward (see section 6.3) – indeed the samples were quite species-rich (12 species/quadrat) – itself suggestive of a transition to **MG6**. *L. perenne* and *Dactylis* were frequent, but otherwise the composition was similar to that reported in section 6.3.1. The presence of *Taraxacum* agg. in the sward was somewhat indicative of **MG7**.

6.4.2 *Location, habitat and management*

These extreme variants of the **MG6** type were found in the "amenity" fields adjacent to the Range Offices, where they received regular and frequent mowing together with disturbance and, it can be assumed, higher inputs of nutrients related to this disturbance. Mowing went on through the summer including cuts during the ground survey in preparation for its use in the "5 Villages Show".

6.4.3 *Zonation and succession*

Further intensification of management (increased stocking rates and disturbance) might extend the **MG7e** grasslands. Conversely, reduced management would rapidly make these fragmentary stands indistinguishable from the surrounding *Lolium perenne-Cynosurus cristatus* grassland (**MG6**).

6.5 **MG10** *Holcus lanatus-Juncus effusus* rush pasture

6.5.1 *Composition*

6.5.1.1 **MG10a** Typical sub-community

There are no large rush-pastures as such on the Ranges, although fragments around the edge of some fields fit fairly well with this community. Here *Juncus effusus* was co-dominant with a grass mixture in which *Holcus lanatus* was prominent together with *Agrostis capillaris* (sic!) and a pleurocarpous moss layer of *Rhytidiadelphus squarrosus* and *Pseudoscleropodium purum*, rather than the ubiquitous *Brachythecium rutabulum* and *Eurhynchium* species. All stands corresponded to the typical sub-community (**MG10a**), although *Agrostis stolonifera* was surprisingly absent in quadrats with the best goodness-of-fit to **MG10**. The correspondence was generally poor, possibly due to the poverty of species *i.e.* 9 species/quadrat, in contrast to the 13 species/quadrat that is typical of the described type (Rodwell 1992). Some areas transitional to **S21c** swamp appear related to **MG10** grassland.

6.5.2 *Location, habitat and management*

Small patches of a few square metres occurred in low-lying corners and margins of fields in the eastern edge of DE Unit 1, notably CEH division 11, where the network of ditches produced wet and less accessible conditions. These areas were sheep-grazed but under a rather extensive regime. The

soils were groundwater gleys of impeded drainage, and the best stands occurred where ditches converged and where disturbance from military training activity was essentially nil.

6.5.3 *Zonation and succession*

Where **MG10** vegetation occurred, the grassland structure was typically quite complex, with patches apparently fitting with **MG6**, **MG11**, **U4b** and **OV25** closely associated. The fine detail of the distribution of these vegetation types reflected local variation in soil moisture conditions.

6.6 **MG11** *Festuca rubra-Agrostis stolonifera-Potentilla anserina* grassland

6.6.1 *Composition*

6.6.1.1 **MG11a** *Lolium perenne* sub-community

As with several other mesotrophic grassland types (**MG5**, **MG7** and **MG10**), the examples identified of **MG11** at Fingringhoe had rather poor goodness-of-fit and were limited to a few small patches, where local conditions altered standard **MG1a** or **MG6c** grasslands. Samples approaching **MG11** were best recognised by the combination of *Agrostis stolonifera* (cover *ca* 5%) and *Festuca rubra* (*ca* 5-10%) in modified *Holcus lanatus-Agrostis capillaris* grassland where the cover of *Lolium perenne* was higher than usual on the Ranges (*ca* 10-35%). This latter feature resulted in all **MG11** samples being placed in the **MG11a** sub-community. The samples had 9 species per quadrat. No uncommon or scarce species were observed in this community, and the poor correspondence of the Range samples to the described **MG11** was underlined by the absence of *Potentilla anserina*.

6.6.2 *Location, habitat and management*

This community is normally found in situations with impeded drainage or where a grazed sward is liable to some seasonal flooding. At Fingringhoe, this situation was found in a very few samples within the seawall by a brackish fleet immediately adjacent to the South Geedon Creek. More surprisingly, similar swards were found in the frequently mown "amenity" fields near the Range Offices. This occurrence may reflect local soil compaction from regular use of tractors leading to impeded surface drainage and the spread of *A. stolonifera*.

6.6.3 *Zonation and succession*

At Fingringhoe MG11 is present only as a very minor component of grassland mosaics – either with **MG13**, **OV28** and **S21c** (where wet) or with **MG6c** and **U4b** in intensively cut and compacted fields. This vegetation type might develop by brackish fleets where sheep and wildfowl grazing are intense, but the examples observed at Fingringhoe are very small and probably transitory or unrepresentative.

6.7 **MG13** *Agrostis stolonifera-Alopecurus geniculatus* grassland

6.7.1 Composition

During field mapping of the vegetation, several stands were provisionally allocated to this inundation grassland, but detailed analyses of field-lists and quadrats revealed it to be very uncommon (largely due to the rarity on the site of *Alopecurus geniculatus*). Those few stands that were true **MG13** were species-poor (5 species/quadrat) and dominated by abundant *Agrostis stolonifera* (cover 75-90%) with subsidiary *A. geniculatus* (cover <5%) and scattered shoots of *Bolboschoenus maritimus* and a few plants of *Atriplex prostrata*. Stands without *A. geniculatus* were usually transitional to **S21c** swamp (section 8.2) or to the more disturbed and open **OV28** *Agrostis stolonifera-Ranunculus repens* community (section 7.2).

6.7.2 *Location, habitat and management*

Confined to the lowest-lying portions of fields in DE Compartment 1.03, this grassland occurred on seasonally-wet flats adjacent to the creek draining Grimps Grove, as well as by the nearby fleets. In addition to the regular flooding with quite brackish water, these stands were lightly sheep-grazed. The realignment of the fleets for nature conservation purposes may have disturbed the grasslands.

6.7.3 *Zonation and succession*

Typical **MG13** was best-represented where disturbance was slight, and it may be that excavation of the fleets favoured **OV28** and that the more prolonged flooding (allied to the brackish water) resulted in the spread of the *Agrostis stolonifera* sub-community of *Bolboschoenus* swamp (**S21c**). In all winter-flooded and drawdown situations at Fingringhoe, there is a mixture of these communities and slight changes in the water-regime would almost certainly lead to altered proportions of the types.

6.8 Other variation in mesotrophic grassland

6.8.1 *Composition*

As discussed previously, the chief variation in grassland types at Fingringhoe was between ungrazed (or lightly grazed) *Arrhenatheretum elatioris* and more intensively grazed *Lolio-Cynosuretum.* In most cases, impeded drainage or flooding led to development of swamp or to swards related to salt-marshes. The chief communities of lowland wet grassland (Benstead *et al.* 1997) were either absent or represented by a few rather atypical patches. In addition to those described (**MG10**, **MG11** and **MG13**), one sample fitted poorly with *Festuca arundinacea* grassland (**MG12**) and a few showed a trend to *Holcus lanatus-Deschampsia cespitosa* grassland (**MG9**). In neither case, however, were the key species present, and these samples are better considered as variants of **MG1**.

7. Open habitats and Disturbed grassland

7.1 **OV25** *Urtica dioica-Cirsium arvense* community

7.1.1 *Composition*

Several grassland types at Fingringhoe were either disturbed or neglected leading to a complex mixture of coarse grasses and ruderal forbs. Such communities were not precisely classified, and may be best considered as variants of the communities described in Section 6 – especially of **MG1** *Arrhenatherum elatius* grassland. However, where *A. elatius* is dominant, with sub-dominant *Elytrigia repens* and *Holcus lanatus*, but where there is a strong representation of tall forbs (especially *Cirsium arvense*), the vegetation may be allocated to **OV25**. The Fingringhoe samples differed from those outlined in Rodwell (2000) in the virtual absence of *Urtica dioica*. This variable vegetation has *ca* 7.5 species/quadrat and often a thick litter layer. Where *H. lanatus* and *E. repens* are especially common, the community approaches **OV25a** *Holcus lanatus-Poa annua* sub-community.

7.1.2 *Location, habitat and management*

Such vegetation is scattered in the unmanaged or neglected parts of the Ranges, or where scrub has been partly cleared, especially in DE Compartments 1.06, 2.01 and 2.03. Such locations differ from those that support **MG1a** merely in the coarser and more overgrown situation.

7.1.3 *Zonation and succession*

In most instances, vegetation allocated to **OV25** is immediately to or mixed with **MG1a**, and these two communities form a mosaic in the rank and disturbed grasslands of the Ranges, especially where there is (or has been) some scrub colonisation. Introduction of annual cutting or light grazing may convert the **OV25** to **MG1** in the strict sense. Conversely further neglect may allow scrub colonisation to develop communities described in sections 9.1-9.3.

7.2 **OV28** *Agrostis stolonifera-Ranunculus repens* community

7.2.1 *Composition*

This community could be separated from the generally similar **MG13** by the absence of *Alopecurus geniculatus* and the presence of *Ranunculus repens* (cover 5-10%) within dominant *Agrostis stolonifera*. Rather few samples were distinguished, but appeared to vary from very species-poor swards with 100% *A. stolonifera* to examples with 75-90% cover of *A. stolonifera* and as many as 9 species/quadrat. In contrast to **MG13**, the associated species tended not to be wetland herbs, but ruderal species such as *Cirsium arvense* and *Rumex crispus*.

7.2.2 *Location, habitat and management*

OV28 was found mixed with **MG13** in similar parts of the Ranges, but also alone or mixed with **MG1** in drier localities where scrub clearance had reduced competition. Both parts of the range were lightly grazed – by sheep in DE Compartment 1.03 and by abundant rabbits in DE Compartment 2.03. In no part of the Ranges was this type of vegetation, but rather it comprised small to very small patches of <1ha.

7.2.3 *Zonation and succession*

In wet areas, **OV28** is part of a mosaic with **MG13** and **S21c** swamp, and its extent appears to be determined by the degree of disturbance, the duration of flooding and the salinity of the soil (see Section 6.7). In dry disturbed areas, the presence of **OV28** may be transient and colonisation by coarse grasses or shrubs would lead to succession to **MG1** or **W21**/**W22**/**W24**.

7.3 Other variation in disturbed habitats

7.3.1 *Composition*

Where *Lolium perenne* and *Dactylis glomerata* are common in grassland with plantains, *Potentilla reptans* and *Taraxacum*, the community approaches **OV23** *Lolium perenne-Dactylis glomerata* and especially **OV23d**, the *Arrhenatherum elatius-Medicago lupulina* sub-community. This vegetation represents a weedier and disturbed trend from **MG6** through **MG7e**, and all examples seen at Fingringhoe are probably better placed in the mesotrophic grasslands. *Rumex pulcher* was found in this type of vegetation on the Ranges – a species otherwise confined to grass verges in only seven 1km squares in northeast Essex (Tarpey and Heath 1990).

At several places on the Ranges, there were discrete areas of disturbed ground created by sand heaps or other ridges of spoil associated with the military training. The flora in such sites was very mixed and comprised an assortment of ruderal species, of which *Onopordum acanthium* was prominent.

7.3.2 *Location, habitat and management*

The *Lolium-Dactylis* vegetation occurred around the poached edge of the frequently mown "amenity grassland" near the Range Offices. This type of composition was observed elsewhere on tracksides or disturbed margins of shorter grassland, but in no instance did the area exceed a few square metres (usually as a narrow strip). There were several weedy spoil heaps placed as barriers (or for safety) within DE Unit 1, generally along roadsides or associated with firing positions.

7.3.3 *Zonation and succession*

OV23 is maintained by vehicle pressure on mown grassland, and is likely to persist where the management of the ranges requires the maintenance of tracks. The spoil-heap flora is of some interest, through adding transient weeds and neophytes to the flora of the Ranges. This flora, with a varied composition, depends on renewed disturbance of the heaps or creation of new heaps, coupled to the chance introduction of seed via vehicles and military personnel.

8. Swamp and aquatic communities

8.1 **S4** *Phragmites australis* swamp and reedbeds

8.1.1 *Composition*

This community was possibly the simplest to distinguish at Fingringhoe, both through the field survey and through examination of remotely-sensed imagery. In floristic terms, the samples are distinguished by their complete cover by *Phragmites australis*, with few other associated species.

8.1.1.1 **S4a** *Phragmites australis* sub-community

The majority of reedbeds at Fingringhoe were typical *P. australis* sub-community, where the tall reed canopy was over a thick layer of broken reed canes and litter. The samples recorded were relatively dry and species poor (2.5 species/quadrat) - the most frequent associated species were *Cirsium arvense* (*ca* 5% cover) and scattered stems of *Solanum dulcamara*. The TABLEFIT procedure indicated that several samples of **S4a** fitted almost equally as well to the **S4b** *Galium palustre* sub-community. The poverty of the associated flora, however, makes **S4a** the more probable type.

8.1.1.2 **S4d** *Atriplex prostrata* sub-community

Some areas differed from the typical reedbed in the absence of *C. arvense* and *S. dulcamara*, and the associated flora having a sub-maritime element that included *Atriplex prostrata* and *Bolboschoenus maritimus*. The species-richness appeared similar to S4a.

8.1.1.3 **S4f** *Atriplex prostrata-Agrostis stolonifera* sub-community

The richest form of reedbed observed (but still only 4 species/quadrat) comprised a stand of this sub-community, which could be distinguished from **S4d** by a ground layer of *Agrostis stolonifera* (cover *ca* 80%) grew under the continuous reed canopy. The litter was not so extensive as in **S4a** or **S4d**.

8.1.2 *Location, habitat and management*

S4a is the most widespread sub-community, growing in fresh to slightly brackish water with no cutting and only sporadic grazing my wild herbivores. The main reedbed occupied the bulk of DE Compartment 2.07 (CEH division 31), except its western portion and the margins. Most of the **S4a** stands recorded here were summer-dry, but nearer the damper margin, there was a transition to **S4d**. **S4a** also lined the wide fleets within Langenhoe Marsh (DE Compartments 2.03, 2.04 and 2.06), especially along the southern edge where they mark relict salt-marsh creeks. Part of the most extensive reedbed in Langenhoe Marsh was the site of a small breach in the seawall that has subsequently been closed (C. Duncan pers. comm). Finally, there are more restricted reedbeds (**S4f** *Atriplex prostrata-Agrostis stolonifera* sub-community) where the stream entering South Geedon Creek from the west is partly dammed by the road and widens to form a lagoon (DE Compartment 1.06). At Fingringhoe, reedbeds are confined to areas of constant shallow water or where the site is only summer-dry and where the salinity is not too high (Wheeler *et al*. 2004). Preferred winter depths may be *ca* 1m of water, with summer water depths from 20cm above to 40cm below substrate surface. *Phragmites* tolerates salinities from 2-12(-22) gm Cl^-/l, but salt may limit bud development in spring, meaning that reedbeds in brackish or tidal sites may be stunted or recede with saline incursions.

The reedbeds in DE Compartment 2.07 are probably affected in this way, whereas those further west and in DE Compartment 1.06 showed vigorous growth.

8.1.3 *Zonation and succession*

In DE Compartment 2.07, the distribution of reeds was quite dynamic with more brackish areas supporting **S21** and micro-topographic variation leading to a transition though to **SM24** and **MG1**. In the deep fleets of the Langenhoe Marsh, reedbed distribution may be quite stable, though *Phragmites* does show signs of vegetative spread into the unmanaged coarse grassland adjacent. In DE Compartment 1.06, the spread of reed from the water is limited by grazing, though a fence on the north side prevents access by stock into the main body of the reedbed. This opening up of the margins of this reedbed to light probably accounts for the spread of *A. stolonifera*, and hence development of **S4f**, rather than dense **S4a**.

8.2 **S21** *Scirpus maritimus* swamp

8.2.1 *Composition*

The Sea Club-rush swamp is characterised by the dominance of *Bolboschoenus maritimus* (previously known as *Scirpus maritimus*), generally in a dense cover with very few associated species (Rodwell 2000). The Fingringhoe examples fit well with this description, and can be divided into quite distinct two sub-communities whose distributions do not overlap within the ranges.

8.2.1.1 **S21a** *Scirpus maritimus* dominated sub-community

This community is extremely species-poor (2.5 species/quadrat), and the Fingringhoe samples typical comprise *ca* 90% cover (75-100%) of *B. maritimus* with *Aster tripolium* (rayed) accounting for the rest of the vegetation (cover *ca* 10%). Very locally, *Elytrigia atherica* is important, and *Atriplex portulacoides* was found in two samples. Litter cover is about 25%, and the soil surface is frequently damp with the *B. maritimus* shoots emerging from wet mud.

8.2.1.2 **S21c** *Agrostis stolonifera* sub-community

Although still species-poor, this sub-community is markedly richer than **S21a**, with 2-6 species/quadrat (mean 4.75). The *B. maritimus* is less dense and in some instances, the cover may be as low as 10%, although the typical range is 50-90% (mean *ca* 80-85%). This allows *Agrostis stolonifera* to form an open carpet below the club-rush (Constancy V and mean cover *ca* 25-30%). Other frequent species are *Atriplex prostrata* (cover *ca* 1%) and *Juncus gerardii* (cover 5%). In contrast to **S21a**, *Elytrigia repens* is sometimes present and *Aster tripolium* is usually absent. Litter cover is reduced to <4% and any bare ground was dry during the survey period. *Rumex* species are a feature of the vegetation, especially the uncommon *R. maritimus* which on the Ranges is preferential for this community. The invasive neophyte *Crassula helmsii* was found in this type of vegetation.

8.2.2 *Location, habitat and management*

B. maritimus swamp is confined to low-lying moist parts of the ranges often close to the seawalls, but never outwith the seawalls under tidal influence. The two sub-communities occurred in different parts of the ranges: a) **S21a** was confined to DE Compartment 2.07 (CEH division 31) and associated with the main area of reedbed (**S4**); and b) **S21c** was found in a mosaic with **MG13,** other grasslands and

SM23 (see section 4.13) mainly in the east part of DE Unit 1 in fields by fleets and the stream draining Grimps Grove. **S21c** was also found lining ditches in the Langenhoe and Wick Marshes (DE Compartments 2.02, 2.04, 2.05 and 2.06). The typical habitat was summer-dry and brackish, occurring on gleys and able to tolerate salinities up to *ca* 20 g/l (Rodwell 1995). The **S21a** sub-community occurred only on ungrazed areas, but **S21c** was probably more typical of fields lightly grazed by sheep (though the Langenhoe stands are unmanaged).

8.2.3 *Zonation and succession*

S21 was sometimes associated with **S4** reedswamp and in such instances tended to occur on the drier and more saline margins, giving way to **SM25** *Elymus pycnanthus* salt-marsh above. **S21c** was closely associated with other communities where *A. stolonifera* is important *e.g.* **MG13** and **OV28**. In these grazed sites, the zonation appeared to be related to increased salinity (favouring **SM23**) or to more intensive grazing and trampling (favouring **MG13** and **OV28**).

8.3 Aquatic vegetation – pools, fleets and drainage channels

The vegetation of drainage channels can be difficult to classify in terms of the *NVC* and at Fingringhoe, as elsewhere, channels often appeared to contain intimate concatenations of types that could not be simply separated into recognised aquatic and swamp associations (Mountford in press). Thus, in this report channel vegetation is represented as combinations of *NVC* described communities. In all 22 samples were gathered from freshwater or brackish aquatic vegetation, including drainage channels in the reclaimed marsh, wider fleets originally derived from salt-marsh channels and a small number of ponds and lagoons.

8.3.1 *Composition*

There were rather few channels with floating and submerged aquatic vegetation, and many of the ditches in the reclaimed grazing marsh were summer dry with vegetation related to the mesotrophic grassland in the adjacent fields. Where there was standing water, tall emergents such as *Phragmites australis* and *Bolboschoenus maritimus* tended to dominate. However, short lengths of ditch contained both **A2** *Lemna minor* community (with additional *L. gibba* and *L. trisulca*) and **A9** *Potamogeton natans* community, both as floating patches. The most widespread submerged vegetation was **A12** *Potamogeton pectinatus* community, often as fairly few stands but with a fringe of emergent *B. maritimus* on the channel margins (referable to **S21** swamp). Much more rarely, the *P. pectinatus* was accompanied or partly replaced by *Myriophyllum spicatum* in a type that corresponded best to **A11** *Potamogeton pectinatus-Myriophyllum spicatum* community, again often with a fringing zone of *B. maritimus*. In two areas, *Ruppia maritima* dominated standing water (see section 10.2) and the resulting assemblage might be classified as **SM2** or possibly, where *P. pectinatus* was also present, as a brackish water variant of **A12**.

Nonetheless, much the commonest vegetation in standing water was essentially identical with those swamp types described above (sections 8.1 and 8.2). **S4** reedbeds, mainly of the **S4f** sub-community, were found in broad channels and fleets, where the *P. australis* was accompanied by *B. maritimus*, a little *Agrostis stolonifera* and a sparse representation of forbs and grasses tolerant of brackish situations, including *Crassula helmsii*. **S21** swamp vegetation is the main cover in standing water through most of the Fingringhoe Ranges. The community in the broad sense, where *B. maritimus* is

dominant to the exclusion of most other species was commoner in deeper water or as a narrow fringe to ditches with submerged macrophytes. The **S21c** *Agrostis stolonifera* sub-community tended to replace it in shallow water or in ditches that dried out in summer.

Other swamp and aquatic communities exist only as fragmentary stands in ponds or ditches. Thus the large pool south of the Range Offices (DE Compartment 1.02 – CEH division 45) has **S6** *Carex riparia* swamp and **S13** *Typha angustifolia* swamp, as well as some areas of **A12** *Potamogeton pectinatus*. The rectangular pond in DE Compartment 1.06 (CEH division 33) is more species-rich, with a complex mosaic of two or more aquatic communities: **S12** *Typha latifolia* swamp (mainly **S12c** *Alisma plantago-aquatica* sub-community), **S21c** *Scirpus maritimus* swamp and **A11b** *Potamogeton pectinatus-Myriophyllum spicatum* community (*Elodea canadensis* sub-community). Finally, a few narrow water-filled field ditches have a floating matrix of *Glyceria fluitans* referable to **S22** *Glyceria fluitans* water margin vegetation or, where mixed with *Agrostis stolonifera, Nasturtium officinale, Lemna* species and *Ranunculus trichophyllus,* to **S23** (Other water-margin vegetation).

8.3.2 *Location, habitat and management*

Ditches with a complex of **A2**/**A9** and **S23** were confined to DE Compartment 1.04 (CEH 11) where they were *ca* 1.7m wide and 0.3m deep, with a freeboard of 1m, and their margins lightly sheep-grazed. Otherwise similar but very shallow ditches in the same area supported **S22** swamp. Those communities where *Potamogeton pectinatus* and/or *Myriophyllum spicatum* are dominant occur in the Wick and Fingringhoe Marshes (but also in DE Compartment 1.03 – CEH division 20). **A12** ditches were shallower (*ca* 0.35m), moderately wide (2.6m), but with only 0.8m freeboard. Within Wick and Langenhoe Marshes, **A11** was found in broad fleets (as much as 35m) that were locally >1m deep and had a freeboard of 1.4m. Both **A11** and **A12** were mainly in areas without any clear management, though in DE Compartment 1.03, the margins were grazed and the pond in DE Compartment 1.06 was partly dredged during August 2005.

Within channels, reedbeds (**S4**) were commonest in much the same parts of the Ranges as described above (section 8.12), but there were a few outlying reed-filled ditches in DE Unit 1 (in lower-lying portions of DE Compartments 1.03 and 1.04). In ditches and fleets, reed-dominated vegetation grew in anything from summer-dry conditions to 0.5m of water, and more sparsely to 1m depth. These channels tended to be broader (>2m) than those supporting **S21** and to have a freeboard of *ca* 0.85m. Almost all reedbeds were in areas where stock had no access, and where they were found adjacent to sheep-grazed fields, fences often prevented access. **S21** swamps grew mainly in narrower (*ca* 1.6m) and shallower channels (*ca* 0.1m), often where these were dry in late summer. Where **S21** grew in deeper and wider fleets, this community was confined to a marginal fringe in the shallows. **S21** was more able to tolerate grazing and was frequent in both DE Units 1 and 2 – ditches with this community being in the same areas as detailed in section 8.2.

Other communities that were distinguished floristically (**S6**, **S12** and **S13**) were confined to single sites (ponds) and it is thus not possible to generalise about the environmental conditions under which they would "normally" be found on the Fingringhoe Ranges.

8.3.3 *Zonation and succession*

As a broad generalisation, the zonation of aquatic and swamp communities follows the familiar successional pattern from submerged aquatic and free-floating communities in deeper water, through increasing colonisation by tall emergents and eventual terrestrialisation to **S21**/**S4** that is dry at least in summer. However, this broad trend is altered by local management factors. For example marginal grazing can prevent the colonisation of reed and, to a lesser extent, *Bolboschoenus*, thus maintaining floating and submerged vegetation. Higher freeboard (or fences) can prevent access to the channel by sheep, hence allowing reedswamp to survive amongst intensively grazed fields. Dredging and cleaning of the channels and ponds can also arrest succession, allowing several seral stages to coexist in one water-body. Similarly fleets, ditches or ponds where depth increases gradually from the margins can support a much greater range of vegetation than those with a trapezoidal cross-section. The presence of the invasive *Crassula helmsii* may alter these zonations and create new communities.

9. Scrub and woodland communities

9.1 **W21** *Crataegus monogyna–Hedera helix* scrub

9.1.1 *Composition*

Scrub communities were present in two situations at Fingringhoe – as patches or blocks of scrub within fields and as overgrown hedges. Scrub blocks tended to be dominated by *Prunus spinosa* (section 9.2) but locally *Crataegus monogyna* was important and this species was the main component of the hedges. Hawthorn scrub (often with sub-dominant blackthorn) tended to be almost impenetrable, from 5-12m tall, and with a tangle of branches from less than 1 metre above the ground. This density of growth resulted in a very poor ground layer under the hawthorns, without an underscrub layer. In most instances, the ground cover was a sparse mat of pleurocarpous mosses with leaf litter and very scattered plants of species from the surrounding grassland (without any true shade species). In places where sheep had access to established thorn scrub, the lower branches were browsed back, more light penetrated and the ground cover was fairly continuous grass (*e.g.* *Agrostis capillaris*). Hedges of hawthorn are present in parts of the ranges, but have almost all lost their stock-proof function and now comprise linear belts of tall scrub with large trunks and emergent trees of *Ulmus*, *Quercus* and *Acer campestre*. Sheep are able to move under and through such scrub, resulting in an open weedy ground layer of grass derived from the adjacent fields. Hawthorn formed an understorey in parts of the conifer plantations (section 9.5), and consequently those areas showed a fair goodness-of-fit with **W21**. However, their peculiar mix of species and management demanded that they be treated separately.

9.1.2 *Location, habitat and management*

More extensive blocks of scrub were present in three areas of the Ranges: a) between Wick Marsh and Wick Farm in DE Compartments 2.01 and 2.03; b) in the eastern part of DE Compartment 1.04 (CEH division 13); and c) in the far northwest of DE Compartment 1.01 (CEH division 38). However, in certain parts of the higher-lying Ranges (DE Unit 1), the hedges had spread so widely as to form belts of scrub – though most of these were blackthorn-dominated (section 9.2). Scrub was largely confined to the higher-lying land on surface-water gley soils. Scrub has developed under a regime of very low intensity or no management, allowing the hawthorn to colonise the grasslands. Nonetheless, once the scrub was established some later management was applied. In DE Unit 1, sheep have access to the scrub, altering the ground flora and browsing the bushes themselves. In DE Unit 2, there have been recent attempts at scrub clearance, removing patches of thorn bushes and creating lines of scrub where once there were blocks. Some scrub areas nearer Wick Farm were used for pheasant rearing, with feeders and enclosures.

9.1.3 *Zonation and succession*

Given time and no renewed management, the **W21** scrub community will ultimately be replaced by climax woodland vegetation. This process may be inferred in some of the overgrown hedges and where trees have been planted for amenity purposes. At the same time, relaxation of sheep grazing might lead to colonisation of the grasslands by shrub species and succession to **W21** and **W22**. Such succession to scrub is more likely in the presently grazed land since there are small bare patches in the sward and the litter cover is minimal – hence there are regeneration niches for plant species including

shrubs. Within the **MG1** grasslands and other overgrown communities in DE Unit 2 *etc*, the litter may be so thick as to severely slow down the spread of scrub. However, where there has been scrub removal and creation of bare soil (DE Compartments 2.01 and 2.03), there is abundant evidence of scrub regeneration – especially of blackthorn and *Rubus fruticosus*.

9.2 **W22** *Prunus spinosa-Rubus fruticosus* scrub

9.2.1 *Composition*

At Fingringhoe, the main scrub areas are often mixtures of hawthorn and blackthorn, which are ascribed to the two main communities (**W21** or **W22**) on the basis of the relative amounts of *C. monogyna* and *P. spinosa*. In good **W22**, *P. spinosa* is at least co-dominant and often the only significant shrub. At Fingringhoe, the examples of **W22** tended to have approximately equal cover of *C. monogyna* and *P. spinosa* (*ca* 60-70%) in an intimate mix, though sometimes with hawthorn overtopping the blackthorn, the latter forming a dense understorey. *Rubus fruticosus* is constant but at very low cover, and the main species in the ground layer tend to be the common mosses *Brachythecium rutabulum* and *Eurhynchium praelongum.* Some grassland species survive as single plants under the canopy, although *Holcus lanatus* and *Poa trivialis* are more frequent and with slightly greater cover. Nonetheless, the greater part of the ground is bare of vegetation or strewn with leaf litter. The vegetation is species-poor with ca 7 species/quadrat.

9.2.1.1 **W22a** *Hedera helix-Silene dioica* sub-community

TABLEFIT suggests that some of the blackthorn scrub may be best placed in this sub-community, although both *Hedera helix* and *Silene dioica* were absent. This classification is based rather on the absence of the key species for other sub-communities and on the constancy of *R. fruticosus*.

9.2.2 *Location, habitat and management*

Blackthorn scrub was the most abundant scrub vegetation recorded by the survey, and was especially extensive in the western part of DE Unit 2 and developing from hedges in DE Compartment 1.04 (CEH divisions 9 and 10). Few patches of **W22** were homogeneous, but instead to a lesser or greater degree a mosaic with other scrub communities. Although the relict hedges were inclined to be dominated by hawthorn, blackthorn showed the strongest tendency toward spread into the neighbouring land. For example, most of the scattered patches of scrub (each often only 250m^2 in extent) within the coarse grasslands of the Langenhoe and Wick Marshes were pure *P. spinosa*. In those parts of DE Compartments 2.01 and 2.03 where there had recently been scrub clearance, blackthorn was overwhelmingly the main species to recolonise – forming small dense patches less than a metre tall. The general management regimes applied to the **W22** are essentially the same as those described for **W21** hawthorn scrub (see section 9.1.2).

9.2.3 *Zonation and succession*

There appears to be some evidence at Fingringhoe of a succession within the scrub types. Hawthorn was probably planted to form the original (now largely derelict) hedge network, with other species including *Prunus spinosa* and tree standards (oak, elm, maple *etc*) colonising. However, where scrub developed within the fields, this was largely dominated by pioneer blackthorn, especially in the younger stands. As the scrub matured, hawthorn seems to have invaded the blackthorn and in some cases

overtopped it. In addition, there may be some significance in the observation that the only scrub where hawthorn dominates and where blackthorn is rare is found at the furthest point on the ranges from the influence of the sea. Blackthorn is known to be more tolerant of exposure to salt-laden winds from the coast and thus able to maintain itself on the Langenhoe peninsula. Succession through W21 to woodland may occur on the ranges, unless there is renewed management.

9.3 **W24** *Rubus fruticosus-Holcus lanatus* underscrub

9.3.1 *Composition*

9.3.1.1 **W24a** *Cirsium arvense-Cirsium vulgare* sub-community

This underscrub occurred in small patches by hedges and scrub blocks as well as in transitional zones between woodland and rough grassland. The community comprised a low (*ca* 1m) thicket of bramble (*Rubus fruticosus*) with coarse grasses, notably *Holcus lanatus*, and a variety of tall forbs. Although the overall flora for this vegetation is quite rich, individual stands are more species-poor at the quadrat scale (*ca* 12 species/quadrat) and, apart from the dominants, only *Agrostis stolonifera* is constant. The composition is variable, however, and showed transition to hawthorn (**W21**) and blackthorn (**W22**) scrubs, as well as frequent *Urtica dioica* and patches of pleurocarpous mosses (mainly *Brachythecium rutabulum* and *Eurhynchium praelongum*).

9.3.2 *Location, habitat and management*

This community was widespread at Fingringhoe but none of its patches were extensive, and both terrestrial mapping and remote sensing tended to unite the narrow transitional zones of **W24** with the blocks of scrub or hedges to which they were adjacent. Examination of individual quadrat samples shows **W24** to be present in the same compartments and management units as the associated **W21** and **W22**. In management terms, **W24** usually occurred where grazing was absent or at low levels, or where other management was minimal. In such circumstances, there was the tendency for boundaries between vegetation types to blur, and for an ecotonal zone to develop *e.g.* **W24** underscrub. Such transitional areas also occurred around the conifer plantations (section 9.5). As was the case for other scrub types, **W24** was found mostly on the higher-lying land with surface-water gley soils.

9.3.3 *Zonation and succession*

W24 underscrub was consistently found in close association with other scrub and woodland communities, usually as a transitional zone implying active succession to scrub.

9.4 Mixed deciduous woodland and tall *Salix fragilis*

9.4.1 *Composition*

The only mixed deciduous woodland present on the Ranges was Grimps Grove (CEH division 44 on the boundary of DE Compartments 1.01 and 1.05). This narrow strip of woodland on the slopes of a stream gulley was very variable and as a whole did not fit convincingly with any particular *NVC* type, although portions of the Grove approached at least two woodland communities in general composition.

The western portion and upper slopes of the gulley had a mixture of tall deciduous trees (*Quercus robur, Acer campestre* and *Fraxinus excelsior*) over a patchy shrub layer where Wild Plum (*Prunus domestica*) and Elder (*Sambucus nigra*) are prominent. The ground cover is also variable, with *Urtica dioica* and *Glechoma hederacea* on the moister slopes near the stream, but Bluebell (*Hyacinthoides non-scripta*) in good numbers on the upper drier slopes. Other species of note in this dry mixed woodland were *Ruscus aculeatus* and *Veronica montana* (decreasing in woodland in this region – Tarpey and Heath 1990). Use of TABLEFIT on quadrat samples suggested that this woodland was **W6d** *Alnus glutinosa-Urtica dioica* woodland (*Sambucus nigra* sub-community) but examination of the compartment list indicated a closer correspondence to **W8** *Fraxinus excelsior-Acer campestre-Mercurialis perennis* woodland. However, it should be acknowledged that the goodness-of-fit values to all *NVC* types were poor.

In the eastern part of the Grove, the gulley widens somewhat and most of the woodland is on the floodplain of the stream. Here the composition of the tree layer altered markedly – oak, ash and maple were absent and replaced by tall Crack Willow (*Salix fragilis*). The scrub layer was principally of *S. nigra* and the ground cover almost entirely *U. dioica* and *G. hederacea* – none of the old woodland specialists were present. This zone of the Grove fitted more convincingly with **W6d**, although the prevalence of willow and absence of alder is more suggestive of **W6b** *Salix fragilis* sub-community. Despite this apparent diversity, both zones of the Grove had 7 species/quadrat only.

9.4.2 *Location, habitat and management*

Such woodland was confined to a single strip of less than 4ha in Grimps Grove, although the southern boundary of the conifer plantation (CEH division 43 *i.e.* the same gulley as Grimps Grove, but upstream) has a very narrow hedge-like strip with some of the same species present. The Grove received no management as such, but the boundary fences were incomplete and the margins of the Grove showed some disturbance. The northern fence was more stock-proof, and it is unlikely that sheep stray into the Grove. The stream was observed during its summer low-level, but the vegetation pattern strongly suggested that winter levels are higher and may flood the Willow area and the lower slopes of the gulley itself. This stream drains quite intensive farmland – not only range pastures with many sheep but also arable land outwith the MoD property. It is probable that winter floods convey agricultural nutrients derived from sheep dung/urine and fertilisers into the woodland, resulting in a ground flora largely composed of nutrient-demanding species.

9.4.3 *Zonation and succession*

This woodland is probably secondary, developing from planted trees, but has been in place for long enough to have acquired some discriminating old woodland species (*e.g. H. non-scripta* and *V. montana*). The block of woodland is very small, however, and nowhere within the wood is more than 60-70m from a margin, resulting in marked transition zones, especially in the south, including areas that resemble scrub and underscrub types, as well as communities of open habitats and disturbed ground (section 7). Further disturbance and nutrient input may lead to the disappearance of Bluebell *etc* and development of nettle-infested secondary woodland.

9.5 Conifer plantation and other mixed amenity woodland

9.5.1 *Composition*

Two rectangular blocks of conifer plantation were surveyed near the Range Offices. Both blocks represented a non-native tree canopy of pine into which had spread local native elements to produce a composition that did not fit well with any *NVC* types – certainly not with semi-natural **W18** *Pinus sylvestris-Hylocomium splendens* woodland. Some elements of the native understorey suggest a variant of **W21** *Crataegus monogyna-Hedera helix* scrub or **W24** *Rubus fruticosus-Holcus lanatus* underscrub. Similarly, the combination of frequent *Urtica dioica* with *Sambucus nigra, R. fruticosus* and *Eurhynchium praelongum* indicates an affinity with **W6d** woodland (see also section 9.4).

Planted *Pinus sylvestris* (from 10-20m tall) dominated the blocks, though there were some mature oaks on the margins of the plantations. The understorey comprised blackthorn, hawthorn or elder, often with sparse bramble. The field layer is sparse and made up of patchy *Urtica dioica* with a few ferns (*Dryopteris dilatata* and *D. filix-mas*), whilst the floor of the plantation was largely covered in litter and patches of both *E. praelongum* and *Brachythecium rutabulum.* The margins of these conifer blocks and the rides that have been cut through them are covered in lush grassland of *Holcus lanatus*, and many of the species cited for these blocks were confined to these open habitats. The body of the plantation was species-poor – 10.5 species/quadrat.

Some further attempts at planting amenity woodland have been made in an area of rough **MG1** south of the Range Offices (CEH division 45), where there are numerous saplings (in tree guards) of Alder Buckthorn (*Frangula alnus*), Hornbeam (*Carpinus betulus*) and *Quercus robur*.

9.5.2 *Location, habitat and management*

The two blocks are sited along the western margin of the ranges north and south of the access road from Langenhoe (CEH divisions 40 and 43). Both blocks are on surface-water gley soil and at relatively high elevation (altitude >10m). Apart from the cutting of the rides for access and for power-lines, there was no evidence of forestry practice, and the main usage of the woods was for shooting – both clay pigeons and pheasant rearing. Both these practices were very apparent throughout the plantations and are undoubtedly responsible for the introduction of nutrients and of seed *e.g. Vicia faba* was frequent along the rides and near the rearing sites.

9.5.3 *Zonation and succession*

Although these woodlands are artificial creations, their flora is increasingly that of a semi-natural type (the goodness-of-fit to **W6d** of one sample being 65). The growth of a deciduous shrub layer, coupled to the presence of standard oaks on the plantation margin, may allow these woods to develop further toward a more diverse community. However, the shooting and pheasant rearing is likely to affect deleteriously the fauna and the nutrient availability to the flora. At present the bounds of these plantations are clearly defined, except by the rides and, to some extent, along the edge by the Range Offices, where there are some ecotonal habitats.

10. Rare species

Any definition of rarity demands a context – is the species rare in the immediate area, the region, the county, the UK, Europe or globally? For the purposes of this vegetation survey, the definition at the UK scale follows that of either "Nationally Rare" based upon Wigginton (1999) or "Nationally Scarce" (Hodgetts *et al.* 1996; Stewart *et al.* 1994). No Nationally Rare species were found during the survey, and none are mapped for this area in the county floras. However, nine Nationally Scarce species were found on the Fingringhoe Ranges in August 2005 (one of which is only naturalised here) and the county floras map a tenth species for the area of the Ranges that was not found during the field survey. These species are described in section 10.1.

However, in order to assess the contribution of the Fingringhoe Ranges to nature conservation more locally, it was decided to use the published county floras as a measure of which species were markedly uncommon in the local context. The last full Flora of Essex (Jermyn 1974) was largely based upon fieldwork conducted between 1945 and 1970, and its picture of the vegetation of the county is thus rather dated. Much more useful was a detailed study of the areas around Colchester ("North East Essex"), covering 19 10km squares (Tarpey and Heath 1990). This flora used the 1km square of the National Grid to map the distribution of plants, and 1,322 such squares were included in their study. As a measure of local rarity, the present report used the threshold of 10 or fewer such 1km square records for Northeast Essex to merit discussion. Section 10.2 deals with such species.

Finally, it is acknowledged that there are other species of more than passing interest but that do not fulfil the criteria as Nationally Rare, Nationally Scarce or rare in northeast Essex. A selection of these is briefly discussed in section 10.3, together with the reasons for their inclusion.

10.1 Nationally Scarce species

Nine Nationally Scarce species were found during the CEH survey of Fingringhoe (Table 10.1). In addition, Tarpey and Heath (1990) map the Stiff Saltmarsh-grass (*Puccinellia rupestris*) as occurring in two 1km squares that include part of the Ranges. The account of each scarce species lists the *NVC* communities within which the plant was recorded at Fingringhoe, summarises the DE Units (and DE Compartments) together with CEH divisions where the plant was noted and provides other information on its abundance and ecology on the Ranges.

Table 10.1 Nationally Scarce (**NS**) species recorded on the Fingringhoe Ranges – the number of 10km square native records for Britain (after Stewart *et al.* 1994) and the number of 1km square records in Northeast Essex (**NEE**) (after Tarpey and Heath 1990).

Species name	NS	NEE	Species name	NS	NEE
Bupleurum tenuissimum	76	64	*Puccinellia fasciculata*	60	11
Hippophaë rhamnoides	41	6	*Puccinellia rupestris*	73	61
Hordeum marinum	70	112	*Sarcocornia perennis*	53	87
Inula crithmoides	88	85	*Spartina maritima*	31	60
Lepidium latifolium	43	81	*Suaeda vera*	30	102

Bupleurum tenuissimum
NVC communities: variant of **SM24** (and possibly **MG11**)
Distribution on the Fingringhoe Ranges: DE Compartments 1.04, 2.02 and 2.05 (*i.e.* CEH divisions 11 and 22).

An uncommon annual that, amongst botanists, is famously difficult to find among the grasses with which it grows. Neither of its areas fitted well with an *NVC* type and both apparently required some disturbance to reduce competition. In DE Compartment 1.04, *B. tenuissimum* grew sparsely on the upper somewhat eroded bank of the borrow dyke, whilst around the Langenhoe Marsh, it was occasional in recently–mown rough grassland within and at the foot of the seawall.

Hippophaë rhamnoides
NVC communities: **SM24**
Distribution on the Fingringhoe Ranges: Confined to the far northeastern edge of DE Compartment 4.03 (CEH division 30NE).

There is some doubt as to the status of this species in northeast Essex – Tarpey and Heath (1990) regard it as originally planted and spreading, whilst Stewart *et al.* (1994) map it as native for 10km square TM01 (and several others adjacent). On the Ranges, it was only found on low drier ridge separating the saltmarsh of the Geedon Saltings from the Fingringhoe Wick nature reserve. In this situation, *H. rhamnoides* appeared to have colonised, or possibly planted as a berry-source.

Hordeum marinum
NVC community: variants of **SM24** and **SM28**.
Distribution on the Fingringhoe Ranges: Around seaward margin of DE Unit 2 and similar situation in DE Compartment 1.06 (CEH divisions 22 and 33)

This annual grass was tolerably common in a very precise habitat within and near the Langenhoe and Wick Marshes. The seawall that runs around the South Geedon Creek and thence around the edge of the Langenhoe peninsula is mown, including the foot of the seawall adjacent to the perimeter track. In this situation, the fruiting heads of *H. marinum* indicated a rich assemblage of coastal grasses (including other scarce species) and *Bupleurum tenuissimum*, probably favoured by the mowing and seepage of saline water. *H. marinum* prefers barish places, including those that are trampled and will occur within the uppermost part of salt-marshes (Preston *et al.* 2002). The cessation of mowing would almost certainly threaten its survival here.

Inula crithmoides
NVC community: **SM14**, **SM24** and **SM26** (see section 4.10)
Distribution on the Fingringhoe Ranges: Scattered through high-level salt-marshes in DE Unit 4, and also more rarely in DE Compartments 5.01 and 2.07 (CEH divisions 26, 28, 30N, 30NE, 30S and 31).

This plant was quite frequent in parts of the salt-marshes on the Geedon Saltings where tidal litter accumulated, enriching the organic content of the soil. Such situations were primarily in the upper marsh, but also on unripened gleys with some coarser soil fraction at lower levels, especially around

the shores of the main rivers and creeks. In DE Compartment 2.07, there was a interesting occurrence within the seawall at the muddy margin of an *Elytrigia atherica* stand – *I. crithmoides* was also occasional in such **SM24** near the tidal limit in the Geedon Saltings.

Lepidium latifolium
NVC community: SM24 and **MG7e**
Distribution on the Fingringhoe Ranges: Mainly at the north edge of DE Compartment 4.03 (CEH division 30N) but also very rare near the Range Offices.

Although quite widespread as a naturalised weed, this species (Dittander) is native to the upper edges of salt-marshes, especially in Essex and there are other populations locally *e.g.* by The Strood. Several large fruiting plants were seen in *Elytrigia atherica* at the northern margin of the Geedon Saltings. However, there were also a few vegetative plants on the disturbed margin of the mown "amenity" grassland (DE Compartment 1.05) where it was probably of transient occurrence.

Puccinellia fasciculata
NVC community: a variant of **SM24**
Distribution on the Fingringhoe Ranges: Only seen in DE Compartment 2.06 (CEH division 22).

The preferred habitats of this grass in Britain are similar to those of *Hordeum marinum* (Preston *et al.* 2002; Stewart *et al.* 1994) and at Fingringhoe *P. fasciculata* was only found in an open sward dominated by *H. marinum* at the inner foot of the sea-wall adjacent to the Pyefleet Channel.

Puccinellia rupestris
NVC community: unknown, but likely to be the same as *P. fasciculata*.
Distribution on the Fingringhoe Ranges: Not recorded but mapped by Tarpey and Heath (1990) for 1km squares TM0316 and TM0416 *i.e.* including the site where *P. fasciculata* was found.

According to Preston *et al.* (2002) and Stewart *et. al.* (1994), the ecology of this species is very similar to the preceding (and indeed to *Hordeum marinum*). Although it is possible that the mapped 1km squares refer to plants in Maydays Marsh or Reeveshall Marsh on the south side of the Pyefleet Channel, *P. rupestris* is frequent enough locally for it to be worth examining the seawalls of the Langenhoe peninsula to check for its occurrence.

Sarcocornia perennis
NVC community: **SM7**, **SM13** (including **SM13a** and **SM13c**) and **SM14c** (see section 4.2)
Distribution on the Fingringhoe Ranges: Throughout most of the salt-marsh areas in DE Units 2, 4 and 5 (CEH divisions 23, 24, 25, 27, 30S and right round the shore of the Langenhoe peninsula)

S. perennis is usually rare where it occurs, but it is widespread at most levels in the salt-marshes (except the pioneer zone) especially where marine alluvium has a significant fraction of coarser material. *S. perennis* was probably most frequent in the *Puccinellia maritima* salt-marshes of the Geedon Saltings, but was also occasional in **SM14c** by the Geedon Creek and Pyefleet Channel.

Spartina maritima
NVC community: **SM13f** and **SM14c** (see section 4.5)
Distribution on the Fingringhoe Ranges: scattered in DE Compartment 4.01 and 4.02, rare in 5.01 but frequent in fringing marsh by Langenhoe peninsula.

In some respects, the populations of *S. maritima* are amongst the most important biodiversity features at Fingringhoe. *S. maritima* is very scarce in Britain, yet its two strongholds are in National Grid squares TM01 (including Fingringhoe Ranges) and TL90 (Gray in Stewart *et al*. 1994). Especially in *Puccinellia maritima* marsh or *Atriplex portulacoides* marsh (where the character species is not too luxuriant), *S. maritima* is locally frequent at Fingringhoe, especially on the north shore of the Langenhoe peninsula. It was normally found at higher elevations than *S. anglica*, including the banks of saltmarsh creeks and in pans.

Suaeda vera
NVC community: **SM24** and **SM25** (including **SM25a**) - see section 4.9
Distribution on the Fingringhoe Ranges: Scattered in DE Unit 4, rare in DE Compartment 5.01 and on the shore of the Langenhoe peninsula (CEH divisions 26, 28, 30N, 30S and 31).

In some areas of the East Anglian coast, *S. vera* forms a dense band of low bushes along the strand line. This was not the case at Fingringhoe, and the species was only described as "rare" in all the areas within which it was seen, usually growing with *Elytrigia atherica*. However, at a few places along the northern edge of the Geedon Saltings groups of bushes formed the characteristic **SM25**.

10.2 Species rare in northeast Essex

Six species that are known for = 10 1km squares in northeast Essex were recorded during the survey, but this total includes *Frangula alnus* (7 squares) whose status on the Ranges is only as a planted shrub in CEH division 45, and is thus discounted from this description. The other five species include three native species and two invasive neophytes (*Crassula helmsii* and *Lemna minuta*), which are included here because of their potentially damaging impact on botanical diversity.

Crassula helmsii was recorded for only 8 1km squares by Tarpey and Heath (1990) scattered over six 10km squares, but by the publication of the Atlas (Preston *et al*. 2002), it had been recorded in *ca* 80% of the 10km squares covered by the flora of North East Essex. Amongst the first sites in this region colonised by *C. helmsii* was the large lake at Fingringhoe Wick nature reserve, where it *"…smothered everything else, reducing the number of birds wintering on the lake by destroying their food supply"* (Tarpey and Heath 1990). In the Fingringhoe Ranges, it is as yet confined to six fields (CEH divisions 10, 14 and 16-19) in DE Compartments 1.03 and 1.04. Here it is rare to occasional at the field scale, but within the low-lying and moist areas, *C. helmsii* is locally frequent to abundant, forming a carpet under *Bolboschoenus maritimus* (**S21c**) and spreading into **MG13**, **OV28, SM23** and along the shores of ditches, fleets and other water-bodies.

Lemna minuta has spread just as rapidly, from 5 1km squares noted by Tarpey and Heath (1990) to, a decade later, *ca* 80% of the 10km squares covered by their flora (Preston *et al.* 2002). The CEH survey only located *L. minuta* in one species-rich ditch in Compartment 1.04, where it grew with other *Lemnaceae* and pondweeds. Amongst the five sites listed by Tarpey and Heath (1990) was a pond at Fingringhoe Wick nature reserve. Hence the opportunity for chance introduction to the Ranges via human agency or wildfowl is very clear. This species does not as yet appear to have the competitive threat to native aquatic vegetation on the Ranges that is posed by *Crassula helmsii*.

Linum catharticum was noted for only four 1km squares in the *Wild Flowers of North East Essex* (1990), and its presence in two fields on the Fingringhoe Ranges is indicative of old grassland that has not been markedly improved agriculturally, and worthy of conservation action. These two fields were adjacent to one another in DE Compartment 1.01 (CEH divisions 6 and 38), and in both *L. catharticum* is locally frequent, especially where the grassland composition approaches **MG5** (see section 6.2).

Rumex pulcher (7 1km squares) is a plant of short old pasture and disturbed ground, often near the sea. Elsewhere in this region, it is known for verges. Occasional plants were seen in three fields (CEH divisions 1, 2 and 39), all in the intensively mown or grazed area near the Range Offices (DE Compartments 1.02 and 1.05). However, within these grasslands, *R. pulcher* tended to occur on edges and especially where there was some trampling or disturbance to open up the sward (probably referable to **MG7e** *etc*).

Ruppia maritima (4 1km squares) is an aquatic macrophyte of brackish water, and although only seen in two places on the ranges, in both of these it was dominant within its habitat. Dense beds of *R. maritima* occurred in the borrow dyke by DE Compartment 1.04 (CEH division 13), and it was more sparse, though still common, in the shallow lagoon at the west end of DE Compartment 2.07 (CEH division 31). In this latter site, *R. maritima* often grew in only a very few centimetres of water in a zone beyond the *Bolboschoenus maritimus* swamp, and the site resembled **SM2** *Ruppia maritima* salt-marsh community.

10.3 Other species of interest

Other species of interest are noted here briefly, together with the number of 1km squares within which they were recorded by Tarpey and Heath (1990). The selection is based primarily on the basis of the species being generally uncommon in Britain and/or indicative of higher quality habitat.

Lathyrus nissolia (92 1km squares) is a plant of grassy banks on calcareous soils and clays, especially near the sea, where it is a frequent plant on seawalls. On the Fingringhoe Ranges *L. nissolia* was mainly found in DE Compartment 1.04 (CEH divisions 9, 12 and 13) but also in DE Compartment 1.03 (CEH division 15). Here it was a rare (but easily overlooked) component of **MG1a** grassland, although one of its sites was in **MG6c**.

Parapholis strigosa (102 1km squares) of damp rather open places near the sea, including **SM24** salt-marsh (Rodwell 2000). During the CEH survey, *P. strigosa* was only seen in the same distinctive mown zone that supported both *Hordeum marinum* and *Puccinellia fasciculata* (see section 10.2) in DE Compartment 2.06 (CEH division 22). Here it was generally rare but locally frequent, and very likely to have been overlooked except where quadrats were taken.

Rosa x andegavensis is not mapped separately by Tarpey and Heath (1990) but they do mention that this hybrid between *R. canina* and *R. stylosa* (12 1km squares) is commoner than the latter parent in the region around Colchester. Bushes of this plant was occasional in rougher ground adjacent to **MG6** in DE Compartment 1.01 (CEH division 3W) and rare on the edge of a conifer plantation just west of the Range Offices (DE Compartment 1.02 – CEH division 40).

Rumex maritimus (31 1km squares) was once thought to be nationally scarce, but more intensive recording removed this status (Stewart *et al.* 1994). It is a species of the drawdown zone on wet nutrient-rich mud around ditches and pools. On the Ranges it was locally abundant in much the same area that was being invaded by *Crassula helmsii*, and indeed within the same *NVC* assemblages *i.e.* DE Compartments 1.03 and 1.04 (CEH divisions 14, 16 and 18-20). In some of the stands within CEH division 19, *R. maritimus* was very locally sub-dominant.

Ruscus aculeatus (53 1km squares) was confined to the steeper banks within the woodland of Grimps Grove, though some of these clumps were sizeable. Although this species is an uncommon native of semi-natural woodland, *R. aculeatus* is also often naturalised from gardens, and its status on the Ranges is uncertain. The woodland within which it grows was difficult to ascribe to an *NVC* type, and the site has several anthropogenic features (*e.g.* Wild Plum) as well as clear disturbance (see *Veronica montana* below).

Tragopogon porrifolius (53 1km squares) is a relatively frequent garden escape in southeast England where it is cultivated for ornament and as a vegetable (Salsify). Nonetheless, *T. porrifolius* rather rarely becomes thoroughly naturalised, as here at Fingringhoe. Salsify was very widespread in rough grassland and on seawalls in DE Units 1 and 2. On a field by field basis, it was rare to occasional throughout except in tidal situations and where grazing was intense (found in CEH divisions 3, 4, 12, 13, 15, 19-22, 33, 35B and 37).

Veronica montana (69 1km squares) is a characteristic native of long-established woodlands, and during the CEH survey was found only in Grimps Grove (DE Compartments 1.01/1.05 – CEH division 44), and even there much rarer than the superficially similar *V. chamaedrys*. Together with the frequency of bluebell in this wood, the presence of *V. montana* argues for the Grove having a relatively old origin, but the presence of *Prunus domestica* and the ambiguous status of *Ruscus aculeatus* somewhat contradicts this conclusion.

11. Vegetation Maps

Two main maps summarise the vegetation cover of the Fingringhoe Ranges. The first is derived from the remote-sensing survey, whilst the second is based on the maps and quadrats gathered during the field survey. Two accompanying tables summarise the areas covered by each cover class, *NVC* type or mosaic, and a further table cross-references the two approaches. Information derived from these maps on the distribution of *NVC* types is described community by community in sections 4-10.

11.1 CASI Land Cover Map

The final CASI Land Cover Class map is shown in Figure A2.5, and details of the classes together with their areas, number of 2m x 2m pixels and relative proportions of the Ranges (as percentages) are given in Table A2.1. The map contains 20 classes in the terrestrial zone (mainly grassland, swamp and woodland) and 7 classes in the maritime zone (salt-marshes, mud and sea). These 27 classes have been compiled from 62 spectral sub-classes. The colour scheme used in the map (Figure A2.5) separates the more productive grassland types (with high near-infrared reflectance) as shades of green ("Managed grass"), while the rougher, less productive swards are shown as yellow or brown. ("Semi-managed grass"). These three classes are more variable in species composition and indeed "Semi-managed grass 1" is derived from 7 subclasses with different selections of species but all dominated by *Arrhenatherum elatius*.

Other major cover classes include 4 types of salt-marsh. A mosaic of *Puccinellia/Limonium* and *Halimione* (*i.e. Atriplex portulacoides*) occupies the Geedon Saltings, whereas *Spartina*/*Halimione*/*Salicornia* tends to replace *Puccinellia/Limonium* in the Fingringhoe Marsh. *Elytrigia* marsh is shown as a clear band along the northern edge of the salt-marshes, as well as hillocks and ridges further south. Rat Island, which was not included in the field survey, is shown to have very similar variation to the Geedon Saltings, whilst Pewit Island (also unsurveyed) is depicted as almost entirely covered in "*Halimione* salt-marsh".

Scrub and hedges (dark-orange and red), woodland (red and pine-green) and *Phragmites* reed-beds (pale orange) are very clearly demarcated on the CASI map. Managed grasslands, subject to sheep-grazing and recent mowing, are also shown to be distinct from other vegetation cover, although with there is considerable variation in structure and composition. In contrast, the map shows that most other cover classes occur in mosaics. This explains to a large extent why the correspondence between CASI and *NVC* maps, although excellent in general terms, is locally poor at finer scales.

There is overlap between the spectra of different Land Cover Classes and this resulted in some misclassification *e.g.* Figure A2.5 shows small amounts of "Reedbeds-*Bolboschoenus*" where there should actually be "Woodland-scrub", and *vice versa*. The spectra of many grassland types, especially variants (sub-communities and mosaics) within *NVC* **MG6** *Lolium perenne-Cynosurus cristatus* grass, are sufficiently similar that MLC cannot separate them completely. However, changes to the sward caused by recent mowing are readily detectible and the recently mown sward in CEH divisions 1, 2 and 3A is shown as a distinct class.

11.2 *National Vegetation Classification* (*NVC*) Map

The *NVC* map derived from field survey (Figure A2.6) shows broadly the same pattern as the CASI method, though the field approach cannot hope to show the same fine detail as reflected in the CASI

MLC thematic map. Instead blocks of land were classified in terms of the mixture of *NVC* types revealed by individual quadrats and especially by the combination of species lists and quadrats for each stand of vegetation. Usually, no clear distinction of stands within a CEH division was possible, but rather there was an intimate mosaic of types. In most cases, these mosaics comprised closely related types *e.g.* **W21/W22**, though in some instances, such as the Langenhoe Marsh, the mixture included as many as five communities *i.e.* **MG1**, **SM24** and **SM28** grasslands with areas of **S4a** and **S21c** swamp. Comparison of the two maps (Figures A2.5 and A2.6) reveals the fine-scale distribution of the different elements of the mosaic. Table A2.2 summarises the relative amounts of these communities and mosaics on the Fingringhoe Ranges, and allows direct comparison with the land cover classes from the CASI approach.

11.3 Comparing and applying the two approaches

These two approaches to mapping and community classification can be cross-referenced via Table A2.3, which indicates the numbers of quadrats where field survey and remote sensing indicate good correspondence, as well as those instances where quadrat was classified as a different community to that indicated by the equivalent pixel. The number of apparent errors (*ca* 22%) is not surprising considering the size of each pixel (2m x 2m) and the limited accuracy of the GPS (generally 5-10m) – hence, in areas of heterogeneous vegetation, there is every opportunity for some misclassification. The largest discrepancy between the two approaches in terms of area arises in the scrub and woodland cover where the field survey mapped *ca* 20.6ha of this habitat whereas the remote-sensing results indicated 56ha. This difference is almost entirely due to the fact that the overgrown hedges of DE Unit 1 were not included in the field habitat mapping but simply scored as boundary features.

It should also be borne in mind that each described *NVC* community is to a very great extent an artificial construct. Real vegetation varies within a multi-dimensional continuum. The great value of the *NVC* is to impose some order and predictability to the description of this continuum, and the units of the *NVC* have very largely been proven robust and practical as a means of characterising and describing the assemblages of species that tend to co-occur under particular environmental conditions. However, in sites like the Fingringhoe Ranges, where there is variation in (*inter alia*) elevation, soil-type, moisture regime, management history and salinity over a horizontal distance of <1m, it is to be expected that the vegetation is correspondingly variable and that quadrat samples or stand-lists do not necessarily "fit" perfectly to described *NVC* types.

Hence, in assessing the habitats and vegetation of a particular field or DE unit/compartment within the Fingringhoe Ranges from the results of the field and remote-sensing surveys, the best practical approach is to:

- Examine Figure A2.5 (CASI MLC thematic map) to ascertain which broad cover classes are present and what is the apparent degree of heterogeneity in the DE unit/compartment.
- Compare this with the *NVC* types reported for the same area and mapped in Figure A2.6.
- Use the community descriptions given in sections 4-10 to help understand the likely ecological conditions and zonation with this unit/compartment.
- From these descriptions, arrive at a conservation assessment for the field (unit/compartment) and design a preferred management (see also section 12).

12. Discussion: conservation and management

The Fingringhoe Ranges are an extremely valuable resource for nature conservation in an otherwise intensively-farmed and urbanised part of south-east England. Despite its relatively small size (when compared to Salisbury Plain, for example), the site has considerable variation in elevation (especially micro-topographic), soil-type, moisture regime (areas influenced by groundwater, impeded drainage and inundation), management history (mown, sheep-grazed, disturbed, scrub-cleared, reclaimed and reverting salt-marsh) and salinity (tidal, brackish and fresh). These result in extensive areas of high quality salt-marsh, as well as a range of dry and mesotrophic grasslands, swamp and scrub/woodland habitats. In addition to the habitat and botanical importance outlined below, the Ranges are a key site for birds and herptiles (both actively studied through the Range Wardens), and there is also evidence of invertebrate interest (*e.g.* many well-established ant-hills), which ought to be the subject of further survey and research.

In terms of both natural habitat and specific botanical interest, the salt-marshes are the most important habitat at Fingringhoe, covering *ca* 225ha. Thirteen *NVC* communities were distinguished and a further five sub-communities identified. The most extensive communities are the fine examples of **SM13** and **SM14** that form mosaics over much of the Geedon Saltings, whilst other *NVC* types (*e.g.* **SM12, SM16** and **SM23**) are present only as fragmentary stands. The value of these salt-marshes is partly confirmed by the number of uncommon and demanding species that are found, often commonly, on the Fingringhoe examples. These include all ten nationally scarce species that were noted at Fingringhoe, six of which are especially found in the **SM24** salt-marsh proper that marks the upper tidal limit at Fingringhoe: *Bupleurum tenuissimum, Hippophaë rhamnoides, Hordeum marinum, Lepidium latifolium, Puccinellia fasciculata* and *P. rupestris*. There is variation in the salt-marshes brought about site history (past reclamation on the Fingringhoe Marsh) and by location and/or elevation *e.g.* the fringing marshes of the Langenhoe peninsula and the broad marshes of the Geedon Saltings. The great majority of these marshes appear to under favourable management, so far as this can be controlled by the Range staff, since much the most important factor is the tidal regime. However, the light sheep-grazing that parts of the marshes receive appears to do no damage, and may indeed convey diversity. Grazing by hares and wildfowl seems especially important in shaping the diversity of **SM13** stands. Where sympathetic management needs to be maintained is in the **SM24** variant within the seawalls, with its remarkable collection of uncommon grasses and *B. tenuissimum* – here light mowing and occasional disturbance to control the *Elytrigia atherica* appears necessary.

Mesotrophic grassland communities are the most extensive inland habitats at Fingringhoe. Nine *NVC* communities (with seven sub-communities) were differentiated. Some 320ha of the non-tidal Ranges were classified as mesotrophic grassland, 90ha of which was intensively mown or grazed by sheep. There is some very localised trend toward other dry grasslands types (*e.g.* **MC9** and **U4b**) but the greater part of the site was referable to either **MG1** *Arrhenatherum elatius* grassland (unmanaged or lightly managed) and **MG6** *Lolium perenne-Cynosurus cristatus* grassland (more intensively managed). A high proportion of these grasslands were of relatively little botanical value, being either too heavily grazed (and dunged) or so unmanaged that the build-up of leaf-litter excluded most species. The most important grasslands botanically tended to be on steeper slopes and were indicated by the presence of *Linum catharticum* amongst a rich assemblage of forbs and mosses. However, even the coarsest *Arrhenatherum-Elytrigia* grasslands supported interesting populations of *Lathyrus nissolia* and *Tragopogon porrifolius* and, most importantly, had considerable value for birds and small mammals. As far as preferred management is concerned, some consideration should be given to a) reducing nutrient inputs (via dung *etc*) to the steeper grasslands of the north, but consistent with

maintaining grazing (*i.e*. consider taking the sheep off overnight); and b) some controlled burning of the coarsest parts of the Langenhoe and Wick marshes to encourage seedling establishment.

Although swamp communities occupy a rather small area of the Fingringhoe Ranges (*ca* 24-30ha), they are of great importance in biodiversity terms. The reedswamp in DE compartment 2.07 is one of the largest in Essex and sufficiently remote from disturbance to be an important roost and refuge, though other important reedbeds (**S4**) occur associated with the fleets further west. In the grassland areas, patches of *Bolboschoenus* swamp (**S21**) are important at lower elevations near fleet-shores where they form diverse mosaics with wet grassland and bare mud, often with good populations of *Rumex maritimus* and, less encouragingly, *Crassula helmsii*. *Phragmites* and *Bolboschoenus* swamps (two *NVC* communities and five sub-communities) occur along watercourses and by pools, but these features are particularly important for a range of other swamp and aquatic communities that occur nowhere else at Fingringhoe, though always with extremely restricted extent: ten *NVC* communities and one further sub-community. The large stands of *Ruppia maritima* are of great interest and amongst the potentially invasive pest species was not only *C. helmsii* but also *Lemna minuta*. The light grazing that **S21** swamps receive appears advantageous to *Rumex maritimus etc*, but the movement of sheep (as well as floodwater) around the site is likely to aid the spread of *C. helmsii*. Some cutting of the reedswamps (**S4**) might serve to diversify them botanically, but since their chief wildlife value is for birds, such disturbance should usually be discouraged. The ditches and pools receive some occasional dredging, and this management should be continued intermittently to ensure that these important aquatic habitats to not succeed to dry reedbed *etc*.

Blocks of scrub cover 46.5ha of the Fingringhoe Ranges, though substantial areas of these were derived from boundary features (hedges and shelter-belts) in the northern part of the site. Only 9.5ha were mapped as true woodland, approximately half of which was planted with conifers, the rest being a mixed deciduous community with some relationship to older semi-natural woodland. Ascribing these hedges, plantations and transitional stands convincingly to particular *NVC* types was not always possible and, especially in the woodlands probably not desirable (see sections 9.4 and 9.5). Nonetheless, three scrub communities and two sub-communities from the *NVC* were differentiated. The presence of *Veronica montana*, *Ruscus aculeatus* and *Hyacinthoides non-scripta* in Grimps Grove (CEH division 44 – Figure A2.2) was somewhat suggestive of higher quality woodland, but most of the treed areas at Fingringhoe were nutrient-rich with a ground flora of nettles *etc*. The conifer plantations are used primarily for pheasant rearing and clay-pigeon shooting. Should biodiversity protection and habitat restoration become the main objectives for the management of the Ranges, then consideration should be given to stopping such activity here and in the scrub areas near Wick Farm. However, the intrinsic biodiversity value of these scrub and wooded areas is low where shooting is the use, and there is thus no pressing biodiversity feature to protect.

The Fingringhoe Ranges represent an interesting and important area for biodiversity, which Defence Estates and the Range Staff should be encouraged to conserve and manage for its wildlife, both fauna and flora. The site offers extensive areas of habitats that are very little frequented by people. The salt-marshes represent a regionally (probably nationally) important area of high quality habitat, and the grasslands not only have existing value but have real potential for ecological rehabilitation. The less extensive habitats of swamp, aquatic and wood/scrub provide important shelter and structural variety that adds further value to the site. The commitment of the Range Staff and the volunteers who study animal groups should ensure that the Fingringhoe Ranges continue to contribute significantly to the wildlife of northeast Essex.

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14 Acknowledgements

The authors would like to thank the staff of the Fingringhoe Ranges for their help and hospitality during the vegetation survey. Particular thanks go to the Range Commandant, Major U. Gurung for arranging access and especially to Chico Duncan for introducing us to the Ranges, guiding us through the Geedon Saltings and answering our many questions. Dominic Ash (Defence Estates) not only defined the scope of the survey but also provided vital maps and accompanied us for a day's fieldwork on the Langenhoe peninsula.

At CEH Monks Wood, we would like to thank Richard Pywell who ensured that, as far as possible, the present study continued the standard he had set on Salisbury Plain and Castlemartin *etc*. Special thanks go to Carole Freeland for converting piles of field data-sheets to a workable Excel spread-sheet and for making sure that the project was properly accounted for within the CEH RMS system.

Appendices

Appendix 1: Recording proformas

Page 2: Overall Defence Estates Unit record: Front page – Location, *NVC* types present, disturbance and management.

Page 3: Overall Defence Estates Unit record: Second page – Unit map and description of site.

Page 4: *NVC* Community record (quadrats in grassland, saltmarsh, reedbed *etc*): Front Page – Locations, vegetation height and description.

Page 5: *NVC* Community record (quadrats in grassland, saltmarsh, reedbed *etc*): Second Page – Checklist of species with columns to assess abundance (DAFOR) at the whole-stand level and more locally, together with quadrats 1-5 (Domin scale).

Page 6: *NVC* Community record (20m channel samples *etc*): First page – Location, channel dimensions and description of *NVC* types.

Page 7: *NVC* Community record (20m channel samples *etc*): Second page – disturbance, management and checklist of watercourse species with columns to assess abundance (DAFOR) for the whole channel length and for up to five 20m sample lengths (Domin scale).

Fingringhoe Training Area *NVC* Survey

Overall Defence Estates Unit Record

DEFENCE ESTATES

Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

Survey Title	**Fingringhoe NVC**	Surveyors	
County	**Essex**		
Site Name		Date:	**August 2005**
DE Unit		Grid Reference	T M
DE Compartment			

Summary of *NVC* Units [Refer to *NVC* Community Records 1) Quadrats (pink); and 2) Channels (blue)]

NVC code	% of compartment	*NVC* code	% of compartment	*NVC* code	Length of channel
(1)		(5)		(C1)	
(2)		(6)		(C2)	
(3)		(7)		(C3)	
(4)		(8)		(C4)	

How many quadrats recorded? ☐ How many channel lengths recorded? ☐

Disturbance check boxes (✓) [Note: distinguish *NVC* types in boxes 1, 2, 3 (more if needed)]

		1	2	3		1	2	3		1	2	3
Type	Vehicle	☐	☐	☐	Excavation	☐	☐	☐	Other	☐	☐	☐
Age	Recent	☐	☐	☐	Old	☐	☐	☐	Mixed	☐	☐	☐
Intensity	Slight	☐	☐	☐	Moderate	☐	☐	☐	Severe	☐	☐	☐
Pattern	Linear	☐	☐	☐	Random	☐	☐	☐	Mixed	☐	☐	☐

Management check boxes (✓) [Note: as above]

		1	2	3		1	2	3		1	2	3		1	2	3
Type	Grazed	☐	☐	☐	Hay/silage	☐	☐	☐	Nil	☐	☐	☐	Other	☐	☐	☐
Grazer	Rabbit	☐	☐	☐	Sheep	☐	☐	☐	Cattle	☐	☐	☐	Other	☐	☐	☐
Intensity	Light	☐	☐	☐	Moderate	☐	☐	☐	Heavy	☐	☐	☐				
Pattern	Uniform	☐	☐	☐	Random	☐	☐	☐	Mixed	☐	☐	☐				

NOTE: Information on channel management and disturbance given on that sheet

Compartment Mapping **DE Unit** **DE Compartment**

Mark *NVC* boundaries and sample locations *i.e.* quadrats and 20m channel lengths

Site description (summary)

1. Shape, size and topography of compartment;
2. Location and type of *NVC* communities and habitats present;;
3. Current management, disturbance and threats; and
4. Species and habitats of conservation importance or notable

Community Number **Fingringhoe Training Area *NVC* Survey**

NVC Community record – quadrats in grassland, saltmarsh, reedbed _etc_

DEFENCE ESTATES

Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

Survey Title	**Fingringhoe NVC**	Surveyors	
County	**Essex**		
Site Name		Date:	**August 2005**
DE Unit		Quadrat number	
DE Compartment		Quadrat size	

NVC Community name

Quadrat Grid References

1										
2										
3										
4										
5										

	Film	Exp.	No.
Photographic record			

Photographic description

Community vegetation height (cm)

Quadrat Vegetation Height (cm)

1				
2				
3				
4				
5				

Quadrat litter (cm)

1				
2				
3				
4				
5				

NVC Community Description – DESCRIBE/NOTE -

1. General composition of the _NVC_ community noting dominant species; the composition and scale of vegetation mosaics and transitions; and variations from typical NVC community descriptions
2. Reasons for siting quadrat(s) _e.g._ a) at random in representative stands, b) in different parts of a mosaic or c) away from disturbance
3. Describe management exclusive to the compartment, particularly those likely to affect conservation interest/vegetation composition.
4. Assess relative conservation interest of the community particularly in relation to the condition of the habitat or key species (e.g. heavily grazed/disturbed), diversity and presence of rare or notable species

Notes:

1. Use DAFOR for unit/compartment, separated where necessary into **W** (Widespread/Whole unit) and **L** (Local) _i.e._ D= dominant; A=abundant; F=frequent; O=occasional; and R=rare.
2. Use Domin for any quadrats _i.e._ **+**=present; **1**=few; **2**=several; **3**=many individuals (all four categories <4%cover), thence **4**=4-10%; **5**=11-25%; **6**=26-33%; **7**=34-50%; **8**=51-75%; **9**=76-90%; and **10**=91-100% cover.

	W	L	1	2	3	4	5
Agro cani							
Agro capi							
Agro stol							
Alop geni							
Alop pra							
Anis ster							
Arrh elat							
Bolb mari							
Brom hord							
Care divis							
Care hirt							
Care otru							
Cyno cris							
Dact glom							
Desc cesp							
Elyt athe							
Elyt repe							
Fest arun							
Fest rubr							
Holc lana							
Hord mari							
Hord muri							
Hord seca							
Junc arti							
Junc bufo							
Junc cong							
Junc effu							
Junc gera							
Junc infl							
Junc mari							
Loli pere							
Para stri							
Phle bert							
Phra aust							
Poa annu							
Poa humi							
Poa prat							
Poa triv							
Pucc dist							
Pucc fasc							
Pucc mari							
Pucc rupe							
Spar angl							
Spar mari							
Tris flav							
Achi mill							
Agri eupa							
Aren serp							
Arme mari							
Aste trip							
Atri glab							
Atri litt							
Atri port							
Atri pros							
Barb vulg							
Bell pere							
Bras nigr							
Bupl tenu							
Caps burs							
Card prat							
Card tenu							
Cent nigr							
Cera font							
Cera glom							
Cirs arve							
Cirs vulg							
Coch angl							
Coch dani							

	W	L	1	2	3	4	5
Conv arve							
Coro squa							
Crep capi							
Cyti scop							
Dips full							
Epil cili							
Epil hirs							
Epil tetr							
Equi arve							
Erod cicu							
Erop vern							
Gali apar							
Gali veru							
Gera diss							
Gera moll							
Glau mari							
Gnap ulig							
Hype perf							
Hype tetr							
Hypo radi							
Inul crit							
Lact serr							
Lact viro							
Lath niss							
Lath prat							
Leon autu							
Lepi lati							
Limo vulg							
Lotu corn							
Lotu pedu							
Malv sylv							
Matr disc							
Medi arab							
Medi lupu							
Moen erec							
Myos arve							
Myos disc							
Odon vern							
Onon spin							
Picr echi							
Plan coro							
Plan lanc							
Plan majo							
Plan mari							
Poly avic							
Pote anse							
Pote rept							
Prun vulg							
Puli dyse							
Ranu acri							
Ranu bulb							
Ranu flam							
Ranu repe							
Ranu sard							
Rese Weld							
Rume acsa							
Rume cong							
Rume cris							
Sagi apet							
Sagi proc							
Sali agg.							
Sali doli							
Sali euro							
Sali frag							
Sali pusi							
Sali ramo							
Sarc pere							
Scle annu							
Sene eruc							

	W	L	1	2	3	4	5
Sene jaco							
Seri mari							
Siso amom							
Sonc arve							
Sonc aspe							
Sper arve							
Sper mari							
Sper medi							
Sper rubr							
Stel gram							
Suae mari							
Suae vera							
Tara agg.							
Tori nodo							
Trag porr							
Trag prat							
Trif arve							
Trif dubi							
Trif frag							
Trif micr							
Trif orni							
Trif prat							
Trif repe							
Trig mari							
Trip inod							
Trip mari							
Tuss farf							
Urti dioi							
Vero cham							
Vici crac							
Vici hirs							
Vici sati							
Vici tetr							
Algae							
Bare mud							
Bare soil							
Bryophyta							
Litter							
Tidal litter							
Water							

☐ **Community Number**

Fingringhoe Training Area *NVC* Survey

NVC Community record – 20m channel samples _etc_

Survey Title: **Fingringhoe _NVC_**
County: **Essex**

Surveyors:

Site Name:

Date: **August 2005**

(Bank A and Bank B)
DE Units
DE Compartments

Sample number
Sample length: **20m**/other (specify):

NVC Community names (best fits)

s

Sample Grid Reference

C1										
C2										
C3										
C4										
C5										

Photographic record

Film	Exp.	No.

Photographic description

Channel dimensions [* give separate values for banks A and B where these differ markedly]

	Total Length (m)	Width (m - water)	Depth (m - water)	Freeboard *(m)	Angle of slope*
Channel C1					
Channel C2					
Channel C3					
Channel C4					
Channel C5					

Community Description – acknowledging that channels are normally a mosaic/concatenation/ecotone of _NVC_ types

5. General composition of the community noting dominant species; the composition and scale of vegetation mosaics and transitions; and variations from typical _NVC_ community descriptions
6. Reasons for siting sample(s) _e.g._ a) at random in representative stands, b) in different parts of a mosaic or c) away from disturbance
7. Describe management exclusive to the compartment, particularly those likely to affect conservation interest/vegetation composition.
8. Assess relative conservation interest of the community particularly in relation to the condition of the habitat or key species (_e.g._ heavily grazed/disturbed), diversity and presence of rare or notable species

Disturbance/Management check boxes (✓) [Note: distinguish samples in boxes C1-C5)]

	C1	C2	C3	C4	C5		C1	C2	C3	C4	C5		C1	C2	C3	C4	C5
Water Tidal						Pumped						Other					
Grazing Rabbits						Cattle						Sheep					
Intensity Light						Moderate						Heavy					
Veg. cut Bucket						Flail						Other					
Age Recent						Old						Mixed					
Slubbing Recent						Old						Mixed					

Aquatic and Emergent Species for C1-C5 (1-5) [Banks not recorded – list any notable bank species below]

	T	1	2	3	4	5		T	1	2	3	4	5		T	1	2	3	4	5
Agro stol							*Lemn gibb*													
Alis lanc							*Lemn mino*													
Alis plan							*Lemn minu*													
Alop geni							*Lemn tris*													
Apiu grav							*Lotu pedu*													
Apiu nodi							*Lyco euro*													
Atri port							*Ment aqua*													
Azol fili							*Myri spic*													
Bolb mari							*Nast offi*													
Call agg.							*Pers amph*													
Call obtu							*Phra aust*													
Call stag							*Poa triv*													
Care otru							*Pota cris*													
Cera deme							*Pota nata*													
Cera subm							*Pota pect*													
Desc cesp							*Ranu baud*													
Eleo palu							*Ranu repe*													
Elod cana							*Ranu scel*													
Elod nutt							*Ranu tric*													
Elyt athe							*Rume cong*													
Gali palu							*Rupp cirr*													
Glyc flui							*Rupp mari*													
Glyc maxi							*Scho tabe*													
Glyc nota							*Spar erec*													
Inul crit							*Trig mari*													
Iris pseu							*Typh angu*													
Junc arti							*Typh lati*													
Junc bufo							*Zann palu*													
Junc cong							*Zostera* spp													
Junc effu																				
Junc gera							Alga (filam.)													
Junc infl							Algae(marine)													
Junc mari							Charophyte													

Notes:

3. Use DAFOR for full length of channel **T** (Total) *i.e.* D= dominant; A=abundant; F=frequent; O=occasional; and R=rare.

4. Use Domin for any samples *i.e*. **+**=present; **1**=few; **2**=several; **3**=many individuals (all four categories <4%cover), thence **4**=4-10%; **5**=11-25%; **6**=26-33%; **7**=34-50%; **8**=51-75%; **9**=76-90%; and **10**=91-100% cover.

Bank vegetation [distinguishing where necessary Bank A (N/S/E/W) and Bank B (N/S/E/W)]

a) Communities:

b) Notable species:

Appendix 2: Figures and Tables

Figure A2.1 **Fingringhoe Ranges**: map of Units and Compartments, as designated by Defence Estates

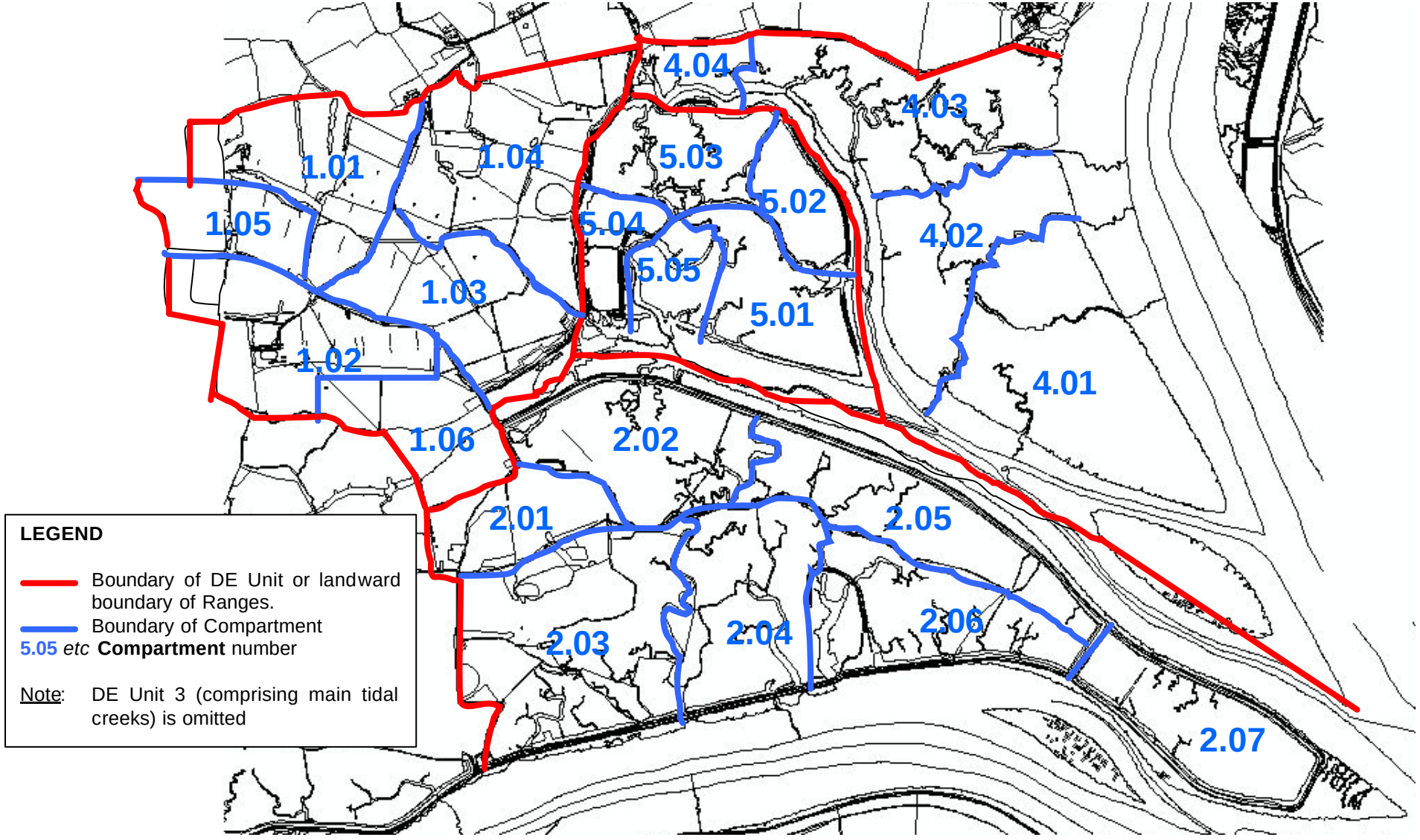

Figure A2.2: **Fingringhoe Ranges**: map of CEH divisions as designated during the vegetation survey.

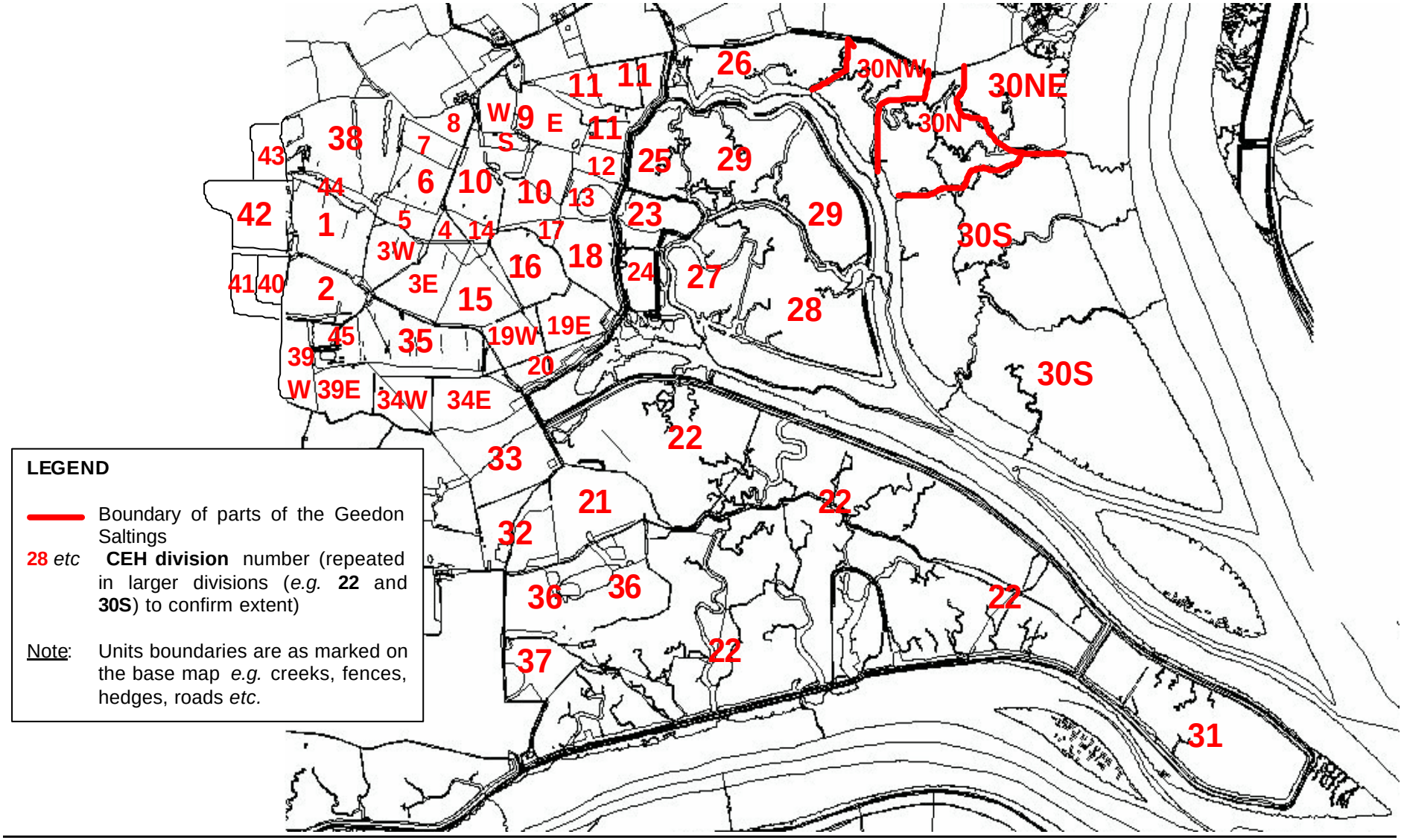

Figure A2.3: **Fingringhoe Ranges**: CASI image of Fingringhoe MoD site

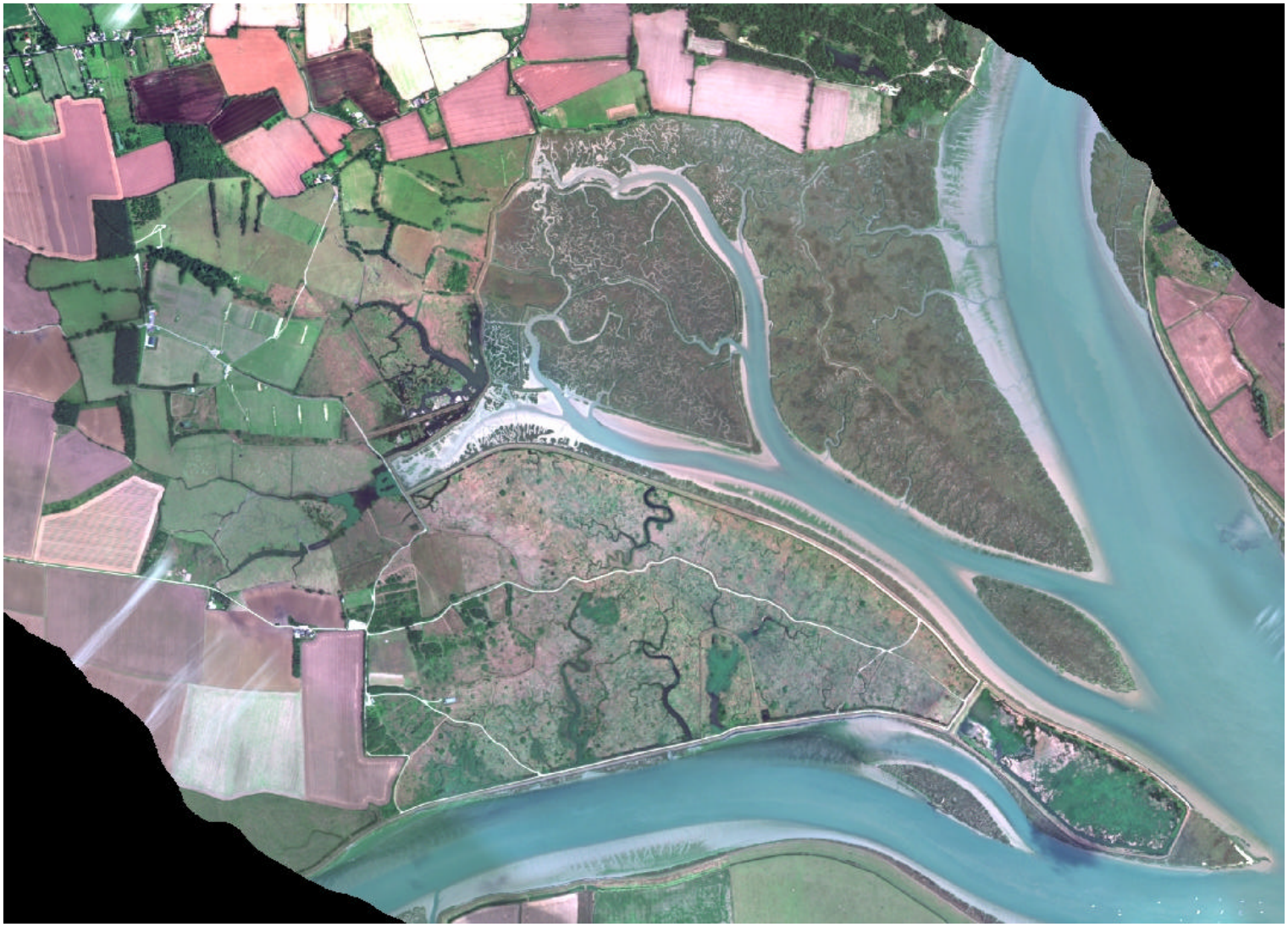

Figure A2.4: **Fingringhoe Ranges**: LiDAR image – coloured to emphasise elevation

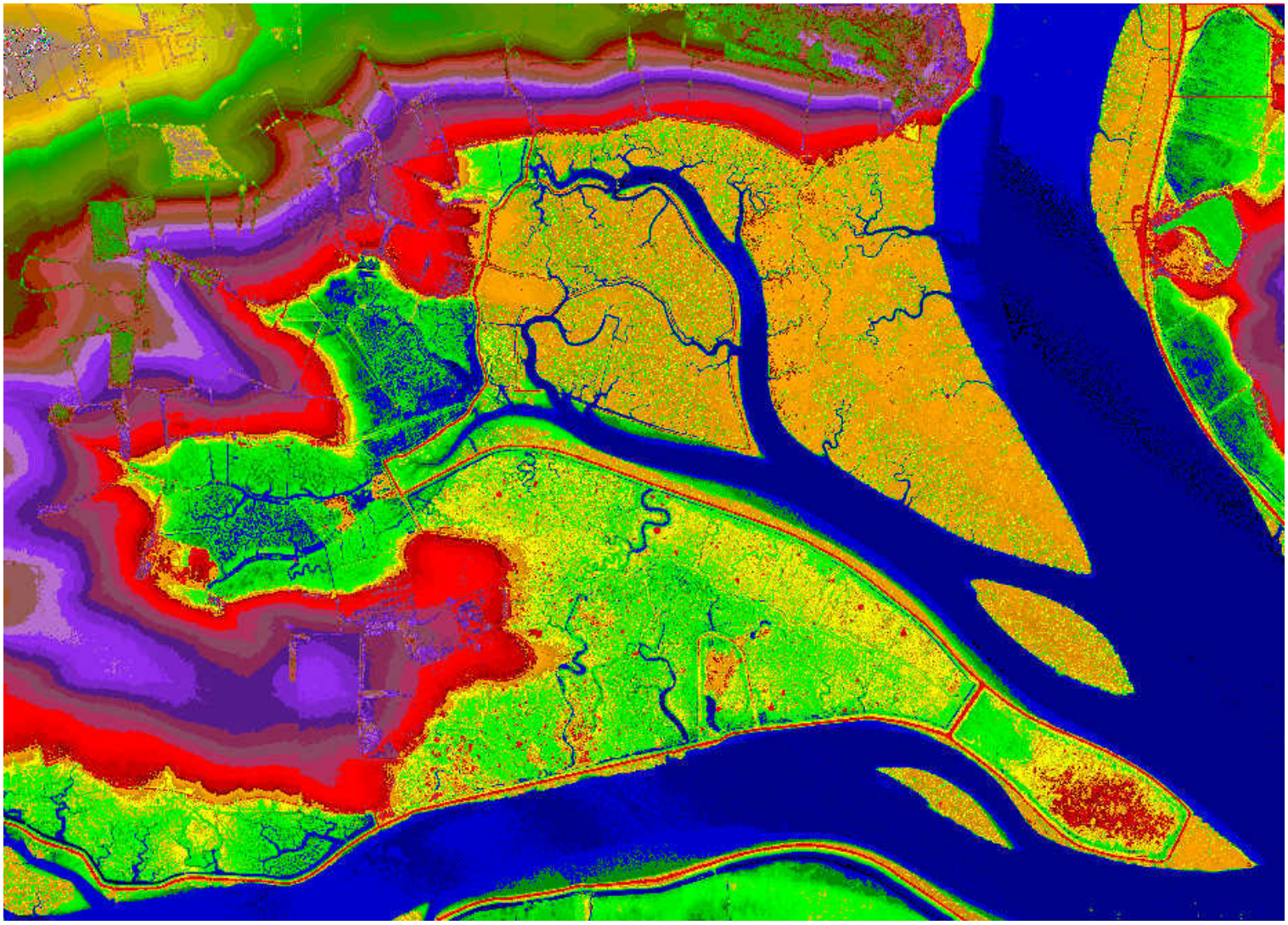

Figure A2.5: **Fingringhoe Ranges**: CASI MLC thematic class map.

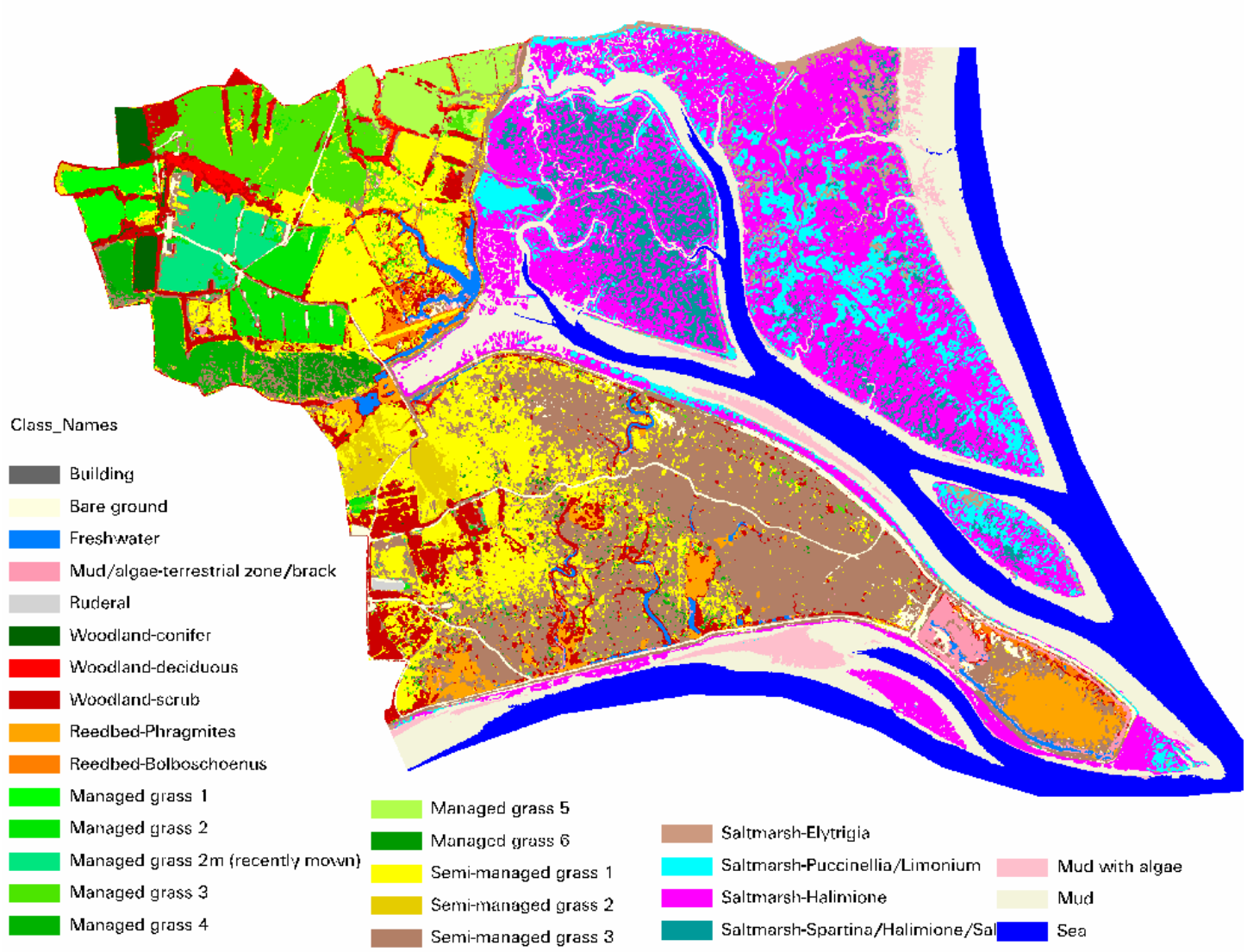

Figure A2.6: Fingringhoe Ranges: map of *NVC* types and mosaics, quadrat and channel sample locations 2005

Note:

LEGEND to *NVC* types and location of samples on next page

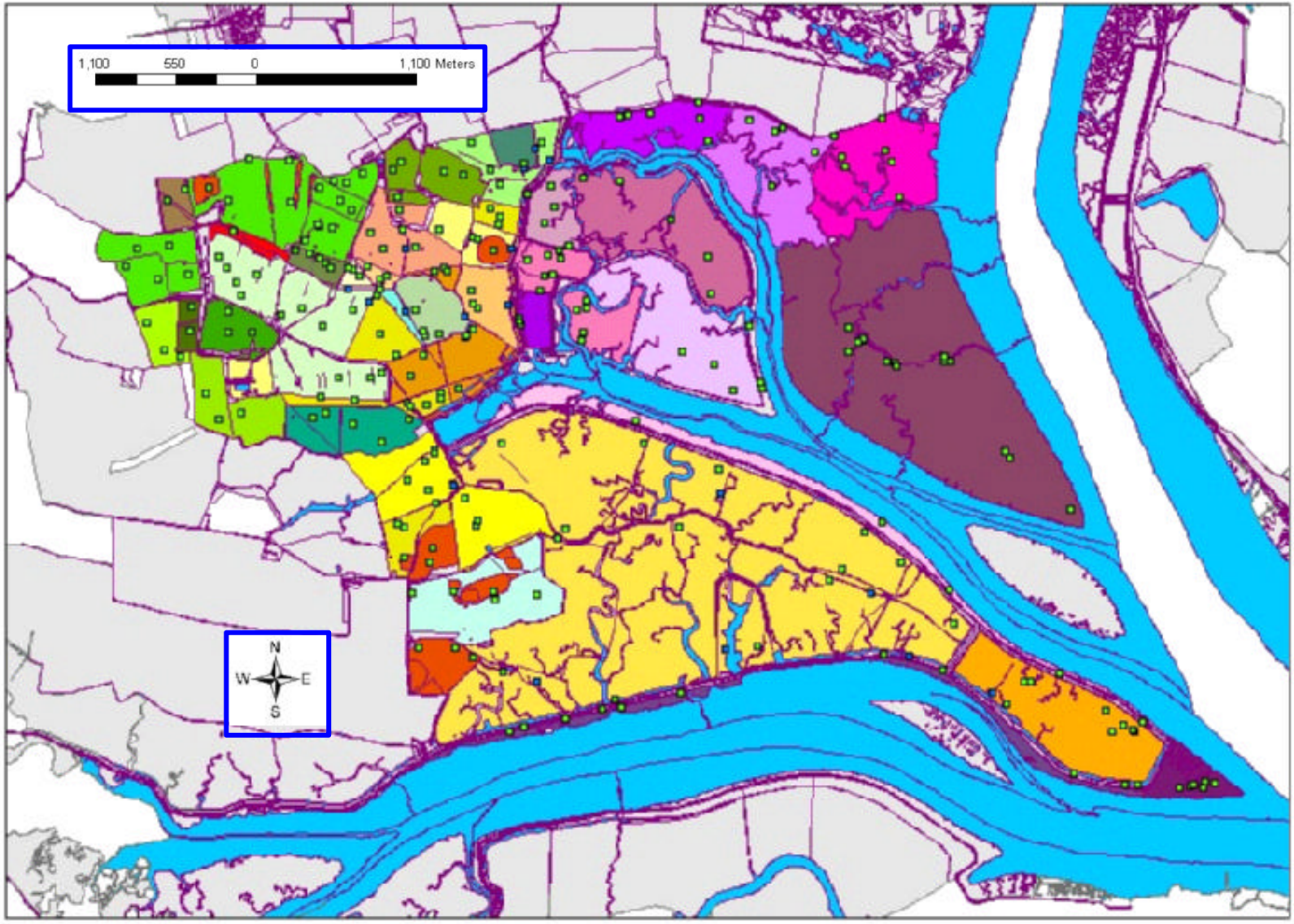

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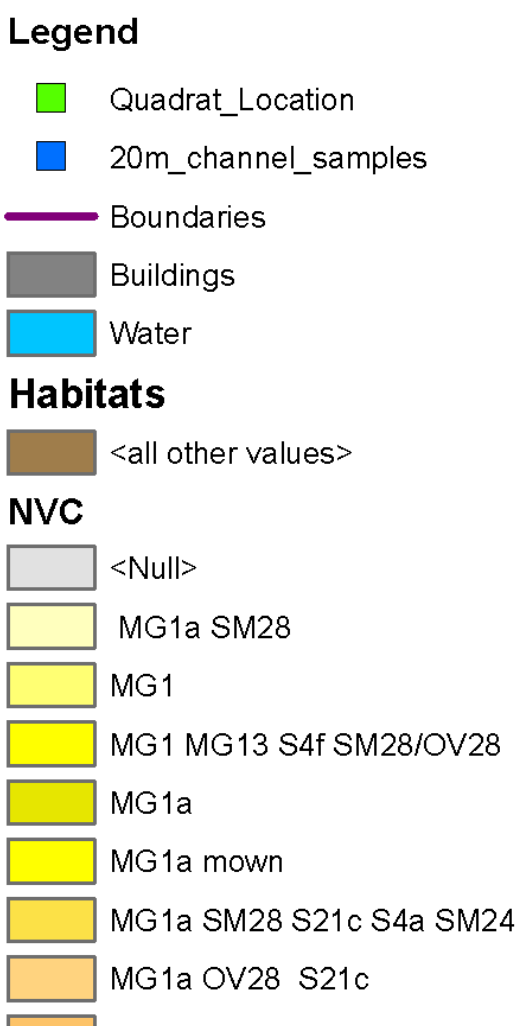
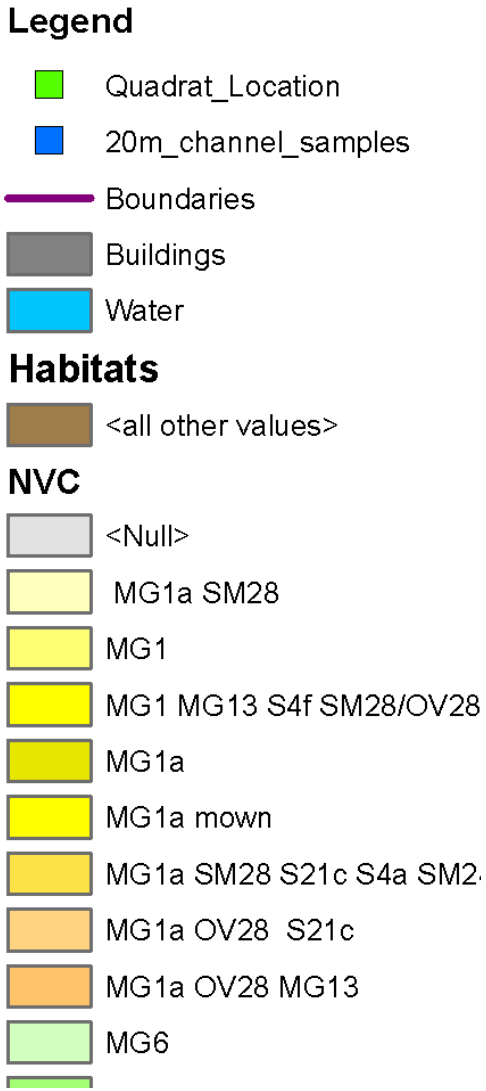
Figure A2.6: LEGEND





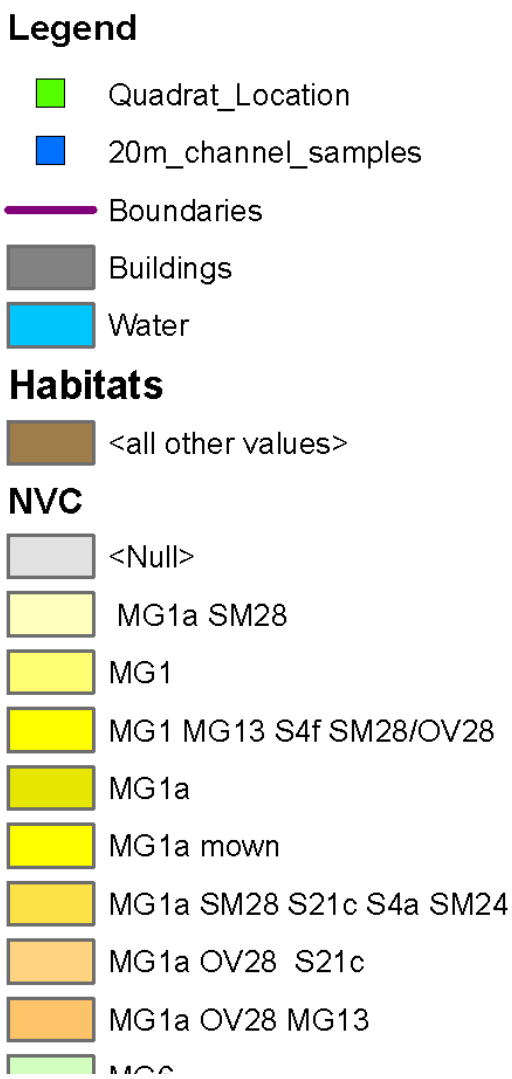


Table A2.1: Fingringhoe Ranges: Land Cover Classes (LCCs) as depicted in **Figure A2.5** listing number of pixels (2m x 2m), area (in hectares) and percentage of the whole for each LCC.

Note: Total area of LCCs = 682.21ha (omitting **Mud** and **Sea).** Percentages were calculated relative to this total

Pixels	Land Cover Class (*abbreviation in Table A2.3*)	Area (ha)	Percentage
159	Building	0.06	0.01
41896	Bare ground (*Bare*)	16.76	2.46
19534	Freshwater	7.81	1.14
17513	Mud/algae-terrestrial zone/brack	7.01	1.03
1107	Ruderal	0.44	0.06
12072	Woodland-conifer (*Wood_con*)	4.83	0.71
11770	Woodland-deciduous (*Wood_dec*)	4.71	0.69
116140	Woodland-scrub (*Wood_scr*)	46.46	6.81
45461	Reedbed-*Phragmites* (*Reed_Phra*)	18.18	2.66
15126	Reedbed-*Bolboschoenus* (*Reed_Bolb*)	6.05	0.87
16646	Managed grass 1 (*Man grs 1*)	6.66	0.98
32597	Managed grass 2 (*Man grs 2*)	13.04	1.91
28882	Managed grass 2m recently mown (*Man grs 2m*)	11.55	1.69
70762	Managed grass 3 (*Man grs 3*)	28.30	4.15
29448	Managed grass 4 (*Man grs 4*)	11.78	1.73
32388	Managed grass 5 (*Man grs 5*)	12.96	1.9
14315	Managed grass 6 (*Man grs 6*)	5.73	0.84
220865	Semi-managed grass 1 (*S-man grs1*)	88.35	12.95
22884	Semi-managed grass 2 (*S-man grs2*)	9.15	1.34
326562	Semi-managed grass 3 (*S-man grs3*)	130.62	19.15
35716	Saltmarsh-*Elytrigia* (*SM_Elyt*)	14.29	2.09
109536	Saltmarsh-*Puccinellia*/*Limonium* (*SM_Pucc*)	43.81	6.42
382414	Saltmarsh-*Atriplex portulacoides* (*SM_Hal (Ap)*)	152.97	22.42
68308	Saltmarsh-*Spartina*/*Atriplex*/ *Salicornia* (*SM_SHS*)	27.32	4.0
33423	Mud with algae (*Mud_algT*)	13.37	1.96
276150	Mud	110.46	Omitted from calculation of percentages
289452	Sea	115.78	

Table A2.2: Fingringhoe Ranges: *NVC* types and mosaics as depicted on **Figure A2.6,** together with their areas (in hectares)

***NVC* type (or mosaic)**	**Area (ha)**	***NVC* type (or mosaic)**	**Area (ha)**
***GRASSLANDS* (omitting dry grasslands)**		***SALT-MARSHES***	
MG1 and mosaics		**SM8** and other lower marsh	
MG1 SM28	1.1	**SM8**	**2.7**
MG1	7.3	**SM13** and mosaics	
MG1 MG13 S4f SM28/OV28	9.9	**SM13a**	**5.3**
MG1a	15.1	**SM13a SM14c SM6**	**6.8**
MG1a mown	9.5	**SM13a SM6**	**4.9**
MG1a SM28 S21c S4a SM24	146	**SM13c SM14**	**5.7**
MG1a OV28 S21c	1	**SM13c SM14 SM24 SM6**	**22.6**
MG1a OV28 MG13	5.5	**SM13c SM14c SM24**	**83.9**
MG6 and mosaics		**SM14** and mosaics	
MG6	25.2	**SM14c**	**21.4**
MG6a MG13	8.4	**SM14c SM13c**	**18.1**
MG6a/6c	8.2	**SM14/14c**	**10.9**
MG6c	30	**SM14c SM24 SM13c MG1**	**16**
MG6c W22 W24a	5.5	**SM14c/14 SM13c**	**4.8**
Other mesotrophic grasslands		**SM24 SM14c**	**10.1**
MG10a	2.8	***U4* - and other dry grasslands**	
MG11 MG1a/OV25	2.4	**U4b**	**9.5**
MG13 S21c MG1a	5.5	**U4b/MG6b**	**8.9**
DISTURBED GROUND		***SCRUB*** (Including mosaics)	
OV25a	14.4	**W21**	**1.7**
OV28	1	**W21/24**	**1.3**
SWAMPS		**W21c**	**2.5**
S4 reedswamp *etc*		**W22/21**	**3.3**
S4 S21 S24 MG1	22	**W22** *etc*	
S21 swamp *etc*		**W22/W24/OV23 MG1a**	**5.1**
S21c OV28 SM28/MG11 MG1a	9.8	**W22b W6**	**1.9**
S21c SM23 OV28	1.7	***WOODS***	
		W6/24	1.9
		W6d/W21 Rides	2.8

Table A2.3: Fingringhoe Ranges: Pivot table cross-referencing allocation of quadrats to *NVC* types and to Land Cover Classes.
Note: *NVC* types indicated by their numbers, and LCC types by abbreviations of their names (see **Table A2.2**)

CASI-LC 16px	W 6b	W 6d	W 21	W 22	W 22a	W 22b	W 24a	W 25a	S4a	S4d	S4f	S21	S 21a	S 21c	MG 5	MG 6	MG 6a	MG 6b	MG 6c	MG 7e	MC 9	MC 9e	MG 10a	MG 11	MG 11a
Bare												1									1				
Mud_algT												1													
Wood_con		2					1																		
Wood_dec								1																	
Wood_scr		1	2	2	2	1	2							1					1						
Reed_Phra									4	1	1		1												
Reed_Bolb												2	1	3											
Man grs 1																	1		4						
Man grs 2																	1		3		1				
Man grs 2m	1																		3	1					2
Man grs 3														1	2		2	1	8		1	2			
Man grs 4																	5					1			
Man grs 5																	1		3				1	1	
Man grs 6																			1		2	2			
S-man grs1														2		1			1		1				
S-man grs2																									
S-man grs3														1											
SM_Elyt																									
SM_Pucc																									
SM_Hal (Ap)																									
SM_SHS																									
Mud																									
Grand Total	1	3	2	2	2	1	3	1	4	1	1	4	2	8	2	1	10	1	24	1	6	5	1	1	2

Total Number of quadrats:	**240**
Total number of correctly-classified quadrats:	**187**
Percentage quadrats classified correctly:	**77.92%**

Total number of terrestrial (T) zone quadrats:	**167**
Total number of correctly classified T zone quadrats:	**132**
Percentage of T zone quadrats classified correctly:	**79.04%**
Total number of maritime (M) zone quadrats:	**73**
Total number of correctly classified M zone quadrats:	**55**
Percentage of M zone quadrats classified correctly:	**75.34%**

Table A2.3: (continued)

CASI-LC 16px	MG 13	U4 b	MG 1	MG 1a	OV 25	OV 25a	OV 28	SD 7e	SM 6	SM 7	SM 8	SM 12A	SM 13	SM 13a	SM 13c	SM 14	SM 14a	SM 14C	SM 16d	SM 23	SM 24	SM 25a	SM 26b	SM 28	Grand Total
Bare				1					1												1				6
Mud_algT																									1
Wood_con																									3
Wood_dec																									1
Wood_scr	1				3															1				1	18
Reed_Phra									1																8
Reed_Bolb																									6
Man grs 1																									5
Man grs 2																									5
Man grs 2m		2																							9
Man grs 3		4		1																				1	23
Man grs 4																									6
Man grs 5		2				1																			9
Man grs 6																									5
S-man grs1			3	17	4		4																	5	38
S-man grs2			2	4	1														1						8
S-man grs3				5	2			1										1			3			3	16
SM_Elyt									1				1	1	2	1		1			2		1		10
SM_Pucc									1	1				3	3	2	1	3			2			1	17
SM_Hal (Ap)									1		2	3	3	8	4	4		8			2	1		1	37
SM_SHS												1		3				3							7
Mud																1		1							2
Grand Total	1	8	5	28	10	1	4	1	5	1	2	4	4	16	9	8	1	17	1	1	10	1	1	12	240