Natural England Commissioned Report NECR153

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

Annex 5 - Site report for Ross Links

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Executive Summary

- Dune wetlands at Ross Links 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.

- There is very limited information from which to develop a robust conceptual groundwater flow model. The model developed so far indicates groundwater flow from south west to north east.

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

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

- Soils were very calcareous in the dry slack types, but decalcified in the wet slack types. Soil organic matter was extremely high (38%) in the *Eleocharis palustris* S19 quadrat.

- Installation of some piezometers and permanent vegetation quadrats in acidic slacks would complement those installed in calcareous slacks at Lindisfarne.

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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 (Radley 1994). Work conducted at Ross Links 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

Figure 1. The location of Ross Links in the UK.

Ross Links dune system is located on the Northumberland coast approximately 9 miles south of Berwick upon Tweed (Figure 1). It is an open coast prograded dune system covering an area of approximately 3 km by 1 km (Figure 2). The site consists of a mixture of raised beach and blown sand overlying a mixture of Carboniferous limestone, mudstone, siltstone and sandstone. In addition to the main dunes, the dune island of Old Law forms a northerly extension to the foreland (Wilson, 2001)

The frontal dune ridge, which is more prominent in the north of the site, reaches an elevation of ~ 5 m AOD. To the west of this lies a lower lying slack area and behind this, a second dune ridge. To the south of the site the frontal ridge is much less apparent, in its place is a more gently sloping band of dunes rising from ~ 2 m AOD nearest the sea, to ~ 10 m AOD at their highest point (Figure 3). The slacks do not generally exceed 5 m AOD in elevation. In the western half of the site, sand thicknesses are usually less than 2 m (Wilson, 2001). There is currently very little detailed stratigraphic information for the site as a whole.

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 the average annual rainfall at Ross Links is roughly near the mean of the sites covered in this study. 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 824 mm, and the long term (1961 to 2012) average annual net (rainfall – actual evaporation) is 316 mm. This means that there is water available to recharge the groundwater system and this excess should provide some buffer to short term fluctuations in meteorological conditions.

Figure 2. Aerial photo of Ross Links dunes. © Next Perspectives.

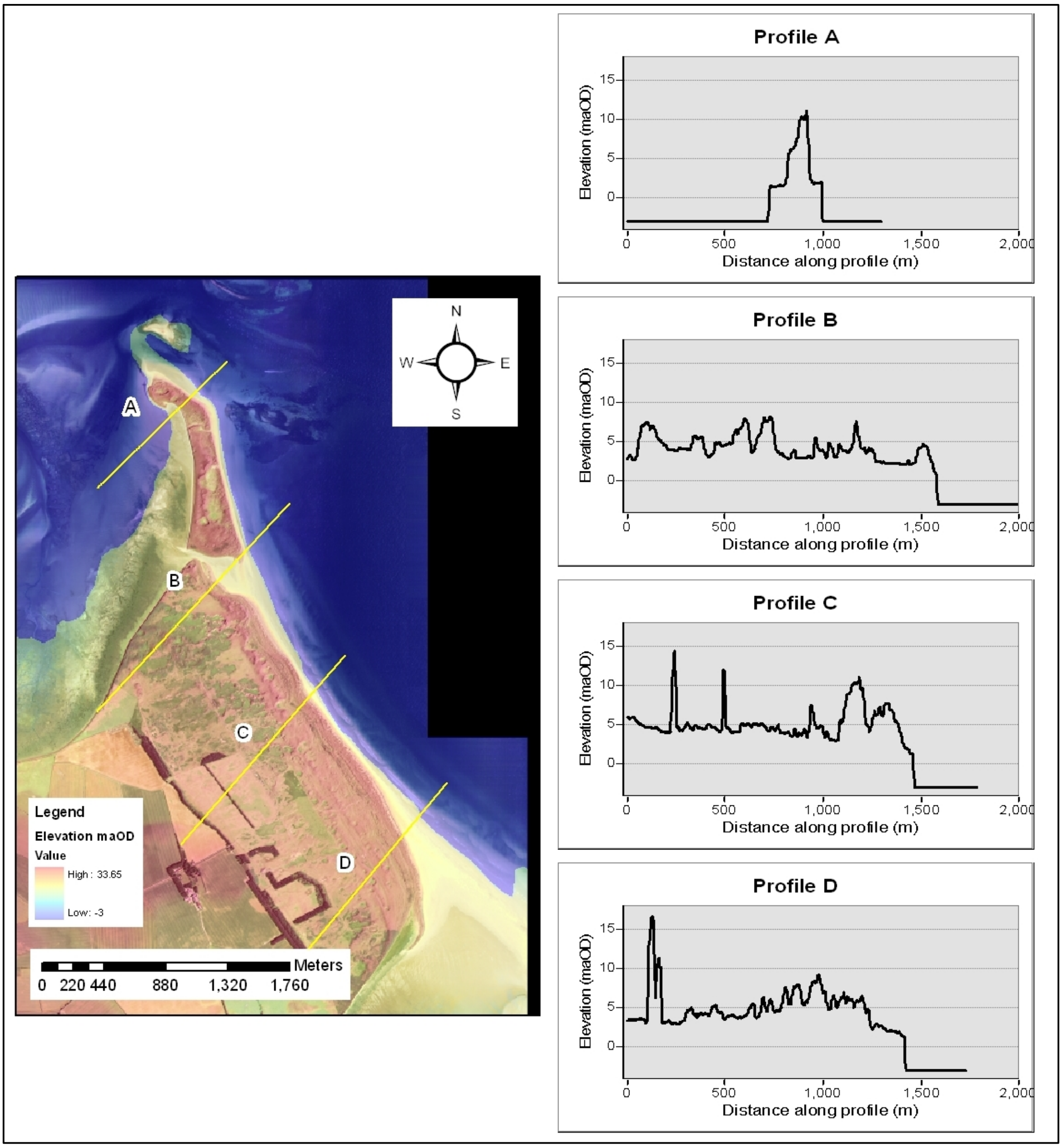

Figure 3. Elevation profiles at several locations along Ross Links dunes. Values represent the elevation of the top surface, not of the ground surface, so are affected by vegetation height. © NERC (CEH) 2013, © Next Perspectives.

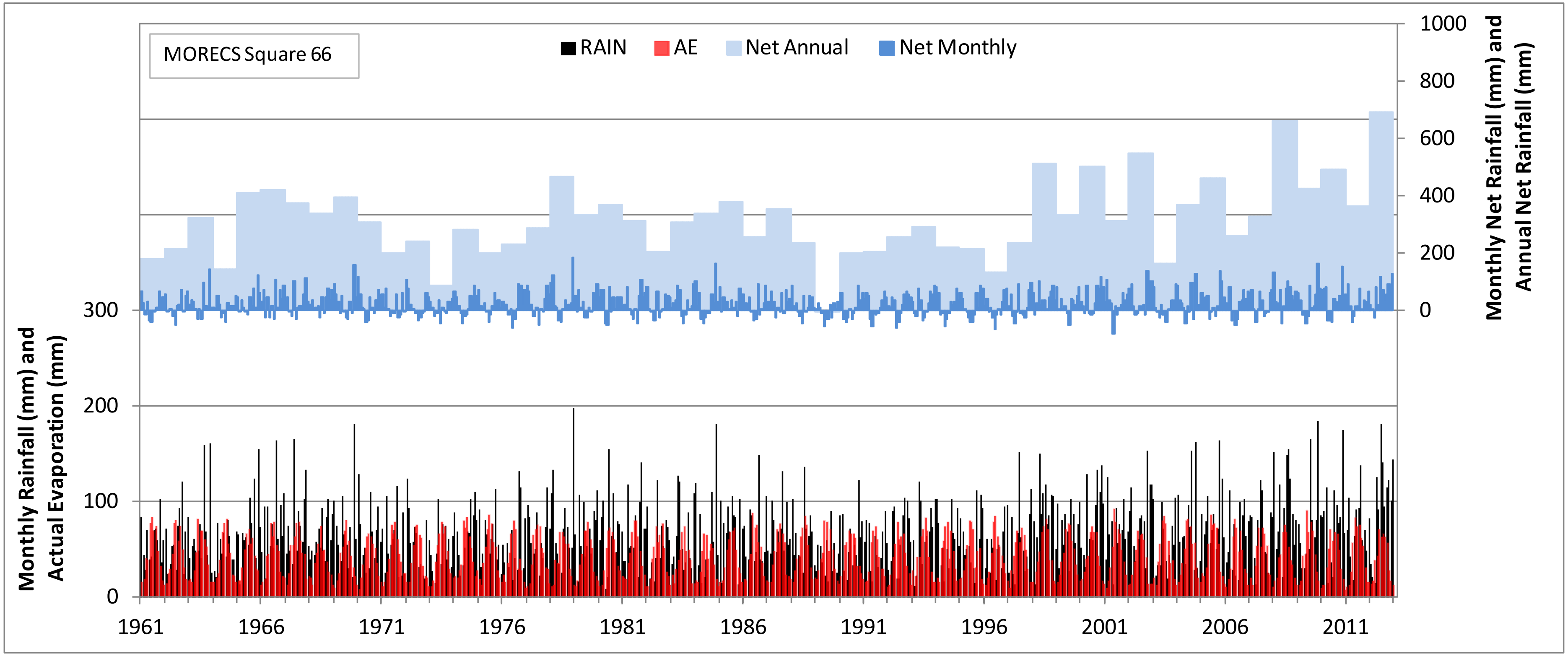

Figure 4. Monthly Rainfall and Evaporation data for MORECS square 66. Net (Rainfall - actual evaporation) monthly and annual totals also shown. MORECS data © Crown copyright 2013, the Met Office.

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 site has also been surveyed and condition assessments conducted by Tom Dargie (Dargie, 1992; 2004). The following ecological setting is based on survey work conducted in 2012 for this study. The majority of dune-slack habitat on Ross Links is SD16 *Salix repens-Holcus lanatus*, with the SD16d *Agrostis stolonifera* sub-community distinguishable in many areas. Large areas identified as SD16 dune-slack in the 1988 survey (and hence comparable to SD17 in the present NVC system), are now lacking dune-slack indicator species and have in the present survey been identified as M23 *Juncus effusus/acutiflorus-Galium palustre* rush-pasture, with some drier areas possibly transitional to MC9 *Festuca rubra-Holcus lanatus* maritime grassland. In some smaller depressions, particularly to the East of these areas, the presence of *Hydrocotyle vulgare* and *Calliergonella cuspidata* is indicative of either SD15 *Salix repens-Calliergon cuspidatum* or SD17 *Potentilla anserina-Carex nigra* dune-slack communities. In some of the drier depressions where *Potentilla anserina* can be frequent, the sward appears transitional to MG11 *Festuca rubra-Agrostis stolonifera-Potentilla anserina* grassland. The heathland presence particularly in the north west of the site is evident in some areas of drier slack, with the occasional occurrence of *Calluna vulgaris, Erica tetralix* and *Potentilla erecta* with slacks, although usually in conjunction with *Salix repens.*

3 Hydrological work

There are currently no hydrological monitoring points on Ross Links dunes. In the absence of monitoring data, the conceptual model is based upon site observations made both during the desk study and field visit. The model developed so far indicates groundwater flow from south west to north east (Figure 5).

As with all the sites in this study, the water table in the dunes is influenced by rainfall and evaporation, with an outflow seepage along the beach. It is quite likely that at Ross Links, there is an additional surfacewater and/or groundwater input to the sand from the land lying along the western edge. Confirmation of this will only be possible through further site investigation. If it is the case then the important implication is that the quantity and quality of water in the dunes could be affected by activities taking place off site.

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.

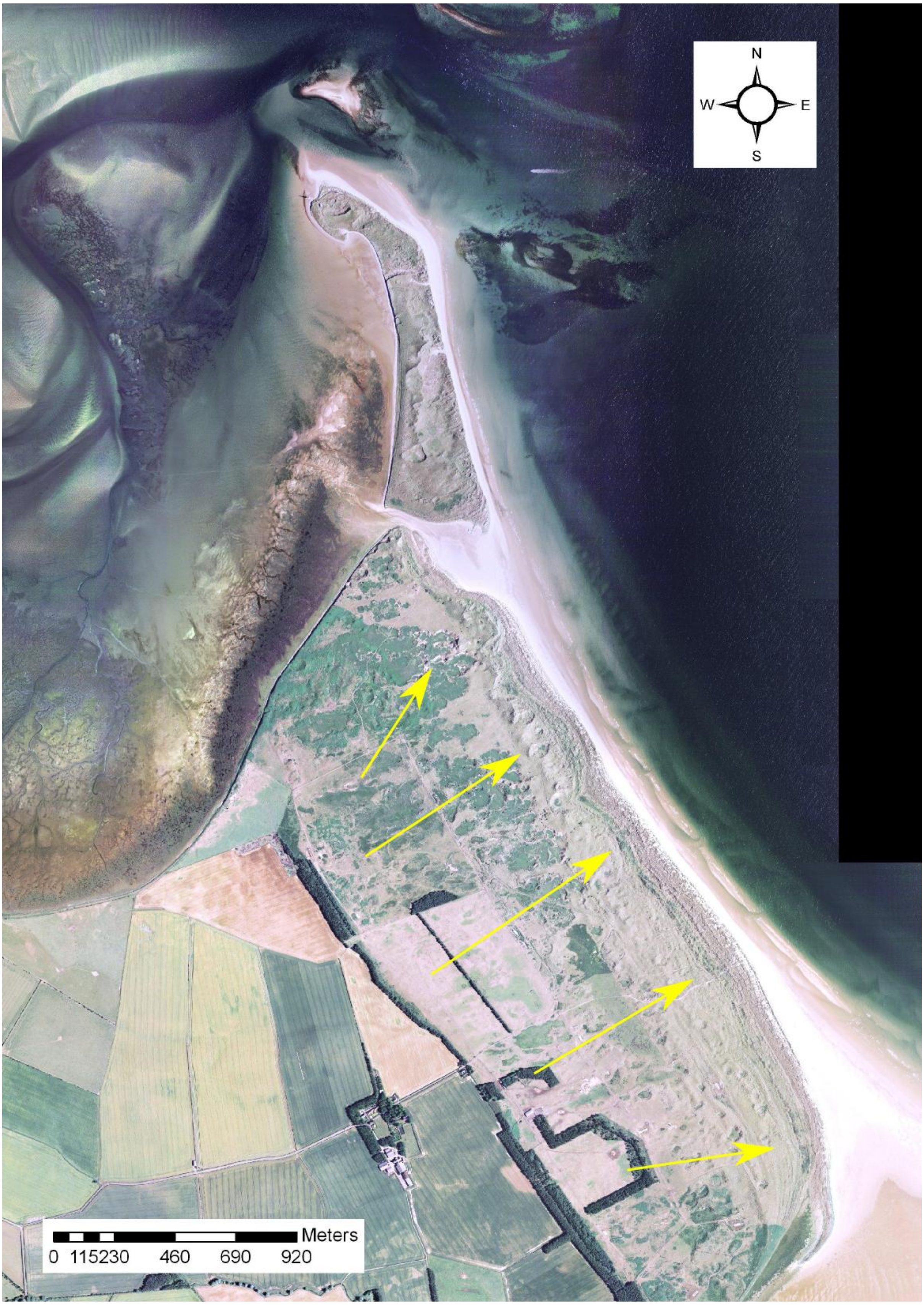

Figure 5. Ross Links conceptual groundwater flow diagram. The yellow arrows indicate the likely direction of groundwater flow. © NERC (CEH) 2013, © Next Perspectives.

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. 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 9-12.

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 Ross Links between 1988 and 2012 are summarised in Table 4 below. Figures 9-12 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 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	24.9	7.3	-17.5	-70.5
Slack/dry transitions	0.2	5.3	5.1	-
Dry habitats	1.9	2.6	0.7	35.0
Other wetlands	1.8	10.2	8.4	456.7
Total slacks	25.0	12.7	-12.4	-49.4
Total slacks and other wetlands	26.9	22.9	-4.0	-14.8
(Total Mapped Area)	28.8	25.5	-3.3	-11.5

There was a small net decrease in wetland area between the two time points of 4 ha, around 15% of the area mapped in 1988. 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 17 ha (70%) in wet slacks and transitions to other wetlands, with an increase in area of 8 ha in wetland habitats. This may represent a change from slack communities to M23 Juncus pasture. There was a 5 ha increase in transitions to dry habitats. The interpretation of area change suggests a small net loss of wetland types in favour of dry habitats. This may partly be due to differences in interpretation of vegetation community by surveyors, and further information is 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 Ross Links. These were all 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 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. However, there was a significant increase in species richness at this site. The reasons for this have not been investigated.

Table 5. 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=6	Indicator	1990	2012	Significance
Mean	Light	7.44	7.43	
Mean	Moisture	6.90	6.90	
Mean	pH	5.43	5.53	
Mean	Nutrients	3.33	3.54	
Mean	Salinity	0.45	0.33	
Mean	JanTemp	3.55	3.56	
Mean	JulTemp	14.37	14.43	
Mean	Precipitation	1129	1114	
Mean	**Spp Richness**	**11.00**	**21.67**	*
s.d.	Light	0.54	0.34	
s.d.	Moisture	1.02	0.42	
s.d.	pH	0.33	0.13	
s.d.	Nutrients	0.04	0.03	
s.d.	Salinity	0.07	0.05	
s.d.	JanTemp	19.37	13.14	
s.d.	JulTemp	3.58	9.03	
s.d.	Precipitation	7.44	7.43	
s.d.	Spp Richness	6.90	6.90	

4.2.3 Analysis of soils data

Simple physical data from soil cores are shown in Figures 6 and 7 below, grouped by broad vegetation type. Soil pH (Figure 6) was high in the drier slack types with average pH > 7.0, while the wetter communities showed strong signs of decalcification, with pH < 6.0.

Organic matter contents (Figure 7) are generally high in both slack types, above 6%, typical of west-coast slacks in England and Wales (Jones et al. 2008; 2010). There was a very high LOI value of 38% in the quadrat assigned to *Eleocharis palustris* swamp S19.

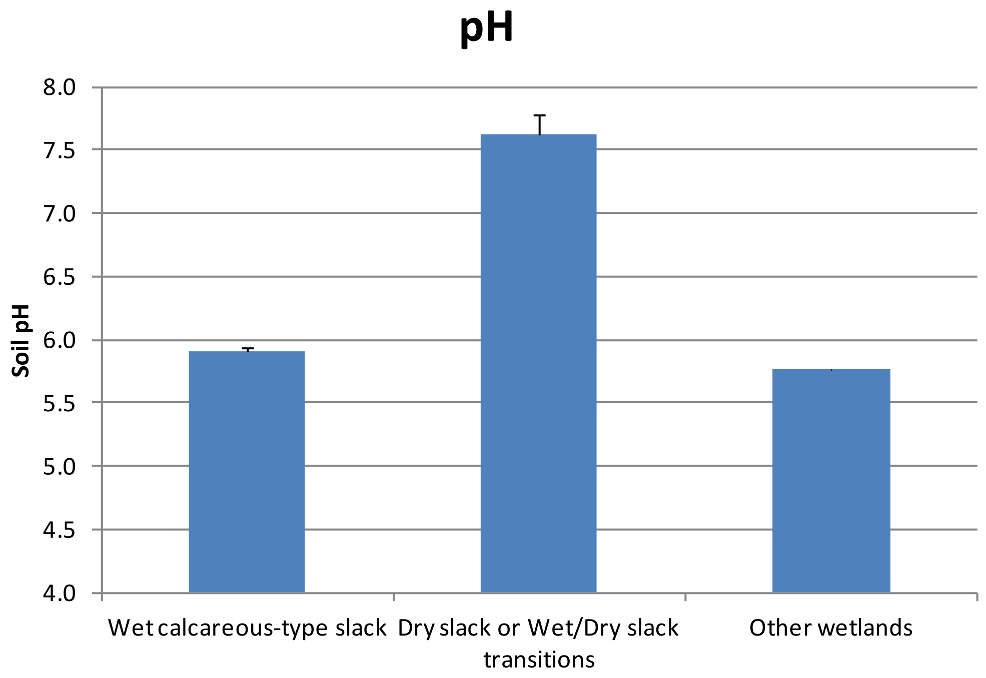

Figure 6. Soil pH, by broad vegetation type. Wet calcareous slack = SD15, SD17 and transitions to M23; Dry slack or Wet/Dry slack transitions= SD16 or slack transitions to SD16; Other wetlands = single quadrat assigned to S19.

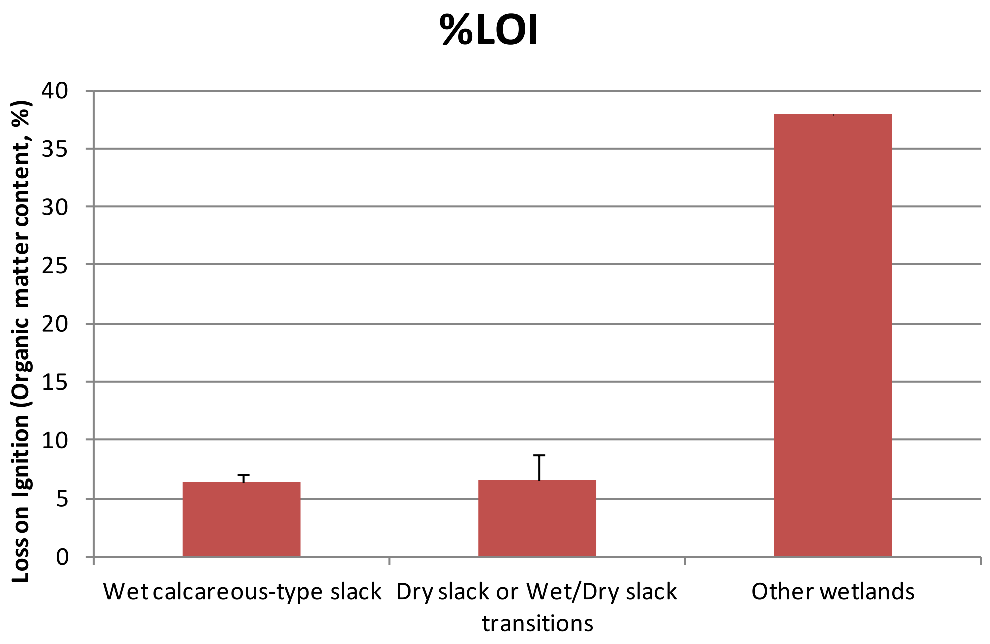

Figure 7. Organic matter (as Loss On Ignition, %), by broad vegetation type. Wet calcareous slack = SD15, SD17 and transitions to M23; Dry slack or Wet/Dry slack transitions= SD16 or slack transitions to SD16; Other wetlands = single quadrat assigned to S19.

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

There are no clear signals of change at Ross Links. 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. Previous studies have identified the impact of stock grazing practices, particularly winter feeding of stock as a potential influence on the vegetation (Dargie 1992; 2004). However although no clear signals of eutrophication were evident from the mapping or limited number of quadrats in this study, the changes in the Ellenberg N quadrat scores were consistent with the trend observed at most other sites, and which contributed to the significant increase in Ellenberg N when analysed across all sites.

The very limited hydrological information for this site makes drawing of meaningful conclusions difficult. Both the vegetation survey and groundwater desk study have indicated that this is a site with a potentially interesting hydrological regime, and further investigation would be worthwhile.

5 Implications for management

- It would be of interest to install some piezometers and co-located permanent vegetation quadrats in the acid slacks at Ross Links to provide complementary information on change to that in the nearby much more calcareous slacks at Lindisfarne.

- It would also be of interest to investigate the connection between water in the dunes and the groundwater and surface water further inland. If the connection was found to be significant then this may have implications for management of both the dunes and the land adjacent to the dunes (on the landward side), with respect to both water quantity and water quality.

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7 Quadrat information

Table 6. List of quadrats surveyed at Ross Links in 2012, 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
Q12	413316	638858	0	0	5.8	13	7.35	8.75	RepeatQuadrat
Q23	413714	638235	0	0	5.4	13	7.66	8.71	RepeatQuadrat
Q22	413829	638164	0	0	3	7	7.88	2.42	RepeatQuadrat
Q29	414040	637667	0	0	12	7	5.89	7.08	RepeatQuadrat
Q30	414262	637296	0	0	40.8	15	5.76	37.95	RepeatQuadrat
Q17	413389	638194	0	0	23.2	10	5.94	5.72	RepeatQuadrat

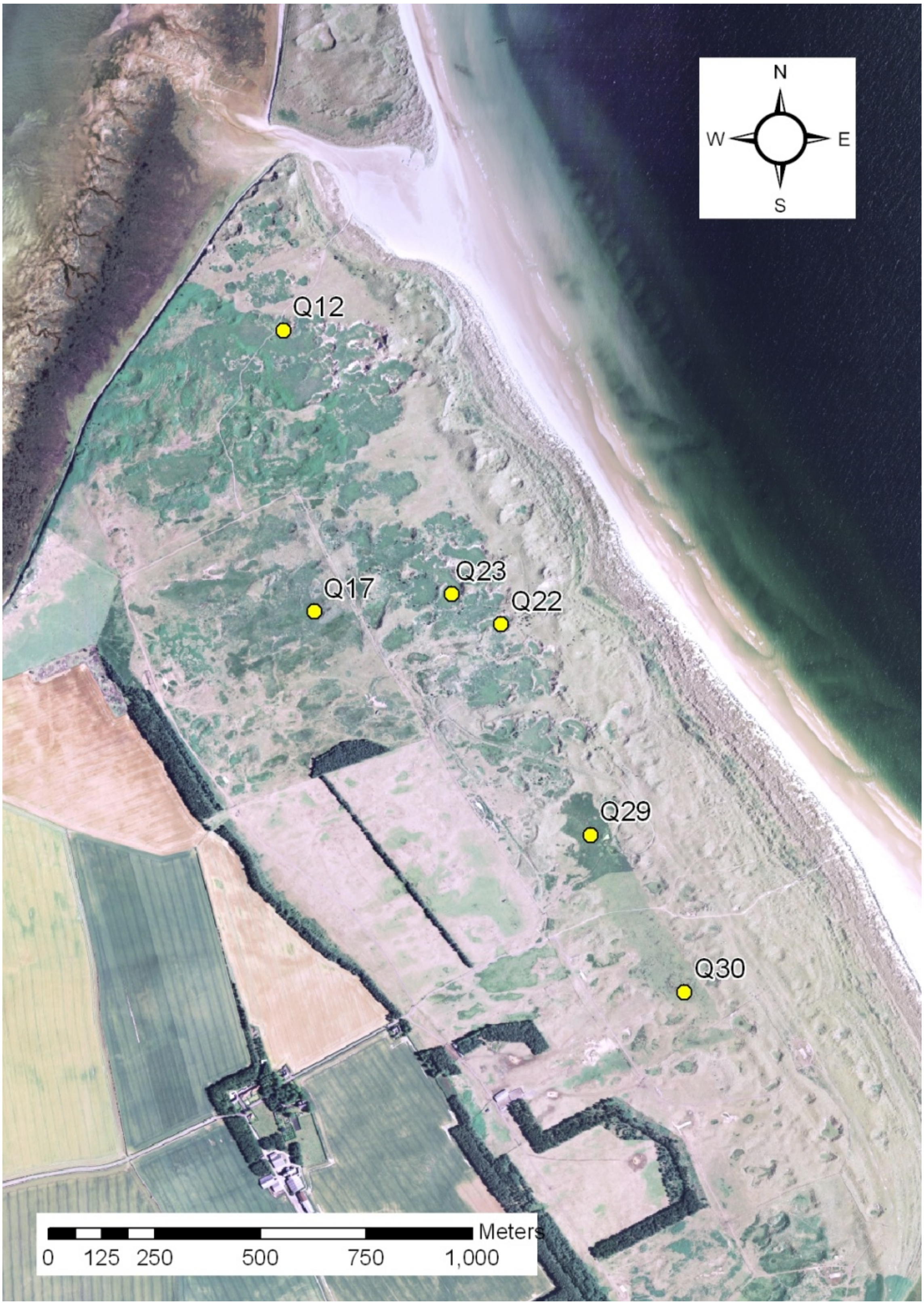

Figure 8. Locations of quadrats surveyed at Ross Links dunes. © NERC (CEH) 2013, © Next Perspectives.

8 Survey maps

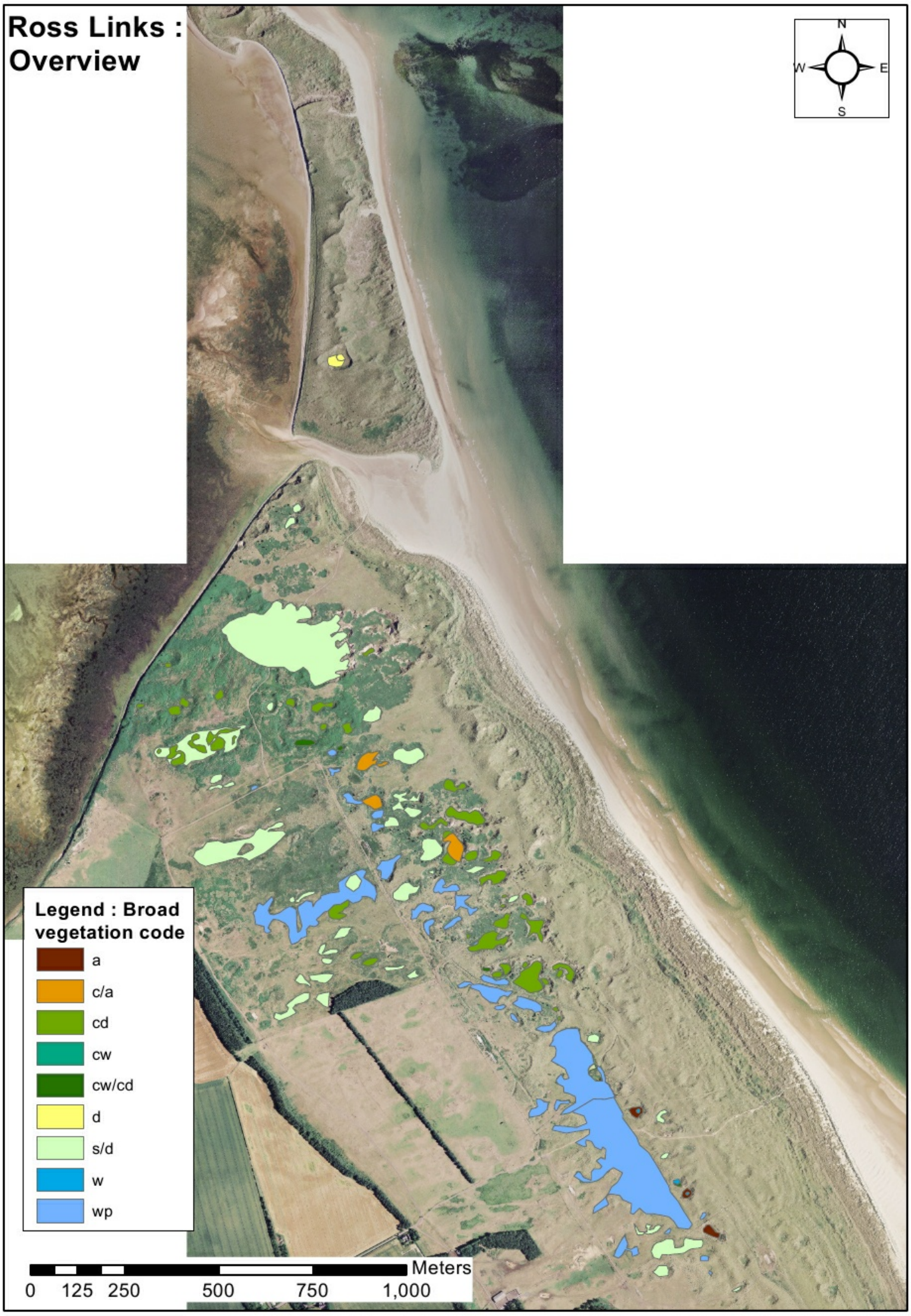

Figure 9. Ross Links. Overview of NVC communities mapped during 2012 vegetation survey, with reference to areas covered by maps 1-3 (Figures 10-12). Broad vegetation codes are described in Table 3. © NERC (CEH) 2013, © Next Perspectives.

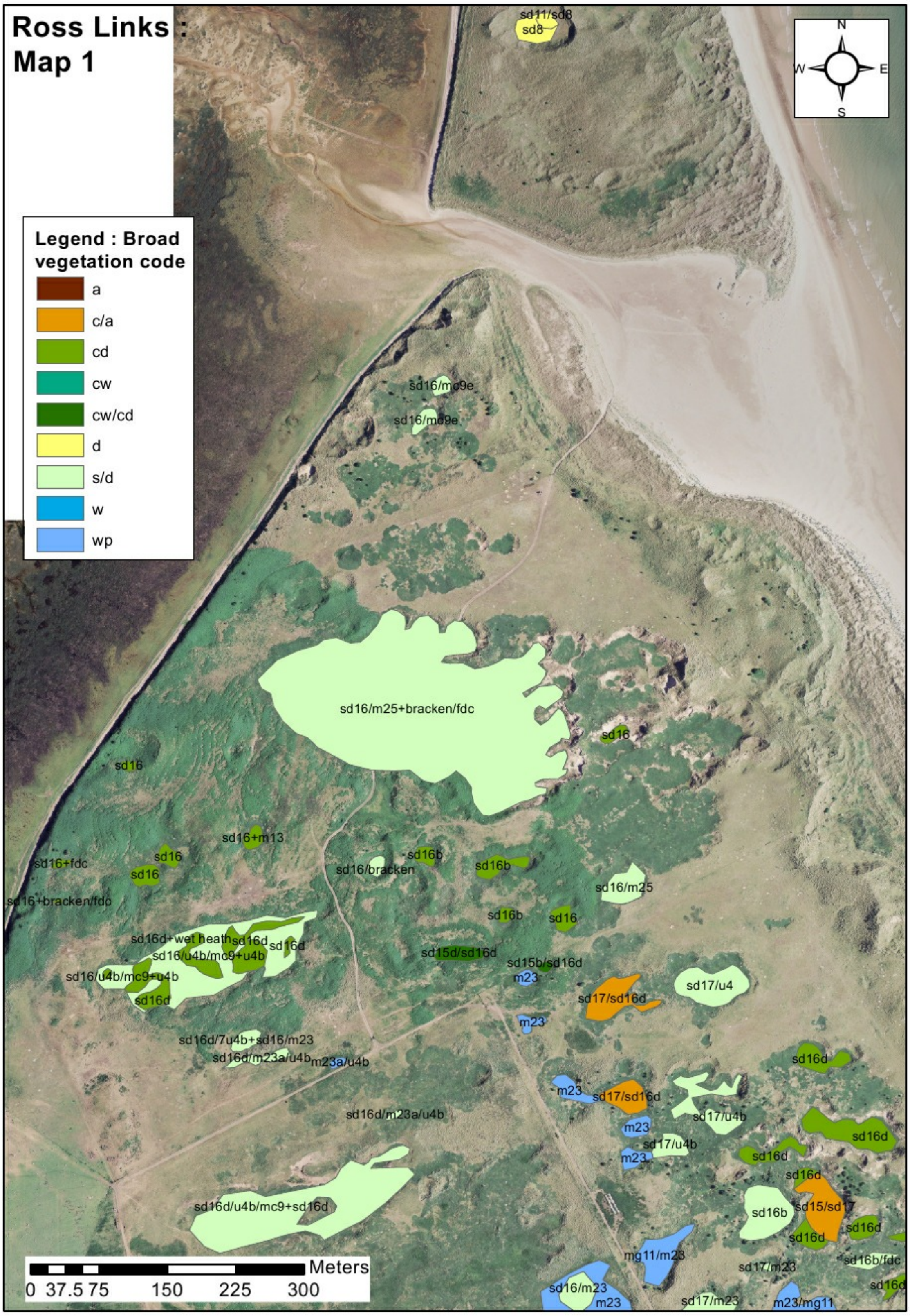

Figure 10. Ross Links Map 1. NVC communities mapped during 2012 vegetation survey. Broad vegetation codes are described in Table 3. © NERC (CEH) 2013, © Next Perspectives.

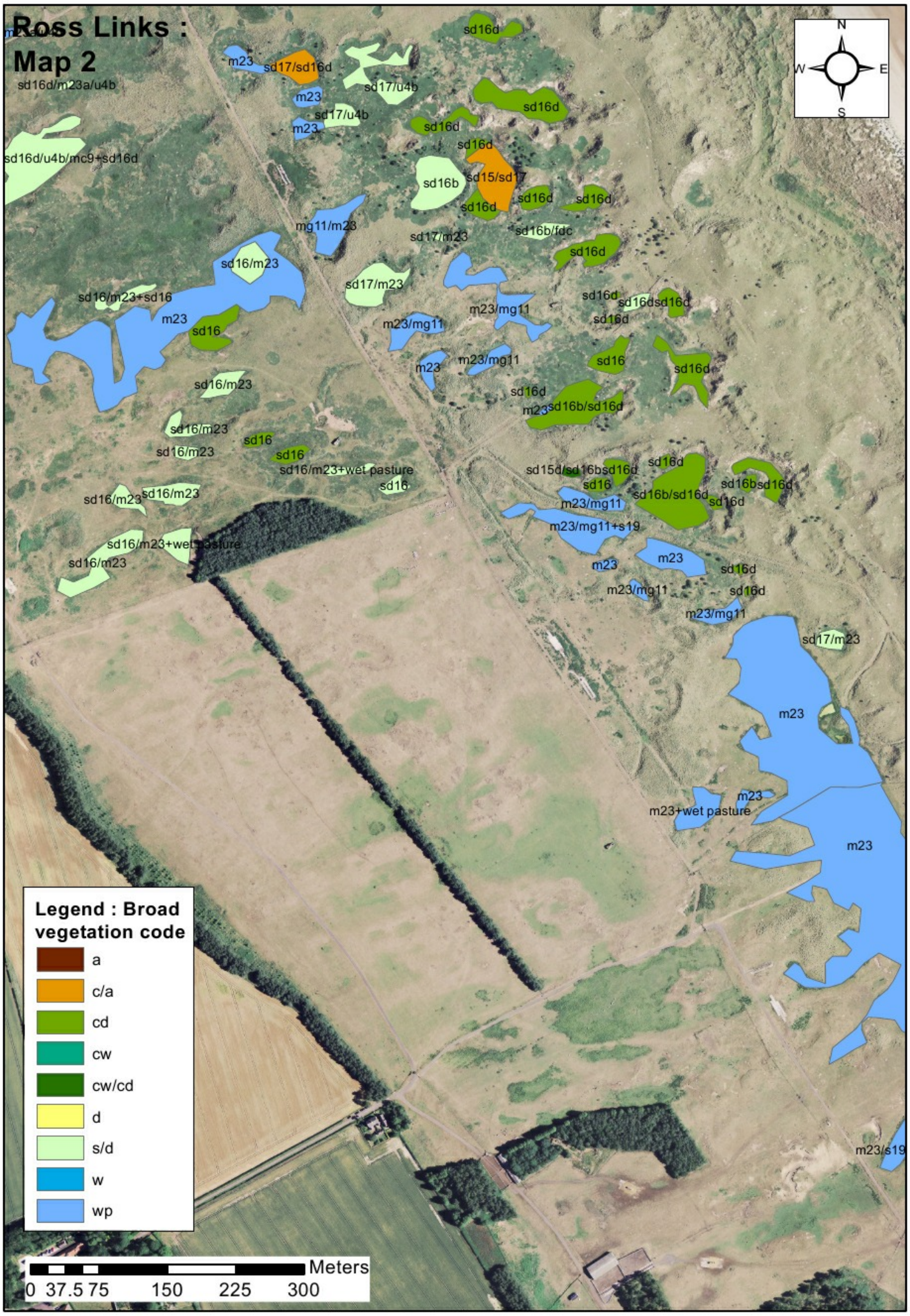

Figure 11. Ross Links Map 2. NVC communities mapped during 2012 vegetation survey. Broad vegetation codes are described in Table 3. © NERC (CEH) 2013, © Next Perspectives.

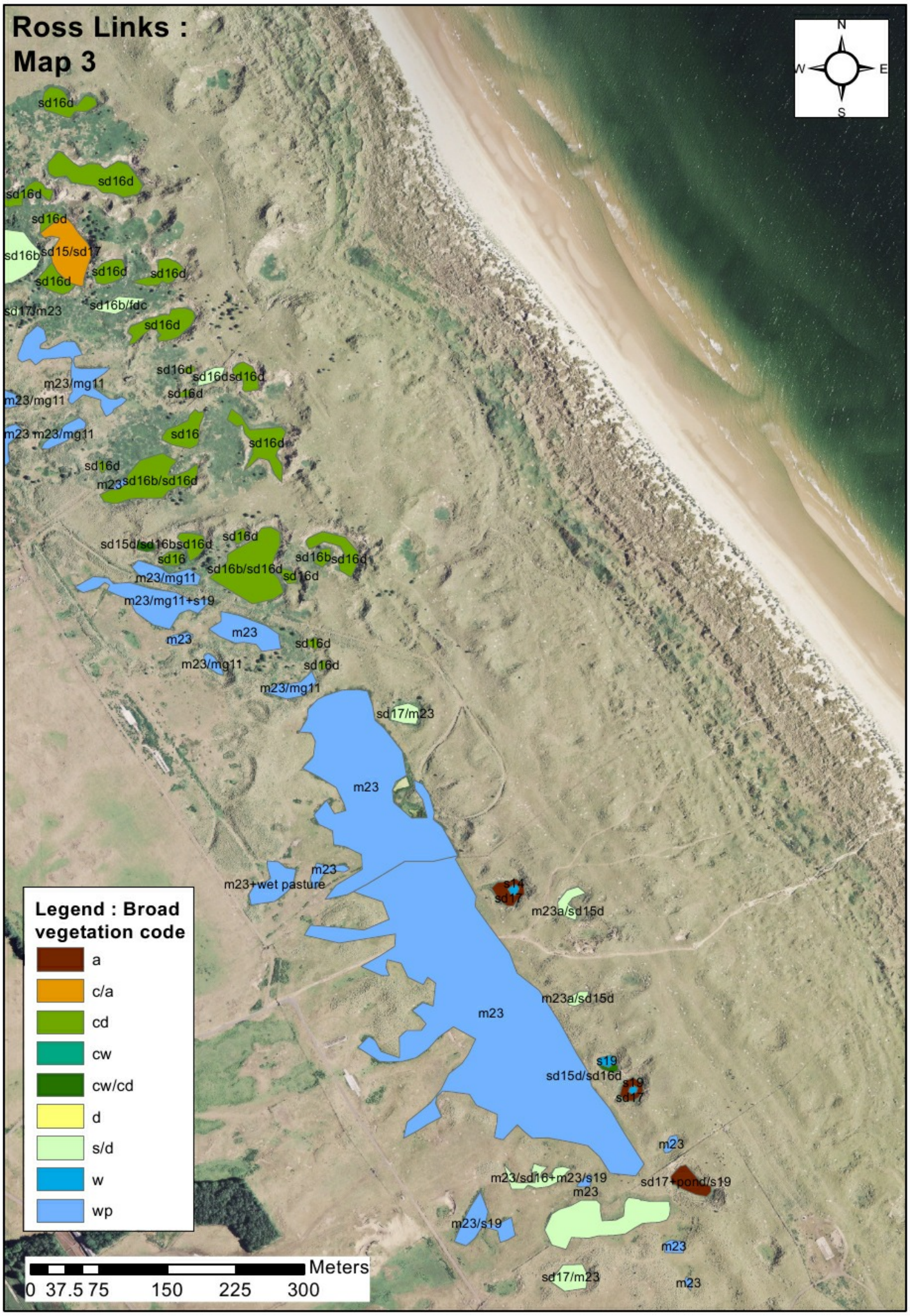

Figure 12. Ross Links Map 3. NVC communities mapped during 2012 vegetation survey. Broad vegetation codes are described in Table 3. © NERC (CEH) 2013, © Next Perspectives.