Natural England Commissioned Report NECR153

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

Annex 4 - Site report for Lindisfarne

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Executive Summary

- Dune wetlands at Lindisfarne 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 1988. Some vegetation quadrats from the 1988 survey were relocated and re-surveyed, and soil samples taken. Some hydrological interpretation is also provided for this site.

- The conceptual groundwater flow model developed for Lindisfarne indicates a relatively simple system. This site offers an excellent opportunity for development of sand dune hydrological models.

- There has been no net change in area of wetland habitats between 1988 and 2012. An apparent change from drier to wetter habitat area is likely to be due to different surveyor interpretation.

- There were no significant changes in indicator values for environmental or climate indicators and no change in species richness

- Soils are still very calcareous with pH>7 in the majority of quadrats.

- Continued maintenance and repeat monitoring of newly installed co-located dipwells and permanent vegetation quadrats would be extremely valuable for interpretation of change over time. An extension of the network and vegetation quadrats in a range of vegetation types, together with 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 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 Lindisfarne 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

Lindisfarne dunes are situated on the northern and landward (this area is also known as 'The Snook') sides of Holy Island. Holy Island lies of the east coast of Northumberland, approximately 9 miles south of Berwick upon Tweed (Figure 1). The Snook comprises a thin cover of blown sand and raised beach material draped over bedrock which comprises limestones and coal measures. Bedrock has been mined for lime production in the past at a number of places on The Snook. The sand is, therefore, self draining.

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

The dunes on the Snook are almost entirely surrounded by sea apart from a narrow band of dunes extending to the east, joining to the main part of Holy Island (Figure 2). There is no evidence of controls on the hydrology of the dunes such as drainage channels or abstraction points and the groundwater table is therefore expected to respond to rainfall and evaporation, faintly reflecting the shape of the surface topography.

The frontal dunes ridge, which extends almost the entire way round the dunes except for a small area to the south east, has an elevation of ~ 6 m AOD. Towards the centre of the dunes, moving inland from the frontal dunes, the western part of The Snook is dominated by high dunes (some reaching an elevation of 12 m AOD) with small areas of low-lying slacks (with a typical elevation of around 4 m AOD), whilst the eastern part of The Snook is dominated by large open areas of low-lying slack, with small areas of high dune (Figure 3).

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 Lindisfarne 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 663 mm, and the long term (1961 to 2012) average annual net (rainfall – actual evaporation) is 152 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.

Figure 2. Aerial photo showing Lindisfarne Dunes. © Next Perspectives.

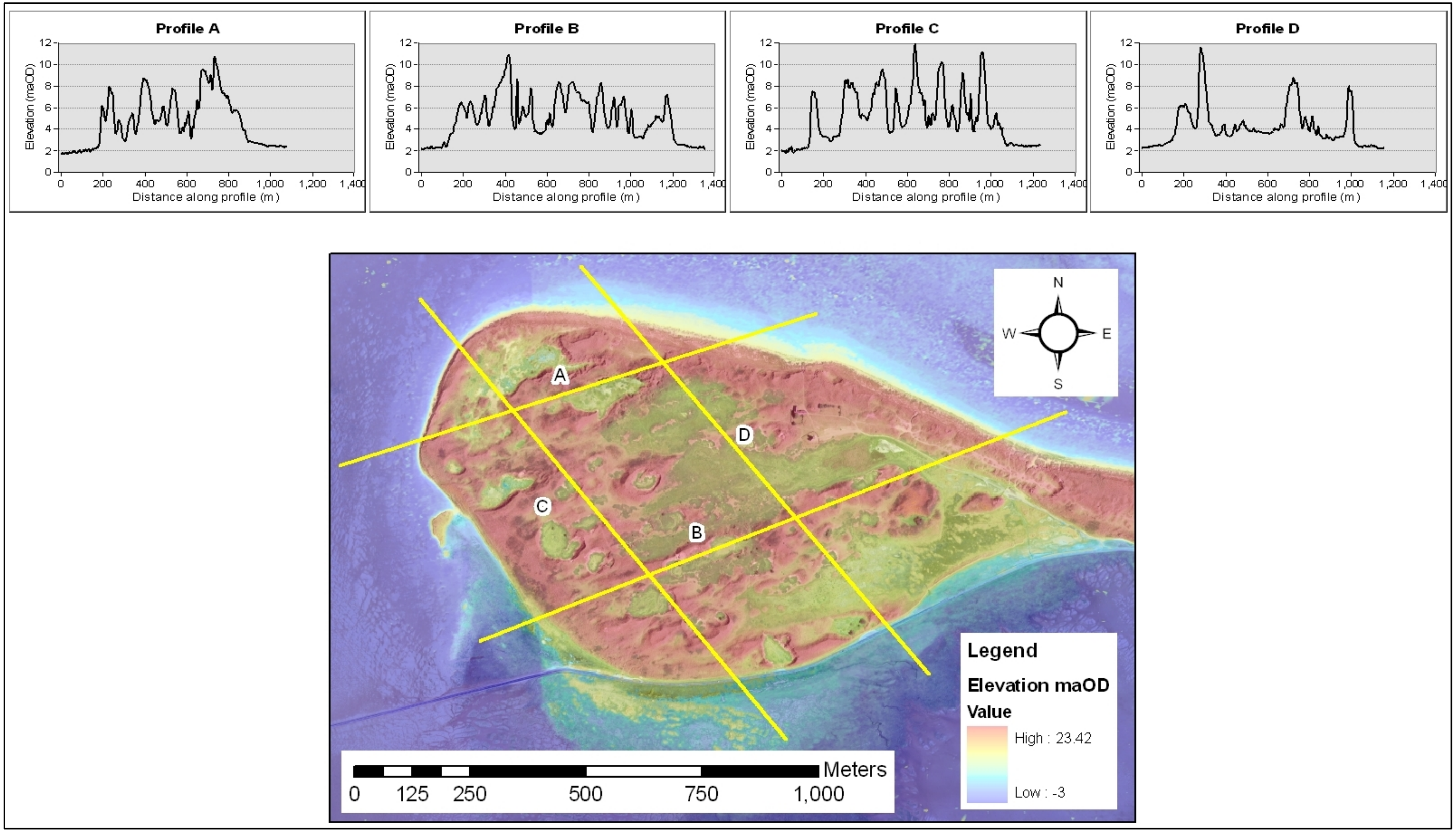

Figure 3. Elevation profiles at several locations along The Snook at Lindisfarne Dunes. Values represent the elevation of the top surface, not of the ground surface, so are affected by vegetation height. © NERC (CEH) 2013. © Next Perspectives.

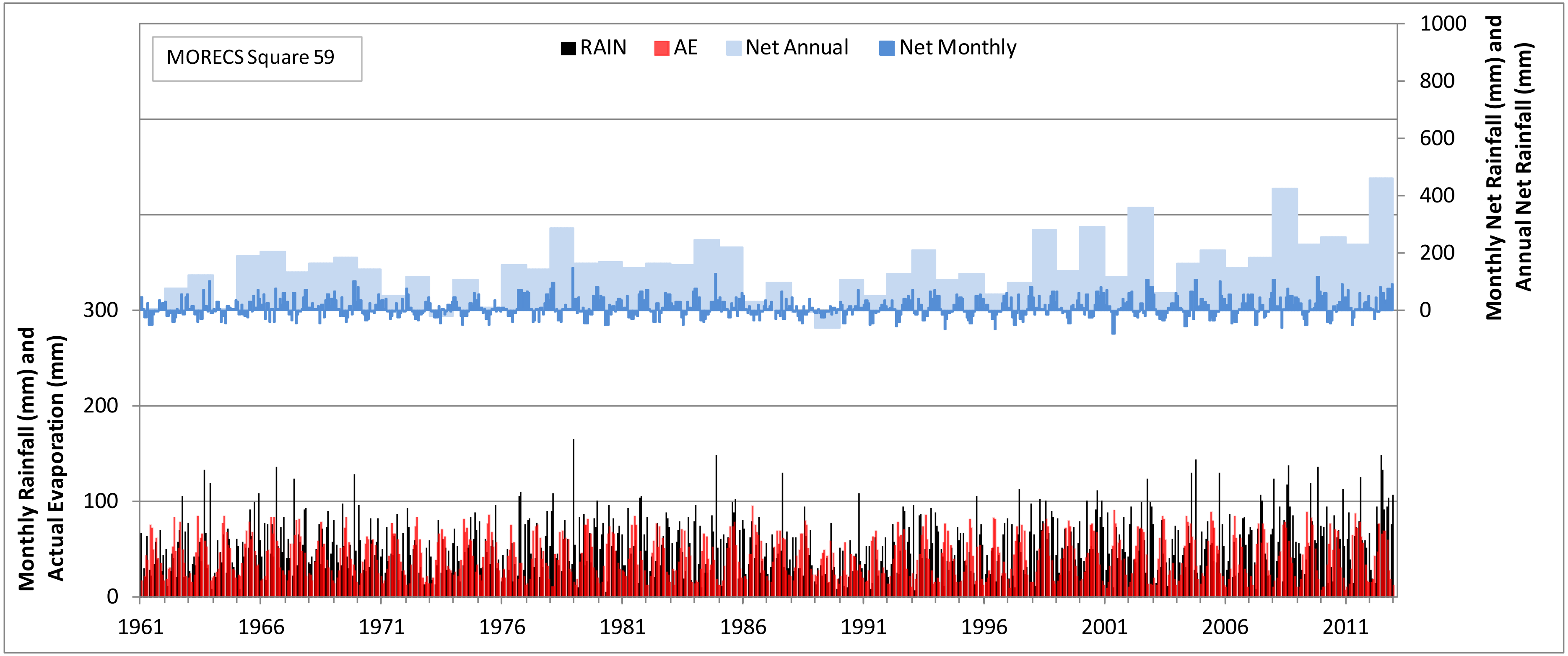

Figure 4 Monthly Rainfall and Evaporation data for MORECS square 59. Net (Rainfall - actual evaporation) monthly and annual totals also shown. MORECS data © Crown copyright 2013, the Met Office.

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. This is particularly noticeable at Lindisfarne and Ross Links, which despite being within a few miles of each other, fall into different MORECS grid squares. As a result the calculated long term average rainfall for each site varies by over 150 mm. This is very unlikely to be an accurate representation of the true situation. Nevertheless, MORECS does provide a very useful long term average view of conditions and its inclusion here is therefore justified.

2.2 Ecological setting

The site was previously surveyed in 1988 by Woolven & Radley (1988). The following ecological setting is based on survey work in this study conducted in 2012. The western section of Lindisfarne (the 'Snook') is dominated by the dune system, with the road separating the Southern edge of the dunes from Saltmarsh. There is a large, flat slack with vegetation indicative of both SD15 *Salix repens-Calliergon cuspidatum* dune-slack community and SD17 *Potentilla anserina-Carex nigra* dune-slack community, with a transition to SM16 *Festuca rubra* saltmarsh community at its eastern end where it opens up and joins the true saltmarsh across the road. Where conditions are drier at the edges of the larger slacks, and within many of the shallower small slacks scattered to the south and east, SD16 *Salix repens-Holcus lanatus* dune-slack (primarily *Agrostis stolonifera* sub-community SD16d) is present. Another larger flat slack in the centre of this section to the West of the 'neck' of the island is primarily SD15d *Salix repens-Calliergon cuspidatum, Carex nigra* sub-community, with large areas of *Schoenus nigricans*, particularly in its eastern half. In the non-slack areas, and particularly evident on the Snook, the invasive non-native Pirri-Pirri bur *Acaena novazelandiae* remains a significant problem, with visitors encouraged to minimise the risk of transmission to other sites by cleaning boots and animals.

To the east of the narrow neck of the island, the dunes run along the northern edge of the main part of the island. This area is quite different in character to the Snook, with the majority of dune-slack occurring as SD17 *Potentilla anserina-Carex nigra*, (frequently most attributable to the SD17b *Carex flacca* sub-community), and with extensive areas of damp grassland in the South occasionally appearing as a transition to SD17. The easternmost dune slack comprises SD16 and SD17 with extensive *Carex rostrata*. Some areas of standing water or S19 *Eleocharis palustris* swamp to the south are surrounded with short vegetation approximating SD17 *Potentilla anserina-Carex nigra* dune-slack community, but with patches of *Equisetum variegatum* and *Samolus valerandi*.

3 Hydrological work

A dipwell monitoring network has recently been installed in Lindisfarne dunes and a time series of hydrological data is being built up. This dataset has not yet been looked at in the context of this study, but it is likely that CEH/BGS will try to work with site management staff at Lindisfarne in order to incorporate any results into future dune hydrology work. In the absence of monitoring data, the conceptual model is based upon site observations made both during the desk study and field visit.

Of all the sites in this study, Lindisfarne is arguably the one with the simplest hydrology. By that, we mean specifically that there are few influences on the hydrological regime other than rainfall, evaporation, sea level, land cover and the hydraulic properties of the aquifer. Where other sites may have networks of drainage ditches or may have hydraulic connection with another groundwater system, Lindisfarne does not. The conceptual groundwater flow model reflects this simplicity and is proposed as a first approximation, which can be tested once sufficient monitoring data have been collected.

The groundwater flow on The Snook has a radial pattern, with flow direction towards the sea. The centre of the pattern is not quite in line with the centre of the dunes. The reason for this is that the higher dunes to the west of the site will likely cause a slight mounding of groundwater underneath the high dunes. The hydraulic gradient therefore slopes away from the high dunes towards the lower lying ground (Figure 5).

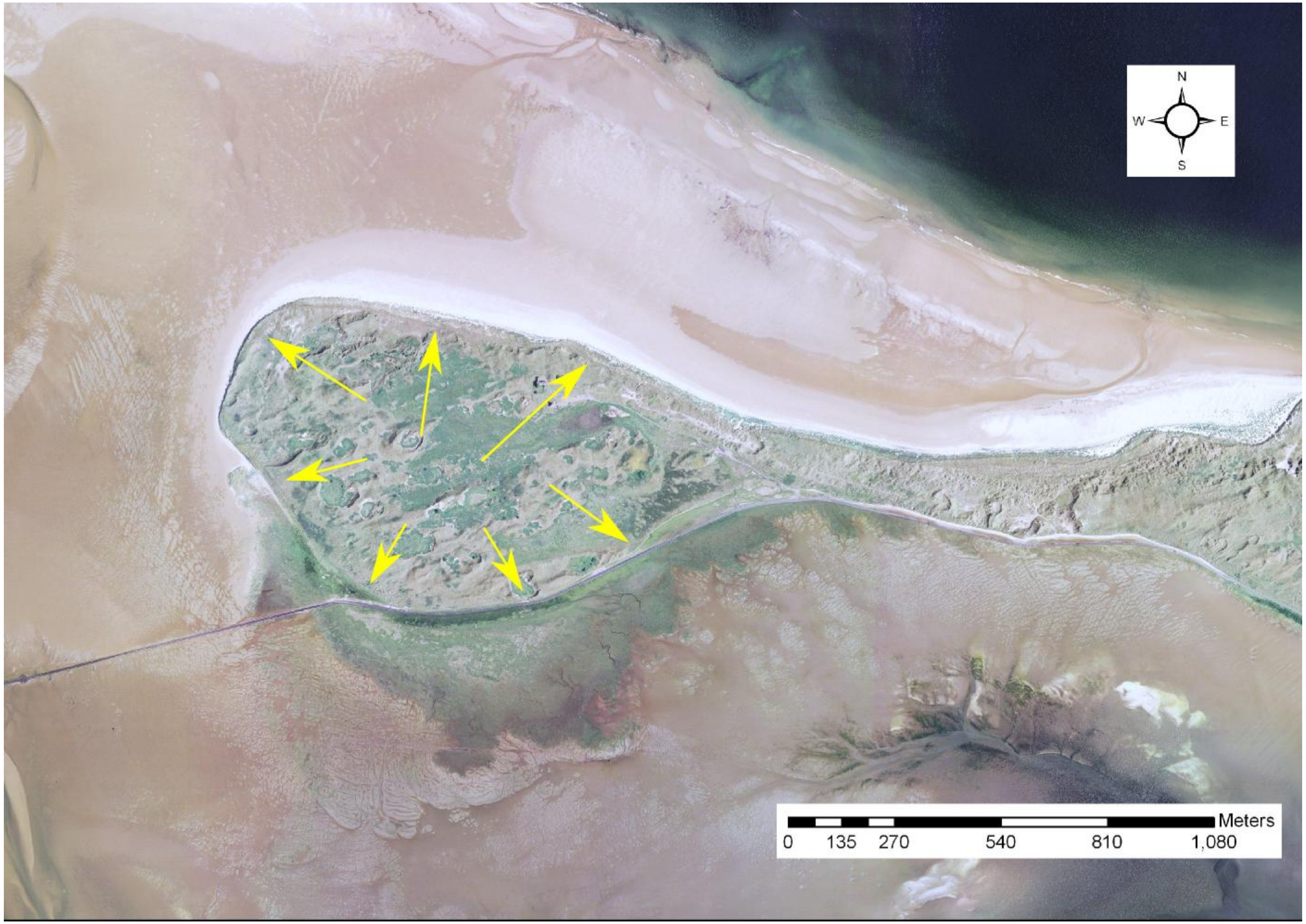

Figure 5. Lindisfarne Dunes conceptual groundwater flow diagram for The Snook. The yellow arrows indicate the direction of groundwater flow. © NERC (CEH) 2013. © Next Perspectives.

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. Additional quadrats were recorded adjacent to grid referenced hydrological monitoring locations (dip wells). Occasionally it was not possible to locate the exact position of dip wells in which case the quadrat was positioned as close as possible. Where dipwells were fenced, and either could not be located or the fenced area was impenetrable due to scrub, quadrats were placed outside the fence touching its SW corner. Where dip wells were not visible at all quadrats were located according to the grid reference. 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 8.

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.

Additional physiognomical 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.

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

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 1988. Change in mapped area was assessed for all mapped dune wetlands. Polygons for wetlands in 1988 which corresponded to areas mapped or revisited in 2012, were digitised from the scanned and georeferenced hard copy vegetation survey map of 1988. The area comparison included the following:

- Locations mapped as wetland in 1988, 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 noted 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 1988 and 2012.

- New wetland features mapped in 2012.

Each polygon (1988 and 2012) was assigned a code for broad vegetation type (Table 3) for ease of interpretation of multiple vegetation classes and communities. The 1988 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. Patches of Juncus M23 grassland were classed as 'wet pasture'. Polygons mapped in 2012 are shown in Figures 9-11.

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 1988 in wetland areas which were resurveyed in 2012. Quadrats were relocated based on maps from 1988 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 1988 was entered by hand from floristic tables in the Woolven & Radley (1988) 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 Lindisfarne between 1988 and 2012 are summarised in Table 4 below. Figures 9-11 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. Lindisfarne. Mapped area (ha) of broad vegetation classes in 1988 and 2012, showing net change, and percentage change for classes with area > 1 ha in 1988.

Area summaries	1988	2012	Net change	%change
Slacks+slack/wet transitions	22.2	27.5	5.3	23.8
Slack/dry transitions	7.1	2.3	-4.8	-67.8
Dry habitats	2.7	0.7	-2.1	-75.3
Other wetlands	1.3	1.0	-0.3	-19.8
Total slacks	29.3	29.8	0.5	1.7
Total slacks and other wetlands	30.6	30.9	0.2	0.8
(Total Mapped Area)	33.4	31.5	-1.8	-5.5

There was no net change in wetland area between the two time points. 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 an increase of around 5 ha in dune slacks and slack/wet transitions, with a corresponding decrease in area of the drier habitats and slack/dry conditions. These changes equate to a 24 % increase in slack area. This may partly be due to differences in interpretation of vegetation community by surveyors, and interpretation can be guided by analysis of change for repeated quadrats.

4.2.2 Vegetation change revealed through analysis of repeated quadrats

In 2012, 24 quadrats were surveyed at Lindisfarne. These included 18 which were repeat quadrats, of which 16 had previous vegetation data and could be used for analysis of change over time. An additional 6 quadrats were recorded adjacent to new piezometer locations. This analysis concerns the 16 repeat quadrats only. All quadrats are listed, together with basic descriptive information in Table 6 at the end of this report. Location of quadrats is shown in Figure 8.

Changes in Ellenberg environmental and climate indicators are summarised in Table 5. There was no significant change in environmental indicator scores, climate indicator scores or species richness at this site.

Table 5. Lindisfarne. Change in environmental and climatic indicators between 1988 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=16	Indicator	1988	2012	Significance
Mean	Light	7.62	7.60	
Mean	Moisture	6.48	6.76	
Mean	pH	5.85	5.93	
Mean	Nutrients	3.42	3.43	
Mean	Salinity	0.62	0.55	
Mean	JanTemp	3.63	3.61	
Mean	JulTemp	14.41	14.46	
Mean	Precipitation	1117	1106	
Mean	Spp Richness	14.31	14.81	
s.d.	Light	0.23	0.13	
s.d.	Moisture	1.04	0.89	
s.d.	pH	0.27	0.32	
s.d.	Nutrients	0.40	0.45	
s.d.	Salinity	0.37	0.37	
s.d.	JanTemp	0.12	0.09	
s.d.	JulTemp	0.11	0.06	
s.d.	Precipitation	25.66	14.26	
s.d.	Spp Richness	4.85	4.39	

4.2.3 Analysis of soils data

Simple physical data from soil cores are shown in Figure 6 and Figure 7 below, grouped by broad vegetation type. Soil pH (Figure 6) was high in all community types, including the acidic SD17 communities, which still had average pH > 7.0, although one individual sample had pH of 5.29. Generally soils at the site are not decalcified, although the surface soil layers may well be more acidic.

Organic matter contents (Figure 7) are generally high in all vegetation types, all above 6%, except the dry or transitional dry/wet slack communities where values were ~4%. This suggests the sampled slacks are at least 60 years old, and have soil thicknesses typical of English and Welsh dune slacks (Jones et al. 2008; 2010).

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

There are no clear signals of change at Lindisfarne. There are no changes in indicators of climate or other environmental factors. Changes between categories in mapped area may therefore be in part due to differences in surveyor interpretation.

The relatively ‘simple’ nature of the hydrological system at Lindisfarne makes it an excellent site at which to develop hydrological understanding. The existing monitoring will provide some very useful data and in time this will help to test the conceptual model and to take this forward to development of a numerical model if desired.

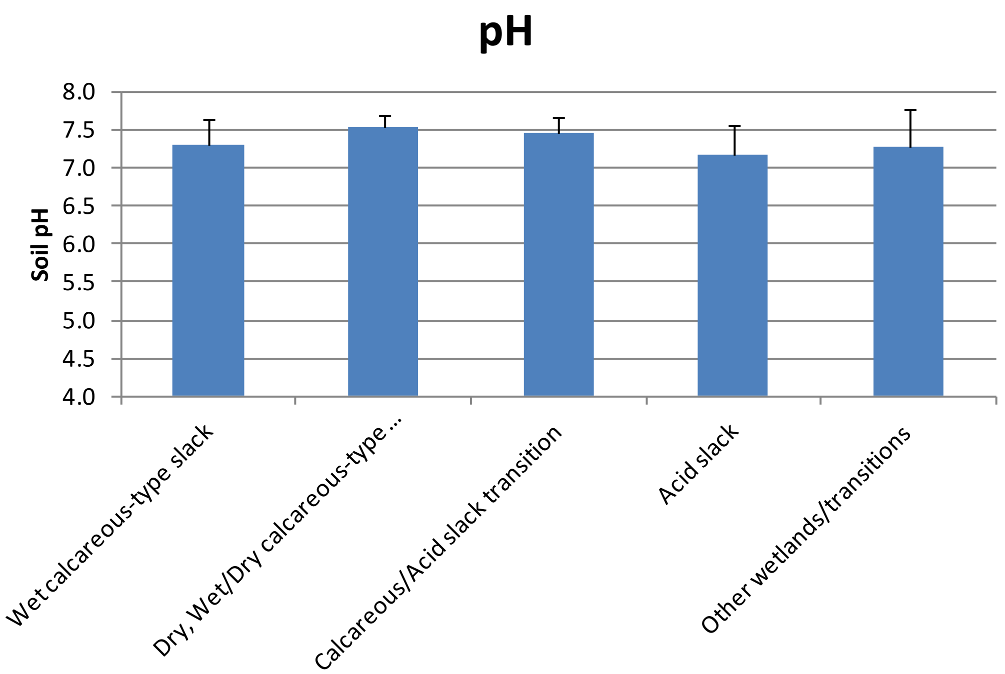

Figure 6. Lindisfarne. Soil pH, by broad vegetation type. Wet calcareous slack = SD14, SD15; Dry calcareous slack = SD16 or slack transitions to SD16; Acid-type slack = SD17; Calcareous/Acid transitions include all combinations of those communities; Other wetlands include M13, SM18, or transitions to them.

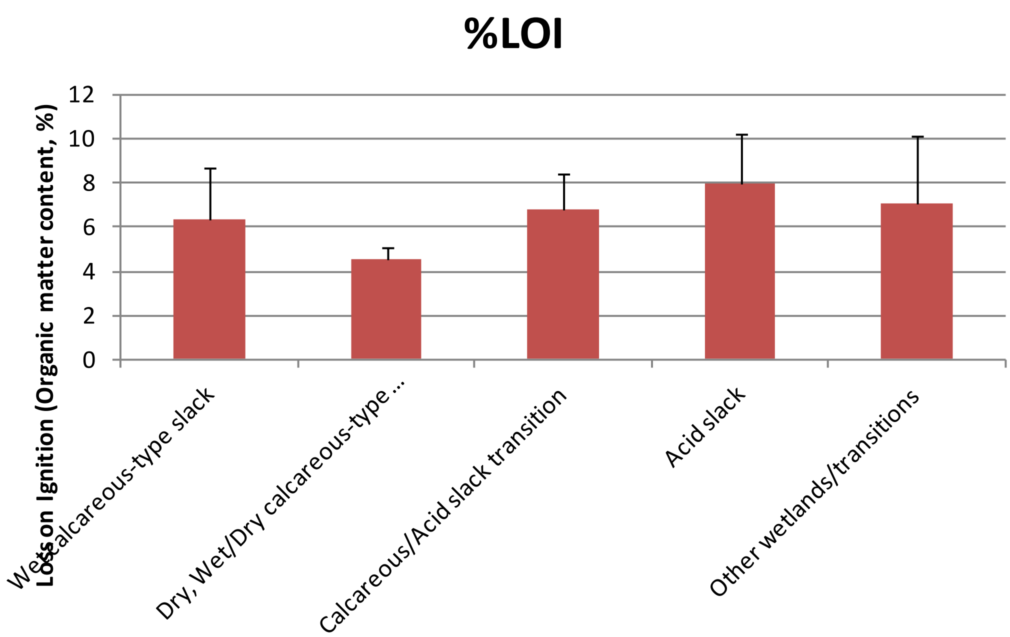

Figure 7. Lindisfarne. Organic matter (as Loss On Ignition, %), by broad vegetation type. Wet calcareous slack = SD14, SD15; Dry calcareous slack = SD16 or slack transitions to SD16; Acid-type slack = SD17; Calcareous/Acid transitions include all combinations of those communities; Other wetlands include M13, SM18, or transitions to them.

5 Implications for management

- It is recommended that the new network of dipwells be extended if possible, together with new permanent vegetation quadrats.
- 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.

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7 Quadrat information

Table 6. Lindisfarne. List of quadrats surveyed, with associated environmental data. Quadrats coded Q represent 1988 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
Q13	409459	643759	0	0	6.8	8	7.95	5.146503	RepeatQuadrat
Q15	409590	643701	0	0	38.2	11	7.78	5.277849	RepeatQuadrat
Q16	409607	643671	0	0	9.6	1	7.93	2.529534	RepeatQuadrat
Q17	409651	643619	0	0	18.8	8	7.65	5.002995	RepeatQuadrat
Q18	409728	643634	0	0	15.4	12	7.37	9.307786	RepeatQuadrat
Q19	409776	643587	0	0	14	15	7.8	5.043828	RepeatQuadrat
Q21	409963	643529	0	0	12.4	15	7.72	13.45047	RepeatQuadrat
Q25	410071	643226	0	0	20.6	11	7	3.398128	RepeatQuadrat
Q26	410037	643257	0	0	10	12	6.82	10.45305	RepeatQuadrat
Q28	410174	643548	0	0	51.8				RepeatQuadrat
Q31	410230	643335	0	0	8.4	15	6.26	13.08086	RepeatQuadrat
Q41	412414	643601	1	320	19.6	11	7.94	6.345803	RepeatQuadrat
Q433	413045	643394	0	0	29.4	5	7.09	1.865555	RepeatQuadrat
Q46	413026	643531	0	0	61.6	13	7.1	5.537604	RepeatQuadrat
Q53	412267	643701	0	0	5.8	8	7.77	5.054279	RepeatQuadrat
Q7	409400	643485	0	0	11	4	7.69	3.262626	RepeatQuadrat
Q85	409551	643500	0	0	9.8	14	7.42	5.847002	RepeatQuadrat
Q9	409527	643384	0	0	10.8	15	7.18	8.948675	RepeatQuadrat
D1	410108	643574	0	0	43	5	7.75	2.688335	DipwellQuadrat
D2	409914	643375	0	0	7.4	15	5.29	15.72871	DipwellQuadrat
D3	409899	643669	0	0	17	13	7.07	9.426018	DipwellQuadrat
D4	409711	643714	45	0	10.8	4	8.2	1.504877	DipwellQuadrat
D5	409838	643508	0	0	8.6	8	7.48	4.957284	DipwellQuadrat
D6	409412	643499	0	0	5.2	15	7.14	6.102325	DipwellQuadrat

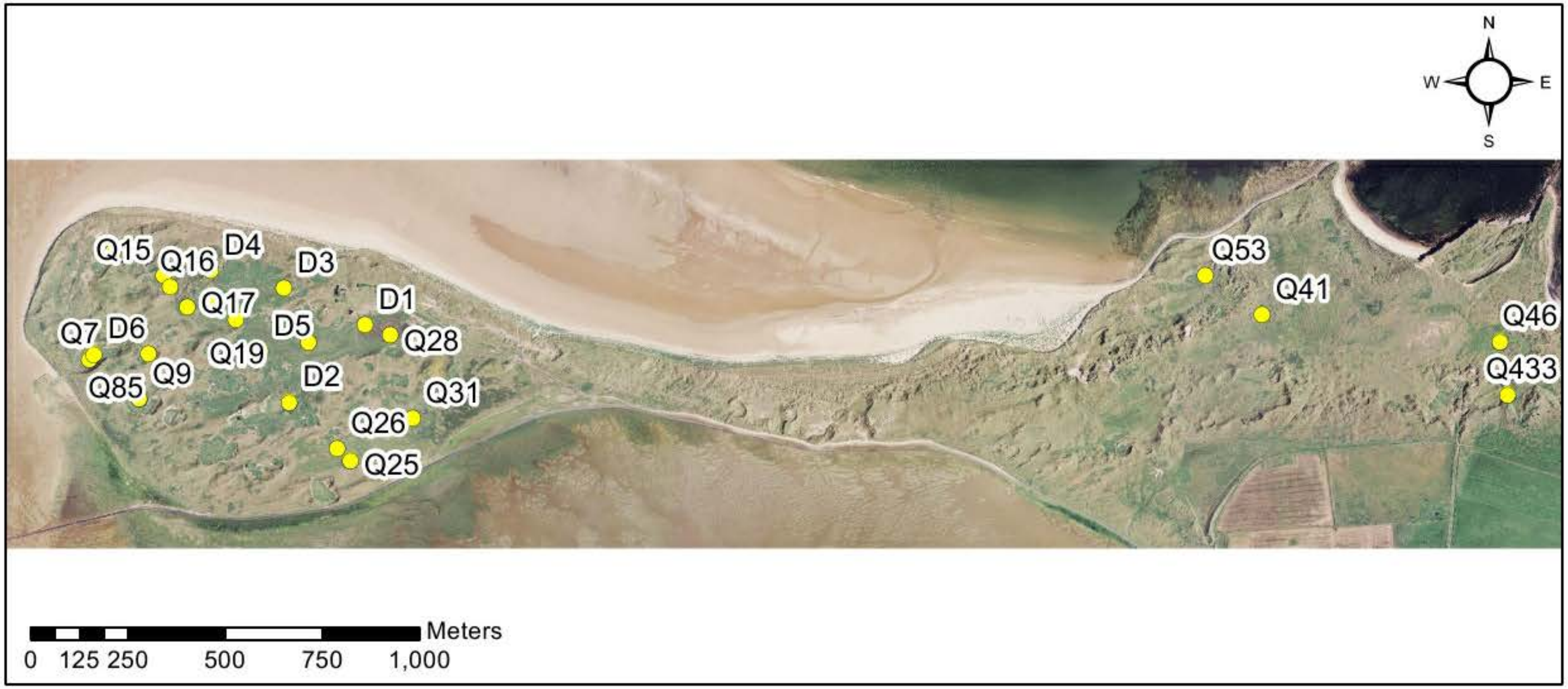

Figure 8. Locations of quadrats surveyed at Lindisfarne. © NERC (CEH) 2013. © Next Perspectives.

8 Survey maps

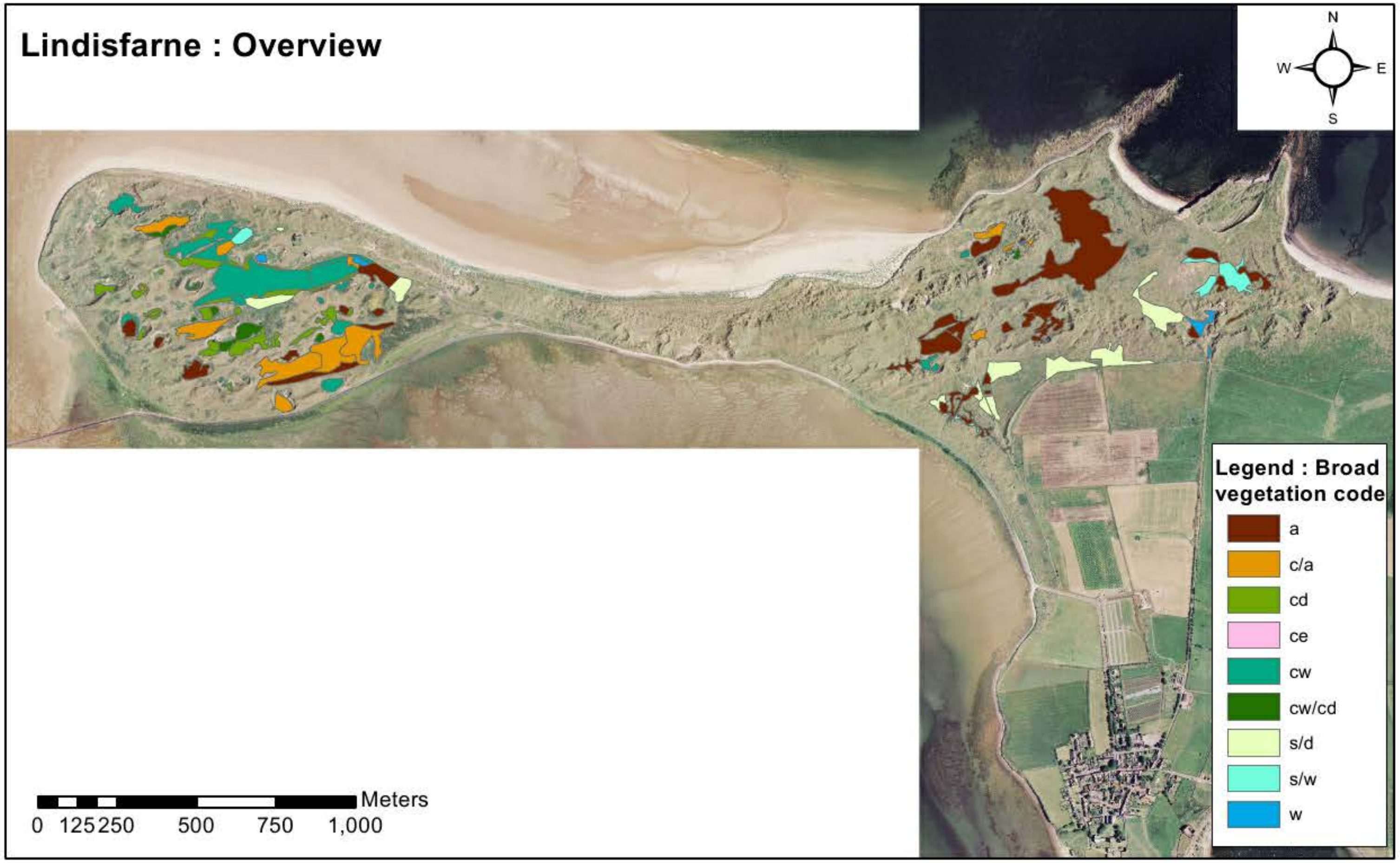

Figure 9. Lindisfarne. Overview of NVC communities mapped during 2012 vegetation survey. Maps 1 & 2 below (Figures 10 &11) focus in on the east and west parts of the island respectively. Broad vegetation codes are described in Table 3. © NERC (CEH) 2013. © Next Perspectives.

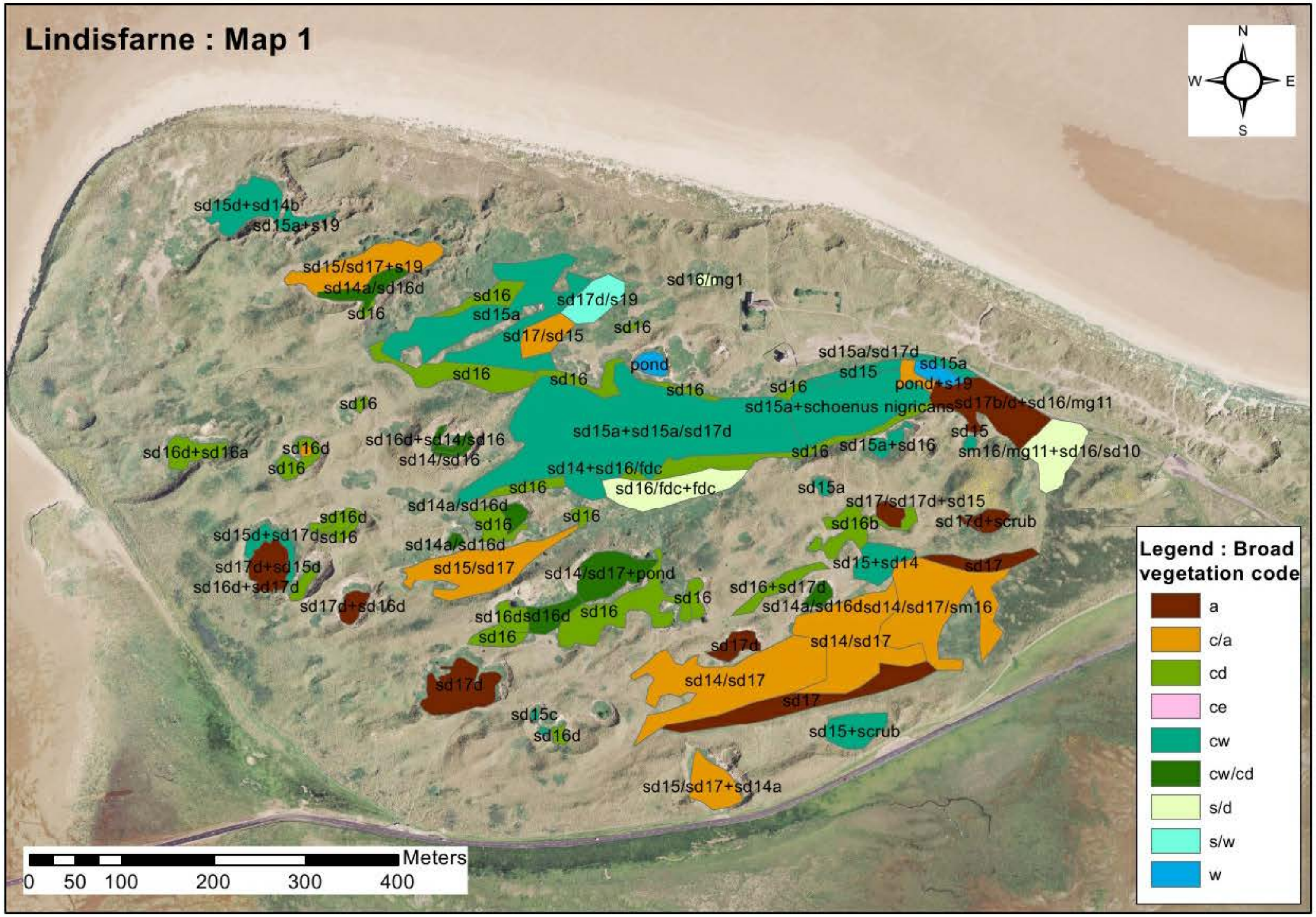

Figure 10. Lindisfarne Map 1. NVC communities mapped during the 2012 vegetation survey. Broad vegetation codes are described in Table 3. © NERC (CEH) 2013. © Next Perspectives.

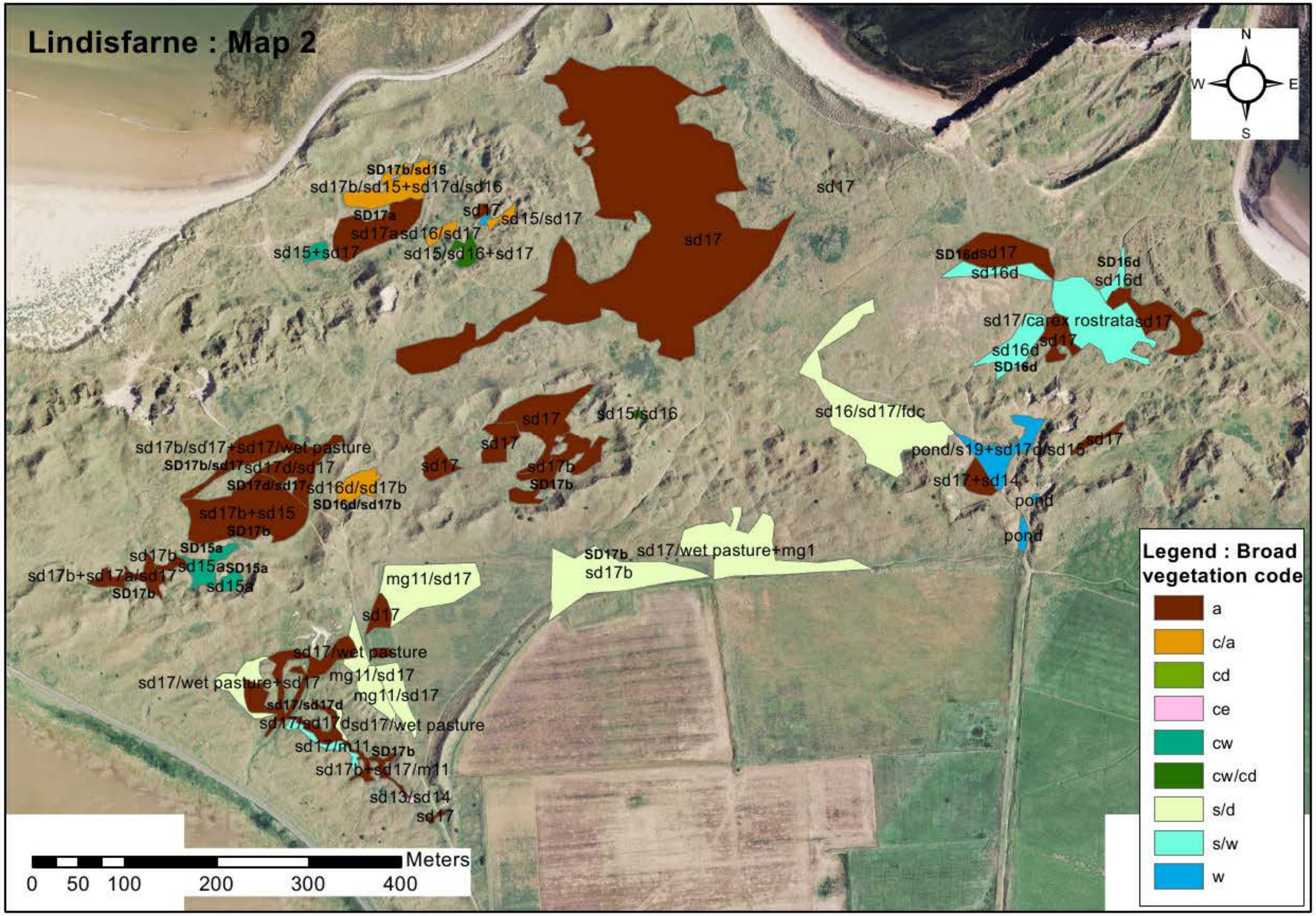

Figure 11. Lindisfarne Map 2. NVC communities mapped during the 2012 vegetation survey. Broad vegetation codes are described in Table 3. © NERC (CEH) 2013. © Next Perspectives.