Natural England Commissioned Report NECR153

Survey and analysis of vegetation and hydrological change in English dune slack habitats

Annex 7 - Site report for Winterton

First published 14 August 2014

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Executive Summary

- Dune wetlands at Winterton were surveyed and mapped in the summer of 2012, repeating the wetland component of the earlier Sand Dune Survey of Great Britain (SDGB) at this site in 1989. Some vegetation quadrats from the 1989 survey were relocated and re-surveyed, and soil samples taken. Some hydrological interpretation is also provided for this site.

- Annual rainfall at Winterton is comparatively low and there is a fine balance between rainfall and actual evaporation. The net availability of water is therefore sensitive to changes in the timing and amount of rainfall.

- The groundwater system is affected by the seawall which, upon visual inspection, is present in the northern part of the site and acts to prevent outflow of groundwater to the beach. The impact of this is to support higher water levels in the north of the site.

- There has been some change in area of wetland habitats between 1989 and 2012. There is an apparent change from drier to wetter habitat area, but this may be due to different surveyor interpretation.

- There were no significant changes in indicator values for environmental or climate indicators. However, there was a significant decline in species richness.

- Soils are rather acidic, with pH<5 in the majority of quadrats.

- Continued monitoring of water levels in piezometers, and installation of additional, co-located permanent vegetation quadrats would be extremely valuable for interpretation of change over time. Automated logger monitoring of water levels would provide additional value.

Contents

1 Introduction

This work was conducted under a Memorandum of Agreement between Natural England and the Centre for Ecology and Hydrology (CEH). It comprised two elements: hydrological studies at key sites and a re-survey of the dune wetland vegetation resource, repeating where possible mapping and survey work conducted as part of the Sand Dune Survey of Great Britain (SDGB) (Radley 1994). Work conducted at Winterton under these two components is reported here.

2 Site Description

The site description is separated into hydrological and ecological components, both focusing primarily on the wetland features of the site.

2.1 Geological and hydrological setting

Winterton Dunes NNR is located on the east coast of Norfolk, approximately 8 miles north of Great Yarmouth (Figure 1). It is a hindshore dune system with low-lying land to the west and beach to the east (Figure 2). Blown sand in the north western part of the site overlies the sand and gravel of the coastal barrier complex, which in turn overlies till. The blown sand in the south eastern part of the site directly overlies till. The full sequence is likely to be blown sand over the sand and gravel of coastal barrier complex, over silt and clay, over peat, over Crag (Geology map 148)**.** The dune system is up to 800 m wide by 6 km long, but continues for a further 8 km to the north west with a width of between 50 and 100 m.

The fine-grained quartz sand that comprises the dunes is up to 7 m thick.

Figure 1. The location of Winterton dunes in the UK.

In the late eighteenth century marram grass was planted to stabilise the coastline against sea encroachments and by the early nineteenth century there was a barrier of dunes between high water mark and the ridge on which the lighthouse stood, leaving a valley (The Valley) between. The site is now largely stable with mature vegetation.

The northern half of the site is fronted by a concrete wall built in the 1960s. The wall sits on foundations that extend to a depth of - 4.5 m AOD (Coulet, 2007). Foreshore erosion with a local area of accretion near the car park is changing the shape of the system. The site is unusual in that it is more similar to the dune systems in the Baltic, which support acidic plant communities. This in contrast to the nearby dunes of the North Norfolk Coast and those on the UK west coast, which are more calcareous.

Figure 2. Aerial photo of Winterton Dunes. The yellow box indicates the area discussed in more detail later in this report. © Next Perspectives.

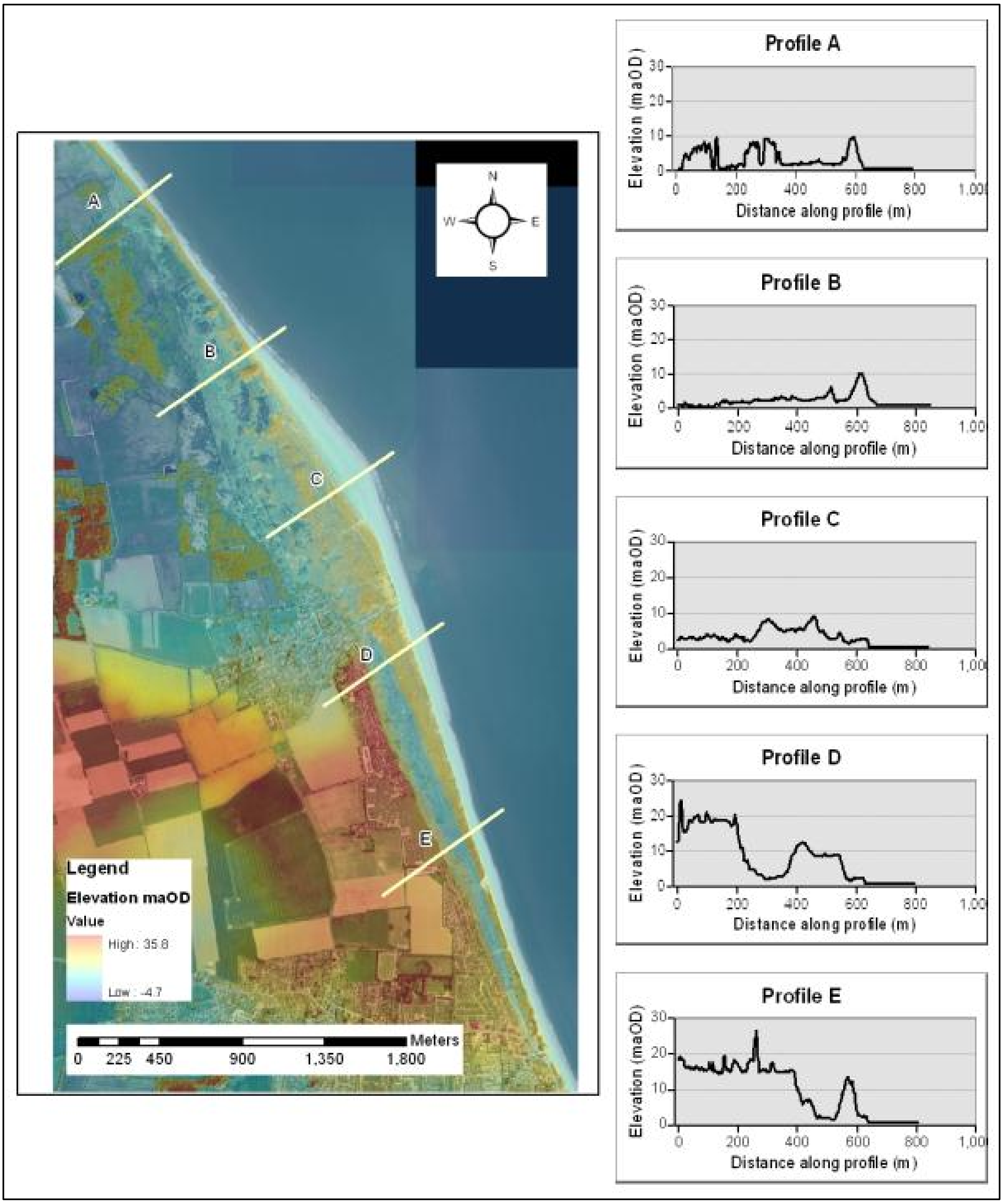

Figure 3. Elevation profiles at several locations along Winterton Dunes. Values represent the elevation of the top surface, not of the ground surface, so are affected by vegetation height. This is particularly noticeable in Profile A from 0 m to 400 m along the profile. © NERC (CEH) 2013, © Next Perspectives.

The frontal dune ridge has a fairly consistent height of ~ 10 m AOD (metres above Ordnance Datum) for the length of the dunes, and at least some of this, most noticeably in the north, coincides with the sea wall (Figure 3). Behind this, in the north of the site the surface slopes gradually inland to an elevation of ~ 0 m AOD (Figure 3, profiles A and B). To the south, the frontal dunes are wider. Inland of the southerly frontal dunes is a low lying area (termed locally as 'The Valley'), and to the west of this, higher ground. The surface elevation to the inland side of the dunes varies considerably (~20 m) between the north and south of the site.

The hydrology of the site appears to differ between the northern and southern ends of the site, with the southern end drier, and the northern end wetter. It is quite likely that the sea wall and its foundations are largely responsible for this, preventing groundwater discharge to the east (beach) in the northern area, whilst outflow is unrestricted in the southern area. The contrasting elevation inland is also likely to influence conditions in the dunes. There are various 'ponds' in the northern part of the site, which are smaller and more deeply incised than the dune slacks seen at other sites. The hydro-ecological conditions in these ponds have been noted as suitable habitat for natterjack toads however a decline in the numbers of natterjack toads recorded in the ponds has been a source of concern over the past 5 to 10 years.

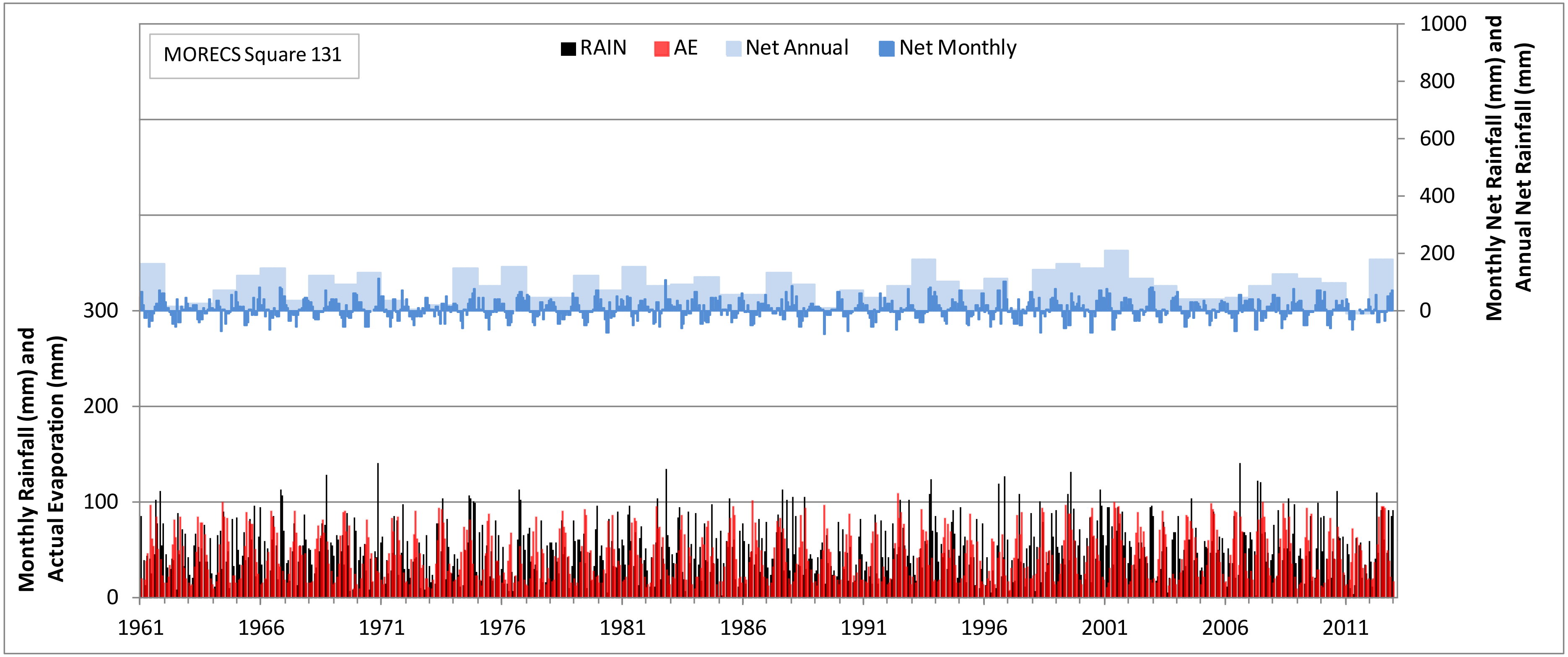

Figure 4. Monthly Rainfall and Evaporation data for MORECS square 131. Net (Rainfall - actual evaporation) monthly and annual totals also shown. MORECS data © Crown copyright 2013, the Met Office.

Long-term data for the basic hydrological drivers (rainfall and evaporation) are shown in Figure 4. Whilst evapotranspiration is broadly similar across many of the UK sites, rainfall varies considerably, and Winterton is one of the sites receiving the lowest average amounts of rainfall. The long term (1961 to 2012) average annual rainfall for this area (area defined as the 40km x 40km grid square calculated using the Meteorological Office Rainfall and Evapotranspiration Calculation System (MORECS)) is 622 mm, and the long term (1961 to 2012) average annual net (rainfall – actual evaporation) is 92 mm. This means that there is very little water available to drive or support a rising water table, and that relatively small changes in the timing and amount of rainfall could bring about a recharge deficit.

Interpretation of MORECS data must remember that the data reflect the average conditions for the whole grid square. It is quite possible the conditions at a single coastal dune system will not be accurately represented by MORECS data and the results should therefore only be used as very broad indicator.

2.2 Ecological setting

The site was previously surveyed in 1989 by Doarks et al. (1989). The following ecological setting is based on survey work in this study conducted in 2012. The dunes at Winterton are of particular interest because of their acidic soils, with Humid Dune Slacks (Annex I habitat 2190) a primary reason for selection of the site as a Special Area of Conservation (SAC). As a result of the underlying soil type, the dune-slack communities more attributable to Mire (M) and Heath (H) communities of the National Vegetation Classification than those traditionally associated with dune-slacks (SD13-17); particularly unusual on the East coast. M16 *Erica tetralix-Sphagnum compactum* wet heath and H11 *Calluna vulgaris-Carex arenaria* heath are the most common communities, occurring individually in comparable measure, and occasionally as mosaics, in depressions of varying size across the site. The Lichen-rich mixed Ericaceous heath is dominated by *Calluna vulgaris* with *Carex arenaria, Agrostis stolonifera* and rare *Erica tetrali*x. Where the *E. tetralix* dominates in the M16 mire, it is accompanied by *Osmunda regalis* and other ferns, *Molinia caerulea, Carex nigra, Juncus conglomeratus.* In the wetter part of the site, and towards the seaward edge of the dunes, W4 *Betula pubescens-Molinia caerulea* woodland occurs with *Salix* spp., grading into the wet heath/bog to the West, and with some transition to M23 *Juncus effusus/acutiflorus-Galium palustre* rush-pasture and S4 *Phragmites australis* swamp and reed-beds. Some small (seasonal) pools of S4 are present with species including *Hydrocotyle vulgaris*, *Typha angustifolia, Eleocharis palustris* and *Potamogeton polygonifolius*. Some of the smaller depressions, particularly in the South of the site also support M23, with areas of M25 *Molinia caerulea-Potentilla erecta* mire where *M. caerulea* is more predominant.

3 Hydrological work

The focus of any hydrological work to-date has been the northern area of the site. This is largely due to the wetter conditions in the north compared to the drier free-draining conditions in the south, and the ecological importance of these wet features.

Figure 5. Dipwell monitoring network in the north of the site. Refer to Figure 2 for the location this in the dune system. © NERC (CEH) 2013, © Next Perspectives.

Analysis of water level data collected during 2006 and 2007 from a network of dipwells in the north of the site (Figure 5) was carried out by William Coulet (Coulet, 2007), and this described the idea of the sea wall preventing groundwater flow towards the sea. Groundwater flow instead moves inland until it is intercepted by a ditch running along the inland edge of the dunes.

Although monitoring has not been installed across the rest of the site, a conceptual groundwater flow diagram has been developed based on observations made during the site visit in September 2012. This conceptualisation reflects the confining effect of the sea wall in the north and the free draining sands in the south (Figure 6).

The extent to which the sea wall acts to maintain a raised water table and the extent to which this might influence the impact of possible future changes in temperature (and related evapotranspiration) and rainfall has not been quantified. For more detail on previous hydrological work, please refer to Coulet (2007).

Figure 6. Winterton Dunes conceptual groundwater flow diagram. The yellow arrows indicate the direction of groundwater flow. © NERC (CEH) 2013, © Next Perspectives.

4 Vegetation Survey

4.1 Methodology

4.1.1 Field Mapping

The use of GPS-linked portable electronic tablet PCs in the field equipped with Arcpad GIS software enabled a variety of layers to be loaded simultaneously and selected or made semi-transparent as required. GIS layers included aerial photos covering the extent of the dunes, scanned and geo-referenced copies of the original survey maps, the editable layers for mapping and, where available, additional survey information for dune slacks recorded since the SDGB survey.

As the project focused very specifically on dune wetlands, there was no scope to map the more widely distributed (dry) dune communities. For each prioritised area surveyed, every slack or wetland mapped in the original survey was revisited as far as possible, aided by printed copies of the SDGB survey maps with wetland habitats highlighted. Additional slacks were then located by covering as much of the intervening ground on foot as possible, and using georeferenced aerial photos as guidance. To aid the surveyors in distinguishing boundaries between dune wetlands and dry dune communities, it was helpful to identify certain indicator species that could be used to help delineate the edge of dune slacks. The basic premise that dune slacks are influenced by the water table meant that in many cases the extent of species strongly associated with damp habitats provided a useful guide. The relative significance of species differed slightly with each site, but usually included *Hydrocotyle vulgaris* (Marsh pennywort), *Carex nigra* (Common sedge), *Agrostis stolonifera* (Creeping bent), *Eleocharis* sp. (Spike-rush) and *Epipactis palustris* (Marsh helleborine) as well as a range of bryophytes. *Calliergonella cuspidata* was particularly useful where it occurred (particularly in NVC communities SD14-15 and SD17) due to its abundance and mat-forming habit. Conversely, certain species strongly associated with dry habitats such as *Ammophila arenaria* (Marram grass) and *Chamerion angustifolium* (Rosebay willowherb) usually helped identify areas outside the extent of the slack.

Once a dune slack was located and delineated, surveyors identified apparently homogenous stands of vegetation, following NVC guidance (Rodwell, 2006). The boundaries of each stand were walked and digitised using the GPS-tracking functionality in Arcpad. Occasionally the GPS accuracy could drop to as low as 20m, at which point the aerial photos were helpful in confirming the location. Associated with each polygon drawn, the information listed in Table 1 was captured.

Table 1. Digital mapping data collection form filled in for each polygon digitised.

Field	***Data entry method***
ID	Unique polygon ID generated by Arcpad
NVC community	Selected from list OR free text
NVC sub-community	Selected from list OR free text
Notes	Free text field for target notes relevant to each polygon; surveyors included dominant species and previous slack ID where relevant
NVC community 2 (mosaic)	Selected from list OR free text
Proportion NVC community 1	Where a mosaic of two habitats occurs the proportion of each was specified
Proportion NVC community 2	

Due to the time constraints of the survey, it was not possible to follow the standard NVC guidance to record at least 5 quadrats in each stand of vegetation (Rodwell, 2006). A variety of resources were used to identify communities, including surveyors' personal experience, NVC habitat keys & descriptions, NVC floristic tables and the use of TABLEFIT software *in situ*. TABLEFIT can perform a useful function with reduced species lists with or without cover data (as well as single or multiple full quadrats), so mappers were able to make use of this for guidance throughout the survey, where the scale of the project otherwise precluded the recording of full quadrats. Close contact throughout the survey of the mappers with those surveyors who were recording quadrats provided an extra level of quality assurance in the mapping exercise.

All wetland communities within the interior of the dune system were mapped at the NVC sub-community level where possible with a minimum mappable unit of 10 x 10m. Although dry dune and other habitats were not mapped, transitions between wet and dry communities were. Former slacks that are now dry and no longer contain slack vegetation were identified by target notes, but their boundaries were not mapped.

4.1.2 Location of vegetation quadrats

Using the GIS resources described above in the mapping methodology, SDGB quadrats for which data were available were re-located. Some expert judgement by the surveyors was required to re-locate the original quadrat position, particularly where error or distortion in the SDGB survey map was evident. Where possible, additional new quadrats were recorded in less common habitats and young natural slacks formed since the SDGB survey. Locations of quadrats recorded in 2012 are shown in Figure 9.

4.1.3 Vegetation quadrat recording methodology

Once quadrat positions were located, a 2x2m quadrat oriented north-south was surveyed. The location of the centre of the quadrat was recorded using a Garmin Etrex GPS, to around ±5 m accuracy. Within the quadrats all vascular plants and bryophytes were identified and percentage cover recorded. Where cover of a species was <1%, a value of 0.1% was recorded where a single individual was present, and 0.5% where more than one individual was present, to enable conversion to Domin values (+ and 1 respectively). Cover values between 1 and 10 were recorded to the nearest 1%, and above that to the nearest 5%. Where species identification was not possible in the field (primarily bryophytes), samples were collected and later verified by a specialist.

Table 2. Data collected associated with each quadrat.

Category	***Sub-category***	***Data entry method***
ID	Unique quadrat ID generated by arcpad	n/a
1990 ID	Quadrat number assigned in 1990 survey	Free text
Characteristics	GPS location	Free text
	Angle of slope (degrees)	
	Aspect (compass degrees)	
	Vegetation height (cm; 5 measurements)	
Management	Grazed?; Rabbit; Sheep; Cattle; Horse; Other animal (specify); Mown; Scrub-cut; Trampled by people; Evidence of fires; Other disturbance (specify)	Choice (yes/no/don't know) & free text to specify 'other'
Additional info.	Flooded at time of survey; Soil sample taken	Choice (yes/no)
	Depth(cm); Photographic record; Soil features	Free text
NVC community	NVC community description	Free text
Vegetation data	Name and % cover for each species	Drop down choice for name and free text for %cover

Additional parameters such as bare ground, aspect, slope, as well as data regarding management in evidence such as grazing, dunging, urine patches, evidence of scrub clearance, etc. were recorded (Table 2). Vegetation height was measured by placing a metre ruler at 5 random locations within the quadrat, and estimating the sward height to which 80 % of the vegetation reached, within a 20 cm radius of the ruler. A unique ID number was assigned to each quadrat within the database, and where relevant the associated quadrat number from the SDGB survey was noted within the recording form. Two photographs were taken at each quadrat facing North; one looking down on the sward, and the other including the surrounding habitat for context. Unique quadrat ID and a four letter site code were included within photographs. Quadrats were allocated to a NVC community following the methodology described for mapping above, though if required TABLEFIT analysis could be delayed until later on with reference to the full species list.

4.1.4 Soil sampling

A soil sample was taken from the SW corner of each quadrat recorded. A plastic corer of 5 cm diameter and 15 cm depth, labelled with quadrat ID and date was hammered into the ground and removed using pliers, and the tube and soil sample within were placed in a plastic bag and sealed. Samples were kept in portable cool boxes with ice packs before being returned to CEH Bangor, where they were stored in cold rooms at 5˚C prior to analysis.

4.1.5 Species nomenclature

Plant species nomenclature follows that of Stace (2010) for vascular plants and Smith (2004) for bryophytes. Biological Records Centre (BRC) species codes are associated with all vegetation data within the database.

4.1.6 Analysis of change in vegetation

As described above, the survey team in 2012 re-visited all areas that were mapped as wetland in 1989. Change in mapped area was assessed for all mapped dune wetlands. Polygons for wetlands in 1989 which corresponded to areas mapped or revisited in 2012, were digitised from the scanned and georeferenced hard copy vegetation survey map of 1989. The area comparison included the following:

- Locations mapped as wetland in 1989, but deemed no longer to be wetland vegetation in 2012 based on lack of slack vegetation indicator species (see main report Stratford *et al*. (2013), and methods section above). Note that only wetland vegetation types were mapped in 2012, so where vegetation had changed to a non-wetland type this was captured in a target note, but the extent was not mapped. These therefore represent a contraction in the area of wetland at the site.

- Locations mapped as wetland in both 1989 and 2012.

- New wetland features mapped in 2012.

Each polygon (1989 and 2012) was assigned a code for broad vegetation type (Table 3) for ease of interpretation of multiple vegetation classes and communities. The 1989 survey used the draft version of the NVC for coastal habitats, which meant only a simplified cross-comparison over time was possible. The draft NVC only distinguishes between calcareous-type slacks and acid-type slacks. Polygons mapped in 2012 are shown in Figures 10-15.

Table 3. Broad vegetation codes used for reporting of change in mapped area.

Code	Vegetation type
c	Calcareous slack type (Final NVC SD13, SD14, SD15, SD16)
a	Acid slack type (Final NVC SD17)
s/d	Slack to dry transitional
d	Dry habitats
sm	Saltmarsh
wp	Wet pasture (usually frequent Juncus spp) (M23, MG8, MG10, MG11, MG12, OV28)
w	Other wetland type (including swamp, mire, open water, wet woodland, ponds etc.)
t	Trees or scrub (most sites this will be conifer plantations)

Change in vegetation composition was assessed by analysis of a number of quadrats from 1989 in wetland areas which were resurveyed in 2012. Quadrats were relocated based on maps from 1989 and interpretation of likely location on the ground in combination with maps and high resolution orthorectified recent aerial photography. GPS grid-references were taken for quadrat locations in 2012, accuracy + 5m. We estimate that the majority of these quadrats were relocated within 10m of the original quadrat location, but it is likely that some were not so accurately relocated. At each quadrat, vegetation height was recorded and a soil sample taken for basic physical description (organic horizon thickness, pH, moisture content and organic matter content) and archiving for future chemical analysis, should resources become available.

Where available, species composition of quadrats from 1989 was entered by hand from floristic tables in the Doarks et al. (1989) report. Species names were harmonised to Biological Recording Centre (BRC) names, and mean Ellenberg indices for environmental indicators (L=Light; F=Moisture; R=Reaction/pH; N=Nutrients; S=Salinity) and for climate indicators (Tjan=Minimum January temperature; Tjul=Maximum July temperature; Prec=Annual precipitation) were calculated for each quadrat in each time period based on the presence/absence of species in the quadrat. Percentage abundance data for 2012 were converted to 10-point DOMIN as in Rodwell (2006).

4.2 Results

4.2.1 Change in mapped area of dune wetlands

Changes in mapped area of dune wetlands at Winterton between 1989 and 2012 are summarised in Table 4 below. Figures 10-15 show the extent of the area mapped in 2012, with polygons colour-coded by broad vegetation code (Table 3), and labelled with the NVC communities assigned.

Table 4. Mapped area (ha) of broad vegetation classes in 1989 and 2012, showing net change, and percentage change for classes with area > 1 ha in 1989.

Area summaries	1989	2012	Net change	%change
Slacks+slack/wet transitions	0.8	0.0	-0.8	-
Slack/dry transitions	0.0	0.0	0.0	-
Dry habitats	6.7	2.8	-3.9	-57.8
Other wetlands	3.1	5.7	2.5	80.0
Total slacks	0.8	0.0	-0.8	-
Total slacks and other wetlands	3.9	5.7	1.7	44.0
(Total Mapped Area)	11.0	8.5	-2.5	-23.0

There was a 44% increase in wetland area between the two time points, with a net increase of 1.7 ha. Detailed change analysis using a change matrix was not possible within the scope of this study. However, based on Table 4 and interpretation of the maps and database (available electronically from Natural England), the following broad changes are apparent from this analysis.

There was a decrease of around 4 ha in dry habitats, with increases in non slack wetland habitats. However, these may partly be due to differences in interpretation of vegetation community by surveyors, and further information can be provided by analysis of change for repeated quadrats.

4.2.2 Vegetation change revealed through analysis of repeated quadrats

In 2012, 6 quadrats were surveyed at Winterton. These included 5 which were repeat quadrats and could be used for analysis of change over time. All quadrats are listed, together with basic descriptive information in Table 6 at the end of this report, with locations shown in Figure 9.

Changes in Ellenberg environmental and climate indicators are summarised in Table 5. There was no significant change in environmental indicator scores or climate indicator scores. There was however a significant decline in species richness at this site, in contrast to many other sites (Stratford et al. 2013).

Table 5. Change in environmental and climatic indicators between 1989 and 2012 showing mean, standard deviation (s.d.) for each year, and whether there was a significant difference over time (in bold, * <0.05, ** <0.01, * < 0.001). N = number of quadrats. See methods for description of indicators.**

N=5	Indicator	1990	2012	Significance
Mean	Light	7.29	7.44	
Mean	Moisture	6.25	6.00	
Mean	pH	3.97	4.11	
Mean	Nutrients	2.92	2.75	
Mean	Salinity	0.30	0.28	
Mean	JanTemp	3.61	3.67	
Mean	JulTemp	14.38	14.38	
Mean	Precipitation	1132	1131	
Mean	**Spp Richness**	**10.60**	**6.00**	*****
s.d.	Light	0.26	0.53	
s.d.	Moisture	0.57	0.54	
s.d.	pH	0.93	1.02	
s.d.	Nutrients	0.81	1.38	
s.d.	Salinity	0.11	0.14	
s.d.	JanTemp	0.02	0.12	
s.d.	JulTemp	0.07	0.11	
s.d.	Precipitation	21.19	25.84	
s.d.	Spp Richness	1.83	1.30	

4.2.3 Analysis of soils data

Simple physical data from soil cores are shown in Figure 7 and Figure 8 below, grouped by broad vegetation type. Soil pH (Figure 7) was consistently acidic in all community types, at or under pH 5.

Organic matter contents (Figure 8) are generally high in all vegetation types, all above 6%, being highest in the heath communities, with one sample of 22%. There are relatively few data from other acidic sites against which to compare these values.

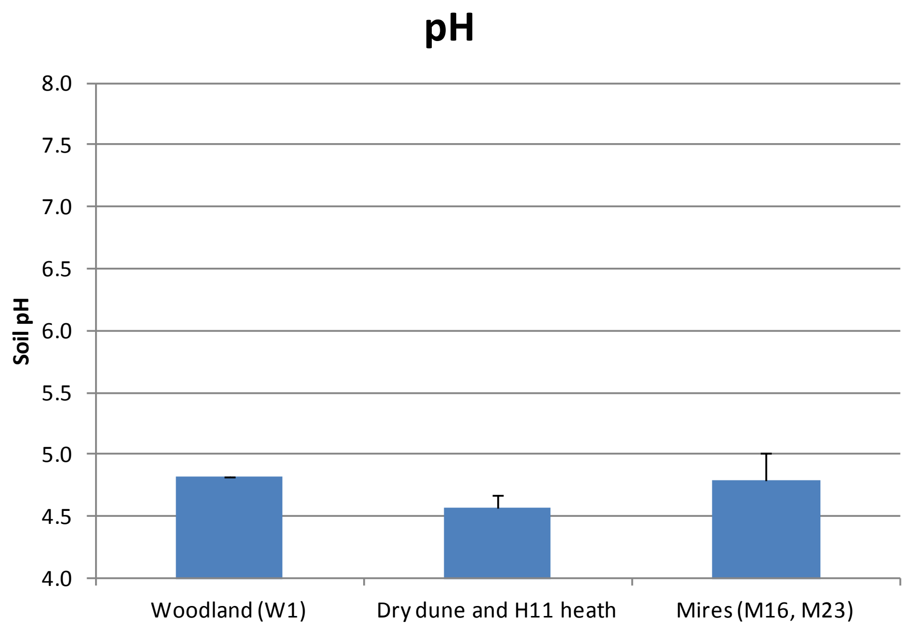

Figure 7. Soil pH, by broad vegetation type.

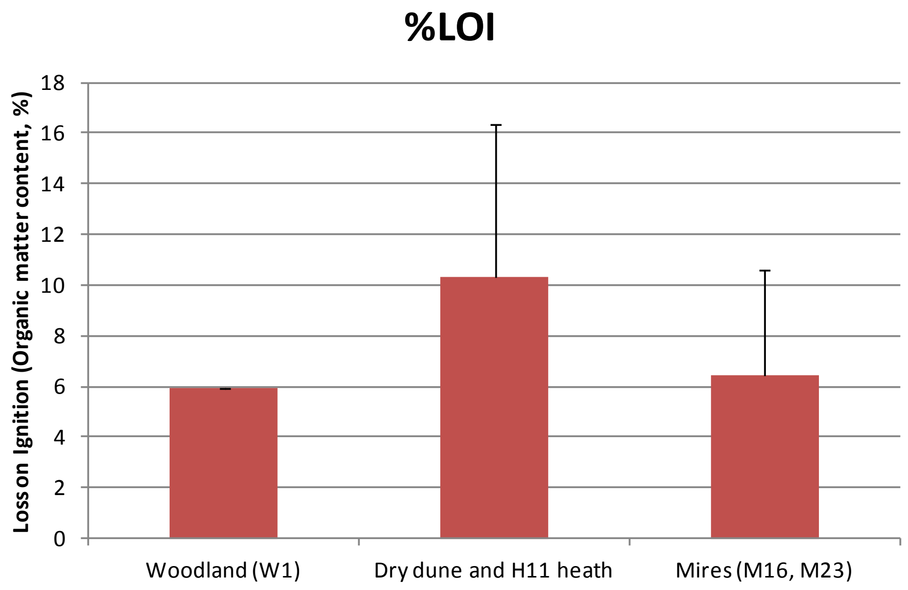

Figure 8. Organic matter (as Loss On Ignition, %), by broad vegetation type.

4.3 Discussion (in context of hydrological & other key local drivers)

There are few clear signals of vegetation change at Winterton. There are no changes in indicators of climate or other environmental factors. There was however a significant decline in species richness, for reasons unknown. Changes between categories in mapped area may be in part due to differences in surveyor interpretation. However, the low number of quadrats did not provide enough statistical power to detect changes in indicator values of a similar magnitude that have occurred at some other sites.

The hydrological system in the northern part of this site is strongly influenced by the sea wall. The regime is therefore different to that observed at the other sites in this study. This, in combination with the differences in soil and groundwater chemistry, create contrasting hydro-ecological conditions and these are reflected by the unusual (for the UK) dune wetland vegetation at the site.

5 Implications for management

- Additional quadrats could be set up at the site to monitor change, preferably adjacent to piezometer locations.

- Regular monitoring of the permanent vegetation quadrats being set up adjacent to these dipwells could provide extremely valuable information to link potential changes in vegetation to changes in hydrology.

- Given the sensitive nature of the hydrological system and its role in the hydro-ecological conditions at the site, it would be worthwhile installing and operating a groundwater monitoring network, to provide better understanding of for both water level and water quality. This could incorporate the dipwells previously installed (Coulet, 2007) but would ideally extend north and, in particular, south of this area.

6 References

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7 Quadrat information

Table 6. List of quadrats surveyed at Winterton, with associated environmental data. Quadrats coded Q represent 1989 quadrat codes. OM (organic matter) = organic horizon thickness. LOI% (Loss On Ignition) = % organic matter content.

Quad Code	x	y	ANGLE SLOPE (degrees)	ASPECT (degrees)	Veg Height (cm)	OM thickness (cm)	Soil pH	LOI %	Quad Type
Q4	646283	324351	0	0	450	8	4.82	5.92	RepeatQuadrat
Q15	648440	321865	0	0	30.4	6	4.65	6.19	RepeatQuadrat
Q17	648562	321678	0	0	24	4	4.71	2.72	RepeatQuadrat
Q18	648604	321614	0	0	30.8	3	4.57	2.32	RepeatQuadrat
Q19	648831	321393	0	0	26.2	14.5	4.34	22.13	RepeatQuadrat
N1	646630	323920	0	0	40.4	6	5.02	10.58	NewQuadrat

Figure 9. Locations of quadrats surveyed at Winterton Dunes. Note: quadrats Q4 and N1 are located to the north of the area covered by the aerial photography and are not shown in this figure. © NERC (CEH) 2013, © Next Perspectives.

8 Survey maps

Figure 10. Winterton. Overview of NVC communities mapped during 2012 vegetation survey, with reference to areas covered by maps 1-5 (Figures 11-15). Habitat groups (broad vegetation codes) are described in Table 3. © NERC (CEH) 2013, © Next Perspectives.

Figure 11. Winterton Map 1. NVC communities mapped during 2012 vegetation survey. Habitat groups (broad vegetation codes) are described in Table 3. © NERC (CEH) 2013, © Next Perspectives.

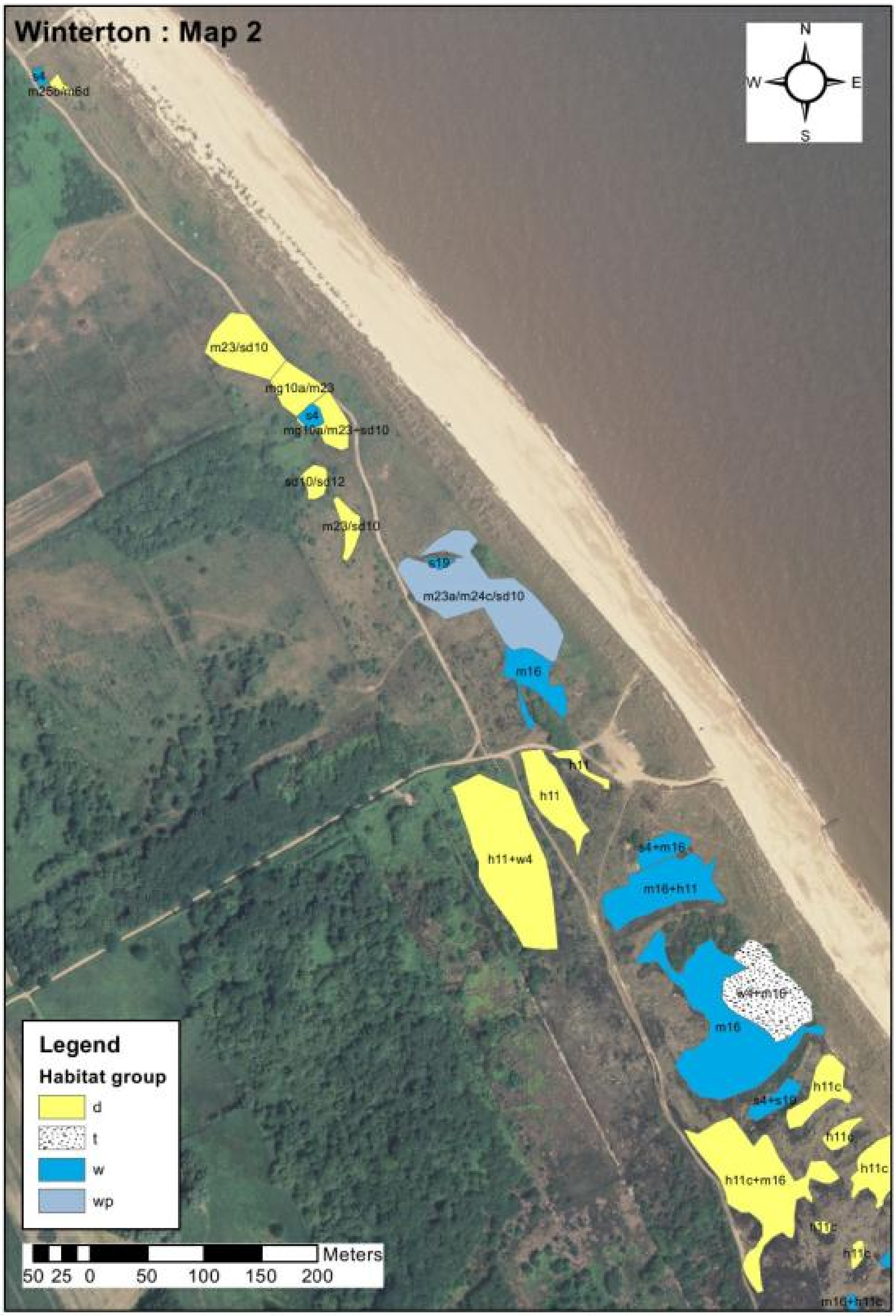

Figure 12. Winterton Map 2. NVC communities mapped during 2012 vegetation survey. Habitat groups (broad vegetation codes) are described in Table 3. © NERC (CEH) 2013, © Next Perspectives.

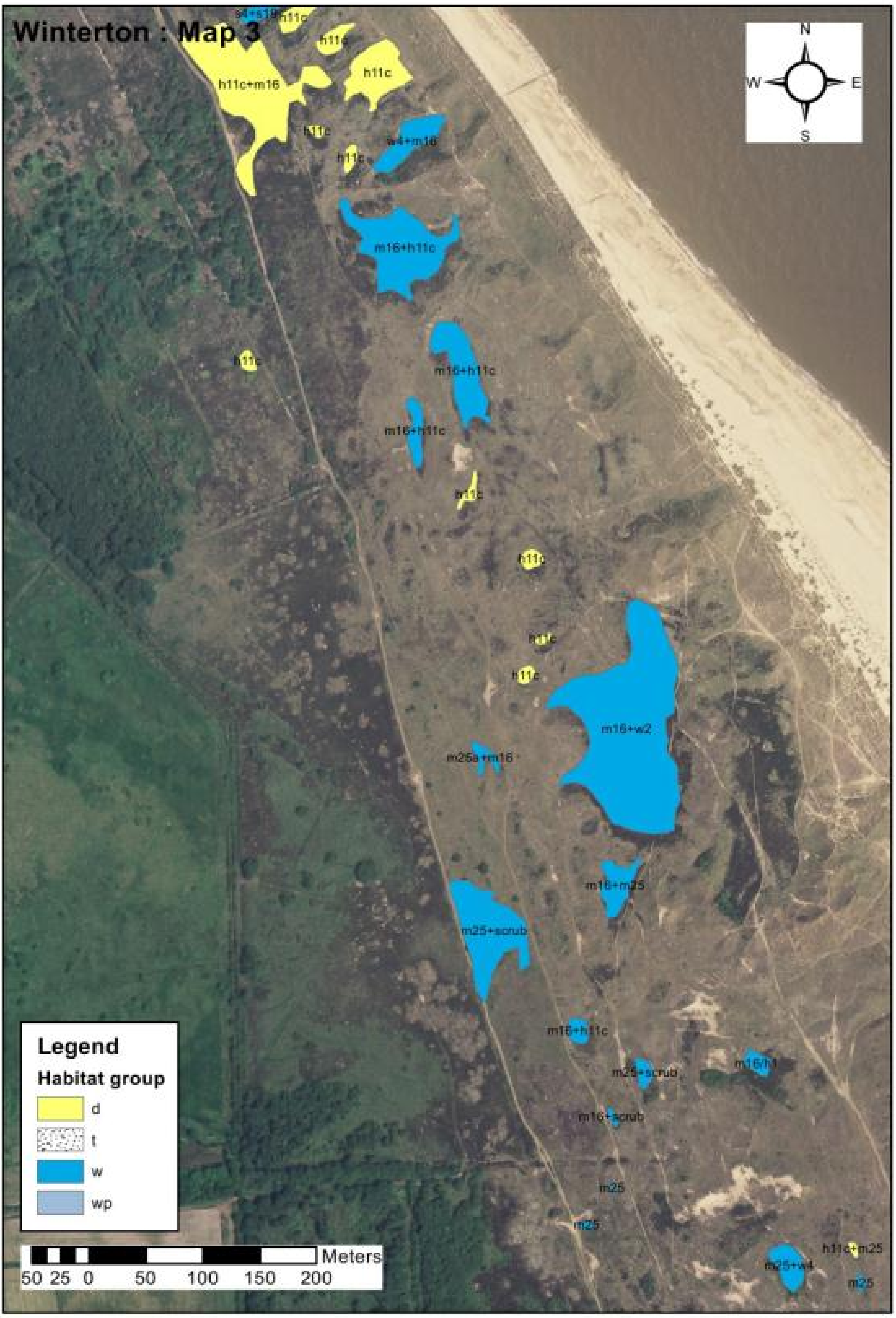

Figure 13. Winterton Map 3. NVC communities mapped during 2012 vegetation survey. Habitat groups (broad vegetation codes) are described in Table 3. © NERC (CEH) 2013, © Next Perspectives.

Figure 14. Winterton Map 4. NVC communities mapped during 2012 vegetation survey. Habitat groups (broad vegetation codes) are described in Table 3. © NERC (CEH) 2013, © Next Perspectives.

Figure 15. Winterton Map 5. NVC communities mapped during 2012 vegetation survey. Habitat groups (broad vegetation codes) are described in Table 3. © NERC (CEH) 2013, © Next Perspectives.